THE REPRESENTATION OF MORPHOLOGY IN CHILDREN'S SPELLING

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Wolfson College

A thesis submitted for the degree of Doctor of Philosophy

University of Oxford

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Abstract

This thesis examines 5- to 9-year-old children's ability to represent spelling patterns determined by morphology. The first question was whether children come to understand the morphological basis for these patterns relatively early in their experience with writing, or relatively late. The second question was whether children's morphological awareness is related to their ability to represent morphological spelling patterns.

Experiments 1 and 2 investigated children's understanding of the stem-plus-inflection structure of past regular verbs. The children were no more likely to use *-ed* to spell such verbs when they were shown a verb's stem (e.g., *peck* for *pecked*) as when they were shown a meaningless fragment of the verb (e.g., *pe* or *pecke*). It is concluded that these children had not yet understood the morphological basis for the use of *-ed*.

The next experiments examined children's spelling of the regular plural inflection, *-s*, when it is pronounced /z/. Experiments 3 and 4 showed that children know that /z/ can be represented with either *s* or *z*. Experiment 5 revealed that children rely heavily on a rule based on sound structure to spell plurals correctly. Experiments 6 and 7 confirmed this finding with pseudowords, and showed also that only better spellers (Experiment 6) and adults (Experiment 7) use the "plural rule" at all, and even then to only a limited extent.

Experiments 8 and 9 tested whether children could use their knowledge of the spelling of base words to spell their derived forms. The idea was supported: children chose the correct letter (*s* or *z*) more often to represent the /z/ sound of words derived from base words (e.g., *noisy*, from *noise*) than of monomorphemic control words (e.g., *busy*). Experiment 10 confirmed this finding with pseudowords, and showed that children performed equally well on derived and inflected words.

Support was gained for the existence of a strong relationship between children's morphological awareness and their spelling of morphological spelling patterns.

It is concluded that children should not be seen to learn to represent morphology simply "early" or "late" in their spelling development, but to acquire individual morphological patterns at different times. Implications for existing models of spelling development, and for education, are discussed.

This thesis contains approximately 99, 000 words.

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Chapter One: Introduction

The representation of morphology in spelling

1.1. Learning to spell in English

1.1.1. The importance of learning to spell

To attain literacy, children must learn not only to read, but to write. Learning to write requires learning how to represent the spoken language in written form, that is, to spell. The ability to spell with accuracy and confidence is important if the writer wants to be able to devote his or her full attention to higher-order processes, such as deciding the right word to use, or what idea to express next (e.g., Bereiter, 1980). Although a vast amount of research has been conducted on reading development, the development of spelling in children has received very little experimental attention (Brown & Ellis, 1994).

However, researchers have recently begun to investigate spelling more fully, realising its potential as a "window" on the development both of children's understanding of language and of the writing system that they are beginning to learn. When children first begin to learn to spell, they have knowledge and experience only of the spoken form of their language. They must learn how to represent this language in its written form, not only on the basis of sound, but on the basis of other patterns and regularities as well. Spelling is not a skill that is always acquired fully as part of a child's primary education; there are aspects which seem to take until young adulthood to learn, or which many individuals never master properly (e.g., Fischer, Shankweiler, & Liberman, 1985). This is a matter of concern. As Gerber and Hall (1987, p.34) point out,

> "...demonstrable ability to spell is still imbued by an admiring public with connotations of studiousness, literacy, and intelligence",

whereas poor adult spellers are often viewed as unintelligent. This thesis will concentrate on the development of aspects of spelling in the first few years of schooling, since the main foundations for spelling are laid at this time, and it is during these years that we can see the most rapid and interesting increases in understanding and skill.

1.1.2. The nature of the English spelling system

The English spelling system is basically alphabetic. It consists of a set of letter-sound correspondence rules which allow writers to represent, and readers to comprehend, the many English words whose spelling is based on sound. However, these grapheme-phoneme relations represent only one level of the system's regularity. There are also orthographic conventions which dictate how parts of words must be spelled, often when more than one possible combination of letters would seem correct just on the basis of sound (Waters, Bruck, & Malus-Abramowitz, 1988). For example, it is an orthographic convention in English that the sound /ɔɪ/ is written *oi* in the middle of words (e.g., *boil*), but *oy* at the end (e.g., *boy*). Similarly, /k/ in word-final position, and after a short vowel, is almost always spelled as *ck* (e.g., *pack*, *rock*), but *ck* can never be used in word-initial position; *c* or *k* is required instead (e.g., *car*, *key*). The convention that the alternation of single and double consonants indicates preceding vowel quality (e.g., *hoping* vs. *hopping*) is also an important rule to learn to attain spelling proficiency. Once a writer has learned these conventions, he or she is able to spell a large number of words whose spelling would be ambiguous if only a phonetic strategy were used.

There also exists a large number of words whose spelling cannot be predicted entirely on the basis of phoneme-grapheme correspondence rules or by orthographic conventions. Some of these words have segments that could legally be represented by several different sound-based spelling patterns, but there is no rule for choosing one above the others to achieve the conventional spelling. For example, *street* could legally be spelled as *streat* or *strete*. In some cases, a number of phonetically possible spellings exists, but there is no way to tell which spelling has which meaning (e.g., *right*, *write*, and *rite*). As there are no rules to determine the spellings of such words, the correct sequence of letters can be learned only by rote memorisation (Waters et al., 1988). Memorisation is also required to learn how to write "strange" words; sections of whose spelling may have little or nothing to do with their sound (e.g., *yacht*, *laugh*).

There is one more important type of rule on which many spellings are based, which depends on relations at the level of *meaning*. The English language sometimes represents the *morphological* structure of words, often at the expense of reflecting the particular phonetic form that those words may take. Chomsky and Halle (1968) saw the English orthography as morphophonemic: bounded by phonemic constraints, but sufficiently removed from phonemic transcription that a single spelling of a morpheme can transcend differences arising from morphological variation. The meaning-based structure of words, and the way that it is reflected in spelling, is the aspect of spelling on which we will concentrate here.

1.1.2.1. Preserving meaning – inflections

Among the commonest ways in which English preserves meaning at the expense of sound is the use of a single spelling for inflectional endings whose pronunciation may change across words. Inflections are morphemes attached to the end of words to add information about attributes such as a verb's tense or a noun's number. Examples include the *-ing* of continuous verbs, the *-ed* of regular past tense verbs, and the *-s* of plural nouns and third-person singular verbs. Inflections do not change a word's part of speech.

The *-ed* inflection of regular past-tense verbs has three possible pronunciations in English: /t/ after an unvoiced consonant (e.g., *walked*), /d/ after a voiced consonant or vowel sound (e.g., *warned, sighed*), and /ɪd/ after a /t/ or /d/ (e.g., *waited, added*). Rigid adherence to a principle of one-to-one grapheme-phoneme representation would require three different spellings for these three pronunciations. However, the use of the single spelling *-ed* for all three pronunciations means that the syntactic identity of these words is clearly signalled; it shows that the words *walked*, *warned* and *waited* are all members of the same class of regular past-tense verbs.

Similarly, the plural or third-person singular verb inflection *-s* can be pronounced in three different ways, depending on the preceding sound. After an unvoiced consonant it is pronounced /s/ (e.g., *cats*), after a voiced consonant or vowel sound it is pronounced /z/ (e.g., *dogs, fleas*), and after any of the sounds /s/, /z/, /ʃ/, /ʒ/, /tʃ/, or /dʒ/, an *e* is added if necessary and the morpheme is pronounced /ɪz/ (e.g., *glasses*, *roses*). Again, the infringement of strict letter-sound correspondence by writing *dog*s but *cat*s is worthwhile, as it allows us to preserve graphically the identity of the plural morpheme, so that this syntactic feature can be extracted easily from the written material (Baker, 1980).

1.1.2.2. Preserving meaning - derivations

Another important way in which meaning, rather than sound, can determine part of a word's spelling is in derived words. Adding a derivational morpheme to a word often changes its whole grammatical category, and the rules which govern these morphemes are very much less strict than in inflectional morphology. There is a range of derivational affixes which can be added to words (e.g., *un-*, *dis-*, *-ness*, *-hood*, *-er*, *-ity*), and unlike some inflectional morphemes, they almost invariably have a constant pronunciation, regardless of the word to which they are attached. There is no variation between the pronunciation of the morpheme *-ness* in, for example, *happiness*, *sadness* and *darkness*. What is more likely to vary despite continuity of spelling is the pronunciation of the "stem" morpheme of derived words; that is, the stable base part of the word that contains its main meaning. Examples include *heal* and *health*, and *courage* and *courageous*. The relation in meaning between a stem and a derived form is often less transparent than the relation in meaning between a stem and an inflected form.

In derivational morphology, too, the choice as to which of two acceptable spelling sequences to use can also be solved on the basis of morphology rather than just sound. The medial /z/ sound of the word *noisy* could plausibly be spelled either with *s* (as in *busy*) or with *zz* (as in *dizzy*). However, if we recognise that the adjective *noisy* comes from the noun *noise*, which is spelled with a final *se*, we will know that the correct letter to use is *s*, to preserve the spelling as much as possible between the two forms of the word.

1.1.3. Beginning writers and the English spelling system

Children in British and other English-speaking schools typically begin to learn to write at the age of five or six. As we have just seen, the English spelling system is a complex one, with regularities at a number of levels, and many irregularities as well. Do young children learn about the regularities that exist in English, and do they make use of them in their spelling, right from when they first begin to put words on paper? Do they immediately recognise and appreciate the many exceptions to our otherwise basically alphabetic writing system?

It would seem more likely that children's ability to represent words would progress with age and experience from an initial low level, gradually improving with increasing experience and understanding, and eventually incorporating the various levels of regularity and the irregularity of English spelling. Much research has supported this second possibility, through observations of children's spelling at varying points of writing experience. These findings have led to the postulation of several models of spelling development, each describing a particular sequential, stage-wise evolution of spelling ability, through which children are seen to progress in an orderly fashion. Some of the most influential of these spelling models are described in the next section.

1.2. Models of spelling development and the acquisition of morphology

1.2.1. Description of models

Only a handful of models has been proposed to account for the development of spelling, from the preschooler's first scribbles to the adolescent's knowledge of complex letter patterns and the ways of signalling in writing the relations between words. While almost all the models acknowledge an initial dependence on phonology for spelling, they show less agreement about the way and the order in which further spelling skills unfold. Most include the acquisition of the ability to represent morphological spelling patterns after a phonological stage. However, the models vary in whether they assign the acquisition of morphology to a single, final stage of spelling development, or whether they assign the acquisition of different morphological patterns to different stages, according to their complexity.

1.2.1.1. Read's observations and conclusions about early spelling

Some of the first data on children's early spelling came from the work of Charles Read, and are summarised in his book *Children's creative spelling* (1986). Read collected the spontaneous writings of a number of young children who had begun spelling on their own, with little adult influence, and also the writings of kindergarten and first-grade children who had not shown this early propensity to write for themselves. The spellings produced, although unconventional, were often strikingly consistent across children, and were clearly based on the *sound* of the words that they were supposed to represent. Read emphasised the phonetic nature of these early "invented" spellings; it seems clear that the children really were breaking up the words they heard into their constituent phonemes, and attempting to represent each phoneme with a letter or letters. The children did not always represent every sound that adults perceive in words (e.g., they wrote *mostr* for *monster*), and they sometimes chose the wrong letter to represent sounds (e.g., *wints* for *once*). However, as Read pointed out, preconsonantal nasals can be heard as part of the preceding vowel, and if children do not know how to represent a short vowel they will often choose the long vowel with the closest phonetic features. Thus, these spellings are actually quite reasonable attempts to represent these words.

Read did not investigate spelling much beyond the first year or so of experience, and nor did he postulate any stage-wise model of spelling development. Nevertheless, his detailed observations and analysis of so many early spelling samples provide strong support for his view that children start off spelling words simply on the basis of how they sound. As will be discussed in greater depth in section 1.3.1.1.i.a., Read examined how his participants represented two common inflectional endings with variable pronunciations: the regular past-tense *-ed* and the regular plural *-s*. The children spelled the endings of past regular verbs just as they sounded (e.g., *halpt* for *helped*), and virtually never used the required morphological sequence *-ed*. When writing regular plurals, however, they nearly always used the correct spelling *-s*, even when it was pronounced as /z/. These results suggest that children may learn to represent different inflections at different stages of development, and that the plural *-s* inflection might be learned very early on indeed.

Read's general contention that beginning writers spell words on the basis of the alphabetic principle has received overwhelming support from many other studies (e.g., C. Chomsky, 1979; Mann, Tobin, & Wilson, 1987). Perhaps the most detailed and important source of support is a longitudinal study carried out by Rebecca Treiman (1993), who collected the spellings of a first-grade class of American children for an entire year, and was able to analyse the representations of a large number of different types of words. She, like Read, found that her participants started off writing words as they heard them, and usually continued using this strategy for the whole of their first year at school. Treiman also provided information on the early representation of morphology in spelling, and concluded that, with the possible exception of the *-s* inflection, children generally fail to represent morphology for at least the first year of writing. These data will be discussed in section 1.3.

1.2.1.2. Marsh, Friedman, Desberg and Welch's strategies in spelling

Marsh and his colleagues (1980) present a developmental theory of literacy acquisition which focuses on the *strategies* used in the acquisition of reading as well as spelling, and note how the strategies used for the two skills change with increasing experience with the written word.

According to this model, when beginning readers encounter an unknown word in context, their initial strategy is to substitute a known word which is visually similar to the unknown word (e.g., it may share a first or last letter) and which fits the semantic and syntactic context. However, this Substitution strategy will be of little use to a child trying to *spell* a new word. Marsh et al. therefore saw the initial strategy of the beginning speller as coinciding with the second strategy of the beginning reader – a simple Sequential Phonemic Encoding strategy. Young spellers divide each word into its constituent phonemes as best they can, and write down what they consider to be the appropriate letter(s) to represent each of these sounds.

As children gain more experience with written language, they begin to use a more sophisticated method of decoding for both reading and spelling; the Hierarchical Decoding strategy. This is based on "conditional rules", or orthographic conventions – the rules which make some spellings appropriate in one context but not in another. One example of such a rule is the final silent, vowel-lengthening "magic" *e*, which distinguishes many long vowels from their shorter alternative (e.g., *hate* vs. *hat*). Another concerns the rules which govern when it is appropriate to use the letter *c* to spell the sound /k/ (*c* is usually used before *a*, *o* and *u*, although there are some exceptions, such as *kangaroo* and *Kathy*).

Finally, by about the age of ten, children are able to use an Analogy strategy to spell, as well as to read unfamiliar words. For example, they can use their knowledge of how to spell the medial *c* in a word such as *critical* to decide how to spell the ambiguous medial /s/ sound in a related word such as *criticise*. They can also spell unknown words (e.g., the pseudoword *jation*) not with a phonetic ending such as *-shun*, but with a standard pattern, here *-tion*, by analogy to the spelling of a word that they already know, such as *nation*.

This last strategy is the only one that has anything to say about children's use of morphology in spelling. However, the authors fail to make it clear that some understanding of morphological relations is necessary for the correct use of analogy in the example given. For a writer to use an analogy strategy to spell *criticise* from *critical*, he or she would first need to be aware that such similar-sounding words can be related in meaning, and that this relation is often signalled by similar spellings of the shared portion.

Marsh et al. provide support for the spelling component of their model of literacy development from experiments that they carried out to follow on from their empirical work on reading development. Twenty children in grade 2 (aged 7), 20 in grade 5 (aged 10), and 30 adults were asked to write down to dictation a number of pseudowords designed to assess the use of Marsh et al.'s four proposed strategies. We will describe only the results which provide information about children's sound-based spelling (achieved via the Sequential Decoding strategy) and their morphology-based spelling (presumably achieved via the Analogy strategy). Use of the Sequential Decoding strategy was tested by the inclusion of consonant-vowel-consonant (CVC) pseudowords with short vowels (e.g., *fis*, *jat*). Ostensibly "related" pseudoword pairs such as *cazicle/cazicise* and individual pseudowords such as *jation* and *zoldier* were included to see whether the writers would use an Analogy strategy, based on the real words that these pseudowords resembled.

All participants were able to decode the CVC words sequentially. The grade 5 children performed at ceiling level, significantly better than the grade 2 children, who nevertheless performed quite well. Thus, as Read's results also suggest, it seems that from early on in their writing experience, children are able to "spell by sound"; to recognise and transcribe each of the phonemes that make up the words that they hear.

The children's performance on the "related" pseudoword pairs, which required the use of Analogy to preserve the spelling of a particular phoneme, showed marked improvement with development. However, the overall use of this strategy was low, accounting for the responses of only 3% of the 7-year-olds, 10% of the 10-year-olds, and 24% of the adults. The use of analogy for the single, irregularly-spelled pseudowords was absent in the youngest group, but occurred in one-third of the 10-year-old spellers' responses, and half of the adults' responses. Marsh et al. suggest that the relatively low frequency of such real-word pairs as *critical/criticise* in the language can probably account for the infrequent use of analogy for the related pseudoword pairs. However, this explanation cannot explain the limited use of analogy for the single words, since most of these were of relatively high frequency. A major limitation to this study is that the experimenters did not check whether the children knew any of the base words from which they were supposed to derive analogies.

A later study (Marsh, Friedman, Welch, & Desberg, 1981), which did ensure that children knew the base words from which they were to make analogical spellings, found that 7-year-olds used the Analogy strategy to spell 26% of the pseudowords that they were given. The authors concluded that the ability to use analogies in spelling was thus at least partly developed by the age of 7 years, but would need more time and experience to develop fully.

As noted above for real words, however, anyone using an Analogy strategy to spell "related" pseudoword pairs such as *cazicle* and *cazicise* must also be using their knowledge of derivational morphology, and its representation in the English orthography. Otherwise, the writer would not even be aware that there might be a reason for preserving the spelling of the stem, *cazic-*. Similarly, anyone using an analogy strategy to spell these pseudowords would have to be aware of the derivational relationship between the analogous real words, here *critical* and *criticise*. Of course, it is possible that a writer unaware of the link of meaning between those two words could happen to base the spelling of one pseudoword on one of the real words and of the other pseudoword on the other real word, and preserve the spelling that way, but this seems unlikely. The speller could just as well choose *particle* and *fantasise*, and thus produce a pair of pseudowords in which the spelling of the stem was not kept consistent.

Thus, it seems likely that to spell by analogy in Marsh et al.'s task, the participants would have needed an understanding of derivational morphology, as well as the ability to use analogy, to show evidence of the Analogy strategy, at least for the related pseudoword pairs.

Since Marsh et al. (1981) showed at least some use of analogy in 7-year-olds, and Goswami (1988) in 6-year-olds (at least when the analogical words are visually available), it would appear that the problem is not due solely to difficulties in employing the Analogy strategy. Marsh et al.'s (1980) results could be seen to show that most 7- and 10-year-olds are not sufficiently aware of derivational relationships to make use of them in their spelling. However, as previously mentioned, the participants' knowledge of the word pairs from which analogies were supposed to be drawn was not tested. Therefore, we cannot be sure whether the participants would have shown their appreciation and use of derivational relations if the pseudoword pairs had been based on more familiar real words.

1.2.1.3. Frith's model of literacy development

Another well-known model of the progression of children's spelling is Frith's (1985) three-stage model of literacy development. This also sets out to explain how both reading and writing develop, and how these developing skills interact at different stages.

In the first, Logographic stage, children are seen to read and spell words as rote-learned wholes. Experience with reading allows the child to store each written word as a "logograph", or pictorial representation, in the mental lexicon. Thus, the development of spelling will at first lag behind that of reading, as the logographic representations must be built up from reading before they can be written. As vocabulary increases, the store of memorised words will become correspondingly large and eventually unmanageable, perhaps providing the impetus for the child to progress to the next, Alphabetic stage.

Children in the Alphabetic stage are those who are beginning to understand and apply grapheme-phoneme correspondence rules. They acquire these rules in spelling *before* reading in this stage, learning how to represent phonemes with graphemes before they can "retrieve" sounds from printed letters. Once children can convert sounds to letters and vice versa, they learn context-sensitive rules, such as the soft *c* rule (*c* is pronounced /s/ but written *c* before the letters *e* and *i*) and the "magic" *e* rule.

Eventually, children move into the final, Orthographic stage, where spelling and reading are again non-phonological. Increasing experience with reading and writing allows young language-users to abstract out and memorise orthographic regularities. They can then instantly analyse words into orthographic units without phonological conversion. These orthographic units include morphological spelling patterns such as *pre-*, *-ing*, and *-ed*, but also non-morphological patterns such as *-ight* and *-ough*. In this stage the relationship between reading and spelling is again reversed, in that the child's skills are more advanced in reading than they are in spelling. Children in the Orthographic stage are able to use analogy to aid both their reading and spelling.

In contrast to nearly all other accounts of spelling development, this model claims that children begin to write not on the basis of the sounds that they hear, but by transcribing whole words as memorised "chunks". There is good evidence that a logographic strategy dominates the first phase of *reading* development (see Torrey, 1979, for a review), and that older and more skilled readers do seem to rely on an orthographic strategy to read familiar words (Snowling & Frith, 1981). However, it is difficult to imagine that children who had not yet understood the alphabetic principle could memorise the letter sequences of enough words in single "chunks" to make spelling logographically a realistic initial strategy to adopt. Exceptions could include their own names, and some very familiar and frequent words, such as *the* and *and*. There is much more evidence that children begin *spelling* at what Frith calls the Alphabetic stage.

The third and final stage of Frith's model is postulated as the one in which children start to represent morphological patterns. However, this stage may be so broad as to be of limited use in understanding the important spelling developments which must still take place once children have gone beyond exclusive reliance on the alphabetic principle in their writing.

Children at this stage need learn to represent a huge range of morphological relations, from the relatively simple plural and past-tense affixes to more complex derivational relationships (such as between *real* and *reality*, *sign* and *signal*). However, Frith's model is not detailed enough to predict the order or time frame in which the learning of such relations might occur.

Thus, although this model does attempt to explain the development of both reading and spelling in a parsimonious way, it does not make many predictions about how or when children learn to represent morphology in their spelling. Further, its depiction of spelling beginning in a logographic, rather than alphabetic, fashion is in conflict with most of the evidence about early writing.

1.2.1.4. Ehri's model of spelling development

Ehri (1986, 1992) also proposes a three-stage model for the development of spelling. Instead of tying stages of development to specific spelling features, she has defined these stages in terms of the nature of the correspondences that children exhibit between written and spoken units of language (Ehri, 1992).

Ehri acknowledges that children start off in what she terms a Precommunicative stage, in which they write down letters which bear no resemblance to their sounds and thus cannot be read. Children then progress to the Semiphonetic stage, in which they are able to select letters (or letter-names) corresponding to the sounds that they detect in the pronunciation of words. The main feature of these spellings is that they are phonetically incomplete, and often symbolise only the first and final sound of each word (e.g., *bt* for *beat*). This may be because the children have not yet learned to divide the speech stream fully into phonemic segments. Children in this stage are typically in kindergarten or just entering the first grade of school.

The Phonetic stage emerges when children begin to represent short vowels, usually midway through the first grade. Children segment words linearly into a sequence of sounds and are able to represent most of those sounds with appropriate letters. A consequence of spellers' reliance on the phonetic strategy at this stage is that higher-level regularities are ignored; for example, past-tense affixes are spelled as they sound (e.g., *drest*, *rubd* and *wutid* for *dressed*, *rubbed* and *wanted*).

The final part to this model is the Morphemic stage, which spellers enter about midway through the second grade. The hallmark of this stage is that children stop relying exclusively on a linear sound-based approach and begin to recognise the importance of letter patterns. Thus, although children still use phonetic principles as the basis of spelling, they now recognise that non-phonetic patterns of letters can symbolise sounds and word parts (e.g., *-ed* symbolises /t/ in *stopped* but /d/ in *stunned*). Patterns which characterise a number of word spellings (e.g., the "magic *e*"), and analogy (such as writing *pashion*, from *fashion*) also appear, although their basis is not strictly morphemic.

There is no final "Correct" stage, as the learning processes developed during the Morphemic stage are seen to be the same ones that are used to improve spelling throughout the writer's lifetime. Also, memory for word spellings is treated as a separate type of knowledge that develops alongside the three stages of orthographic knowledge. The acquisition of correct spellings for specific words begins early in the phonetic stage, so "correct spelling" is not defined as something which emerges last in the scheme, as a separate stage.

This model postulates slightly different stages from the two preceding models, beginning at an early stage of writing but finishing with the same broad, descriptive level. There is plenty of evidence to support Ehri's contention that children start off representing some and then all of the sounds in words, before learning how to represent non-alphabetical spelling patterns (e.g., Henderson & Templeton, 1986; Read, 1986; Zutell, 1980). Her omission of a "correct" stage is interesting and seems well-justified.

Ehri (1992) acknowledges that her Morphemic stage may be misnamed, as there are still patterns and sequences to be learned which do not have a morphemic basis. She also admits that the wide scope of this one final stage may overlook distinctions at the upper levels of spelling development. However, she points out that we do not yet know whether there are true stages (that is, qualitative shifts) in these upper levels, or just major milestones attained within a general morphemic stage. This is true, but it means that Ehri's model, like those of Frith (1985) and of Marsh et al. (1980) is vague about when we might expect children to start using various morphological patterns in their spelling. In her later work (1992) Ehri specifies that relatively simple morphological patterns such as the past and progressive endings (*-ed* and *-ing*) will be learned first, and that more complex word relations will be learned over the next few years of spelling experience.

1.2.1.5. Gentry's model of spelling development

Gentry (1982) presents a more detailed model of spelling development. The description begins at the Precommunicative phase, when children realise that letters can represent a message, but have not yet developed any understanding of letter-sound correspondences. They string together randomly the letters and letter-like symbols that they can produce. The Semiphonetic stage represents the beginning of children's understanding of the alphabetic principle, that letters stand for the sounds in spoken words. Children represent some of the sounds in each word, and use their knowledge of letter names wherever possible (e.g., *RUDF* for *Are you deaf?!*).

In the next, Phonetic stage, children learn to "sound their way through" each word, making linear, concrete, sound-letter matches as they write. Thus, they become able to symbolise the entire sound structure of words, but without regard to acceptable letter sequences or other orthographic conventions.

From this strictly sound-based strategy, children's spelling moves into the Transitional stage, in which they begin to rely more on visual and morphological information. Transitional spellers are starting to abandon their concept of English spelling as a fixed, one-to-one, letter-sound code, and are beginning to adhere to the basic conventions of English orthography. Vowels appear in every syllable, preconsonantal nasals are represented, the "magic *e*" is learned, and inflectional endings such as *-s*, *-'s*, *-ing* and *-est* are spelled correctly. For the first time, relations of meaning are represented. For example, the number 80 may be written as *eightee* rather than the phonetic *ate*.

The final stage is the Correct stage, although Gentry admits the relativity of this term. He also acknowledges that the major cognitive strategies necessary for spelling competency may well be established by the end of the transitional stage, and that any further growth could just be an extension of these strategies. However, by the correct stage, children's knowledge of the English spelling system and its rules is now firmly established. They will continue to learn about uncommon and irregular words and they will still make errors, but spellers in this stage have mastered the basics of the phonological, orthographic and morphological aspects of their written vocabulary.

1.2.1.6. Henderson's model of spelling development

Henderson (1985) and Henderson and Templeton (1986) describe a similar series of stages in the development of children's spelling. They define Preliterate writing as the very beginning of the process of learning to write. Young children's jumble of letters, numbers and letter-like scribbles reflect their concept of the form and function of print, but no understanding of the alphabetic principle – as exemplified by the preliterate rendering of *bed* as *sq4R* (Bear, 1992). Children then progress to the strategy of Letter-name spelling, when they first begin to match letters and sounds systematically, in a left-to-right, sequential fashion. Writers know the names of the letters of the alphabet, and tend to represent short vowels with the closest-sounding letter name, leading to spellings such as *ladr* for *letter* and *kekt* for *kicked.*

As their sight vocabulary grows, children learn more about the ways in which the spelling system represents speech, and this in turn influences their spelling of new words. This marks their entry into the Within-Word Patterns stage, and into the realisation that writing does not always involve the one-to-one matching of sounds to letters. The typical age of entry is about eight to nine years. The patterns of letters that appear in English words are often predictable. For example, the rime /aɪt/ is very often transcribed as *-ight*, and although *gh* can represent more than one sound, the choice is greatly restricted by where it occurs in a word (e.g., *ghost* vs. *rough, high*). Children in this stage are able to master such sequences, as well as other orthographic conventions, including long-vowel spellings and digraphs such as those in *should* and *pause*. Finally, children begin to deal with the role of *meaning* in spelling. The first sign of this new understanding is when they begin to spell the past tense ending *-ed* consistently correctly, despite changes in its sound, and eventually the correct spelling of other prefixes and suffixes is achieved.

By this time, children have mastered the within-word patterns of monosyllabic words, but must now learn about the patterns specific to polysyllabic words. Between the ages of about nine to eleven years, children are at the Syllable Juncture stage, in which they learn how to join common inflections to monosyllabic base words. They must learn when to double consonants (e.g., *hopping*, *hopped*) and when to leave them undoubled but remove the *e* (e.g., *hoping*, *hoped*). Eventually they come to understand how the number of consonants can determine vowel quality (e.g., *skater* vs. *scatter*), and how to spell more difficult affixes (e.g., *-able/-ible*).

The final stage of Henderson's model, Derivational Principles, may begin any time from late primary school onwards, and progresses throughout the writer's life. The derivational principles – roots, origins and meanings – that children began to explore in the Syllable Juncture stage are now developed extensively. Children learn how to represent vowel alternations (e.g., *define/definition*), consonant alternations (e.g., *critic/criticise*), and other visual links between word meanings (e.g., ***sign/signal***).

These last two models seem to be based on the analysis of a greater variety of spellings from a greater variety of children than any of the models described earlier. This has allowed more specific descriptions of the skills gained at each stage of development. Both models predict that children's early spelling reflects increasingly sophisticated attempts to represent the phonetic structure of the words that they hear. Gentry's model predicts that letter patterns not based on phonology, including inflectional endings and some derivational relations, will be learned after the Phonetic stage, in the Transitional stage, but that more complex morphological relations might only be mastered in the final Correct stage.

Henderson and Templeton's model is the most explicit about the order in which young writers learn how to represent morphological spelling patterns. Children begin to represent the simplest inflectional morphemes, such as *-ed*, in the Within-Words Patterns stage (following on from the sound-based Letter-Name stage), learn more about how to combine root words with inflections and simple derivations in the Syllable Junction stage, and begin to understand more complex derivational relations once they reach the Derivational Principles stage.

Varnhagen, McCallum and Burstow (1997) examined the spelling of the *-ed* inflection in stories written by 272 Canadian children in grades 1 to 6. They wished to see whether the children's representations would show features indicating progression from semiphonetic, to phonetic, to transitional, to correct spelling, as described in Gentry's (1982) model (which they saw as a simplified version of Henderson's (1985) model). This progression was not supported by the data. Virtually all the children's spellings were either written entirely on the basis of their constituent phonemes (and thus classed as phonetic spellings), or were entirely correct. There were hardly any examples of words written correctly but for erroneously doubled or non-doubled consonants, which could have been classed as transitional spellings. Varnhagen et al. took their results as evidence against a strong developmental progression of qualitatively distinct stages, and concluded that existing stage classifications are too broad to describe spelling development adequately.

However, the examination of children's naturalistic writing means that it is impossible to tell how many spellings were produced correctly from memory, and how many the children spelled on the basis of a rule. As Ehri (1992) points out, children can write words correctly from the phonetic stage onwards, while still using less sophisticated strategies to spell unfamiliar words. Also, the examination of just one morphological pattern does not really allow us to draw conclusions about children's representation of morphology in general. Finally, these data on the spelling of the *-ed* inflection do not seem very useful for evaluating the very model the authors set out to test, as Gentry's account makes no mention of the stage at which the correct spelling of the *-ed* inflection is supposed to be achieved.

1.2.2. Conclusions about spelling models' predictions about the acquisition of morphology

Except for the model proposed by Frith (1985), all the models discussed above describe beginning spellers as relying exclusively on sound for their first year or more of writing. There seems to be general agreement that only once that they have mastered this alphabetical principle will children learn to represent other orthographic patterns. Some of the models are specific: simple inflectional patterns such as the plural *-s* and the past-tense *-ed* are learned first, then the conventions for joining these and other inflectional and derivational morphemes to root words, and finally more complex derivational relations between words linked by meaning.

However, not every researcher would agree with this general order of development. As will be discussed in section 1.3.2., Treiman and her colleagues (Treiman & Cassar, 1996, 1997; Treiman, Cassar, & Zukowski, 1994) argue that children are able to understand and represent simple morphological relations right from when they begin to spell. They claim that although beginning writers start off spelling on a mainly phonological basis, even at this early stage they possess some knowledge of morphological relations as well, and are able to represent these in their writing. This hypothesis, that an understanding of morphology is gained "early", goes against the general consensus of the spelling models. The models instead see morphology as being represented not until "late", by children who have already spent at least a year, if not much longer, learning the alphabetical principle. In the following sections, we will present evidence for both of these hypotheses.

1.3. Research on spelling development

The researchers whose findings support the "late" acquisition of morphology hypothesis and those whose findings support the "early" acquisition hypothesis seem to have set about designing their experiments in rather different ways. The evidence which suggests that children do not learn to represent morphological relationships in their spelling until they have had at least several years of writing experience, has come mostly from experiments which have examined children's ability to produce the *correct* spelling of various inflections and of derivational roots. In contrast, the experiments which suggest that even very young spellers have some ability to represent morphological relations, have concentrated more on identifying signs that children understand the morphological structure of the words they are writing. The identification of such signs does not usually require the correct spelling of entire words, or even of whole parts of words (such as the stem portion or the inflectional ending). We will now review the evidence from both of these types of experiments.

1.3.1. Evidence from the correct spelling of morphological patterns

1.3.1.1. Inflectional morphology

1.3.1.1.i. Flouting letter-sound correspondence rules: the regular past -ed *inflection*

The *-ed* inflection is probably the best-studied example of a morphological letter sequence which flouts letter-sound correspondence rules and can be pronounced in more than one way, but which remains spelled the same across words. As described in section 1.1.2.1., regular past verbs are always spelled with a final *-ed*, regardless of whether this ending is pronounced /t/, /d/ or /ɪd/. If young spellers have grasped this morphology-based convention, they should spell all past regular verbs with an *-ed* ending, regardless of pronunciation. If they do not realise the morphological status of these words and transcribe them just like any other, non-inflected words, they should spell the endings of these verbs just as they sound, with *t* or *d*.

1.3.1.1.i.a. The representation of -ed *in early and invented spelling*

Read (1986) examined how his participants spelled the endings of any regular past tense verbs that they had included in their writing. He found that his beginning spellers wrote the endings of regular past verbs according to their pronunciation; they did not appear to pay any attention to the words' morphological status. Thus, *helped* was spelled as *halpt*, *stayed* as *stad*, and *waited* as *watid*. By the end of a year of writing instruction, a few of the children had begun to realise the existence of an "alternative" way to represent the final sound of these verbs, and sometimes used *d* to complete verbs which actually ended in a /t/ sound (e.g., *fixd*, *lookd*). Thus, they were beginning to realise that a phonetic strategy was not necessarily the way to spell regular past verbs, but had not yet learned exactly what the alternative was, or when to use it.

Overall, then, Read showed the great importance of sound to early spellers. However, he did not analyse enough morphological spellings to show compelling evidence for or against the possibility that children start off spelling all morphemes on the basis of sound alone.

Some of the authors of the spelling models reviewed earlier also cite examples of children's spelling of *-ed*, and, like Read (1986) conclude that such representation is sound-based for quite some time before the conventional letter sequences are learned. For example, Beers and Henderson (1977) (whose findings contributed to Henderson's later (1985) model) looked at children's spellings of the regular past tense in naturalistic writing. For most of their first year of school, the participants used a phonetic strategy to produce past forms, writing, for example, *pavd* and *kikt* for *paved* and *kicked*. Only towards the end of the year did they begin to show a partial understanding of the nature of the inflectional ending, inserting vowels to produce such spellings as *-id, -ad* and *-od* as well as *-ed.*

Treiman (1993) presented data about early spelling of several morphemes, including the *-ed* inflection. She, like Read, found that her first-graders showed very little knowledge about the need to use morphological spelling patterns for certain words, and instead tended to write these words just as they sounded. When writing regular past verbs, the children usually used the appropriate phonetic ending, rather than the conventional *-ed.* Thus, they wrote *jumt, clend* and *flotide* for *jumped, cleaned* and *floated* (although at the beginning of the year many of the children tended simply to omit any representation of the inflection altogether). In the first semester of the school year, only 1.3% of the regular past verbs attempted were spelled with *-ed*, but by the second semester it had risen to 25%. The children therefore needed at least half a year of writing instruction before even a few of them began to use the *-ed* inflection.

Thus, there seems to be good evidence that when they first begin to write, children fail to represent the *-ed* ending of regular past verbs, and instead spell the endings according to their pronunciation. It seems to take at least half a year, and possibly longer, for even some children to start to use the *-ed* inflection in their spelling of past regular verbs. None of the children in the studies reviewed above appeared to be anywhere near a stage of using this inflection consistently correctly in every case. This evidence thus seems to constitute support for the "late" acquisition of morphology hypothesis. We now turn to experiments on the representation of the *-ed* inflection in the spelling of children from various age groups, and of older children.

1.3.1.1.i.b. The representation of -ed *by older children and across age groups*

A naturalistic study of the type conducted by Read and Treiman, although with much older children, is reported by Sterling (1983). He collected essays from 56 12-year-old children and examined the nature of the 557 errors they made. Even if children do not learn to represent the *-ed* inflection correctly immediately they begin to learn to write, it would seem probable that most would have learned to spell it conventionally after the six or more years of writing experience that most 12-year-olds would have had. However, of the 214 errors made in transcribing inflections (including *-ed*, *-s* and *-ing*), 26 were phonetic renderings of *-ed*, shown in spellings such as *past* for *passed* and *laught* for *laughed*. Thus, it seems that occasionally even children in the first year of secondary school erroneously use sound rather than morphology as the basis for their spelling of the ending of regular past-tense verbs. However, most studies of younger children suggest that the correct spelling of the *-ed* inflection is for the most part mastered, if not from the beginning of writing instruction, at least well before the end of primary school.

A more experimental report of children's spelling of the *-ed* inflection was provided by Zutell (1980), who asked 60 children in grades 1 to 4 to write down a number of words, including a group of regular past-tense verbs. He found that children in the first two grades of school almost always spelled the ending of the verbs phonetically. Use of the *-ed* inflection was rare until grade 3, when it emerged rather abruptly. Zutell notes that his grade 2 group seemed to be unusually weak spellers, which could explain the sudden emergence of *-ed* spellings in the grade 3 group. Nevertheless, other research supports the finding that use of the *-ed* inflection usually appears in about grade 2 or 3.

Beers and Beers (1992) examined the representation of a number of morphological spelling patterns, including the *-ed* inflection, by 238 children in grades 1 to 6. Their task was based on the well-known study by Jean Berko (1958). In Berko's task, in which instructions and responses were given entirely orally, children in pre-school (aged 4 to 5 years) and first grade (aged 5½ to 7 years) were shown pictures of novel creatures and actions. These pictures were given pseudoword names that the children had to inflect orally. For example, children were shown one creature called a "*wug*" and told "Now there is another one. There are two of them. There are two…?". Even the youngest participants were usually able to provide the correct answer, "*wugs*", although pseudowords which required the /ɪz/ allomorph of the plural proved more difficult. Similar questions were posed for verbs. For example, each child would be shown a picture of a man with a jug on his head and told "This is a man who knows how to *rick*. He is *ricking*. He did the same thing yesterday. What did he do yesterday? Yesterday he…". Participants were expected to produce the appropriate response, "*ricked*". The pre-school children provided the correct form of such verbs between 60 and 73% of the time, and the first-grade children between 73 and 80% of the time. The performance of both groups dropped significantly, however, when they were presented with stems which ended in a vowel sound (e.g., *spow*) or a /t/ or /d/ (e.g., *mott*), to below 36% for pre-schoolers and to below 60% for first-graders.

Beers and Beers adapted this technique to assess how children would produce inflected forms of pseudowords in *written* form. The participants were presented with a picture for each pseudoword, and asked to write down the inflected form of each, which was pronounced aloud. Half the children saw pictures accompanied by the (printed) stems of the inflected words; half saw the pictures alone. In contrast to the requirements of Berko's task, the participants did not have to produce the inflected form. They just had to write it to dictation. For example, the children were shown a picture of a dog engaged in some action with "mick" written below it, and asked to write down the form "*micked*", which was presented in a sentence such as "See the dog *mick*? Yesterday it *micked*. Write down the word *micked*".

In order to "focus the discussion" (p. 236), the authors present data only from the children who had seen the stem forms, but not from those who had not. The most common error for past-tense verb endings by the children in the first two grade levels was to write them just as they sounded. It was not until grade 3 that they began to represent this inflection correctly. Learning to join the *-ed* inflection correctly to the visually-presented verb stems took even longer. Even well into grade 6, the participants often failed to double consonants or drop the letter *e* when required. However, Ehri (1992) points out that since the children were shown the base forms of the inflected words that they were asked to spell, they may have been reluctant to "tamper" with the letter string they had seen, by doubling consonants or dropping silent *e*. This criticism could have been answered if Beers and Beers had discussed their findings from the children who wrote the inflected words without being shown any stem form. Ehri (1992) also notes that it would be useful to verify whether spelling performance in this pseudoword task accurately reflects performance with real words.

Most important for the present discussion, however, is that Beers and Beers' findings provide further evidence against the idea that children understand and represent morphological spelling patterns from early on. For at least the first year or two of school, these children seemed to represent word endings as though they were merely phonetic extensions of base words. They did not represent past-tense endings (or any other endings) as discrete morphemes whose spelling is unaffected by phonetic features in the base word. By grade 3 they seem to have learned that there are standard spellings for specific morphological endings, but even by grade 6 they had not properly worked out how to join these inflections to word stems conventionally. However, this last skill requires knowledge of spelling conventions, rather than an appreciation of morphological rules.

The most detailed description to date of children's acquisition of the *-ed* inflection is a longitudinal study by Nunes, Bryant and Bindman (1997a). They saw 363 children originally in school years 2, 3 and 4 (aged 6 to 8 years) three times a year for three years, and each time asked them to spell 30 words: ten regular past verbs (e.g., *called*), ten irregular past verbs (e.g., *kept*), and ten similar-sounding non-verbs (e.g., *cold*). The inclusion of irregular past verbs was an innovation. Irregular past verbs, like regular past verbs, end in /t/ or /d/, but unlike regular past verbs, their endings require a phonetic (*t* or *d*), rather than a morphology-based (*-ed*) spelling. The children's progression in spelling the ending of irregular past verbs would provide an indication of how children conceptualise word types early on. Would they treat the two types of verbs and the non-verbs in the same way at first, and only gradually distinguish between verbs and non-verbs (or regular and irregular verbs, and non-verbs) in their spelling, or would they make distinctions in their spelling from the beginning?

Nunes et al. found that the children tended to spell all three types of word phonetically at first, but gradually began to use the *-ed* inflection. However, they initially used it with littl regard for morphology, adding *-ed* to non-verbs and irregular past verbs to produce spellings such as *coled* for *cold* and *keped* for *kept*. Later these overgeneralisations were confined to the appropriate morphological category (verbs), but applied to irregular verbs as well as to regular verbs. It took several years for the children to learn to limit their use of *-ed* to past regular verbs.

Nunes et al. developed a five-stage model to describe how children between the ages of 6 and 10 learn to spell past verbs. In the first stage, children are unsystematic in the way that they spell the endings of past regular and irregular verbs and non-verbs. The letters they choose do not conform to letter-sound correspondence rules, let alone morphological spelling rules. In the second stage, many endings are spelled phonetically (e.g., *kist*, *soft*), but very few, if any, *-ed* endings are produced. By the third stage, children begin to use *-ed* as an ending, but do not discriminate between the types of words to which they will attach it. Spellers at this stage have discovered *-ed* as an alternative spelling for word-final /t/ or /d/, bu have not yet realised that it is only a conventional spelling for past regular verbs, and not for past irregular verbs or non-verbs. Thus, although they may write *kissed*, they may also write *sofed*.

The fourth stage comes when children learn to confine their use of the *-ed* inflection to verbs rather than non-verbs, but still do not realise the inappropriateness of using *-ed* for irregular verbs to produce spellings such as *sleped* for *slept*. Finally, in the fifth stage, children are able to employ the *-ed* ending correctly, confining its use to past regular verbs and completing irregular verbs and non-verbs with the required phonetic ending.

Thus, children begin by spelling this particular inflection just as it sounds. They soon become aware of an apparently alternative spelling to word-final /t/ or /d/, but do not yet understand the morphological basis for its application, and tend it "overgeneralise" it to any word with this final sound. Later on, children start to become aware of the morphological status of the words to which *-ed* may be attached, and finally they learn exactly which words should be written with this inflection and which should not.

Bryant, Nunes & Snaith (2000) used pseudoword spelling to investigate whether children learn this last step on the basis of an untaught rule about which past verbs require a regular ending and which do not. If the pronunciation of a verb stem changes from present to past tense, it is irregular and its ending should be spelled phonetically (e.g., *keep-kept*), but if its pronunciation remains the same, the verb is regular and requires a final *-ed* (e.g., *call-called*). Bryant et al. found that 8- and 9-year-old school children did seem to follow this rule in their spelling. They were more likely to use *-ed*, and less likely to use a phonetic ending, for pseudoverbs whose stem pronunciation remained the same from present to past tense ("regular" pseudoverbs). In contrast, they were more likely to use a phonetic endings and less likely to use *-ed* for pseudoverbs whose stem pronunciation changed between present and past tense ("irregular" pseudoverbs).

This evidence suggests that children are able to use their knowledge of morphological structure to help their spelling. They must be able to think of the present-tense form of the past verb to be spelled, and then compare it to the past verb's stem, which they must mentally detach from its ending[1]. The children who were able to use their understanding of word structure to apply *-ed* endings correctly, however, were old enough to have already gone beyond the stage of purely phonetic spelling, so this evidence by no means indicates that the morphological structure of these words is understood right from the beginning.

1.3.1.1.ii. Flouting letter-sound correspondence rules: the regular plural -s inflection

The past regular verb ending *-ed* is not the only morphological spelling pattern to conserve a constant spelling despite changes in pronunciation. Even more common is the inflection *-s*, which is used to denote plurality in nouns, the third-person singular in present-tense verbs, and the possessive (either with an apostrophe for nouns, e.g., *hare's*, or without one for pronouns, e.g., *hers*). In each of these cases, the *-s* can be pronounced /s/, /z/ or /ɪz/, depending on the ending of the base word (see section 1.1.2.1.). This situation is thus different from the situation for *-ed.* There, children's spelling of all three pronunciations (/t/, /d/, /ɪd/) is useful for evaluating their understanding of morphology, as none corresponds exactly to the inflection's spelling and thus none could be spelled correctly simply on the basis of sound. In contrast, when assessing children's understanding of the need to represent the *-s* morpheme consistently, there is no point in asking them to write words in which the *-s* is pronounced /s/, as the correct spelling could be achieved simply by using letter-sound correspondence rules. An understanding of morphology can only be revealed through the correct spelling of words in which the *-s* inflection is pronounced /z/ or /ɪz/. Here we will focus on the simpler case, where the pronunciation is just /z/. We will also concentrate mainly on *-s* as a *plural* inflection, as this has received relatively more study than the others.

If children acquire an understanding of the role of morphology in writing relatively late, and start off spelling exclusively according to sound, we would expect their early representations of words whose *-s* inflection is pronounced /z/ to be spelled phonetically, with *z*. Thus, beginning writers should write *cats* but *dogz*; *cups* but *mugz*. If instead children understand the role of morphology in writing relatively early, we would expect their early transcriptions of such words to ignore variations in sound and to respect the constant *-s* spelling of the inflection, to produce both *cats* and *dogs* correctly. Despite the ubiquity of the *-s* inflection in both written and spoken language, the way in which children's spelling of this morpheme develops has received little experimental attention.

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[1] Irregular past verbs ending in /t/ or /d/ are not so obviously bimorphemic and structurally divisible as regular past verbs. Still, some kind of division into "section acting as stem" and "final /t/ or /d/" presumably occurs for children to be able to choose the appropriate ending.

Read (1986) provides the earliest evidence, from his observations of the invented spellings of very young writers. He found that the children he observed used the *-s* inflection for plurals very frequently indeed, regardless of whether the pronunciation was /z/ or /s/. Even when the representation of most other spellings in a word were clearly invented (e.g., *chribles* for *troubles*, *trces* for *turkeys*), the *-s* was nearly always spelled consistently. There were some instances of sound-based spelling of *-s* when it was pronounced /z/, for example *owsenz* for *oceans*, but these were very rare. Other occasional misspellings of /z/ consisted of alternative (but inappropriate) spellings for *s*, for example, *ec*, *irss,* and *ise* for *is*, *ears*, and *eyes*. Read reports that the children spelled the sound /z/ with *s* 80% of the time, with *se* 7.1% of the time, and with *z* only 3.7% of the time (the remaining spellings were a variety of other guesses, e.g., *c*, *x*, *fs*). However, it is not clear what proportion of these /z/ sounds were in word-final position, and what proportion of those represented inflectional morphemes. Thus, no definite conclusions can be drawn about young spellers' representation of the *-s* inflection, for plurals or for other words.

Still, it appears that in general, even these very beginning spellers were able to represent plural words with a constant ending, regardless of variations in pronunciation. It could be concluded that these children had quickly learned the morphological basis for the *-s* spelling, and knew to use the correct morpheme *-s* for word-final /z/ whenever they had to write a regular plural word. This conclusion is a plausible one. Even 2-year-olds apply spoken markers (/s/ or /z/) to plural sets and leave non-plural sets unmarked (e.g., de Villiers & de Villiers, 1973), while 4-year-olds can do the same for novel words (Berko, 1958). More support comes from a study carried out in French by Fayol, Thevenin, Jarousse, and Totereau (1999). This study is described in greater detail in section 1.3.1.1.iv.b., but it should be noted here that the researchers found that French children were able to distinguish plural from non-plural words in their writing as soon as they learned to use the plural ending. This early distinction contrasted with their ability to distinguish between nouns and verbs in spelling, which took several years to achieve. So, it appears quite feasible that 5- and 6-year-old English children could quickly learn to apply a constant written marker to plural words.

Beers and Beers (1992), in their study of primary school children's spelling of the inflections of pseudowords, also found evidence which seems to support the "early" acquisition of morphology hypothesis for the plural *-s* inflection. The 238 participants were asked to transcribe nonsense plurals ending in /s/ (e.g., *pakes*) and /z/ (e.g., *guds*) (as well as a few words ending in /ɪz/). The children used the inflection *-s* correctly approximately equally often for plurals ending in /s/ and for plurals ending in /z/ (86% and 83% of the time, respectively), and there were only minor variations across grade levels. Almost all the mistakes involved the use of *-es* instead of *-s* alone. There was no mention of any *z* spellings at all, and even if any were produced, these must be included in the very small number (0.8%) of "other" spellings. Again, this suggests that children seem to understand the need to represent all plurals with *-s*, regardless of pronunciation, from very early on in their writing experience.

Further support could be seen to come from Treiman (1993), who found that her first-grade spellers nearly always used *-s* to represent the plural morpheme. She did note that the letter *z* was used 4.6% of the time for plurals pronounced /z/, but never for plurals pronounced /s/. Nevertheless, the remainder of her participants' representations of the plural consisted of the letter *-s*, which again could suggest that the children understood that these variations should be spelled alike because they represent the same morpheme.

Treiman argues against this interpretation, however, on the basis of the way the children spelled the final /z/ sound of other, non-inflected words, such as *because* and *cheese*. There was no significant difference in the percentage of *-s* spellings used for word-final /z/ when the sound represented the *-s* morpheme and when it did not. However, this does not necessarily show that the children had just chosen *s* to represent word-final /z/, and were not using morphological rules to spell. As an example of an "*s*" spelling for *because*, Treiman gives *"becuse"*, which reveals that she did not distinguish between *-s* and *-se* spellings. Thus, even if the children had correctly used *-s* for plural words, and *-se* for non-inflected words, this scoring system would have described their responses as being identical, and not given them credit for marking the plural/non-plural distinction.

Nevertheless, it is clear that the use of *-s* for /z/ allomorph plurals is not absolute proof of an understanding that these words must be spelled according to their morphological status. The children could simply have been using *-s* because *s* is the most common spelling of /z/ in English (Venezky, 1970). They would not need to grasp the morphological basis of this spelling rule to be correct almost every time they wrote a word ending in /z/. Since *z* is the least commonly used letter in English (Venezky, 1970), teachers and parents may never notice if children failed to use it appropriately at the end of words, and the children's exclusive use of word-final *-s* would be rewarded. Read (1986) did note that 3 out of 17 children represented *fizz* as *fis*, so it does seem plausible that children could adopt the strategy of always using *s* to represent word-final /z/ sounds, regardless of morphological status[2].

The only way to discover whether or not young spellers do tend to use only *-s* to represent word-final /z/ sounds is to re-conceptualise the type of morphological spelling pattern that the *-s* inflection represents. Studies which simply compare children's spelling of plural words whose inflection is pronounced /s/ to plural words whose inflection is pronounced /z/ will not answer our question. If children use *-s* for both sounds, we will not know whether they have learned a morphological rule, or have simply assumed that both /s/ and /z/ are transcribed as *s* and thus are actually spelling by sound. If instead we think of word-final /z/ as a sound which can be represented in several different ways, depending on its morphological status, a meaningful experiment can be designed. In terms of phonology, word-final /z/ can be legally represented in several ways; *-s*, *-z*, *-zz*, *-se* or *-ze*. The only way to use *-s* correctly, though, is to choose on the basis of an understanding of morphological

[2] Shakespeare himself seems to have recognised the possibility of getting by with such a strategy: in the tragedy of *King Lear*, Kent calls Oswald "Thou whoreson zed! Thou unnecessary letter!" (Act II, scene ii).

status. If the word is a plural (or another inflected word; a third-person singular verb or a possessive)[3], the correct spelling is *-s*. If it is not inflected, and the word is of one syllable, with a short vowel sound, the orthographic convention has it that the correct spelling is *-z* or *-zz* (e.g., *quiz, jazz*)[4]. Non-inflected words with a long vowel sound (e.g., *daze*, *rose*) can be spelled with either *-ze* or *-se* and there is no rule, morphological or orthographic, to decide which one is correct.

Thus, the only study which could determine whether beginning writers understand the need to represent all regular plurals with final *-s* would have to ask whether young spellers could distinguish between words which sounded similar but differed in their morphological status, and thus in their representation of word-final /z/ – for example, plurals and non-plurals.

<u>1.3.1.1.iii. More than one phonologically acceptable representation of a sound sequence</u>

In English, and in other languages as well, there are examples of sounds which may be represented in one of several ways, depending on the morphological structure of the word in which they occur. The investigation of children's spelling of these sounds can provide further evidence about the stage at which they first begin to understand and represent morphological structure.

1.3.1.1.iii.a. Children's representation of word-final /ks/ in English

In English, there are two acceptable ways of spelling word-final /ks/; with *-x* (e.g., *six*), or with *-cks* (e.g., *socks*). However, in terms of morphology, only one of these ways can be correct for any word. If one understands morphological structure, the rule is easy: if the word contains only one morpheme (i.e., if it is not inflected), use *-x*; if it is made up of two

[3] The third-person singular forms of the common irregular verbs *to be* (*is*, *was*) and *to have* (*has*) and the possessive pronoun *his* are perhaps not strictly "inflected", as they are not formed from a stem word plus *-s* (as in *says* or *hers*). However, since their final *-s* signals their morphological status, in this thesis *is*, *was*, *has* and *his* are considered to be inflected words.

[4] The one exception is *as*.

morphemes (i.e., if it is inflected), use *-cks*. Thus, singular nouns such as *fox* and stem forms of verbs such as *fix* require a final *-x*. In contrast, plural nouns and third-person singular forms of present-tense verbs, both of which require a final *-s* inflection (e.g., *socks*, *(he) picks*), should be completed with the letter sequence *-cks*[5].

Thus, another way to assess the "late" and "early" hypotheses of acquisition of morphology is to ask children to spell words and pseudowords ending in /ks/, and to examine whether their spelling of this final sound varies with the words' morphological status.

Da Mota (1996) asked 31 7- and 8-year-old children to spell 18 words ending in the sound /ks/. Twelve of these words were regular plurals or third-person singular present-tense verbs (e.g., *clocks, packs*) and therefore required *-cks*; the other six were singular nouns (e.g., *fox, wax*) and required *-x*. She found that the children wrote *-cks* more often for plurals and third-person singular verbs than for singular nouns, and that they wrote *-x* more often for singular nouns than for the plurals and inflected verbs. Thus, overall, these children did discriminate between the one-morpheme and two-morpheme words. However, their performance was much better on the inflected words than the non-inflected words. The extension of *-x* to inflected words was rare, but they sometimes overgeneralised the use of *-cks* to non-inflected words. The performance of the 8-year-olds was superior to that of the 7-year-olds, but even the older children's spelling of the /ks/ was by no means perfect. This, then, is another example of a spelling pattern whose morphological status is not fully exploited as an aid to spelling until at least the age of 8, and even then there is still learning to be done.

[5] This also applies to possessives, but an apostrophe is also required, e.g., *Rick's*. Such cases will be considered in the next section.

1.3.1.1.iii.b. Children's representation of word-final /o/, /e/, and /i/ in Greek

The Greek language contains a number of examples of letters or letter sequences which denote morphological information rather than simple letter-sound correspondences. One is word-final /o/, which is spelled with *ο* if the word is a singular, neutral noun in the nominative case, but with *ω* if the word is a first-person, singular verb in the active voice (Bryant, Nunes, & Aidinis, 1999). Similar choices exist for the sounds /e/ and /i/ in word-final position. If young Greek children understand the need to represent morphology from the start, they should quickly learn that one letter or letter sequence is appropriate for one category of words, and that another is appropriate for a different category. Thus, they should distinguish between words of different morphological status from very early in their writing experience. However, if children learn to spell by sound first and only come to understand morphology much later on, then their early spellings should include one or more of the appropriate letters, but not attached consistently only to the right type of word.

A study by Bryant, Nunes, and Aidinis (1999) can help to resolve this question. Approximately 200 Greek children, aged 7 to 10 years, were asked to spell 64 words. The words ended in one of three sounds (/o/, /e/, and /i/), each of which can be written in several ways in terms of phonology, but for which only one spelling can be correct in terms of morphology. It was found that the children could be classified into five stage groups, similar to those developed by Nunes et al. (1997a) to describe English children's progress in learning to spell the past-tense inflection *-ed*.

The Greek children allocated to the lowest stage were those who used only one spelling for the end sound of each of the three categories of words. Slightly more advanced children, classified as spelling at stage 2, showed some knowledge of the alternative spellings, but still tended to use one spelling most of the time. Stage 3 included children who had learned to spell the two alternatives for both /o/ and /e/ systematically correctly, but who were still having difficulties with representing more than two of the four possible spellings for word-final /i/. Children who showed knowledge of three of /i/'s possible spellings were placed in stage 4. Finally, those who systematically chose the correct spelling for all the types of the three categories of experimental words were allocated to stage 5.

Although this was a cross-sectional study, it seems fairly clear that children's performance improves with age; there was a rather steady increase in the mean age of each stage of children. It also seems clear that beginning Greek writers do *not* grasp early on the fact that different morphological categories require different spellings for the same sound. It seems to take at least three years for them to learn firstly that there can be more than one spelling for the same sound, and then that each spelling is appropriate only for certain grammatical categories.

1.3.1.1.iii.c. Spellers' representation of word-final /eza/ and /aũ/ in Portuguese

Another language which contains letter sequences whose spelling depends on the word's morphology is Portuguese, and beginning writers' spelling of these sequences can also provide evidence about when morphology is first represented in writing. One example is the word-ending /eza/, which is written *-eza* for abstract nouns (e.g., *pobreza*, poverty) and *-esa* for feminine titles (e.g., *principesa*, princess). Another instance is the word-ending /aũ/, spelled *am* at the end of past-tense verbs (e.g., *comeram*, ate) and *ão* at the end of future tense verbs (e.g., *comerão*, will eat) and non-verbs (e.g., *camarão*, prawns). Da Mota (1996) asked 184 people (135 children and 49 adults in evening literacy classes) in school grade equivalents 1 to 4, to write down 21 words ending in /aũ / (seven past verbs, seven future verbs and seven non-verbs) and six ending in /eza/ (three abstract nouns and three feminine titles).

For the /aũ/ words, the participants' spelling improved across grade levels, although they did show overgeneralisation of the spelling *am* to words which were not past-tense verbs. Interestingly, *am* was used inappropriately more for future-tense verbs (which at least represents the appropriate grammatical category) than for non-verbs. This suggests that even though the participants had not all worked out exactly which words required *am*, they were beginning to understand that it was only appropriate for one category of words, that is, verbs.

For words spelled with *-eza*, the grade-1 standard children wrote *-esa* and *-eza* about equally often, and the adults at the equivalent stage performed only slightly better. Eventually all groups reached ceiling levels. For the words spelled with *-esa*, the participants also used *-esa* and *-eza* about the same amount, but did not seem to improve across grade levels.

These spellers, too, could be categorised into a series of stages of spelling development, similar to those of Nunes et al. (1997a) and Bryant, Nunes, and Aidinis (1999). Again, it seems that beginning writers, even adult ones, did not start off with an appreciation that words of different morphological categories needed to be spelled differently. In Portuguese, as in English and Greek, this appreciation appears to take several years, if not longer, to develop.

1.3.1.1.iv. Silent morphemes

The spoken form of English and certain other languages contains other instances of morphological distinctions that cannot be written simply on the basis of letter-sound correspondences. For the examples to be discussed here, letter-sound correspondences are of no help in spelling, not because the morpheme flouts these correspondences, or because several legal correspondences exist, but simply because the morpheme is not marked in speech. For the morphological status of the word to be understood from speech alone, a meaningful context is required. In some cases a word's morphological status is unmarked not only in speech, but in writing as well. For example, the English word *play* can act as a verb or a noun, and only the context can reveal which meaning is intended (Bryant, Nunes, & Aidinis, 1999). However, since the spelling is the same in both cases, there would be no point in asking children to write such examples in an attempt to examine early understanding of this aspect of morphology.

1.3.1.1.iv.a. Children's representation of the apostrophe in English

A more profitable area of research is in children's spelling of a silent morpheme which *is* marked in writing: the apostrophe. In English, the apostrophe is used in writing to distinguish possession (e.g., *the boy's fish*) from plurality (e.g., *the boys fish*), and also to denote contraction (e.g., *the boy's fishing*). As Bryant, Nunes and Bindman (1999) point out, this is an example of a spelling distinction which has an entirely morphological basis: the plural, possessive (genitive), and contracted forms of the noun in question are all pronounced identically but require a distinction in their written representation. Thus, it provides an even better test of children's understanding of morphology than, for example, the spelling of /ks/ (which could be achieved correctly on the basis of letter-sound correspondence rules), or of the *-ed* inflection (which in many cases represents only a partial departure from letter-sound correspondence rules, e.g., *smiled, waited*).

Bryant, Devine, Ledward, and Nunes (1997) examined the spelling of plural and genitive nouns in year 6 and 7 children, both before and after a series of training sessions. Before the study, the children in years 6 and 7 had already had some school instruction on the use of apostrophes, but the children in year 5 had not. The 75 participants wrote down 16 words, half of which were singular genitives (and required an apostrophe) and half of which were plural nominative or accusative nouns (and required no apostrophe). Pre-intervention, the year 5 children used apostrophes only rarely, and assigned them incorrectly to plural words nearly as often as they did correctly to genitives. The older children used apostrophes more frequently, but often included them in plurals, and even more often omitted them from genitives.

During the intervention period, one group of children was taught over ten sessions to include apostrophes in genitives and to omit them from plurals. Another group was seen for the same number of sessions, but was trained to distinguish homophonic words on the basis of meaning, a skill irrelevant to the experimental task. The final group of children received no training. The children's spelling of genitives and plurals was then tested again. The year 5 children showed no sign of an intervention effect, but the year 6 and 7 children who had received relevant training showed dramatic improvement in their spelling of genitive words. However, their correct use of the apostrophe was still by no means perfect. Surprisingly, their spelling of plurals did not improve, and they still included as many inappropriate apostrophes as before. The year 6 and 7 children who had received irrelevant or no training showed virtually no change in their spelling of either word type.

These results were confirmed in a second experiment employing participants in years 5 and 6 only. This time contractions were included as well (e.g., *I'm*, *you're*), and both year groups, trained or untrained, were found to perform markedly better on these than on genitives.

Thus, despite the apparently clear semantic distinction between the idea of, for example, a single cup which possesses a handle (*the cup's handle*) and a number of cups (*the cups*), the ability to recognise and represent this distinction seems to present difficulties even to children entering secondary school. Increased school instruction could well ameliorate the spelling of this particular morpheme; even a short intervention period caused marked improvement. Nevertheless, the fact that intervention did not aid 9-year-olds, and that it improved appropriate but not inappropriate use of the apostrophe, shows that this is another aspect of inflectional morphology that is not easily grasped.

The children's difficulty with learning to use the apostrophe is not really surprising if one notes the abundance of signs and notices in shops and other public places advertising, for example, *"Banana's"*, *"Potato's"*, *"Womens magazines"*, *"Young Persons Railcards"*, or the enigmatic *"Residents refuse to be put in bins"*[6]. It seems that many adults never grasp the role of the apostrophe either. Even intelligent, educated undergraduate students write essays littered with references to "*Piagets work*" and "*study's with children*", and grammatically meaningless phrases such as "*the babies head was supported*". Writers seem to acquire the

[6] Seen above the rubbish disposal area of a block of flats.

ability to decide when to include and when to exclude the apostrophe not just "late", but often "never"!

1.3.1.1.iv.b. Children's representation of nominal and verbal plurals in French

The French language is rich in silent morphemes, as many of its written word endings go unpronounced in speech. For example, the nouns in *la lampe* (the lamp) and *les lampes* (the lamps) are pronounced the same, without the final *s*. Similarly, the phrases *il mange* (he eats) and *ils mangent* (they eat) are pronounced the same; the final *nt* of the second example is not realised in speech, and nor is the *s* of *ils*. (An exception is when *-s* precedes a word beginning with a vowel sound, in which case the *-s* is pronounced, e.g., /ilzɔ/, *ils ont*, they have.) Thus, children must learn these plural markers in writing with no support from the spoken language with which they are familiar.

Totereau, Thevenin and Fayol (1997) examined the spelling and reading of nominal and verbal plurals in 60 French children aged 6 to 8 years (school grades 1 to 3). In the Production task, participants were shown pictures of objects, persons or actions with the French equivalent of *This is a*___ or *There are two*____ written below for nouns, or, for example, *The chimney*___ or *The chimneys*___ for verbs. The children were presented with a whole spoken phrase (e.g., *C'est un poisson*, This is a fish), and required to write down the final word. Their understanding of plurals was also tested in a Comprehension task. Children were shown pairs of pictures depicting one or several objects, persons, or actions, and asked to indicate which picture matched the printed title provided. For example, for nouns, children could be asked to choose whether a picture of one fish or of two fish matched the title *les poissons* (the fishes). For verbs, children might have to choose whether a picture of one bird or several birds flying matched *ils volent* (they fly). The grade 1 children were tested twice, the grade 2 children five times, and the grade 3 children only once.

The children in all three grades performed above chance on the comprehension tasks, but the production tasks proved more difficult. The children were found to write both plural and singular nouns with the singular form until the end of grade 1, when they began to represent the plural appropriately with *-s*. Learning the plural *-nt* marker for verbs took much longer, and the children represented both singular and plural verbs with the singular form until at least halfway through grade 2.

A later experiment by the same group (Fayol et al., 1999) provided further, more detailed evidence about how French children acquire written number morphology. Seventy-two children aged 6 to 10 (school grades 2 to 5) were asked to complete (in writing) printed words preceded by an article or pronoun. The words were nouns (e.g., *le nuage__* vs. *les nuage__*; the cloud__ (singular) vs. the cloud__ (plural)) and verbs (e.g., *il pilot__* vs. *ils pilot__*; he pilot__ vs. they pilot__). The words were pronounced aloud in each case, and it is important to note that the singular and plural nouns and verbs are pronounced identically in French, despite the differing ending required. For example, *pilote* ([he] pilots) and *pilotent* ([they] pilot) are both pronounced /pilot/. Further, half the words chosen were homophones, in that they could function either as a noun or a verb (e.g., *rêve*, [a] dream/[he] dreams). The other half were not homophones, and could only function as a noun or as a verb (e.g., *le nuage*, the cloud; *mange*, eats). It was predicted that a "homophone effect" would occur, with the homophonic words causing the children more confusion about which (if any) spelling marker to include, compared to the words which were not homophonic.

Fifteen percent of the grade 1 spellings failed to include a plural marker, but this failure decreased steadily with increasing grade level, to only 1% among grade 5 spellings. Like English, Greek and Portuguese children, these French children also showed overgeneralisation of plural markers to the wrong grammatical category. They sometimes used *-s* inappropriately for plural verbs and *-nt* inappropriately for plural nouns, although these proportions decreased from 31% at the beginning of grade 2 to 4% in grades 4 and 5. Overgeneralisation of *-s* to plural verbs was especially high (59%) for the youngest children (probably because they had not yet learned the plural marker *-nt*), but dropped to 2% in the grade 5. Overgeneralisation of *-nt* to plural nouns was rare in the youngest children (2%) but rose to 18% in grade 3, then decreased to a still substantial 6% in grade 5.

The predicted "homophone effect" was shown as soon as children became aware of the two plural endings. The *-nt* overgeneralisation was more frequent for nouns with a verb homophone than without one, and the *-s* overgeneralisation was more frequent for verbs with a noun homophone than without one. This was especially true when the homophones were of high frequency. The results suggest that children may feel confused about the syntactic category of the words they try to spell, and that this confusion can be heightened by ambiguous words.

Thus, it seems that French children, too, take some years to learn to represent accurately the morphological distinctions of their language in spelling. Further, they go through a stage of overgeneralisation of both nominal and verbal plural inflections before they eventually learn to confine these to the right type of word, an ability that may not be fully attained until the end of primary school or even beyond.

1.3.1.1.v. The representation of inflectional morphology by poor readers and spellers

Although this thesis is concerned with the spelling development of normal writers, this section will briefly describe some of the evidence concerning the representation and understanding of inflectional morphology in the writing of poor readers and spellers. It is apparent from a number of studies that those who have problems with written language (both children and adults) seem to experience particular difficulty with inflected and derived forms of words.

There is only limited evidence available about how poor readers/spellers cope with morphological spelling patterns, and some of this comes from small case studies rather than large experiments. For example, Henderson and Shores (1982) found that two 9-year-old learning-disabled boys had particular difficulty with reading aloud suffixes such as *-ed* and -

ing. Turning to spelling, Anderson (1982) assessed the representation of such patterns in the written expression of five normal children and five children with a learning disability in grade 4 (aged 9 to 11). She found that the learning disabled group had significant difficulties in spelling inflected and derived words. Henry (1989) showed that backward readers in grades 2 to 5 had particular difficulty in spelling what she termed “morpheme patterns”: prefixes, suffixes and word roots.

This tendency for poor readers/spellers to experience particular difficulties with written morphology seems to hold not only for English, but for other languages as well. Morchio, Ott, and Pesenti (1989) found that in comparison with same-age peers of average reading ability, young Italian backward readers made many spelling errors which were plausible in terms of phonology, but which seemed to ignore grammatical criteria, such as errors in the placement of word boundaries. For example, a backward reader might write *l'aradio* instead of *la radio* (the radio). Valtin (1989) observed similar examples of the running-together of words written by German backward readers in the first grade of school. She also found that in comparison with children of the same age but of normal reading ability, backward readers in grades 3 and 4 had difficulty applying a rule that exists (in German) to signal a grammatical distinction in writing that is not marked in speech: all nouns should be capitalised. To achieve this, German children must be able to distinguish nouns from other types of words. However, the poor readers seemed not to show any real understanding of why certain words require capitalisation; instead they just developed a rule and applied it rigidly, often with erroneous results. For example, one child explained that “If *der*, *die* or *das* [definite articles] comes before a word, you capitalise it”, and so mistakenly failed to capitalise nouns preceded by definite articles in other cases, such as the dative *dem*.

A few larger experimental studies have been conducted in English, comparing the ability of poor and normal readers/spellers to write words containing selected morphological spelling patterns. Bryant, Nunes & Bindman (1997) tested backward readers' spelling of the -*ed* of past regular verbs and the *wh-* of interrogatives. Both of these types of word have a consistent spelling despite changes in pronunciation (e.g., ***asked***, ***called***, ***added***; ***why***, ***who***), and thus both require an appreciation of morphological status to be spelled correctly. Irregular verbs and non-verbs, neither of which contains morphological spelling patterns, were also included. Fifteen children aged 7 to 9 years whose reading age was more than 12 months behind their chronological age were identified as "backward readers", and their spelling performance was compared to that of 74 children matched for chronological age and of 82 younger children matched for reading age. The backward readers performed more poorly on the interrogative words than their chronological age matched peers. They also performed more poorly on the verbs and non-verbs, and here the difference between the groups was most prominent on the past regular verb endings. However, compared to the younger children matched for reading age, the backward readers did just as well on the verbs and non-verbs, and actually better on the interrogatives.

These results show that although backward readers' ability to employ a morphological spelling strategy is compatible with their reading level, they do show striking difficulties with representing morphological spelling patterns for their age.

1.3.1.1.vi. Conclusions about the representation of inflectional morphology

A variety of studies has assessed the ability of children of a range of ages and abilities to spell inflected words correctly. Their results suggest that it takes at least two or three years of writing experience for children to learn to represent the past-tense ending of regular English verbs consistently and correctly, and to choose the appropriate spelling for the endings of words with the same sound but different morphological statuses, such as plurals (-*cks*) and non-plurals (-*x*) in English or feminine titles (-*esa*) and abstract nouns (-*eza*) in Portuguese. Inflections which are marked in the written, but not the spoken, form of a language, such as the English apostrophe or the French inflectional plural endings for both nouns and verbs, seem to take even longer to acquire. In almost every case, children start off spelling inflectional endings simply on a phonetic basis. After a year or more of writing, they begin to notice that alternative spellings exist for the inflection, and to use them in their spelling. However, children do not immediately apply these alternative spellings to the correct set of words; they can take two years or more to learn to confine each spelling to the appropriate morphological category. The one possible exception is the plural *-s* inflection. Although it appears that children are able to spell this inflection correctly from when they first begin to write, it is not yet clear whether beginning spellers have realised the need to preserve its morphological status in their spelling, or whether they have just learned to represent both /s/ and /z/ with the letter *s*. Experimental studies, rather than just observations, will be needed to clarify this issue.

Children who are backward readers seem to have even greater problems representing morphology in general in their writing, including problems spelling inflectional endings. Nearly all the results presented here thus support the "late" acquisition of morphology hypothesis.

1.3.1.2. Derivational morphology

1.3.1.2.i. Complex derivational relationships

Derivational relations are generally more complex than inflectional relations. They are less predictable, more variable, and base words often undergo alterations in sound or (more rarely) spelling when they are changed to a derived form (Sterling, 1983). Thus, we might expect that children's understanding of how to represent derivational relations might take even longer to develop than their understanding of inflectional relations. This idea is in concurrence with some of the spelling models discussed earlier, which contend that an understanding of derivational links is not acquired until quite late in the process of spelling development. The usual way to test understanding of the link of meaning between word stems and their derivations has been to see whether children spell the common stem of the two words in the same way. The preservation of the same spelling across different forms, regardless of changes in pronunciation, is seen to indicate an understanding of the morphological relationship between these forms.

Treiman (1993), in her study of the spellings produced over a school year by a class of first-grade children, attempted to analyse how well her participants represented the stems of any derived words that they spelled. However, the children produced so few examples of derived words that no statistical analysis was possible. The few derived words that were produced included a variety of representations for the word *vacation*, including *vaycayshawn* and *vacasn*. Both of these are clearly sound-based spellings, and the *t* spelling of the stem word, *vacate*, is not preserved. But as Treiman acknowledges, it is very unlikely that children in the first grade would even be aware of the word *vacate*, let alone of its relation to the better-known derived form, *vacation*. Thus, this study cannot tell us much about early understanding of the need to preserve derivational relations in writing.

Sterling (1983), who also studied naturalistic spelling, but in much older (12-year-old) children, observed quite a large number of misspelled derived words, even though his participants had had at least six years' writing experience. These errors were not as numerous as the misspellings of inflected words described in section 1.3.1.1.i.b., but were made at least once by more than a third of the participants. They produced a handful of un-categorisable mistakes (e.g., *comiption* for *competition*) and errors of "concatenation" (e.g., *snobish* for *snobbish*), but for the most part the participants' errors on derived words were "phonetic". That is, the children spelled the derived forms as they sounded, for example, *closlay* for *closely*. Moreover, some of the misspellings described as "articulation errors", such as *amazinly* for *amazingly* and *diffrent* for *different* could also be seen to represent phonetic spellings of derived words, so the number of errors may be even greater the author described. Sterling concluded that

> "there is no evidence to suggest that the spelling of derived words is governed by a morphemic component that takes into account their morphemic structure" (p. 358).

Thus, it seems that even children in their first year of high school may not yet have acquired a sufficiently firm understanding of the nature of derivational morphology to represent it conventionally in their spelling. Unfortunately Sterling only gives one example (*closlay*) of a phonetic derivational error, so it is not clear how many of these errors consisted of wrongly-spelled derivational endings, and how many of failure to preserve a stem morpheme's spelling. More evidence is needed for a better understanding of when children begin to represent derivational relations between words in their spelling.

Templeton (1980) also assessed the spelling of base and derived words in relatively old children. He presented 60 good spellers in grades 6, 8, and 10 with a series of base words either orally or in writing, and showed a printed suffix for each. There were 12 real and 12 pseudoword bases. The participants were then asked both to pronounce and to spell the derived word resulting from each base-suffix combination. Spelling of derived words did not improve significantly across grade levels (both real and pseudowords were spelled equally well), but pronunciation did improve, although not to perfect levels. Interestingly, participants at each grade level were more likely to pronounce and to spell both types of derived forms correctly when the base forms were presented in written form than when they were presented in spoken form. Templeton concluded that the rules about spelling derived words are for the most part mastered by the end of primary school, but are still not known perfectly, as spelling cues caused better performance than sound cues.

These results were replicated in a follow-up study by Templeton and Scarborough-Franks (1985), in which poor as well as good spellers in grades 6 and 10 participated. Although the poor spellers did not have such a good grasp of stem constancy as the better spellers, both groups' performance followed the same patterns as in the previous study (Templeton, 1980).

Thus, in terms of spelling, these studies show that children acquire the basic ability to abstract the stems of derivationally related words by the end of primary school, but that their performance can be improved if the stems are presented. However, we still need more information about the approximate age or grade level at which children first start to represent derivational relations. Most experiments seem to have included words whose derivational relations are fairly opaque, so it is perhaps not surprising that only the older children tested have shown any ability to represent such relations in their writing.

A better test of children's representation of the links of meaning between derivational word pairs was provided by Carlisle (1988). She examined the spelling of base and derived words by children in late primary and early secondary school. She asked 65 children in grades 4, 6, and 8 to spell 40 base words and their derived forms (making 80 words in all). In ten of the word pairs neither the orthography or the phonology of the base word changed in its derived form (e.g., *warm-warmth*), in ten the base underwent an orthographic change only (e.g., *sun-sunny*), in another ten it underwent a phonological change only (e.g., *equal-equality*), and in the final ten it underwent both an orthographic and a phonological change (e.g., *deep-depth*).

The number of correct spellings of both base and derived forms increased significantly across grade levels. However, at each grade level, the participants were better at spelling the base words than their derived forms. The grade 8 children's spelling of base forms had nearly reached ceiling level, but their spelling of derived forms was less proficient. The complexity of the relationship between the word pairs was found to influence children's representation of morphological links. Children at all grade levels made fewer errors when the relationships were transparent (such as in the no-change pairs) than when they were more opaque (such as when the base word's orthography and phonology changed in its derived form).

Thus, this study suggests that by grade 4, children have acquired some understanding of the way that derivational relations are represented in spelling. However, there are aspects of derivational morphology that are still being developed in late primary school and early secondary school. Although the base forms of the words seemed to have been learned by the oldest participants in the study, the derived forms had still not been mastered, especially when their stems differed substantially from their base forms.

1.3.1.2.ii. Simple derivational relationships

The difference that Carlisle (1988) found between children's spelling of transparent and opaque derivational relationships highlights an important distinction that must be made when testing or drawing conclusions about children's representations of base and derived words. Although derivational relations *are* often complex and involve changes in the sound and/or spelling of the base word, simpler relations also exist. Carlisle's "no change" and "orthographic change only" word pairs are examples of the relatively transparent derivational relations that are also found in English. For example, derivational suffixes such as *-y*, *-ness*, *-er* or *-est* can be added to base words with no change to their sound and no change (or minimal change, such as dropping *-e* or doubling a consonant) to their spelling. This wide variation in complexity means that we must take care about making generalisations about children's representation of derivational relations; the ability to represent some relations may develop months or even years before the ability to represent others.

Thus, despite the general consensus from the spelling models discussed, and from the studies of more complex derivational links presented – that the ability to represent derivational meaning relations is acquired quite late in spelling development – it does seem possible that children might come to understand more simple derivational relations from earlier on in their writing experience. The links of meaning between *mud* and *muddy*, or *teach* and *teacher*, for example, seem so clear that it is difficult to imagine that even young children fail to notice them. However, it is the very simplicity of these relations that makes it impossible to tell, from children's spelling of most of these word pairs, whether these links have been noticed. Clearly, if a young child writes *sun* and *suny* (for *sunny*), the fact that she has written the common stem consistently does not necessarily show she has understood and recognised the common meaning – she could just be spelling what she hears in both words: /s/, /Λ/, /n/. Thus, we must treat Carlisle's (1988) interpretation of her participants' performance on the "no change" and "orthographic change only" words with caution. If we are to draw valid conclusions about young children's understanding of transparent derivational relations through their spellings, we must be careful about the words that we ask them to write. Some of the experiments which have studied children's representations of simple base-derived relationships have employed rather different methods of scoring. These experiments are discussed in section 1.3.2.

1.3.1.2.iii. The representation of derivational morphology by poor readers and spellers

As discussed in section 1.3.1.2.i., Templeton and Scarborough-Franks (1985) found that poor spellers in grades 6 and 10 showed less understanding of the principle of stem constancy (the tendency of related words to have their stems spelled the same, e.g., *inspire/inspiration*) than better spellers. This indicates that morphological relationships – here, derivational ones – can still pose substantial spelling problems for poor spellers in late primary and even late secondary school.

Carlisle (1987) also examined the spelling of derived words, comparing the performance of 17 dyslexic children in grade 9 to that of 65 normal children in grades 4, 6, and 8. The grade 6 children were reading at the same level as the dyslexic grade 9 children. Among normal children, substantial learning about derivational morphology occurred between grades 4 and 8. The dyslexic children, however, seemed not to recognise derivational relationships between words, but produced phonetically acceptable misspellings instead. Thus, they might write *magic* correctly, but transcribe its derived form as *magition*, *magishion*, or *magishan*. Nevertheless, their erroneous use of sound-based spellings did not differ significantly from that of younger, normal readers of the same reading age (the grade 4 children). This is in line with the conclusions of Bryant et al. (1997). Thus, even though older poor readers experience problems in transcribing morphological patterns, these problems are not worse than would be expected for their reading level.

Fischer, Shankweiler, and Liberman (1985) investigated the spelling of college students for sensitivity to the morphophonemic structure and word formational principles that underlie much of the English spelling system. They asked 18 good spellers and 20 poor spellers to write down 120 words, grouped into three different levels of transparency of orthographic representation. These ranged from being highly transparent (e.g., *harp*), to having an ambiguous section (e.g., *thinned, conference*), to being rather opaque (e.g., *gnaw, bourgeois*).

The poorer spellers made significantly more errors than the better spellers on all three types of word, but performed especially badly on those words with a section that was ambiguous in terms of grapheme-phoneme correspondences. This suggests that the poorer spellers had particular difficulty in accessing the underlying morphophonemic structure of words when it was not obvious from their pronunciation. For example, the poorer spellers may not have been aware of the base word *confer* in *conference*, and therefore would not have been able to use the root word's spelling to disambiguate the derived form's reduced or even unpronounced medial vowel (*conference*).

A second experiment sought to confirm these results by examining the same students' spelling of pseudowords as well as real words. A list of items was prepared to test mastery of the principles of affixation (knowledge of how the orthography attaches affixes to a base word) and the disambiguation of reduced vowels (e.g., if a base word forms its noun by the addition of *-ion*, the correct ending of its adjective is likely to be *-ible*, e.g., *digestible*). Participants wrote 60 affixed real words and had to indicate the affix/base word boundaries (e.g., *connubial* vs. *constable*). Their knowledge of the principles of suffixation was assessed by their spelling of 24 pseudowords (e.g., *prin–prinnish*), and their ability to disambiguate reduced vowels was examined by their spelling of 50 pseudowords (e.g., *extrupt–extruption–extruptible*).

In this second experiment too, the good spellers out-performed the poor spellers on all three tasks. Fischer et al. concluded that it was the ability to access and utilise morphological knowledge that distinguished most clearly between the better and poorer spellers.

1.3.1.2.iv. Conclusions about the representation of derivational morphology

Although the range of research that has been conducted on children's representation of derivation morphology is not as broad as that on inflectional morphology, the evidence that does exist suggests similar conclusions. Children appear to develop some ability to represent derivational relationships correctly from towards the end of primary school, but it seems to take several more years before they are able to signal the links of meaning between word stems and more opaquely related derived forms. As with inflectional morphology, poorer readers seem to have particular difficulty noticing and representing derivational relations between words, even as adults. Thus, these experiments, too, support the "late" acquisition of morphology hypothesis.

1.3.1.3. Conclusions about children's correct spelling of morphological patterns

A variety of evidence exists about the correct representation of both inflected and derived words by children who are just learning to write, by children in primary school and high school, and by young adults at college level. With the possible exception of the plural *-s* inflection, it seems that spellers of varying levels of ability, from varying linguistic backgrounds, are not able to represent morphological patterns correctly from when they first begin to spell. Learning to represent inflectional endings accurately typically appears to take two or three years, and to include stages of phonetic spelling and inflectional overgeneralisation before correct usage is achieved. "Silent" morphemes, such as the English apostrophe and French plural endings, may take even longer to acquire. Learning to represent derivational relationships between words linked by meaning also seems to take many years of writing experience. Here, too, children start off spelling according to sound, but may take up to four years, or longer, to recognise the need (in some words) to preserve stem spellings in their derived forms, especially if these relations are not obvious from sound alone.

Overall then, the evidence from experiments which have set out to test children's ability to represent morphological patterns correctly is nearly all in favour of the hypothesis that young writers acquire the ability to represent morphology relatively "late" in their writing experience.

1.3.2. Evidence from the effect of morphological structure on early spelling

Virtually all the evidence from children's spelling discussed so far comes from experiments whose participants were required to spell the entire morphological section of interest *correctly* to be credited with having grasped the morphological nature of this section. This requirement of correct spelling is useful for discovering exactly when children achieve a full understanding of where and how to use morphological spelling sequences. However, it may be that this requirement is too strict if we wish to find out whether younger children have any understanding at all of the morphological structure of the words they are writing. Beginning writers have probably not yet had enough experience with the written language to realise where and why the *-ed* inflection should be used, or the fact that the sound /ks/ *can* be written in two different ways. They probably do not yet have a vocabulary large enough to include words such as *combine* and *combination*, so it is hardly surprising that it appears to take several years before they learn to spell the shared section of these words the same. Children must learn the meanings of both words before they can be expected to realise, and represent, their derivational relationship.

Thus, the experiments discussed so far may underestimate any understanding of morphological structure, however rudimentary, that young spellers might have developed. Several experiments rather different from those requiring correct spelling of morphological patterns have been conducted in an attempt to assess the representation of morphological structure in the spelling of young writers. The participants in these studies have not been required to achieve the correct spelling of an inflectional ending or a derived word stem to be said to understand the word's morphology. Instead, the experiments are set up so that correctly representing a particular phoneme of one of a word's morphemes can be taken to indicate an understanding that the word contains that morpheme. This method has been used to assess children's understanding of the morphological structure of both inflected and derived words. Other experimenters have considered that if a child fails to represent the inflectional ending of a regular past verb, he or she must possess at least a rudimentary understanding of the stem-plus-inflection structure of these words. Other indications of an understanding of morphological structure are the errors made apparently through an overly rigid application of inflectional attachment rules.

Before we discuss such experiments, however, we will describe two studies which have examined children's earliest understanding of the role of morphology in written English, *before* they are formally taught to read and write. The first investigated young children's ability to read words which differed in their morphological structure; the second, their ability to write such words.

1.3.2.1. Preschoolers' understanding of morphological structure in reading and spelling

Byrne (1996) designed an unusual study to test whether 4- and 5-year-old children would grasp the phonological nature of print when they were taught to read word pairs which exemplified this nature, or whether they would assume the words to be related morphophonologically instead. Twenty-four pre-school, pre-reading children were taught to read pairs of words such as *hat/hats* and *book/books*, with the *s* printed in red in each case. Half the children knew the sound of the letter *s* prior to the study; half did not. Byrne reasoned that the children could have understood the role of the red *s* in one of two ways. They could have grasped its phonological role by noticing that the two words looked the same except for the (visually salient) *s* and that they sounded the same except for the sound /s/, and thus that the *s* must represent /s/. Alternatively, they could have grasped its morphological role by noticing that the word that meant "more than one *x*" had an *s* on the end, and the word that meant "just one *x*" did not, and thus that the *s* must indicate plurality.

To test these possibilities, the children were shown pairs of words of four different types: (a) regular singular/plural pairs where the *s* was pronounced either as /s/ (e.g., *bike/bikes*), or (b) as /z/ (e.g., *dog/dogs*, (c) two non-plural words, one ending in *s* and one not (e.g., *bug/bus*), and (d) irregular singular/plural pairs (e.g., *man/mans* ["men"]). The children were then read each pair of words aloud and asked which written word was which.

Both groups of children performed well on word pairs such as *bike/bikes*. This success could have come from an understanding of the phonological *or* morphological value of the letter *s*, or from a simple match between word length and plurality ("longer word = more things"). On word pairs such as *dog/dogs*, where the *s* is pronounced /z/ instead of /s/, both the *s*-aware and the *s*-naïve children again performed well. Thus, both groups seem to have accepted that *s* has a morphological role (the *s*-aware children must have grasped this in addition to its phonological role). However, this result could be also interpreted more simply: the children might have accepted that *s* could represent more than one phoneme, or they might just have matched word length with plurality.

When asked to choose which word said *bug* and which said *bus*, however, most of the *s*-aware children performed reasonably well, but the *s*-naïve children performed at chance level. This seems good evidence that although both the *s*-aware and the *s*-naïve children learned quickly that *s* could play a morphological role in writing, the *s*-naïve children did not grasp that it could also play a phonological role. However, being asked which of the words *man* and *mans* said "man" and which said "men" (a task on which all children did quite poorly) might have discouraged any tentative phonological hypothesis the children might have been building up. Still, this condition was always presented last, so it should not have affected performance on the other word types.

Byrne replicated this pattern of results with two other morphological markers; the comparative *-er* and the superlative *-est*. Pre-school children who were taught to read pairs of words distinguished by the comparative *-er* (e.g., *small/smaller*) were able to generalise this learning to distinguish between other comparatives (e.g., *mean/meaner*), but not to similar non-comparative pairs (e.g., *corn/corner*). Similar results were found with children taught to read superlative pairs (e.g., *small/smallest*) trying to distinguish between other such pairs (e.g., *fat*/*"fatest"*) and non-superlatives (e.g., *for*/*forest*). However, this last result seems less convincing; the above-chance performance for superlative pairs came mostly from a sub-group of *s*-aware children, who could have used their phonological knowledge to choose the correct word.

The overall conclusion that Byrne reached goes against the evidence from children's early spelling, which suggests that their first understanding of written language is that it is based entirely on sound. Instead, he suggests that if children have not been explicitly drilled in letter-sound relationships, their first hypothesis about written language is that it represents morphological relationships.

However, there is a number of problems with his study, not least of which is his failure to have replicated his results in later studies (Bryant & Byrne, 1997). Sometimes the differences observed came only from two or three children; testing more participants would improve the validity of the results. Some of the word pairs were not fully comparable; the words *bike* and *bikes* both look similar and mean similar things, whereas the words *"pur"* (purr) and *"purs"* (purse) look similar have entirely different meanings.

Finally, the order in which the test words were presented was not counterbalanced. For example, the children were always tested on regular plurals straight after the training words, then, after a break, on non-plural pairs, and then irregular plurals. Four- and five-year-olds would easily have become more fatigued and forgetful as testing time increased, so their responses on the first questions might have been more valid than their later responses. Still, having the conditions in the chosen order meant that the children could entertain either a phonological or a morphological hypothesis for as long as possible. Presenting *bug*/*bus* first, for example, would have gone against a morphological hypothesis from the start.

Levin and Korat (1993) conducted a study with young Hebrew-speaking children who had not yet received any formal instruction in writing, to investigate whether they would represent morphology in their early attempts at spelling. The authors asked nursery and kindergarten children (aged 4;08 to 6;08) to read and write pairs of nouns which differed in terms of number of morphemes (and also in phonology and semantic content). Some pairs contained two one-morpheme words (e.g., *ets*, tree, and *ya'ar*, forest), and others contained two two-morpheme words (e.g., *ets*, tree, and *etsim*, trees). The younger children produced longer sequences of letters for words that sounded longer or that denoted a number of objects, but the older children produced longer sequences of letters for words that contained two morphemes rather than one. Since even the older children had not yet been given any formal literacy instruction at school, this is evidence that in Hebrew, too, children might grasp the idea that writing can represent morphology, even before they have been taught anything about the written language.

Although these two experiments provide some interesting results, further and more compelling evidence will be needed before it is accepted that even the most beginning readers can spontaneously grasp the role of morphology in writing.

1.3.2.2. Representing or failing to represent both morphemes of bimorphemic words

In his study of the naturalistic writing of 12-year-olds, Sterling (1983) observed that his participants made more than just phonetic errors when writing words inflected with *-ed*, *-s* and *-ing* (as described in section 1.3.1.1.). They made what he termed "concatenation errors" just as often, where they applied their knowledge of the stem-plus-inflection structure of these words too rigorously and produced misspellings such as *sayed* for *said.* Seventeen of the 56 participants made at least one such concatenation, and these errors made up 26 of the 547 errors produced overall. This seems fairly convincing evidence that at least some of the children were aware of the morphological structure of the inflected words that they wrote. Still, this is hardly surprising, given that these children were in their final year of primary school and the more rigorous experimental studies described in section 1.3.1.1. all concluded that most children can write simple inflected words by school year 2 or 3.

Another spelling error that Sterling observed was the omission of inflectional endings, especially *-ed* and *-s*. On the inflected words written, 26 children made 36 errors of omission in all, with most of these occurring for regular past verbs. These letters were not omitted simply because children had trouble discriminating or transcribing the final sounds of words in general; the omission rate for inflections was significantly higher than it was for the same word-final sounds when these were non-inflectional. Sterling took the omission of inflections as another indication of children's knowledge of the morphological structure of the words that they were writing. He explained that children store word stems and affixes separately in the mental lexicon, but that they might fail to retrieve the affix, or retrieve it but then forget it just prior to writing the word.

Omission of the *-ed* inflection from regular past verbs has been observed in other studies of young children's writing. Rubin (1988), whose study will be discussed in detail in the following section, found that poorer and better kindergarteners omitted an average of 9 and 14% of *-ed* inflections respectively, and that poorer and better grade 1 children omitted 29 and 6% respectively. Like Sterling, Rubin found that the number of omissions of *-ed* endings was significantly greater than the number of omissions of non-inflectional endings pronounced in the same way. Rubin, too, took these results to indicate that her participants possessed "at least a moderate degree of understanding" (p. 351) of the morphological structure of regular past verbs.

The children in grades 1 to 4 studied by Zutell (1980) often failed to represent *-ed* endings, producing spellings such as *stab* for *stabbed.* Zutell postulated that these omissions might be due to children's inability to separate clusters of word-final phonemes, but Sterling's and Rubin's comparison of the omission of inflectional versus non-inflectional endings suggests that this is not a likely explanation.

Treiman (1993), too, found that her first-grade participants sometimes omitted inflections, and that they were significantly more likely (13.1%) to omit final consonants when they were inflectional suffixes (e.g., *kil* for *killed*) than when they were not (4.8%) (e.g., *bil* for *build*). She put forward a simpler explanation: that young children write so slowly that they may forget that they are using the past tense, or the plural, when they are writing a word. Thus, if attempting to write *loved*, a child might switch to the present tense halfway through, and end up just producing *love*.

Beers and Beers (1992) noted that their first-grade children left off some *-ed* inflections from past pseudoverbs (9%), but this tendency was virtually absent at all other grade levels. Nunes et al. (1997a) observed an omission rate of only 0.2% in their longitudinal study. Thus, the evidence about the frequency with which children omit inflections at different ages is variable, and it is not clear what significance such omissions may have. A child who leaves the *-ed* off a regular past verb may fully understand its morphological structure and just have failed to represent the second of the two morphemes she knows it to contain – or she may simply have changed to present tense halfway through laboriously transcribing the word, and not even intend to produce *-ed* by the time she has finished. Another method is clearly needed if we are to gain a better understanding of young children's knowledge of the morphological structure of inflected words. One alternative is discussed in the next section.

1.3.2.3. Including a representation of a critical sound from the stem

Several studies have examined young spellers' understanding of morphological structure in a different way; by testing whether they understand that word stems generally maintain their spellings when inflectional and derivational suffixes are added. In the research discussed earlier (section 1.3.1), participants would have been required to spell the entire stem correctly to show they had understood the need to maintain the spelling. However, in the following studies, the criterion used to measure stem maintenance is much more lenient, and simply requires that children include some representation of a particular sound from the stem. This sound is typically a stem word's last phoneme, which usually becomes the penultimate phoneme once a morphological ending is added (e.g., /pɪn/→/pɪnd/ (*pin→pinned*)).

Rubin (1988) developed an interesting way to assess the representation of morphological structure in the spelling of children even in kindergarten and grade 1. She capitalised on young spellers' tendency to omit nasal consonants when these precede a word-final consonant, such as the /m/ in *hummed* or the /n/ in *wind*, compared to non-nasal penultimate consonants, such as the /s/ in *list* (Marcel, 1980; Read, 1986). Since penultimate consonants of both kinds can define morphemic boundaries in past regular verbs, Rubin designed a word list to test whether young spellers would be more likely to represent such consonants in inflected words, where they mark a morphemic boundary (e.g., *pinned*) than in non-inflected words, where they do not (e.g., *wind*). If children are aware that *pinned* is made up of *pin* plus an ending (even if they are not yet aware of its inflectional nature), they should be more likely to represent the penultimate nasal consonant /n/ than in a similar word such as *wind*, where there is no morphological structure to aid spelling.

Eighty-six children in kindergarten and grade 1 were asked to spell 28 words, nine of which were non-inflected words and nine inflected past regular verbs, with six words ending in /st/ (e.g., *nest*, *messed*) and twelve in /nd/, /nt/, or /md/ (e.g., *band*, *hummed*). The other ten words acted as fillers. Overall, the participants tended to omit the final consonant of inflected words significantly more often than of non-inflected words. They omitted penultimate nasal consonants much more often than penultimate non-nasal consonants and, most interesting for the experimental question, these nasal omissions were significantly more common for non-inflected words (26%) than for inflected words (14%). This finding supports the idea that even children who are just beginning to write can use their knowledge of the morphological structure of past regular verbs to help their spelling.

However, Treiman (1993) pointed out a problem with the way the experimental words were matched. In all six of the inflected words with a nasal consonant, the *-ed* ending was, inevitably, pronounced as a (voiced) /d/, as in *pinned*. This final voiced sound was only present in three of the six non-inflected words with a nasal consonant; the other three ended in (unvoiced) /t/, as in *pant*. Since Treiman found that children are more likely to omit nasals from before unvoiced than voiced final consonants, their tendency to omit fewer in the inflected words may have resulted from the sounds of the experimental words, rather than from a precocious understanding of morphological structure. Using the naturalistic spellings that she had collected over a year from a first-grade class of American children, Treiman conducted similar analyses to those made by Rubin. Because of the naturalistic nature of her data, Treiman could not control the sound structure of the inflected and non-inflected words that her participants had written. Nevertheless, the words that she analysed did not have the same bias as the words in Rubin's (1988) study.

Treiman compared the percentage of times that children failed to represent, for example, the *n* of inflected words such as *canned*, with similar-sounding but non-inflected words, such as *band*. In contrast to the differences found by Rubin, Treiman found no significant difference between the percentage of penultimate consonants omitted from inflected (22.3%) and non-inflected (23.6%) words. The children did not seem to spell stems in a consistent fashion. A similar analysis was carried out for word stems which ended in a two-consonant cluster. Treiman found that grade 1 children did not often (8.8% of the time) fail to represent the final consonant of these words (e.g., the *p* in *jump*). However, when this final consonant instead became the penultimate consonant through the addition of an inflection (e.g., *jumped*, *jumps*), the children's tendency to omit it from their representation increased dramatically, to 30.6%. Overall, then, Treiman (1993) concluded that children's early spelling is affected more by the phonemic context of the stem than by any tendency to spell the stem in a consistent way. This goes against the conclusion drawn by Rubin (1988), and suggests that her results may indeed have been affected by the sound structure of the words that she asked her participants to write.

A later study by Treiman and Cassar (1996) set out to confirm these results using an experimental (rather than naturalistic) design which included more, and more carefully chosen, words than Rubin's (1988) study. The authors asked 69 children from grades 1 to 3 (aged 7 to 9 years) to write down a series of inflected and non-inflected words. There were 30 words with a two-consonant final cluster, half of which were inflected (1 plural, *bars*, and 14 past regular verbs, e.g., *tuned*) and half of which were not (e.g., *Mars*, *brand*). There was a mixture of nasal and non-nasal penultimate consonants. The participants also wrote the 15 stems of the inflected words.

The proportion of spellings in which both final consonants were represented increased with grade level. Still, children very commonly represented only one of the two final consonants, and overall, the representation of the final consonant was significantly more common than of the penultimate consonant. Thus, spellings such as *tud* for *tuned* and *brad* for *brand* were frequent. However, this tendency to symbolise only one of the two final consonants varied with word type: the participants were significantly less likely to omit the penultimate consonant from inflected than from non-inflected words. Also, they did not represent the penultimate consonant of inflected words as often as they did when it was the final consonant of the relevant stem word. The children thus symbolised the /n/ and /s/ more often in stem words such as *tune* and *face* than in their inflected forms *tuned* and *faced.*

Thus, Treiman's conclusions from this experimental study are very different from those she drew from her earlier naturalistic study. She and Cassar interpret their results to show that children can use a morphological spelling strategy from as early as the first grade of school. They acknowledge that the influence of morphology on spelling still has a long way to go, however, as evidenced by the differences between the spelling of stems and the spelling of inflected words.

This general pattern of results was replicated in a second experiment involving younger children in kindergarten and grade 1, who were required just to fill in the last letters of printed words rather than transcribing the whole of each word. Finally, it was also replicated in grade 2 children who wrote the words to dictation (as in the previous experiments) or as part of naturalistic sentences which they produced themselves. The most common error in this story-writing condition was the failure to represent the inflectional ending of the inflected words.

The authors' suggested explanation for the frequency of this error in all three experiments is that the children may

> "fail to retrieve the graphemic form of an inflection when assembling the spelling of a two-morpheme word from the spellings of its components" (p. 167),

or that they may retrieve the form but forget to write it down. However, a simpler explanation closer to Treiman's earlier (1993) suggestion could account for children's tendency to omit inflections, especially when they are writing whole sentences, and especially when the inflected words are rather unusual ones, such as *tuned* and *faced.* It may be that young spellers write such words so slowly and laboriously that they forget the word that they are supposed to be transcribing, and just stop when they see that they have produced a real word that they know, especially if it is related in meaning to the original word (e.g., *tune* for *tuned*). This could not happen for most non-inflected words (e.g., *blind*), so it could be argued that the differences observed are due more to children's premature cessation of writing when they see that they have formed a word, rather than to their precocious morphological understanding.

More compelling evidence would have come from the children representing both the penultimate and the final consonant more often for the inflected than the non-inflected words. However, this evidence was quite variable. In the first experiment the number of these "complete" spellings was greater in inflected than in non-inflected words for the younger children, but there was no difference for the older spellers. In the second experiment "complete" spellings were more likely for non-inflected than inflected words, and in the third experiment there was no difference between the two word types.

Nevertheless, Treiman and Cassar's findings are potentially important. Their conclusion, that children from kindergarten to grade 3 are at some level using their knowledge of the morphological structure of inflected words to help their spelling, is one that requires further investigation. It would therefore be useful to find other methods of assessing children's early understanding of morphological structure, before they have learned to use the

-ed pattern consistently. One possibility would be an adaptation of the method used by Beers and Beers (1992), in which they presented children with printed base forms of pseudowords and asked them to spell orally-presented inflected forms. Beers and Beers reported data only from when the base word was presented. However, it would be interesting to compare children's use of the *-ed* inflection when they were presented with the base form of an inflected word, with a portion of the word that did not constitute the base, and with no visual cue at all.

1.3.2.4. Correctly representing a critical sound from the stem

Young children's ability to maintain a critical portion of a stem's spelling from base to derived forms has been investigated in a different way in several other experiments. In the studies discussed immediately above, the question was whether or not a child had included some representation of a crucial sound in his or her spelling of a given word (such as the /n/ in *pinned* or *wind*). In the following studies, the critical sound is again the last phoneme of a word stem, and thus the penultimate phoneme in the stem's inflected or derived form. However, the potential difficulty with the critical sound in these words is not that it is easily omitted from the inflected or derived form, but that it is easily spelled incorrectly. This is because although its conventional spelling in the base form may reflect its sound, its conventional spelling in the inflected or derived form does not.

One example is of vowel sounds, which are often pronounced to their full extent in base words, but reduced to an ambiguous schwa sound (/ə/) in their derived forms. Zutell (1980) took advantage of this phenomenon by asking 60 children in grades 1 to 4 to write down real words of various types, including derivational pairs such as *inflame/inflammation* and *combine/combination*. He wished to see whether his participants would preserve the spelling of the final vowel sound from the base word, to the unaccented second vowel sound in the derived form (e.g., *inflame-inflammation*).

Although performance improved across grade levels, these derived words were clearly very difficult to spell correctly (compared to words containing the past tense, long and short vowels, and doubled consonants), even for the oldest children. Many of the children in grades 1 and 2 simply left out whole blocks of letters from the derived words, usually around the unaccented vowel of interest. Very few went beyond a simple sound-based or even letter-name-based approach (e.g., *xpln* for *explain*). The older participants performed significantly better: 12% of those in grade 3 and 40% of those in grade 4 consistently used the same vowel for the base and derived words of a pair. Zutell concluded that a writer must possess a highly sophisticated understanding of the way words relate before he or she can represent these relations in spelling. Further, he noted that although this understanding begins to develop by grade 3 or 4, proper mastery is not developed until some time beyond this grade level.

However, this study appears to show a similar weakness to that of Marsh et al. (1980), as discussed in section 1.2.1.2. No attempt was made to check whether the participants knew the meaning of the base or derived words – and it seems quite likely that most of the children in grades 1 and 2, and quite possibly many in grades 3 and 4, were not familiar with the relatively uncommon words chosen. If they did not know what the words meant, they would not necessarily have realised that they were related in meaning, even if they *did* know that related words are often spelled similarly. For example, a child who did not know the etymological basis of the word *breakfast* (and had not learned its spelling by rote) could not be expected to guess that its first syllable should be spelled *break*.

Another example of a sound that can be exploited in such studies is the glottal stop (/ʔ/) used for medial *t* in some varieties of British English (e.g., /leɪt/, /leɪʔə/ (*late, later*)). Another is the "flap" (/ɾ/) used for medial *t* and *d* in North American English (e.g., /leɪt/, / leɪɾər/, /læɾər/ (*late, later, ladder*)). To spell the medial *t* correctly in either form of English, children could have learned the spelling by rote, or, in the second example, they could be aware that either *t* or *d* could be correct, and happen to choose the right one.

However, these strategies would not result in faultless spelling. Consistently correct spelling would only be achieved through an awareness of the link of meaning between the base and derived form, a realisation that words linked by meaning are often spelled similarly, and the use of the base word's final sound (or spelling) to spell the derived word's medial sound. Even if children do not choose the correct letter every time, an indication of whether they might be making some use of meaning relationships in spelling can be gained by comparing their spelling on one- and two-morpheme words. If children can use a stem word's spelling to help spell a derived word, their representation of the medial sound in two-morpheme words (e.g., *later*) should be superior to that in one-morpheme words (e.g., *letter*), where there is no stem to exploit. If they have no idea about derivational relations and spelling, their performance on the two types of word should be about equal.

Ehri and Wilce (1986) ran experiments to assess the formative influence of print over speech, but their findings can also provide evidence about primary school children's understanding of morphological structure in both inflected words and simple derived words. Children in grades 1, 2 and 4 listened to tape-recordings of 30 familiar words, and had to repeat each one. Each word was pronounced with a medial flap in American English, spelled as either *t/tt* or *d/dd*. They were then asked to report the sound that they had heard in the middle of the word. Half the words were inflected or derived (e.g., *smarter*, *maddest*) and half were not (e.g., *letter*, *modern*). The older children were more likely to report hearing sounds that reflected the words' spellings (*t* or *d*); the younger children were more likely to report the sound that is actually in the words' usual pronunciations (that is, /d/, the closest familiar sound to the actual sound /ɾ/).

The most important result for the present discussion is that the children did *not* judge the flaps spelled with *t/tt* more accurately in two-morpheme than in one-morpheme words. The authors found this result "surprising"; they had expected the participants to think of morphemic roots and report their final sounds, especially in light of the strong effect that spelling had had on the older children's overall performance. However, this lack of difference could have been caused more by the nature of the words used than by the children's lack of ability to divide them into morphemic root and affix. One problem with the experiment lies in the choice of two experimental words. Careful attention to the pronunciation by North Americans of two of the eleven one-morpheme /t/ words, *cotton* and *centre*, reveals that these words are *not* actually pronounced as flaps in American English. Instead, they are articulated as a glottal stop and an aspirated /t/, respectively. Thus, the /t/ sound in these two words would probably have been easier to identify than the truly flapped /t/ in the five two-morpheme /t/ words, and may have masked the advantage that knowledge of the root word's spelling may have conferred, especially if it were only slight.

Further, no check was made as to whether the participants knew the spellings of any or all of the experimental words. This could explain why the older children appeared to rely more heavily on spelling and the younger children more heavily on sound. The older children may just have known how to spell more of the words and/or their roots. Finally, different results may have been gained if the children had been required to write down, rather than say aloud, the sound that they perceived in the medial position of each word. Although many of the older children in Ehri and Wilce's experiment reported the *letter* they knew to be in the word's conventional written form, they were actually asked to report the *sound* they heard. Thus, the results probably contain a mixture of letter- and sound-based judgements. If the children had been required to write down their responses, they might have been even more likely to respond with the letter that they knew to be in the word's written form, rather than the sound in its spoken form.

Treiman (1993) investigated the spelling of word-medial flaps in the class of first-grade children whose naturalistic writing she observed for a school year. She, too, compared the number of confusions of *t* and *d* in one-morpheme words such as *city* with two-morpheme words such as *squirted.* There turned out to be no significant difference between the two; the spellings of *t* and *d* were confused in 21.3% of the one-morpheme words, and in 19% of the two-morpheme words. This result, like that of Ehri and Wilce, suggests that the children were not aware of the morphological structure of the two-morpheme words, and had not yet realised the importance of retaining the spelling of stems of inflected and derived words. However, because these data came from children's spontaneous writing, there was no control over the number of each type of word written. Further, not all the children produced spellings of such words, and for those who did, it was not possible to check whether they knew how to spell the relevant stem words.

Treiman and colleagues rectified these problems soon afterwards in an experimental study (Treiman, Cassar, & Zukowski, 1994). The researchers asked children to spell a series of words with a medial "flap": two-syllable words consisting of one morpheme or two morphemes (both inflected and derived words). After two initial experiments in which it was confirmed that American children in the first few years of school have difficulty deciding how to represent word-medial flaps, Treiman et al. asked 126 children in grades 1, 2, and 4 to write down 60 words. Eighteen of these words had a medial flapped *t* (six were derived words, six were inflected, and six were monomorphemic) and 18 had a medial flapped *d* (six derived, six inflected, six monomorphemic). The remaining 24 words were the stems of the derived and inflected items, half of which ended in /t/ and half in /d/. As above, it was hypothesised that if children are able to use meaning relations to help their spelling, then they should spell the ambiguous flapped sounds better in the derived/inflected words (where the spelling of the stem's ending can disambiguate the flap) than in the one-morpheme words (where there is no stem).

The prediction was confirmed in the results, at least for the two younger groups of children. The participants in grades 1 and 2 showed significantly better spelling of flaps in inflected and derived words (on which they did not differ significantly) than they did for one-morpheme words. This difference was particularly striking for the words spelled with *t*. The mean proportion of times that the correct letter was chosen by grade 1 children was 0.46 for two-morpheme words and 0.24 for two-morpheme words, and by grade 2 children, 0.81 and 0.43, respectively. There was no difference between word types for participants in grade 4, presumably because these children performed at near-ceiling levels on all word types.

However, Treiman et al. concluded that the younger children were using the stems to help them spell the flapped sounds in the two-morpheme words. As in Treiman and Cassar's (1996) study of final consonant clusters, the children in the present experiment did not represent the flapped sounds in two-morpheme words as well as they represented the equivalent letters at the end of these words' stem forms. The children were more likely to spell the *t* of *dirt* or the *d* of *ride* correctly than they were to spell these same letters correctly in derived and inflected forms such as *dirty* and *rider*. Thus, the children were seen to be using a morphological strategy to spell the two-morpheme words, but not to the maximum extent possible.

In a final experiment, the spelling of younger children on a shorter list of similar words was assessed, to see whether even children in kindergarten could use morphological reasoning to aid their spelling. One hundred and four children from kindergarten, grade 1 and grade 2 were presented with the experimental words in printed form, each with a blank space for the *t* or *d*, and asked to write down either *t* or *d* as appropriate, as each word was read aloud. There were 12 words with a medial *t* and 12 with a medial *d*, and for each letter there were 6 one-morpheme words and 6 two-morpheme words (a combination of inflected and derived words). There were also 6 control words (with an unflapped medial *t* or *d*), and the 12 stems of the two-morpheme flapped words.

Again, the children in kindergarten and grade 1 did better on the two-morpheme words than the one-morpheme words, although the grade 2 children showed no difference. No explanation is offered for this lack of difference in the grade 2 children, even though this finding goes against the finding from the previous experiment. The participants were not as accurate at spelling the flapped sounds in the two-morpheme words as they were at spelling the final sound of the stem words, which was again taken to show that they did not use morphological relations among words to the greatest extent that they could have. The authors suggest that these participants were able to show abilities not observed in the grade 1 children studied by Treiman (1993) because of the difference in the ease of the tasks. Treiman (1993) observed children's spelling of whole words in whole sentences or stories; the present study required children simply to fill in a single letter – an easier task which would have left more room for morphological analysis.

Treiman et al. conclude that their results go against the "widespread belief" (and against Treiman's (1993) original claim) that children begin writing in an exclusively phonetic manner. They claim instead that even very beginning spellers

> "know that spelling represents levels of the language that are deeper than the phonetic surface [and that they] have some ability to use meaning relations among words to help them select spellings" (p. 1336).

The two studies suggest that this holds not only for inflectional relationships, but for easy derivational relationships as well.

A final way to assess children's ability to represent derivational relations would be to see whether children preserve a stem-final letter if it becomes the medial letter of a derived form when there is no change in sound, but when the spelling is potentially ambiguous in both cases. For example, the sound /z/ can be represented as *z*, *zz*, *ze* or *se* in word-final position or as *s*, *ss*, *z*, or *zz* in word-medial position, resulting in pairs such as *rose-rosy* and *fizz-fizzy*. To achieve the correct spelling of the (usually more difficult) derived word every time, children would have to be aware of the <u>spelling</u> of the stem's /z/ sound. This is slightly different from words with a medial flap, in which a speller only needs to be aware of the <u>sound</u> of the stem's final sound to spell the flap correctly. For example, thinking of the pronunciation of the word *dirt* (from *dirty*) reveals that a *t* spelling is required, but thinking of *rose* in *rosy* requires a knowledge of *rose*'s spelling to get the medial /z/ of *rosy* correct. As with medial /ɾ/, consistently correct spelling of medial /z/ would reveal an awareness of the meaning link and the need to preserve spelling, and the use of their knowledge of how to spell /z/ in the stem to spell /z/ in the derived form. Again, the spelling of one- and two-morpheme words could be compared. Better spelling of the medial sound of two-morpheme words (e.g., *rosy*, *fizzy*) than of one-morpheme control words (e.g., *busy*, *dizzy*) would suggest children were making some use of morphological relationships in their spelling. If there were no difference, this would suggest that children were still spelling by sound or just making guesses about whether *s* or *z* was the appropriate letter. No such experiment appears to have been carried out.

1.3.2.5. Conclusions about the effect of morphological structure on early spelling

These experiments have all used relatively lenient criteria to assess young children's ability to represent morphological relations in spelling. The first two experiments examined some very general ideas about the representation of morphology in written language, as conceptualised by pre-school children. The other studies, instead of accepting only the completely correct spelling of a particular part of a word (such as the stem or inflection) as an indication of morphological representation, have accepted the inclusion or correct representation of a critical sound. They have also seen the over-rigid application of inflectional attachment rules, and even the omission of inflections, as indications of an understanding of morphological structure. Although the results have been somewhat mixed, the findings from the most recent and rigorous studies suggest a much more positive assessment of very young children's ability to symbolise morphological relations than has been made from the studies which have instead required the production of completely correct spellings.

These findings lend support to the hypothesis that children do not start out as purely phonetic spellers, but instead that they understand, from the time they first begin to write, that the English spelling system represents multiple levels of regularity. Thus, even children in kindergarten, and certainly those in the first two years of school, are seen to have at least a rudimentary ability to analyse words into their component morphemes, and to use this ability to help their spelling of multimorphemic words, both inflected and derived. Further research will clearly be needed if we are to decide whether the necessity of representing morphological relations in writing is indeed understood "early", as suggested by the studies in this section, or "late", as claimed by the studies in the previous section.

1.4. Morphological awareness and literacy skills

The previous sections presented evidence for two competing hypotheses. One holds that children are able to represent morphology as well as sound in their spelling from when they first begin to write, and the other that children start off writing according to an entirely sound-based strategy and only learn to incorporate morphological patterns after some years of writing experience. Despite their opposing claims, both hypotheses acknowledge that when children first begin to represent morphology, this representation is far from perfect, and it that takes months or years of practice with the written language before they learn to symbolise the full range of English morphological relations.

The question that we must ask, then, is how do children make the transition from writing via an exclusively, or at least predominantly, sound-based strategy, and begin using morphology more and more in their writing? There is by now a large body of evidence to show that children's early *phonological* awareness – their ability to analyse the sound structure of language – is strongly associated with their later reading and spelling skills. This relationship is a robust one, and has been shown to hold across individual differences in age, school grade, IQ, and vocabulary (e.g., Adams, 1990; Bradley & Bryant, 1978; Rack, Snowling, & Olson, 1992). Since the English orthography is basically alphabetic, it is not surprising that an ability to break its words into constituent sounds is so helpful for learning to read and write, and also for improving one's reading and writing skills. However, as we have been arguing, the English orthography has many regularities at the morphological level as well. Thus, children's *morphological* awareness may also have a large part to play in their developing literacy, especially when it comes to learning to spell morphologically based spelling patterns.

When talking about any type of linguistic awareness, we must be clear about the *level* of awareness that we mean. The most common division is into "implicit" and "explicit" awareness (e.g., Carlisle, 1995; Rubin, 1988). Other divisions have also been suggested. Valtin (1984) proposes three increasingly sophisticated levels (unconscious, actual, and conscious awareness), Karmiloff-Smith (1987) proposes four (implicit knowledge, and then primary, secondary and tertiary explicit knowledge), and Gombert (1992) proposes two (epilinguistic and metalinguistic awareness). Although their definitions differ, the basic division seems to be based on the transition from an initial ability to manipulate or judge linguistic units intuitively or implicitly, without being "conscious" of exactly how this is achieved, to a later ability to reflect on the structure of language deliberately or explicitly, and to manipulate or judge linguistic units consciously. Cazden (1976) defines this latter ability ("metalinguistic awareness"), as "the ability to make language forms opaque and attend to them in and of themselves" (p.603).

The distinction between implicit and explicit awareness is clearly an important one for phonology. Children can distinguish between different phonemes from soon after birth (e.g., Eimas, 1975), and learn to understand their mother tongue in the first few years of life. The production of speech requires the articulation of the strings of phonemes that they have been hearing in their environment. Thus, at least by the time that children utter their first words, it seems clear that at some level they have some awareness of phonemes. By the age of about four years, children are typically adept at identifying the "odd one out" in a series of spoken words, all but one of which share a common phoneme (e.g., *bus*, *bun*, *rug*) (e.g., Bradley & Bryant, 1983). This task probably involves *implicit* phonological awareness; the children can identify which word is "odd", but not why or how it differs from the other words. It takes several more years, however, before children achieve success on tasks which are seen to test *explicit* phonological awareness. These include asking children to tap out the number of phonemes in a word (e.g., Liberman, Shankweiler, Fischer, & Carter, 1974) or to delete specific phonemes from a spoken word (e.g., Bruce, 1964).

It seems likely that the same kind of distinction between implicit and explicit levels of awareness is important for morphology as well. Studies by Brown (1973) and de Villiers and de Villiers (1973) have shown that children begin to use some morphemic (inflectional) endings in their speech from the age of two or two-and-a-half years. The plural *-s* and the progressive *-ing* are the first to appear, followed by the possessive *-'s* and the regular past *-ed*. It is beyond the scope of this thesis to discuss fully the acquisition of morphology in speech. However, it does seem that children have some ability with morphemes from relatively early on in life. As we saw in section 1.3.1.1.i.b., children are able to add simple inflectional endings to nonsense words in speech by the age of four or five (Berko, 1958). This ability is generally seen to reflect an implicit level of morphological awareness (Rubin, 1991). However, most of the evidence reviewed in section 1.3. seems to suggest that children do not learn to represent morphologically based spelling patterns correctly until they have had at least several years' writing experience. This has led several authors to suggest that the development of an *explicit* awareness of morphology is necessary before children can become proficient writers (Rubin, 1991), especially of morphologically based spelling patterns (Nunes et al., 1997a).

1.4.1. Morphological awareness and literacy in normally-achieving children and adults

The relationship between a variety of measures of morphological awareness (also called morphological knowledge, morpho-syntactic awareness, morpheme recognition or grammatical awareness) and literacy in both adults and children has been examined in several experiments. These experiments have employed tasks which have aimed to test levels of awareness ranging from implicit to explicit, although not all authors have made their intended level clear.

Freyd and Baron (1982) asked two groups of children, matched for vocabulary scores for one-morpheme words, to define one-morpheme (e.g., *bachelor, benign*) and derived (e.g., *tubular, oceanic*) words. It was not made clear what level of morphological understanding this task was designed to tap. One of the groups consisted of 48 grade 8 children of average IQ (aged about 14) and the other of 32 above-average grade 5 children (aged about 11). The grade 5 children performed significantly better on both types of word, but their superiority was much greater on the derived word pairs. It was hypothesised that these children were better able to analyse derived words into root and suffix, and to work out their meaning from the meanings of the two elements. This possibility was supported in a second study, in which the grade 5 children out-performed the grade 8 children in a test of ability to learn pseudoword "meanings". The younger group learned significantly better when the pseudowords were derivationally related (e.g., *skaff-steal, skaffist-thief*) than when they were not. The older group showed no such difference.

Freyd and Baron concluded that the grade 5 children's superior performance in the two studies came entirely from their ability to analyse words morphologically. Thus, this study reveals a strong relation between the ability to analyse words morphologically and having a good vocabulary, independent of intelligence. However, it does not tell us about these children's skill in reading or, more critically, in spelling such derived words.

A study of much younger children by Brittain (1970) compared reading achievement with the ability to apply morphological rules to new words, which is considered to reflect implicit morphological awareness. In a slightly modified version of Berko's (1958) classic task, 134 children in grades 1 and 2 (aged 7 and 8) were required to complete spoken sentences by producing the correct inflected forms of the given nonsense words. Reading achievement was measured in terms of the children's scores on standardised tests of word recognition, word attack, and reading comprehension, and a measure of intelligence was also taken. Brittain found that the children's ability to supply correctly inflected forms on the nonsense word task was strongly correlated with their composite reading achievement score, independent of intelligence.

Further evidence comes from Carlisle (1995), who conducted a longitudinal study on 84 children from kindergarten to the second grade of school, to see whether early morphological awareness could predict later reading ability. There were two tasks of morphological awareness, a Production task and a Judgement task. In the Production task, the children heard a base word and a sentence with the last word missing, and asked to complete the sentence with a form of the given base word (e.g., "*Farm.* My uncle is a ______."). One-third of the responses required were inflected forms, one-third were derived forms with transparent relations (e.g., *drive-driver*) and one-third were derived forms that underwent phonological changes (e.g., *explode-explosion*).

In the Judgement task, the children heard statements of agentive or instrumental relations, such as "A person who teaches is a teacher" vs. "A person who makes dolls is a dollar", and were asked to judge whether each sentence made sense or was "silly". A picture-identification test was also included to check that the children knew the experimental words. Carlisle notes that since her tasks of morphological awareness required judging or completing sentences, they may have tapped implicit knowledge. This is probably true especially of the Production task. For example, since there is only one form of the word *farm* that fits into the example sentence context given above (*farmer*), this type of task probably depends on children's ability to think of a similar-sounding word as much as on their ability to transform its ending correctly. However, since the children were also required to analyse these sentences to some extent, she suggests that some level of explicit awareness was also involved.

The children's phonological awareness was also assessed. They were asked to delete phonemes from words to create new words, for example by removing the /m/ from *meat* to produce *eat*. Finally, they completed two tests of language knowledge; the Picture Vocabulary and Grammatical Completion subtests of the Test of Language Development.

When language knowledge was controlled for, the children's kindergarten scores on the Morphological Production task did not add to the prediction of their grade 2 reading performance (word analysis and reading comprehension). The kindergarteners' performance varied with word type, but was overall quite poor. They did significantly better on the inflected than on the transparent derived forms, but found the phonological-change derived forms very difficult indeed. Scores improved substantially by grade 1, although here, too, the children performed significantly better on inflected than on derived transparent forms, which in turn were completed significantly better than the phonological-change derived forms. Still, the fact that the children could succeed on any of the phonological-change forms at all suggests at least some early awareness of complex phonological relations. Finally, a multiple regression analysis showed that only grade 1 Morphological Production score (but not Morphological Judgement or phonological awareness score) contributed significantly to grade 2 reading ability.

Carlisle concluded that the development of phonological and morphological awareness may be reciprocal. The ability to manipulate sound segments in words might foster growth in morphological awareness, which in turn might enhance the development of phonological awareness, as children learn to recognise the systematic variations of morphologically related words. The most important finding, however, is that even as children are gaining basic reading skills in the first two grades of school, there is a relationship between their sensitivity to the morphological structure of words and their reading achievement.

The results of both Brittain and Carlisle demonstrate that both implicit and more explicit levels of morphological awareness in the early years of school might be related to children's general reading ability, both at the time of testing and up to a year later. However, relating morphological awareness to general reading ability is of limited use in answering the question posed at the start of this section. We also need evidence about how morphological awareness relates to children's *spelling* ability, especially their ability to represent sequences whose spelling is determined by morphology.

An earlier study by Carlisle (1988) set out to provide such evidence, from 65 average readers in school grades 4, 6, and 8. The participants' knowledge of derivational morphology was assessed in the same type of Production task as described in the same author's 1995 study (see above). They heard a base or derived word and a sentence with the last word missing, and were asked to complete the sentence with the appropriate derived or base form of the given word (e.g., "*Warm.* He chose the jacket it for its ______."). The children were also asked to spell these word pairs, which were the same words as described in section 1.3.1.2.i. (Briefly, in some words the base portion underwent no change when the word was derived, in some it underwent an orthographic change only, in some a phonological change only, and in some, both an orthographic and a phonological change.)

The ability to spell the base and derived words correctly was found to increase with grade level, and all children made fewer errors on derived forms whose relations to their bases were transparent rather than opaque (see section 1.3.1.2.i.). Very similar results were obtained for the Production test of morphological awareness. Here, too, performance increased with grade level, and the most successful predictor of grade was knowledge of derived forms. Carlisle also examined the relation between morphological knowledge and spelling by comparing the participants' spelling of base words and their derived forms. As expected, the number of pairs in which both base and derived word were spelled correctly increased with grade level. However, although the children in grades 4 and 6 often spelled a base word correctly but its derived form incorrectly, they rarely did the opposite – that is, base word incorrect but derived form correct. Carlisle thus concluded that the correct spelling of a base word is a precondition for correct spelling of its derived form, and that the participants were, at least to some extent, using their knowledge of the spelling of base words to produce their derivational counterparts.

One limitation of the studies discussed so far this section is their correlational nature: we cannot determine the direction of causality. It is not clear whether being a good reader/speller makes it easier for a child to abstract morphological regularities which he or she can then use in a spoken task, or whether a child who has already abstracted these regularities from speech can exploit these abstractions to become a good reader/speller. Conversely, the results cannot determine whether not having sufficient skill in reading/spelling makes it more difficult to glean morphological rules from spoken language, or whether being poor at noticing these rules in speech makes it difficult to learn to read and write in the first place.

Also, the differences between the measures of morphological awareness employed must be borne in mind. The Berko task is often seen as tapping "implicit" morphological awareness (Rubin, 1988), whereas the Production task used by Carlisle was designed to require a more "explicit" level of understanding. It is unclear what level of awareness is tapped by the morphological analysis tasks employed by Freyd and Baron (1982), but it seems to be more implicit than explicit. Success on Carlisle's Production task probably depends on semantic as well as syntactic knowledge, and therefore is measuring a greater range of abilities than the Berko task. If we are to learn more about how children's understanding of morphological patterns and structure helps them to spell morphological spelling sequences, we will need more specific tests of morphological awareness.

Although direction of causality could not be inferred from any of the above experiments, their general approach, like that of other authors to be discussed, seemed to be that morphological awareness might be an important factor in the development of reading and writing skill. A different tack was taken in two studies reported by Derwing, Smith, and Wiebe (1995), who wanted to see if the relationship could go the other way. They set out to discover whether the way that children and adults spelled similar pairs of words would influence their "morphological knowledge" of those words; their knowledge of whether they were related in meaning.

Derwing et al. first report an unpublished study by Smith (1987), with 207 children in grades 4 to 7. Smith asked the children to spell 60 word pairs, each consisting of a "root" and a "derived" word. In some cases these connections were true (and relatively obvious, e.g., *electric/electricity*, or relatively opaque, e.g., *cave/cavity*) and in some false (e.g., *table/vegetable*). For each word pair that they wrote, the participants were categorised as being "S"(ame) or "D"(ifferent) spellers. "S" spellers were those who represented the putative "root" word and the "root" section of the "derived" word in the same way, whether correctly or incorrectly (e.g., *no* and *noladge* for *know* and *knowledge*). "D" spellers were those who represented the two differently (e.g., *know* and *noladge*).

The children's Morpheme Recognition ability (MR) was also tested on a subset of these words. They were asked questions such as "What does the word *teacher* mean to you?", "Why is a teacher called a *teacher*?", and "Does the word *teacher* come from any other word you can think of?" (with probes if necessary). This is a test of explicit morphological awareness, since it requires participants to explain and justify their responses in terms of morphological relations. It was predicted that predominantly "S" spellers would be more successful than predominantly "D" spellers on this MR test, since spelling the common portion of root and derived words identically should indicate an understanding of the relation between the two.

Many of the children failed to provide adequate responses to the first two MR questions, and so the analysis focused on their answers to the third question and any probes (asking why the child thought that, and if he or she had ever thought about it before). When performance on these questions was combined, a significant difference was found between the "S" spellers and "D" spellers on 4 of the 11 word pairs with which each child was presented. Those children who could identify and explain that, for example, a *teacher* is someone who *teaches*, were more likely to spell the root and derived forms of this word pair in the same way. These results were unreliable on the remaining word pairs, although there was a general but non-significant tendency in favour of "S" spellers. The findings thus give some support to the prediction that "S" spellers have a better ability to identify root morphemes in derived words than "D" spellers.

Derwing et al. (1995) conducted a similar study with 114 undergraduate students. The students were asked to spell 50 "derived" words, some of which were truly derived (e.g., *acknowledge*, from *know*), and some of which were not, but might have been erroneously seen by students as derived (e.g., *infinitesimal*, which some students might think comes from *infant*). In another session they were given a Morpheme Recognitition (MR) task, in which they were asked to judge how sure they were that each of the "derived" words really came from the putative "root" given. Success in this type of task requires explicit morphological awareness. In each case, the "root" was presented visually and the "derived" form read aloud, and the students rated their certainty on a 5-point scale. There were four types of word pairs; two truly related: True Positive (TP, e.g., *preside/president*) and False Negative (FN, e.g., *price/precious*), and two not related: False Positive (FP, e.g., *pea/pearl*) and True Negative (TN, e.g., *infant/infinitesimal*). As in the study with children, the participants were categorised as "S" or "D" spellers. Their spelling of the "root" words was not tested, as these were assumed to be already known, and the exposure to the "roots" in the MR task was assumed to correct for any unfamiliarity anyway.

There was a ceiling effect for many of the FN items and a floor effect for some of the FP and TN items on the MR task. The participants seemed quite aware of the meaning relations between phonologically similar words such as *fire* and *fiery* despite the differences in their spelling, and also of the fact that similar-sounding words are not necessarily related in meaning (e.g., *tail/tailor* and *long/lingerie*). A few items in these sets did provide evidence for a strong relationship between the tendency to produce "S" spellings and the ability to identify word roots correctly in the MR task, but most of this evidence came from the items in the TN set. The students who said that these words were related (e.g., *cost/caustic*) were almost always the same students who produced "S" spellings (e.g., *costic*).

Derwing et al. concluded from their two studies that both children and adults make use of orthographic information when analysing words morphologically, and that their knowledge of spelling (or lack thereof) can influence their morphological judgements. However, Derwing et al. also acknowledge that since their results were reliable on less than half the items, further research will be required to confirm their findings.

Nunes, Bryant, and Bindman (1997a) set out to provide a more satisfactory test of morphological awareness than those developed previously, and employed a longitudinal design to assess the direction of causality between morphological awareness and ability to spell morphological patterns over several years of schooling. The 363 participants were tested first (Session A) when they were in school years 2, 3, and 4 (aged 6 to 8), and again 7 months later (Session B) and then 20 months later (Session C).

The participants' spelling of the morphological spelling pattern *-ed* was tested in each of these sessions by asking them to spell regular and also irregular past verbs and non-verbs, as described in section 1.3.1.1.i.b. The children were also given three tests of morphological awareness (called grammatical awareness (GA)); one implicit test based on Berko's task, and two explicit tests that were entirely new. The two new tests both used the a:b::c:d format of tasks of analogy commonly used in cognitive psychology (Piaget, Montanegro, & Billeter, 1977). The Sentence Analogy task was presented with two hand puppets. Each time the first puppet "said" a sentence, the second puppet would "repeat" it, changing the tense of the verb. The first puppet would then say a second, similar sentence, and the child was asked to provide the words that the second puppet should say; that is, the same sentence but with the verb transformed in the same manner as in the first transformation. Thus, the first puppet might say "Tom helps Mary" and the second, "Tom helped Mary". The first puppet would then say "Tom sees Mary", and the child would be asked to produce the required response (here, "Tom saw Mary").

There were eight trials, and the changes made to the verbs were from present or present continuous to past tense, or vice versa. Both regular and irregular past forms were included, with the aim of testing children's understanding of past verbs in general, rather than their ability to manipulate just regular or just irregular forms. The children were given a score out of eight, for the number of times that they successfully transformed each verb.

The Word Analogy task had the same structure, but the puppets spoke single words instead of whole sentences. Again, eight trials were presented, and the children were required to transform not only present to past tense verbs and vice versa, but also nouns to adjectives and nouns to verbs, and vice versa (e.g., "Anger"–"Angry"; "Strength"– ______).

The final task (of "Productive Morphology") was adapted from Berko (1958). The participants were shown pictures and heard a pseudoword to describe each one, either in its base form, or in an inflected or derived form. The children then heard an incomplete sentence, which they were required to complete with the appropriate (inflected/derived or base) form of the given pseudoword.

Nunes et al. conducted discriminant function analyses to determine how well the children's scores on the three GA tasks predicted their movement through the stages of the authors' model of development of the *-ed* spelling pattern (see section 1.3.1.1.i.b.). A close relationship was found between the children's scores on the Word Analogy task in Session A and the spelling stages to which they were assigned at the time of testing and in Session B, even after controls for age and IQ. These links were confirmed in multiple regressions which indicated that Word Analogy scores in Session A also predicted successful use of *-ed* in Session B. Scores on the Sentence Analogy task proved to be even better predictors, foreshadowing spelling stage membership and successful use of *-ed* for Session C as well as Session B.

Scores on the Productive Morphology task, in contrast, did not make any significant predictions about children's spelling development. Nunes et al. suggest that this might have been caused by a difference in the explicitness of understanding required for the two types of task. In the Productive Morphology task, the child has to use contextual meaning to transform a nonsense word's grammatical status. In the Analogy tasks, a more explicit understanding is required: the child has to recognise a grammatical relation between two words or sentences and then apply that relation to a different word or sentence. It may be that children cannot adopt a morphologically based spelling strategy until such a relatively high level of explicitness is attained. Nunes et al. emphasise the need for experiments examining the link between children's grammatical awareness and their spelling of other morphological patterns as well.

The same authors (Nunes, Bryant, & Bindman, 1997b) carried out a further study to see if children's success on the Word Analogy task of morphological awareness would continue to predict successful spelling of the *-ed* ending in pseudoverbs, rather than real verbs. In a test of their knowledge of the untaught rule which distinguishes past verbs which should be spelled with *-ed* from those which should not (see also Bryant et al., 2000, section 1.3.1.1.i.b.), some of the children from the previous study were asked to write down both "regular" and "irregular" pseudoverbs. The participants' performance on the Word Analogy task was found to be significantly correlated with their spelling of regular pseudoverb endings 12 months later, even after controls were made for differences in age, IQ and phonological skill. Further, Word Analogy score also predicted skill at spelling regular pseudoverb endings up to 21 months after the original testing session.

The fact that these predictions were found to hold for pseudoverbs as well as real verbs (Nunes et al., 1997a) is impressive. It suggests that children's use of the *-ed* ending is not the result of rote learning, but that it is influenced by their knowledge of grammatical distinctions. Thus, these two studies provide strong evidence for a causal hypothesis: that children learn to use the *-ed* ending by understanding its morphological basis, rather than vice versa. They also contribute a new method of testing (explicit) morphological awareness; a method that is not confounded by semantic factors and that is able to predict the ability to spell morphological spelling patterns over nearly two years.

1.4.2. Morphological awareness and literacy in poor readers and spellers

As discussed in sections 1.3.1.1.v. and 1.3.1.2.iii., there is evidence from a number of studies to suggest that poor readers and spellers of all ages have problems dealing with the representation of morphology in written English. As with normally achieving readers and spellers, their difficulties with producing morphological spelling patterns (as well as with general problems in reading and spelling) may stem from difficulties with underlying morphological awareness. However, it is possible that the problems that poor readers and spellers experience with written morphology may result from a much more basic, and very striking difficulty: their weakness in making explicit judgements about phonology (e.g., Bradley & Bryant, 1978; Johnston, 1982; Bruck, 1992). If poor readers and spellers are slow from the beginning to learn to deal with the phonological structure of language, they might experience what Bryant, Nunes, and Bindman (1997) term a "knock-on" effect, and thus end up far behind their peers in learning about morphologically based spelling sequences. A number of studies have assessed morphological awareness in those who find reading and writing difficult. Some have also attempted to discover if it is weak morphological awareness that leads to poor literacy, or if limited experience and skill with the basics of reading and writing hinders the development of morphological awareness, or if there is some other explanation for the difficulties observed.

Elbro (1989) asked dyslexic children in grade 9 to read aloud inflectional morphemes, and found a strong correlation between the number of errors made on this task and the ability to add inflectional suffixes to nonsense words in a Berko-type task. These participants also experienced great difficulty in a task requiring the reversal of the elements of compound words (such as *mailbox* to *boxmail*), compared to children matched for chronological age and children matched for reading age. These results support the idea that children who have problems with reading also have difficulty manipulating morphemes. However, the design of this study does not allow any conclusions to be drawn as to whether these morphological difficulties stemmed from the dyslexics' poor reading ability, or whether poor morphological awareness may have contributed to their reading problems in the first place.

Fowler & Liberman (1995) assessed the morphological awareness of children with a wider range of reading ability. They tested the general reading skills (word attack and word recognition) of 48 children, divided into groups of Low, Mid and High reading ability for two age groups; 7½ to 8½ years, and 8½ to 9½ years. General spelling ability and vocabulary were also assessed, on the Test of Written Spelling and the Peabody Picture Vocabulary Test, respectively. Finally, morphological awareness was tested on a Morphology Production task (modelled after Carlisle, 1988). Participants were presented orally with a word's base or derived form and asked to complete a sentence with the appropriate derived or base form of the word given. The complexity of the relation between base words and their derived forms was varied, so that some were "Phonologically Complex" (e.g., *five/fifth*) and some "Phonologically Neutral" (e.g., *four/fourth*).

The children's overall performance on the morphology task was found to correlate significantly with their reading and spelling skills, even after shared variance due to age and vocabulary knowledge was controlled for. The "Low" and "High" readers performed very similarly on the Phonologically Neutral items, but the "Low" readers were disproportionately affected by the Phonologically Complex items on the morphology test, compared to the "High" readers. Thus, the problems that all the children seemed to have with the Complex items may well have been exacerbated by the phonological deficits known to exist in poor readers.

Fowler and Liberman also wished to test whether reading-related variation in the morphology task scores derived from, or contributed to, each participant's current reading level. They therefore compared the scores on the Morphology Production task of the older "Low" and the younger "Mid" readers, who had attained equivalent levels of reading, spelling and vocabulary despite their different ages. The two groups showed no significant differences in Morphology Production performance. Thus, it remains unclear from these data whether poor morphological skills were hampering the older children's literacy development, or whether their below-average reading and spelling skills caused their below-average morphological awareness.

Thus, although these results confirm the common observation that poor readers are often insensitive to derivational relationships, they cannot confirm that this insensitivity constitutes a separate deficit over and above their limitations in vocabulary, spelling and phonological sensitivity. Also, the reading and spelling measures taken here were general ones. To discover whether morphological awareness plays a role in children's developing ability to represent morphological spelling patterns, it would be more useful to see how their morphological awareness relates to their ability to spell words containing such patterns.

A study which made this comparison was conducted by Rubin (1988). She noted that although there had been a reasonable amount of research on morphological errors in the written language of older children with reading and writing difficulties, there was not so much evidence about the same mistakes in the writing of poor readers and writers in the first few years of school. She therefore set out not only to test the ability of beginning writers to represent the morphemes of inflected words (described in section 1.3.2.3.), but to assess how this ability related to their morphological knowledge. Further, she sought to distinguish between implicit and explicit morphological knowledge more carefully than in other studies.

Rubin measured the implicit morphological knowledge (IMK) of children in kindergarten and grade 1 with a Berko-type task. She asked her participants to apply inflectional and derivational morphological rules (orally) to nonsense base words, also presented orally. The children whose scores were in the top third of all scores on the IMK task were placed in the "high" group for their grade level, and those whose scores were in the bottom third were placed in the "low" group for their grade level. The resulting 86 participants were given a task to assess explicit morphological awareness (EMK), in which they heard 28 words consisting of one or two morphemes, of which 18 were of experimental interest. For each word, they were asked "Is there a smaller word in *kissed* (*list*) that means something like *kissed* (*list*)?". The youngest children found this task quite difficult. Finally, about a week later, the participants were asked to spell the same 28 words (see section 1.3.2.3. for a description). For the two-morpheme words, it was considered that both morphemes were represented if the child included a representation of the last sound of the base word, and of the sound of the inflection (e.g., *cand* or *knd* for *canned*).

The ability to represent both base and inflectional morphemes of past-tense verbs in spelling increased with grade level, but also with IMK score. This relation persisted regardless of whether the IMK score used came only from those test items which required the application of the past tense, or from all the items on the test. The scores on the EMK task did not differ significantly for the "high" grade 1 and "high" kindergarten children, but they were significantly lower for the "low" grade 1 children and significantly lower again for the "low" kindergarteners. Finally, there was a highly significant relationship between the children's scores on the IMK and EMK tasks.

These results suggest a number of interesting conclusions. Firstly, it appears that IMK does not develop solely as a function of grade level (although this did have an effect). There was great variability in this skill between the children in each grade, despite their similar ages and instructional experience. IMK score had a significant effect on the ability to represent both morphemes of inflected words in spelling. Also, it was IMK score (rather than grade level) that distinguished the children who could explicitly analyse the internal morphological structure of words from those who could not. This result can provide evidence about the origin of the difficulties that some children experience with inflected and derived words. If EMK develops solely as a consequence of experience with written language, the "low" grade 1 children should have performed better, not worse, than the "high" kindergarteners. Rubin concludes that it may be a lack of explicit understanding of morphemic structure, in conjunction with a generally weak knowledge of implicit morphology, that accounts for most of the morphological errors made by some children in their early attempts at spelling.

Bryant et al. (1997) used cross-sectional data from their longitudinal study to test whether backward readers would experience difficulty representing two particular morphological spelling sequences compared to normal readers, and whether any such difficulty could be identified as the cause, or the effect, of deficient morphological awareness. As described in section 1.3.1.1.v., the study involved a group of backward readers aged 7 to 9 years, a group of normal readers of the same chronological age, and a group of younger readers whose reading age was matched to that of the backward readers. As previously described, the children were asked to spell regular past tense verbs, which require a final *-ed* spelling; irregular and non-verbs, which require a sound-based spelling, and interrogative pronouns, which usually require the spelling *wh-*. The participants were also administered Nunes et al.'s (1997a) Word Analogy and Sentence Analogy tests of explicit morphological awareness, which had previously proved to be excellent predictors of the ability to spell morphological patterns in normal readers, and are largely free of semantic confounds.

As discussed earlier, the backward readers were significantly worse than the chronological age-match controls at representing morphological spelling patterns, but they were the same as or better than the younger children of the same reading age. To discover whether weak morphological awareness has any role to play in the backward readers' poor performance on morphological spelling patterns, however, we must turn to the results of the Word and Sentence Analogy tasks. The backward readers scored significantly lower on these tasks than did their same-age peers. This result rules out the possibility that (at least on these measures) these children's morphological awareness is normal for their age, and suggests that a "knock-on" effect from their poor phonological skills has delayed their learning of the spelling of morphological patterns.

The backward readers' performance on the tasks of morphological awareness was about the same as that of the reading-level matched children. This suggests that, since both groups had attained roughly the same reading level, the backward readers were not suffering from some inherent weakness with morphological awareness that was preventing them from progressing with their reading. Instead, it seems that their initial difficulties with phonology limit the benefits that they can gain from reading, and thus also limit the opportunities for the development of morphological awareness that reading experience offers.

This conclusion was confirmed in a larger, longitudinal study by Bryant, Nunes, and Bindman (1998). They reasoned that if children who eventually become poor readers do start out with normal levels of morphological awareness, then, if tested early in their reading/writing experience, they should show normal scores on morphological awareness tests, and normal spelling of morphological patterns. They should only become worse than their normal age-mates after several years at school. Problems with phonological awareness, however, should be consistently present. Thus, it could be that it is a child's morphological awareness that determines how easily he or she will learn to represent morphological spelling patterns. Alternatively, causality may go in both directions: experience with reading and writing morphologically based spelling sequences may influence children's explicit morphological awareness, which in turn may affect how they read and write these sequences.

The children were tested in three sessions; Session A, when they were aged 6 to 9 years, Session B, 11 months later, and Session C, 9 months after that. In Sessions A and C they were asked to spell the same verbs, non-verbs and interrogative pronouns as in the study by Bryant et al. (1997). They were also given a standardised single word reading test in these sessions. Their morphological awareness, as measured by the Word and Sentence Analogy tasks, was assessed in Session A and Session B.

A group of children who had been identified as poor readers by Session C was chosen for further study. They were matched to a group of children who had been of the same (poor) reading level in Session A, but who had reached normal levels by Session C (the RL-CA group). They were also matched to a group of younger, normal readers whose reading in Session C matched that of the poor readers (the RL-Y group). The authors wished to see if there had been any differences in performance among the three groups in Session A that could have predicted their later reading ability.

When writing endings which required a sound-based strategy (the irregular and non-verbs) in Session A, the poor readers were significantly worse than the other two groups. However, when it came to writing morphologically based spelling patterns (of regular past verbs and interrogatives) they were as good as, or even better than, the control groups. This led Bryant et al. to argue that although poor readers start off at a disadvantage in representing letter-sound relationships, they have no such early disadvantage with morphologically based spelling patterns. This argument is supported by the children's performance on the morphological awareness tasks. In Session A, the children who went on to become poor readers were just as adept as the RL-CA group, and slightly better than the RL-Y group. By Session C, however, the poor readers had lost their advantage, and all three groups performed about equally.

The results of this study provide further evidence that poor readers do experience difficulty with morphological spelling patterns, and that their morphological awareness lags behind that of other children of the same age. Further, it can explain how this lag develops, and how it might effect the spelling of morphological sequences. As is well documented, these children start out with problems of phonological awareness, and find letter-sound correspondences difficult to grasp. This causes them to lag behind in reading, and thus in the chances they get to develop their morphological awareness. This, in turn, eventually holds back their ability to learn how to represent morphological spelling sequences in their own writing. Finally, the relation could work in the other direction as well; the longer it takes for these children to learn how to spell morphological sequences, the more slowly their later morphological awareness will be able to develop.

This idea of a two-way relationship between morphological awareness and writing ability was supported in a longitudinal study by Levin, Ravid, and Rapaport (1999). They tested 40 Hebrew-speaking children once in kindergarten (when they were aged 5½ to 6½ years) and once in grade 1 (aged nearly 6 to nearly 7 years). These children were not poor readers or spellers, but were reading at a level that would be expected for their age. Nevertheless, this study is presented here, as its conclusions seem to follow on quite directly from those reported in the previous study. At each stage in the present study, the participants were given a spelling test of 32 words which differed in syntactic category, gender, and phonological ending, and three tasks of oral morphology. These tasks required children to fill in the missing word of a sentence with a changed form of target word (e.g., "A baby who looks like an *angel* is an ______ baby" (*angelic*)), to express possessives with a single word (similar to saying in English "My aunt's pen" instead of "The pen of my aunt"), and to express a phrase as a single, compound noun (similar to saying in English "doghouse" for "A house where a dog lives").

The participants' scores on these spoken morphology tasks were found to correlate significantly with their scores on the spelling test in both kindergarten and grade 1. Performance in kindergarten on each of the two types of task was also predictive of performance on the same task in grade 1. Further, this predictive relationship occurred between, as well as within task types. Thus, children's kindergarten morphology scores predicted their grade 1 spelling scores, and kindergarten spelling scores predicted grade 1 morphology scores. Levin et al. conclude that early ability with spoken morphology promotes early writing skill, which in turn promotes further development in ability with spoken morphology. This conclusion is seen to support the view that children can "bootstrap" their way from pre-conventional writing of simple words in kindergarten to conventional, or near-conventional writing in grade 1.

1.4.3. Conclusions about morphological awareness and literacy skills

The results of studies with children, adolescents and adults, of a range of levels of reading and spelling ability, thus confirm that morphological awareness is strongly linked to literacy skills. Further, this link seems strongest when the writer is asked to represent spelling patterns determined by morphology, especially when the level of morphological awareness tested is designed to be relatively explicit. There is some evidence that it is morphological awareness that enhances the development of such skills, but it also seems that facilitation can flow in the other direction as well, so that increasing ability with reading and writing also allows the development of morphological awareness. It seems that the particular problems that poor readers experience with morphology may stem from their initial problems with phonological awareness, which have a "knock-on" effect that inhibits their morphological awareness and morphological spelling abilities as well.

Despite this general consensus from many of the studies, there are also a number of discrepancies between their findings, concerning the nature and time-scale of the development of morphological awareness, and the exact nature of its relation to literacy. Many of these discrepancies probably come from the differences in the tasks used to assess morphological awareness, as well as the different measures of literacy employed. The measures of morphological awareness that have been used vary in their difficulty, their level of explicitness, and the extent to which other variables, such as semantics and phonology, are implicated.

The recent Analogy tasks of morphological awareness developed by Nunes et al. (1997a) seem a particularly useful way to explore the links between children's understanding of morphology and their use of it in their own spelling. These tasks are manageable for even young children, and are free of semantic confounds. Further, they have been shown to presage children's spelling of morphological patterns for nearly two years beyond original dates of testing. So far they have been successful in predicting performance on the past regular inflection *-ed* and the interrogative opening sequence *wh-*, but further experiments will be necessary to see if they are equally successful for other morphological spelling patterns.

1.5. Summary of chapter and questions for research

1.5.1. Summary

The English orthographic system is basically alphabetic, but the presence of several other regularities, especially morphological regularities, makes learning to spell a difficult task for young children. Nearly all models of (English) spelling development hold that young children begin to spell solely on the basis of sound, with no understanding of the need to represent morphological relationships until at least a year after they first learn to write. The process of learning to represent more complex relationships is seen to last throughout primary school, into secondary school, and even into adulthood. There is a large amount of empirical support for this view of morphological representation as a relatively late acquisition. This evidence comes from writers from pre-school to adulthood, of low, average or high ability, in English and in other languages, spelling a range of morphological patterns.

However, more recently there has been evidence presented for an alternative point of view: that children start out with the idea that our orthographic system represents more than just sound, and are able to represent morphology, at least at a simple level, from when they first begin to learn to write. It therefore seems important to determine which of these hypotheses is correct, as evidence to change the widespread acceptance of the "late" acquisition hypothesis would have important consequences not only for a number of models of spelling development, but also for the way in which spelling is taught in schools.

Whether or not children are able to symbolise some aspects of morphology in their earliest attempts to spell, it is clear that over the next decade or so of their experience with the written language, their ability to represent morphological relationships in their spelling improves enormously. The findings from a number of studies suggest that this increasing ability is the result of increasing morphological awareness. Numerous ways of measuring morphological awareness have been developed, each with different advantages and disadvantages. The most successful measure so far seems to be the two Analogy tasks of

Nunes et al. (1997a), performance on which has been shown to predict proficiency at spelling particular morphological patterns nearly two years later. Further experiments will be needed to determine whether these tasks are equally successful at predicting performance on the spelling of other morphological patterns as well.

1.5.2. Questions for research

This thesis sets out to assess some of the claims about when children first begin to represent morphology in their spelling. The more recent argument, that children may make such representations quite early in their writing experience, will be set against the more widespread and better documented idea that morphology is not represented until children have had at least a year, or more, of practice with the English orthography. Experiments will be carried out on children's understanding and representation of the structure of two types of inflected words – past regular verbs and plural nouns, and on some simple derived words.

First, an investigation will be made into children's ability to produce correct endings for regular past verbs when these are presented so as to focus children's attention on, or distract it from, the words' morphological structure. The words will be presented orally, but these changes in attention will be achieved by presenting varying parts of the words visually as well, in a method similar to that used by Beers and Beers (1992).

Second, a study is planned to examine children's spelling of the plural inflection *-s*, in words where it is pronounced /z/ and is therefore impossible to spell correctly on the basis of sound alone. A comparison will be made of how children represent the sound /z/ in word-final position in cases where it functions as a plural inflection (e.g., *jars*) with cases where it is simply part of a monomorphemic word (e.g., *jazz*). Children's representation of the sound /z/ in word-medial position, where there is no morphological rule to determine whether *s* or *z* is the appropriate spelling, will also be examined.

Third, young children's ability to preserve base spellings in simple derived forms will be assessed, by comparing their tendency to use the correct spelling for word-medial /z/ in derived words (e.g., *rosy*, from *rose*) and non-derived words (e.g., *busy*, which has no base form).

Finally, in all of these studies, the participants' morphological awareness will be assessed, via Nunes et al.'s (1997a) Sentence and/or Word Analogy tasks. Variations on the original tasks will be attempted so that the specific type of awareness (e.g., of plural formation) will match the particular type of morphological spelling pattern being assessed. Since the experiments to be carried out will all be cross-sectional, we will not be able to draw conclusions about causal relationships. Nevertheless, on the basis of others' findings, it is predicted that in all cases, the children's ability to represent morphological spelling patterns and to understanding morphological relations will be correlated with their explicit morphological awareness, as measured by the Analogy tasks.

Chapter Two: Experiment 1

Children's spelling of the endings of regular past verbs: The effects of cue morphology and cue length

2.1. Introduction

This experiment was designed to investigate young children's spelling of regular past verb endings. As discussed in section 1.1.2.1., the inflectional ending of these words can be pronounced /t/, /d/, or /ɪd/, but is always spelled *-ed.* Several studies have shown that children take several years to learn to use the *-ed* spelling only for regular past verbs (see section 1.3.1.1.i). These results suggest that children do not understand the stem-plus-inflection structure of regular past verbs until they can employ the *-ed* spelling consistently correctly. However, other studies, which have focused on children's spelling of verb stems, and which have used more lenient scoring criteria, suggest that young spellers already have some understanding of the morphological structure of these words at the time that they first begin to write (see section 1.3.2.).

One way to investigate these two hypotheses is to use a technique developed by Beers and Beers (1992), and to ask children to write regular past verbs with the aid of visual spelling "cues" (see section 1.3.1.1.i.b.). These cues consist of several letters of the verbs and could constitute either the verb's stem morpheme (e.g., *peck*, for *pecked*), or a meaningless fragment that was shorter (e.g., *pe*) or longer (e.g., *pecke*) than the stem, or there could be no spelling cue.

A potential confounding factor in this design is the relative length of the spelling cues. This might have an effect on children's spelling of the verbs' endings, beyond any effect of the morphological status of the cues. Providing part of a word's spelling might make it easier to complete its ending correctly just by lightening the cognitive load required for writing that word. In an attempt to separate the relative contributions of the spelling cues' morphological status and their length to the children's correct use of *-ed*, we varied the type of verb stems included in this experiment.

The words were chosen so that the stems of half the regular past verbs ended in *-e* (e.g., *poke*), and the stems of the other half did not (e.g., *peck*). Thus, half the relatively long spelling cues constituted a verb stem (e.g., *poke* for *poked*), and half did not (e.g., *pecke* for *pecked*). Similarly, half the relatively short spelling cues constituted a verb stem (e.g., *peck*), and half did not (e.g., *pok*).

The two hypotheses about children's understanding of the morphological structure of regular past verbs make different predictions about how children should spell the endings of these verbs across the different types of spelling cue.

The hypothesis that children *do* understand the stem-plus-ending structure of regular past verbs predicts that children's use of the *-ed* inflection will improve when their attention is directed towards this structure (by the presentation of verb stems as spelling cues), and decline when their attention is directed away from this structure (by the presentation of meaningless fragments as spelling cues). The relative length of the spelling cues should not affect performance.

More specifically, the most *-ed* spellings should be written in response to the presentation of the stem morpheme of a verb as a spelling cue. The children should recognise this stem as a morphological unit and be reminded to add to it another morphological unit, *-ed*. Longer or shorter cues should result in significantly less use of *-ed*, since these cues have no morphological meaning, and might divert children's attention from the words' morphological structure. The no-cue condition, although failing to provide any help towards how to spell the word, at least does not violate a morphological boundary. Thus, the children should do no worse, and perhaps even better, at providing the correct endings to verbs presented with no cue at all than to verbs presented with a cue longer or shorter than the verb's stem morpheme.

The alternative hypothesis holds that children begin to use *-ed* correctly only when they have grasped the morphological structure of regular past verbs. If they have not yet understood this structure, then the morphological status of the spelling cues should not affect them. The children's use of *-ed* to complete regular past verbs should therefore not change across the varied types of spelling cue. Alternatively, if the relative length of the spelling cues is important, then the children's correct use of *-ed* should increase with increasing cue length.

We had wanted to include non-verbs in this experiment, matched by sound structure to the regular past verbs (e.g., *blind* matched to *lined*; *frost* matched to *crossed*). Such non-verbs require a sound-based ending of their final /d/ or /t/ sound (i.e. *-d* or *-t*), and would have allowed a comparison with the number of sound-based and *-ed* endings that the children wrote to complete these non-verbs and the regular past verbs. The inclusion of non-verbs would also have allowed a further check on the effects of cue length on the children's spelling of word endings. However, it was not possible to design a cue type for non-verbs that would be equivalent to the longest verb cues (e.g., *pecke* for *pecked*; *poke* for *poked*). Non-verbs with this type of sound structure never have an *e* (or any other letter) between their two final consonants. Thus, this experiment contained only regular past verbs.

The children chosen to participate in this experiment were in school years 1, 2 and 3. Most children begin to learn to use the *-ed* ending during years 2 and 3 (Nunes et al., 1997a; Zutell, 1980), but since Treiman and Cassar (1997) suggest that even beginning writers have some idea of the morphological structure of regular past verbs, we decided to include some children in year 1 as well.

Finally, this experiment included a test of morphological awareness: the Sentence Analogy task developed by Nunes et al. (1997a). Previous research has shown that morphological knowledge is strongly associated with general spelling ability (e.g., Fowler & Liberman, 1995), and especially with the ability to spell morphologically determined spelling patterns (e.g., Carlisle, 1988; Nunes et al., 1997a). It was hypothesised that ability to use the -

ed inflection appropriately would be significantly correlated with morphological awareness score. Those children who were good at using *-ed* correctly were predicted to perform well on the sentence analogy task, and those who made more mistakes in their application of *-ed* were predicted to perform more poorly on the sentence analogy task.

2.2. Method

2.2.1. Participants

The participants were 73 children (37 girls and 36 boys) in years 1, 2 and 3 at a primary school in Oxford, ranging in age from 5;10 to 8;08, with a mean age of 7;04. Data from three of these children had to be omitted from the analysis; one because she did not complete one of the tasks, one because her spelling age was below the 6-year minimum required by the spelling test administered, and one because his spelling age was more than 8 years above his chronological age. This left 70 participants; 35 girls and 35 boys. Fifteen were in year 1, 35 in year 2, and 20 in year 3.

The children completed the Spelling Subtest of the Wechsler Objective Reading Dimensions (WORD) (Rust, Golombok, & Trickey, 1993), and their raw scores were converted to spelling age equivalents. The children were divided into two Spelling Groups on the basis of these spelling ages. Those whose spelling age was below the median of 7;03[1] were allocated to the "Poorer" Spelling Group, and those whose spelling age was equal to or above 7;03 were allocated to the "Better" Spelling Group. The division was made on the basis of spelling age rather than chronological age or school year because there was such a range of spelling ability within each school year and chronological year group. Preliminary analyses on the basis of those two groupings found no significant differences in terms of raw

[1] This median of 7;03 years was some months different from the *mean* spelling age of 7;10 years, as the children's spelling ages were not as evenly distributed as their chronological ages. This turned out to be the case in most of the experiments in this thesis. Nevertheless, we decided that the median was the more appropriate way of dividing the children into two spelling groups, especially since it made them of approximately equal size.

score or spelling age on the WORD, nor on any of the experimental variables, and so spelling age was taken as the best way to group the participants.

Means and standard deviations for the chronological age, spelling age, and standard score on the WORD test for each Spelling Group are shown in Table 2.1.

Table 2.1 Means and standard deviations for Better and Poorer spellers' chronological and spelling ages (SDs in months) and standard score on WORD spelling subtest

	Poorer spellers (n=36)	Better spellers (n=34)	Overall (n=70)
Chronological age	7;02 (8.92)	7;07 (8.70)	7;04 (8.91)
Spelling age (WORD)	6;11 (3.75)	8;09 (10.03)	7;10 (13.44)
Standard score* (WORD)	97.08 (11.25)	114.91 (12.55)	105.74 (14.84)

*Scores on the WORD should be normally distributed, with a mean of 100 and a S.D. of 15

2.2.2. Procedure

The experimenter saw the children in two testing sessions, about one week apart, in a small private area within their school.

2.2.2.1. Session 1: Experimental spelling task

In the first testing session, the experimental spelling task was given to groups of three participants at a time. The task took about 15 to 20 minutes to complete. The children were told they would be doing some writing, and that the words that they would be asked to write would be read aloud once alone, once in a sentence, and once alone again. The experimenter explained that some of the words might be easy and some a bit harder, but that the children should try to write them down as best they could, on the lined paper provided. There were 44 words in all, 32 of which were the experimental words. (The remaining 12 words contained a /z/ sound and acted as fillers, but also contributed pilot data to Experiment 4.)

The stems of half the 32 regular past verbs ended in *-e* ("e-stem" verbs, e.g., *poke*) and the stems of the other half did not end in *-e* ("non e-stem" verbs, e.g., *peck*). Each "e-stem" verb was matched as closely as possible with a "non e-stem" verb for length, frequency (Carroll, Davies, & Richman, 1971), onset complexity, and final consonant. The frequencies used were for present-tense forms, since the experiment investigated children's ability to add the *-ed* suffix to these forms. In half the verb pairs the *-ed* was pronounced as /t/, and in the other half, as /d/. Care was taken to choose verbs whose stems ended in differing letters, so that the children would not have to write the same few final consonant clusters each time. A one-way analysis of variance revealed that there was no significant difference in frequency between "e-stem" and "non e-stem" verbs, whether they ended in a /t/ or a /d/ sound ($F(3, 31)=0.13, p>0.05$). Table 2.2 shows the frequencies for the experimental words.

Table 2.2 Frequencies[2] of the experimental words (Carroll et al., 1971). Frequencies listed for past verbs are those for their present-tense forms.

	End sound			
	/t/		/d/	
Stem type	Word	Frequency	Word	Frequency
e-stem	hoped	59.8	lined	67.7
	smoked	57.5	ruled	60.0
	taped	54.4	blamed	51.2
	chased	51.5	phoned	50.6
	baked	49.4	stared	50.1
	wiped	46.9	tamed	49.7
	poked	44.8	sneezed	46.8
	creased	39.9	snored	40.0
Mean (SD)		50.53 (6.23)		52.01 (8.39)
non e-stem	hopped	50.4	grinned	50.1
	tricked	54.8	rolled	56.8
	tapped	51.9	warmed	62.7
	fussed	45.5	fanned	50.4
	licked	46.6	stirred	52.0
	whipped	48.6	slammed	41.4
	pecked	42.1	buzzed	46.5
	crossed	59.5	purred	43.6
Mean (SD)		49.93 (5.12)		50.44 (6.94)

The experimenter told the children that on each page of her workbook, the word to be written would be printed, but with some or all its letters covered up. She then showed a picture of a boy holding a coloured balloon, and explained that this balloon would sometimes cover up just a little bit of the word, sometimes a bit more, and sometimes the whole of the word. The children were allowed to use the letters that they could see as a "clue" to spelling the word, but would have to guess how to complete the remaining letters themselves. The experimenter presented one word at a time, each on a separate page in an A5-size ring-bound folder. The word was printed in 72-point font in the centre of each page, and the balloon was made from a circle of coloured card pasted over part or all of the word. The boy and the balloon were coloured differently on each page. The children found the stimuli interesting and largely enjoyed the task.

There were four different types of spelling cue. Table 2.3 gives a description and example of the letters contained in each.

Table 2.3 Description and examples of spelling cues at Cue Levels 0, 1, 2, and 3, for regular past verbs whose stems do and do not end in *-e*

		Example	
Cue Level	Letters included	e-stem verbs	non e-stem verbs
0	None	(no cue)	(no cue)
1	Onset and vowel(s)[3]	*po* for *poked*	*pe* for *pecked*
2	All but final *-ed*[4]	*pok* for *poked*	*peck* for *pecked*
3	All but final *-d*	*poke* for *poked*	*pecke* for *pecked*

It should be noted that at Cue Level 2, the spelling cue cut short the morphological stem for e-stem verbs, but preserved it intact for non e-stem verbs. At Cue Level 3, the spelling cue preserved the morphological stem of non e-stem verbs, but was longer than the morphological stem for the e-stem verbs.

[2] Expressed in terms of SFI (Standard Frequency Index), related to estimates of frequency per million. For example, a word with an SFI of 40 would be expected to occur once in every one million tokens.
[3] The spelling cue for the word *warmed* at this Cue Level was *war*, since in the accent of the experimenter and (most of) the participants, the *r* was pronounced as part of the vowel sound, rather than as a following consonant.
[4] If a verb stem ended in a single consonant that was doubled in its past form (e.g., *grin-grinned*), the spelling cue showed only the single consonant.

An example of the workbook pages for the word *poked* at Cue Levels 0 and 2 is shown in Figure 2.1.

Figure 2.1 Stimuli for Cue Level 0 (left) and Cue Level 2 (right), for the experimental word *poked*, shown to participants as separate A5 pages in a ring-bound folder

The experimenter gave the children a practice trial before presenting the experimental words. Each child was presented with four e-stem and four non e-stem verbs (two ending in /t/ and two in /d/) at Cue Level 0, and four of each at Cue Levels 1, 2 and 3. The assignment of the words to Cue Levels was systematically varied, so that an equal number of children saw each of the words at each of the Cue Levels. These words were presented in a different order for each group of children tested.

2.2.2.2. Session 2: Tests of spelling ability and of morphological awareness

The second testing session was conducted with one child at a time, and lasted about 15 minutes. The experimenter administered the Spelling subtest of the WORD. She then gave the children the Sentence Analogy task of morphological awareness. The experimenter introduced the child to two hand puppets, and explained that each time the badger said something, the hippopotamus would copy him, but change one word a little. In each case the badger would "say" a sentence and the hippo would repeat it but with a change to the tense of the verb. The badger would then "say" a second, similar sentence, and the child was asked to "say what the hippo would say", that is, to make the same change to this sentence as the hippo had to the first.

After two practice items (for which feedback was given if necessary), she gave the participants eight sentences to transform. These were presented in a different random order for each child. Some target verbs were regular and others irregular, and some required transformation from present or present continuous to past, or vice versa. Nunes et al. (1997a) note that this variety should transcend any differences in the mechanisms involved in the production and recognition of regular and irregular verb forms (Marcus et al., 1992), and test linguistic knowledge of verbs as a whole. The practice and test analogies were as follows:

<u>Practice analogies</u>

a) She opens the door. She sits down.	She opened the door. ________________.
b) That man made a cake. That man read a book.	That man is making a cake. ______________________.

<u>Test analogies</u>

1. Tom helps Mary. Tom sees Mary.	Tom helped Mary. ______________.
2. Bob gives the ball to Anne. Bob sings a song to Anne.	Bob gave the ball to Anne. ____________________.
3. Jane threw the ball. Jane kicked the ball.	Jane throws the ball. ________________.
4. I felt happy. I was ill.	I feel happy. __________.
5. The dog is scratching the chair. The dog is chasing the cat.	The dog scratched the chair. ______________________.
6. Bob is turning the television on. Bob is plugging the kettle in.	Bob turned the television on. ________________________.
7. The cow woke up. The cow ran away.	The cow wakes up. _______________.
8. She kept her toys in a box. She hung her washing on a line.	She keeps her toys in a box. ______________________.

2.3. Results

2.3.1. Experimental words

2.3.1.1. Correct spellings

The number of times that each child spelled each type of verb correctly with *-ed*, at each Cue Level, was counted. These means are shown in Table 2.4. The means are collapsed across End Sound, since no predictions had been made about the differential effects of this factor, and also so that sufficient means per cell were included to justify analysing the results via analysis of variance.

Table 2.4 Mean number of *-ed* spellings (out of 4) used by Poorer and Better spellers to end e-stem and non e-stem verbs at the four Cue Levels. Standard deviations in parentheses.

Stem Type	Cue Level	Poorer spellers (n = 36)	Better spellers (n = 34)	Overall (n = 70)
e-stem	0	0.72 (1.16)	3.38 (1.04)	2.01 (1.73)
	1	0.78 (1.29)	3.35 (1.12)	2.03 (1.77)
	2	0.78 (3.62)	3.62 (0.89)	2.16 (1.85)
	3	2.19 (1.26)	3.71 (0.68)	2.93 (1.27)
non e-stem	0	0.69 (1.17)	3.32 (1.07)	1.97 (1.73)
	1	0.72 (1.34)	3.41 (0.92)	2.03 (1.78)
	2	0.81 (1.39)	3.44 (0.96)	2.09 (1.78)
	3	2.39 (1.08)	3.74 (0.51)	3.04 (1.08)

It seems from the table that the children produced *-ed* spellings for e-stem and non e-stem verbs approximately equally often. For both types of verb, there appears to be little difference in the number of *-ed* spellings produced at Cue Levels 0, 1, and 2, but the number of *-ed* spellings increases dramatically at Cue Level 3. The fact that this pattern appears to be very similar for both e-stem and non e-stem verbs goes against the hypothesis that these children's use of *-ed* depends on the morphological structure of the spelling cues that they see.

In all cases, it is clear that the Better spellers used the *-ed* ending much more often than did the Poorer spellers.

A repeated-measures analysis of variance (ANOVA) was conducted on these data. It had one between-subjects factor, Spelling Group (Poorer or Better) and two within-subjects repeated measures: Stem Type (e-stem or non e-stem) and Cue Level (0, 1, 2, or 3). The dependent variable was the number of *-ed* spellings produced.

The two Spelling Groups differed significantly in the mean number of *-ed* spellings that they gave to the experimental words ($F(1,68)=113.7, p<0.01$). Better spellers wrote *-ed* significantly more often (mean=28.0, out of 32) than did Poorer spellers (mean=9.08). This was as expected; previous research has shown that it takes several years to learn to use *-ed* consistently correctly, and the Better spellers were clearly further ahead in this learning process than were the Poorer spellers. The main effect for Stem Type was not significant. Thus, the likelihood that the children would use *-ed* to end regular past verbs did not differ depending on whether or not the verb's stem ended in the letter *-e*.

For the effect of Cue Level, the assumption of sphericity was violated. This means that the variances of the differences between all pairs of repeated measures for this factor were not equal, and requires that a correction be made to the degrees of freedom (Everitt, 1996). Even after applying the Greenhouse-Geisser (GG) correction factor, however, the effect of Cue Level remained significant, ($F(1.7,117.5)=44.7, p<0.01$).

The greatest number of *-ed*s written was at Cue Level 3, where all but the final *-d* was presented as a cue (mean=5.97, out of 8). Fewer *-ed*s were written at Cue Level 2 (all but final *-ed* presented, mean=4.24), at Cue Level 1 (onset and vowel/s presented, mean=4.06), and at Cue Level 0 (no cue, mean=3.99). Newman-Keuls post-hoc tests showed that significantly more *-ed* endings were written for verbs presented at Cue Level 3 than for verbs at any other Cue Level ($p<0.01$). There were no further significant differences between Cue Levels. Thus, if all but the last letter of a word was presented as a spelling cue, children were significantly better at providing the correct ending than if a smaller fragment (whether or not it constituted a morpheme) was presented, or if there was no cue.

This main effect reveals that cue length affected the children's spelling of regular past verb endings, but it does not indicate whether or not the morphological status of the cues also played a role. The "morphological understanding" hypothesis predicted that the interaction between Stem Type and Cue Level would be significant. However, it was not. Thus, the children's correct use of *-ed* was apparently not affected by the morphological structure of the spelling cues presented.

Cue Level did interact significantly with Spelling Group, $F(1.7,117.5)=20.12, p<0.01$, with GG corrected degrees of freedom. The means for this interaction are shown in Figure 2.2.

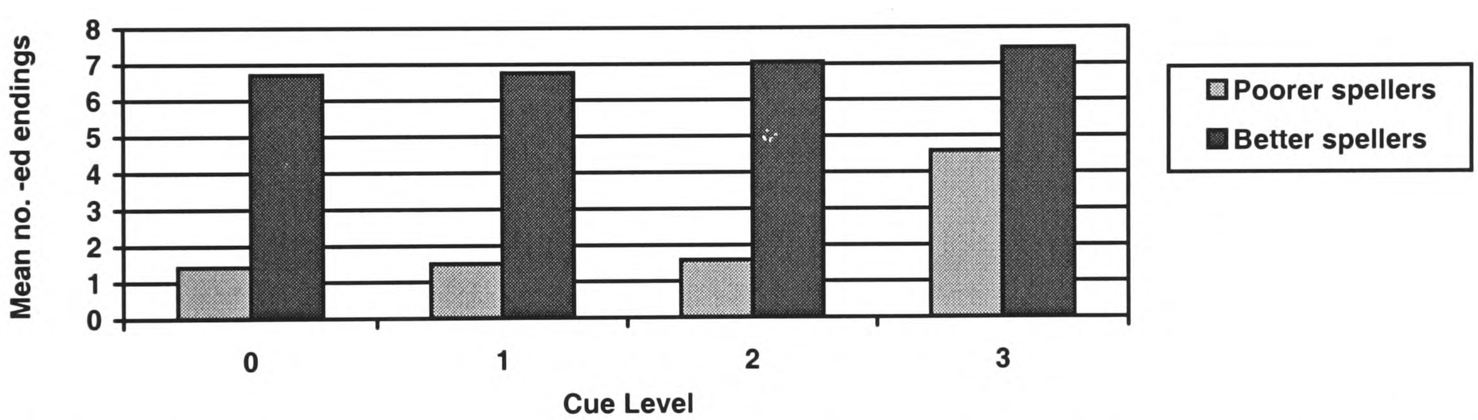

Figure 2.2 Mean number of *-ed* endings (out of 8) written by Better and Poorer spellers, across the four Cue Levels.

Newman-Keuls post-hoc tests revealed that Better spellers wrote significantly more *-ed* endings than did Poorer spellers at each of the four Cue Levels ($p<0.01$). The Poorer spellers wrote *-ed* significantly more often at Cue Level 3 than at any of the other Cue Levels ($p<0.01$), which did not differ significantly. The Better spellers wrote *-ed* significantly more often at Cue Level 3 than at Cue Levels 1 and 0 ($p<0.05$), but showed no other significant differences across Cue Levels. However, it appears from the figure that the difference between the Spelling Groups across Cue Levels could be caused by ceiling effects. The

Better spellers performed so close to ceiling at Cue Level 3 that they could not have gained as much benefit from this type of cue as the Poorer spellers.

2.3.1.1.i. *Effects of end sound?*

It is possible that the elevated number of *-ed* endings produced by the Poorer spellers at Cue Level 3 was not caused by these relatively long cues making it easier for the children to remember to use the *-ed* ending. It could instead result simply from these children providing a phonetic spelling to the verbs ending in the sound /d/ (e.g., the addition of *-d* to *snore-* to produce *snored*). The *-ed* ending could not have been similarly achieved for verbs ending in the sound /t/ (e.g., *poke* for *poked*), as a phonetic spelling would produce a word with the incorrect ending (e.g., *poket*).

To check for differences between the number of *-ed* endings produced for verbs ending in /t/ and in /d/ across Cue Levels, these means were compared for the two Spelling Groups. A repeated-measures ANOVA was conducted on these data, with one between-subjects factor, Spelling Group (Poorer or Better) and two within-subjects factors, End Sound (/t/ or /d/) and Cue Level (0, 1, 2, or 3). Stem Type was omitted as a factor, since the first ANOVA had shown that it had no effect on the number of *-ed* endings produced. Collapsing across e-stem and non e-stem verbs also meant that there were still enough means per cell to justify an ANOVA. The relevant means are shown in Figure 2.3.

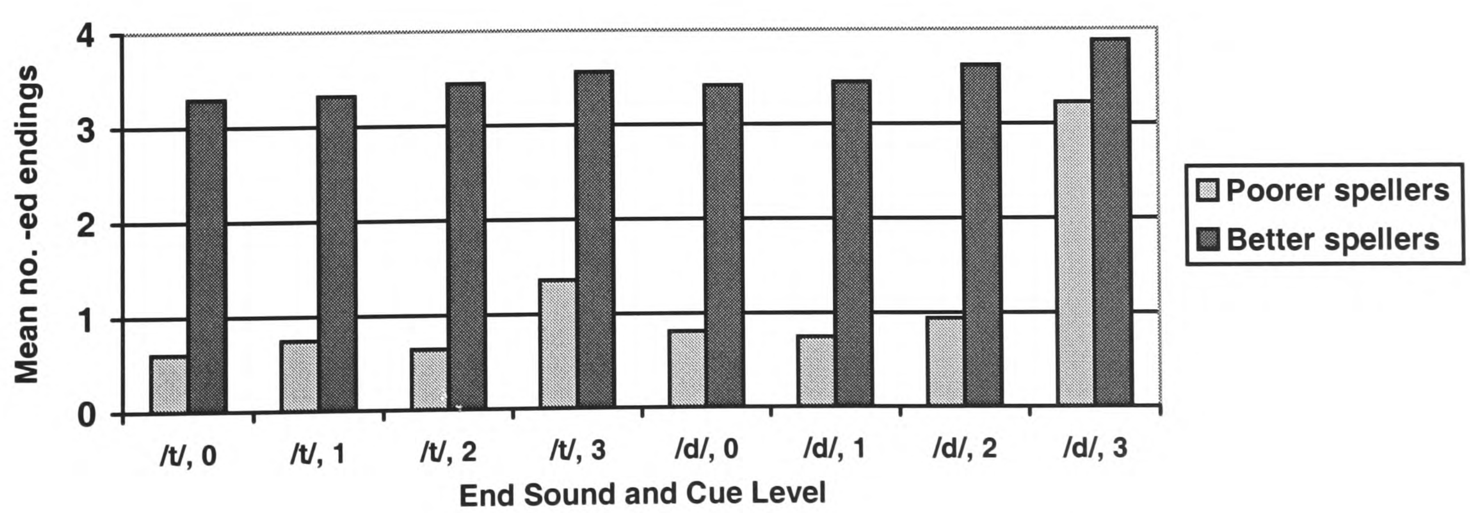

Figure 2.3 Mean number of *-ed* endings (out of 4) written by Better and Poorer spellers for verbs ending in /t/ and in /d/, across the four Cue Levels.

The analysis revealed a significant main effect of End Sound, $F(1,68)=29.3$, $p<0.01$, and significant interactions between End Sound and Spelling Group, $F(1,68)=8.08$, $p<0.01$ and End Sound and Cue Level, $F(2.4,164.3)=21.9$, $p<0.01$ (with GG correction for violation of the assumption of sphericity). However, of greatest interest was the significant three-way interaction between End Sound, Spelling Group, and Cue Level, $F(2.4, 164.3)=14.0$, $p<0.01$ (with GG correction), whose means are shown in Figure 2.3.

Newman-Keuls post-hoc tests indicated a number of significant differences between the means. First, the Better spellers wrote the *-ed* pattern significantly more often than the Poorer spellers in all cases ($p<0.01$). Second, at Cue Level 3, the Poorer spellers wrote *-ed* significantly more often for verbs ending in /d/ than for verbs ending in /t/ ($p<0.01$), but there was no significant difference for the Better spellers. The differences between /d/ verbs and /t/ verbs at the other three Cue Levels were not significant for either Spelling Group.

There were also some significant changes in the number of *-ed* spellings produced across Cue Levels. When the Better spellers wrote verbs ending in /t/, there were no significant difference in across Cue Levels. When the Better spellers wrote verbs ending in /d/, they produced significantly more *-ed* endings at Cue Level 3 than at Cue Levels 1 and 0 ($p<0.05$), but there were no further differences across the other Levels.

When Poorer spellers wrote verbs ending in /t/, they produced significantly more *-ed* spellings at Cue Level 3 than at any other Cue Level ($p<0.01$). These other Levels did not differ significantly from each other. The pattern was the same when Poorer spellers wrote verbs ending in /d/. Overall, these results suggest that although the use of *-ed* by both Poorer and Better spellers may have been boosted by some children's phonetic responses producing *-ed* endings for /d/ verbs, this cannot be the whole story. The results from Poorer spellers writing /t/ verbs suggests that Level 3 cues did remind at least some children to use the *-ed* ending.

2.3.1.1.ii. Individual differences in the use of -ed

The raw data were inspected to discover how many of the children were indeed able to use the *-ed* ending. Nine children produced *-ed* spellings only for words ending in a /d/ sound presented at Cue Level 3, such as *sneeze-* and *buzze-*. It is almost certain that these *-ed* endings do not represent the children's budding use of the correct inflection, but merely the result of their adding a phonetic ending, *-d*, to the *-e* provided in the cue. The remaining 27 Poorer spellers did show some deliberate use of the *-ed* inflection (i.e., for verbs other than those ending in /d/ presented at Cue Level 3). Most wrote *-ed* deliberately one to six times, and a few children wrote it 20 or more times. Eleven of the Better spellers used the *-ed* inflection correctly every time, while the remaining 23 used it mostly between 22 and 31 times, and a few less than 20 times. Thus, well over two-thirds of the children tested had learned of the existence of the *-ed* inflection, but were still learning exactly when it is appropriate to apply it.

Five children (on one occasion each) added *-ed* to verb stems which already ended in *-e* and which were presented at Cue Level 2, to produce spellings such as *snoreed* (for *snored*) and *creaseed* (for *creased*). These children were obviously aware of *-ed* as a cohesive unit for spelling /t/ or /d/, but this does not necessarily mean that they were aware of its unique morphological role. Only six children (on one or two occasions each) failed to produce any representation of the *-ed* inflection.

2.3.1.2. Phonetic spellings

The mean number of times that each type of experimental word was incorrectly completed with a phonetically appropriate ending (*-t* or *-te* for /t/, *-d* or *-de* for /d/), rather than the *-ed* inflection, was also counted. However, if children did not use *-ed* to end a verb, they almost always used a phonetic ending instead. Thus, the main effects, interactions, and post-hoc tests from an analysis of variance conducted on these means were all essentially the "opposite" of those discussed for the "correct" analysis. Thus, these means and their analysis will not be reported.

2.3.2. Morphological awareness

The number of sentences (out of 8) in the task of morphological awareness in which the children were successful in transforming the tense of the target verb were counted. The Better spellers had a mean score of 4.71 (SD=2.08), and a one-way ANOVA revealed this performance to be significantly better than that of the Poorer spellers, whose mean score was 3.06 (SD=2.20) ($F(1,69)=10.4$, $p<0.01$).

2.3.3. Correlations and regression analyses

Pearson correlation coefficients were calculated between scores on the sentence analogy task and chronological age, spelling age, standard score on WORD, and mean number of verbs whose endings were written correctly and incorrectly. Table 2.5 shows these data.

Table 2.5 Correlations between Sentence Analogy score and measures of age, spelling ability, and use of appropriate (*-ed*) and inappropriate (phonetic) verb endings

	Analogy score	Chronological age	Spelling age	SS on WORD	*-ed* endings	Phonetic endings
Analogy score	--					
Chron. age	0.18	--				
Spelling age	0.41**	0.31**	--			
SS on WORD	0.30**	-0.37**	0.73**	--		
-ed endings	0.41**	0.41**	0.78**	0.49**	--	
Phonetic endings	-0.36**	-0.37**	-0.74**	-0.47**	-0.97**	--

**$p<0.01$

It is apparent from the table that the children's spelling age correlated much more strongly and positively with their scores on the other measures than did their chronological age. This again constitutes support for the decision to group participants according to their spelling skill, rather than their chronological age.

The table shows that, as before, the children's scores on the Sentence Analogy task correlated significantly with every other measure, except their chronological age. However, the children's chronological age (as well as their spelling age) correlated significantly and positively with their ability to apply the *-ed* inflection correctly to past verbs. Thus, a regression analysis was conducted to see if the relationship between morphological awareness and ability to spell verb endings correctly would still hold when we controlled for chronological age. Because spelling age was also correlated strongly with this variable, we also included spelling age in the analysis. Chronological age was entered as the first step of the analysis, spelling age as the second, and analogy task score as the third. The outcome measure was the number of *-ed* endings produced. The results are shown in Table 2.6.

Table 2.6 Multiple regression analysis for number of *-ed* endings written appropriately, with chronological age, spelling age and score on analogy task entered in fixed order

Outcome measure	Verbs spelled with *-ed*			
Variable and order entered	r^2 change	*B*	S.E. *B*	beta
1. Chron. age	0.167**	0.242	0.104	0.179
2. Spelling age	0.472**	0.613	0.074	0.686
3. Analogy score	0.007	0.488	0.423	0.093

**$p<0.01$

Table 2.6 shows that when chronological age and spelling age are entered first, analogy score no longer predicts the number of verbs spelled correctly with the *-ed* inflection. Another regression analysis was therefore conducted, to see if analogy score would account for any of the variance in *-ed* use if entered before spelling age. The results for this analysis are shown in Table 2.7.

Table 2.7 Multiple regression analysis for number of *-ed* endings written appropriately, with chronological age, score on analogy task and spelling age entered in fixed order

Outcome measure	Verbs spelled with *-ed*			
Variable and order entered	r^2 change	*B*	S.E. *B*	beta
1. Chron. age	0.167**	0.242	0.104	0.179
2. Analogy score	0.115**	0.488	0.423	0.093
3. Spelling age	0.365**	0.613	0.074	0.686

**p<0.01

Table 2.7 shows that when controls are made for chronological age, and Sentence Analogy task score is entered as the next step in the regression analysis, this analogy score can significantly predict children's successful use of the *-ed* inflection in their spelling. When spelling age is entered as the third step, it still accounts for a significant amount of the variance in *-ed* use. Thus, although spelling age appears to be the best predictor of children's correct use of the *-ed* inflection, it seems that both chronological age and morphological awareness (as measured by the Sentence Analogy task) are also important.

2.4. Discussion

This experiment aimed to test the understanding of the morphological structure of regular past verbs by children who are still in the process of learning when to use *-ed* appropriately. The children tested were indeed in this process. Overall, they used *-ed* appropriately more often than not, but few of them had yet learned to make the correct choice of ending for every word.

In section 2.1., two hypotheses were put forward. The first was that children are aware of the morphological structure of regular past verbs, and it predicted that their use of the *-ed* inflection would change across spelling cues of varying morphological status. The second hypothesis was that children in the first few years of school do not understand the morphological structure of regular past verbs. It thus predicted that children's use of *-ed* would not vary with the presentation of spelling cues of varying morphological status, or that their use of *-ed* would increase only with increasing cue length.

The second hypothesis was supported. The lack of a significant interaction between Stem Type and Cue Level meant that these children's correct use of *-ed* did not vary according whether or not the spelling cues they saw constituted a verb stem.

It is possible that the children's knowledge of the spelling of the experimental verbs' stems was simply not good enough for them to be affected by the presence or absence of a final *-e* in a verb stem. Any child who did not yet know, for example, that the verb stem *poke* is spelled with a final *-e*, and that *peck* is not, would not be sensitive to the changes in the morphological status of these cues across Cue Levels. However, if the non-significance of the interaction between Stem Type and Cue Level were attributable simply to some children's poor familiarity with the spelling of the verb stems, then we would expect a significant interaction between these two factors and Spelling Group. The use of *-ed* by the Better spellers (presumably more familiar with the spelling of the verb stems) would depend much more on the combination of Stem Type and Cue Level than would the use of *-ed* by the Poorer spellers (who would be less familiar with how to spell the verb stems). Since this interaction was not significant, we must conclude that morphological structure had little or no effect on the spelling of regular past verb endings by the children in this experiment.

If the children's use of *-ed* was not influenced by the morphological structure of the spelling cues with which they were presented, we must ask whether it was influenced instead by the relative length of these cues. The effect of Cue Level was significant, and it also interacted significantly with Spelling Group. The Better spellers' use of *-ed* increased only very gradually with increasing cue length (from Level 0 to Level 3), and only some of the differences between Cue Levels reached significance. The Poorer spellers' use of *-ed* did not vary so gradually. They used *-ed* significantly more often at Cue Level 3 than all the other Cue Levels, between which there were no further significant differences. Thus, it seem that the relatively high number of *-ed* spellings produced at Cue Level 3, especially by the Poorer

Spellers, resulted from the final *-e* of these cues reminding the children to use the *-ed* inflection. Cue length did have an effect, but only for the very longest cues.

However, an alternative explanation is also possible. It could instead have been caused by the children using a phonetic spelling strategy to complete verbs with a final /d/ sound (see section 2.3.1.1.i.). Even the children who were not yet familiar with the *-ed* pattern could have achieved an *-ed* spelling for these words simply by adding the phonetic ending *-d* to the Level 3 cues (e.g., *snore* for *snored*). This would not have occurred for verbs with a final /t/ sound, as a phonetic spelling strategy would produce such incorrect spellings as *poket* for *poked.* The Better spellers showed no significant differences across Cue Levels in the number of *-ed* spellings produced for verbs with a final /t/ sound. For verbs with a final /d/ sound, they showed only a small (although significant) increase in the number of *-ed* spellings produced at Cue Level 3 compared with Cue Levels 1 and 0. Thus, the fortuitous achievement of *-ed* spellings by phonetic spellers probably accounts for only a few of the correct endings produced by Better spellers at Cue Level 3.

The Poorer spellers, in contrast, produced a much greater number of *-ed* spellings for verbs with a final /d/ sound at Cue Level 3 than at any other Cue Level. There were no further significant differences between Cue Levels. This suggests that the fortuitous achievement of *-ed* spellings made a major contribution to the relatively high use of *-ed* at Cue Level 3 by Poorer spellers. However, the number of *-ed* spellings that they produced for verbs with a final /t/ sound was also significantly (even if not so dramatically) greater at Cue Level 3 than at any other Cue Level. Thus, it seems that the deliberate use of the correct inflectional ending also contributed to the Poorer spellers' elevated use of *-ed* for verbs presented at Cue Level 3.

It is possible that the inclusion of only one type of word (regular past verbs) in this experiment decreased the effectiveness of the spelling cues presented. The only ending appropriate for all the words included (apart from the 12 filler words with a /z/ sound) was -*ed.* Children who had learned about the *-ed* inflection might have realised after a while that it was the only appropriate way to complete every word in the test. They would therefore have been only minimally affected by changes in Cue Level, except for in the "extreme" case of Cue Level 3. This possibility should be examined by asking another group of children to spell the same regular past verbs as in the present experiment, but to include a set of non-verbs as well, so that the children had to choose between an *-ed* or a phonetic spelling each time.

Finally, the children's score on the Sentence Analogy task correlated significantly and positively with their ability to apply the *-ed* inflection correctly to the end of regular past verbs, as well as with their spelling age (although not their chronological age). Thus, the children who were good at transforming verbs from one tense to another were also good at using morphologically appropriate word endings. A regression analysis showed that analogy score continued to predict the correct use of *-ed*, even when we controlled for chronological age and spelling age, provided that analogy score was entered as the second step of the analysis and spelling age as the third. When spelling age was entered before analogy score, analogy score no longer significantly predicted the correct use of *-ed*. These findings suggest that spelling age has a large part to play in determining children's ability to use the *-ed* spelling pattern correctly. However, they also suggest that both chronological age and morphological awareness (as measured by the Sentence Analogy task) also play an important role.

Chapter Three: Experiment 2

Children's spelling of the endings of regular past verbs and non-verbs: The effects of cue morphology and cue length

3.1. Introduction

The first experiment showed that children's correct use of the *-ed* inflection was not influenced by the morphological status of the spelling cues with which they were presented. Instead, the number of *-ed* endings increased significantly only when the spelling cue provided all but the last letter of the regular past verb to be written (e.g., *poke* for *poked*; *pecke* for *pecked*). However, since the only words included in Experiment 1 were regular past verbs, it is possible that the children soon became accustomed to providing the same kind of ending (*-ed* or otherwise) to each experimental word, regardless of the morphological status of the accompanying spelling cue. The relative length of the spelling cues may have been more salient, and thus more likely to exert an influence on the children's spelling.

Thus, in this second experiment, another group of children was asked to spell the same set of regular past verbs as in Experiment 1, but the same number of matched non-verbs was also included. It was hoped that this would provide a better test of the relative effects of cue morphology and length on children's use of the *-ed* inflection.

The large number of words involved in this comparison had to be administered in two separate testing sessions. Since it was not possible to see the children on more than two occasions, their spelling ages and morphological awareness scores were not measured.

3.2. Method

3.2.1. Participants

The initial participants in this experiment were in years 1, 2, and 3 at two primary schools in Oxford. However, all of the children in year 1 at these schools, and also some of the children in year 2, found the experimental words very difficult, and did not manage to write more than a handful in the first testing session. For this reason, some participants from year 4 were also included, so that 72 children from school years 2 to 4 acted as participants in the first session. Seven of these participants did not want to attend the second session, which left 65 participants in all. There were 39 girls and 26 boys, ranging in age from 6;06 to 9;00. The mean age was 7;09 (SD=7.85 months). Eleven of the participants were in year 2, 31 were in year 3, and 23 were in year 4.

Because of the constraints on the number of testing sessions available, the Wechsler Objective Reading Dimensions Spelling Subtest could not be administered. Thus, the participants were not divided into "Poorer" and "Better" spellers. There was too much variation in ability between age and year groups to divide children by either of these categories, so the participants were considered as a single group for this experiment. The previous experiment had not revealed any striking qualitative difference in the way that the two Spelling Groups responded to the varying Cue Levels (the interaction in Experiment 1 was probably due mostly to the Better spellers' scores approaching ceiling). Thus, considering all the participants together should not conceal any important effects.

3.2.2. Procedure

The experimenter saw the children in two separate testing sessions, about three days apart, in a small private area within their school. Half the experimental words were presented in the first session, and the other half in the second session, and the procedure was the same for each. The experimental words were presented to two, three or four participants at a time, depending on their age (the younger children required more individual attention and encouragement). Each session lasted between 12 and 25 minutes.

As in the previous study, the children were told that they would be doing some writing, and that each word to be written would be read aloud once alone, once in a sentence, and once alone again. The experimenter explained that some of the words would be easy and some a bit harder, but that the children should try to write them down as best they could, on the lined paper provided. She presented 82 words over the two sessions, 64 of which were the words of interest to the present study. (The remaining 18 words contained a /z/ sound and acted as filler words, but they were also designed to provide the data discussed in Experiment 8).

Thirty-two of the words were the same regular past verbs that had been presented in Experiment 1. The stems of half these verbs ended in *-e* (e.g., *poke*), and the stems of the other half did not end in *-e* (e.g., *peck*). Within each type of verb, half were pronounced with a final /t/ sound (e.g., *poked*), and half with a final /d/ sound (e.g., *snored*). For each of these 32 regular past verbs, a non-verb was chosen, matched as closely as possible for length, frequency, onset complexity, and final consonant cluster. In some cases non-verbs of two syllables had to be selected, and in others the final consonant clusters were not identical. However, most pairs were similar, and there was no significant difference in frequency across any of the word types – verb or non-verb, e-stem or no e-stem, /t/ or /d/ ($F(7,63)=0.30$, $p=0.95$). The words and their frequencies are shown in Table 3.1.

Table 3.1 Frequencies of the experimental words (Carroll et al., 1971). Frequencies listed for past verbs are those for the present tense of those verbs.

		Word Type			
		Regular past verbs		Non-verbs	
Stem Type (verbs only)	End Sound	Word	Frequency	Word	Frequency
e-stem	/t/	hoped	59.8	Egypt	53.6
		smoked	57.5	contact	52.7
		taped	54.4	pest	41.7
		chased	51.5	chest	55.7
		baked	49.4	fact	62.4
		wiped	46.9	craft	51.8
		poked	44.8	perfect	56.7
		creased	39.9	crust	53.1
		Mean (SD)	50.53 (6.66)	Mean (SD)	53.46 (5.82)
	/d/	lined	67.7	blind	54.4
		ruled	60.0	shield	48.3
		blamed	51.2	grand	52.5
		phoned	50.6	friend	61.8
		stared	50.1	guard	54.2
		tamed	49.7	pound	55.4
		sneezed	46.8	weird	46.6
		snored	40.0	sword	51.0
		Mean (SD)	52.01 (8.39)	Mean (SD)	53.02 (4.69)

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		Word Type			
		Regular past verbs		Non-verbs	
Stem Type (verbs only)	End Sound	Word	Frequency	Word	Frequency
non e-stem	/t/	hopped	50.4	except	61.3
		tricked	54.8	strict	48.4
		tapped	51.9	quest	43.8
		fussed	45.5	vest	44.4
		licked	46.6	insect	54.3
		whipped	48.6	raft	52.0
		pecked	42.1	correct	61.6
		crossed	59.5	frost	51.3
		Mean (SD)	49.93 (5.12)	Mean (SD)	52.14 (6.79)
	/d/	grinned	50.1	ground	64.3
		rolled	56.8	bald	46.3
		warmed	62.7	wand	41.2
		fanned	50.4	brand	49.2
		stirred	52.0	third	62.4
		slammed	41.4	fond	51.4
		buzzed	46.5	beard	51.2
		purred	43.6	curd	39.2
		Mean (SD)	50.44 (6.94)	Mean (SD)	50.65 (9.00)

As in Experiment 1, the experimenter showed her workbook and the picture of the boy with his balloon to each group of participants. She explained that the balloon would cover up some or all of each word to be spelled, and that the children would have to write down the whole word, and guess how to spell the covered-up letters. The four Cue Levels for verbs were the same in Experiment 1, and the cues were presented in the same way as in that experiment (see section 2.2.).

Equivalent cues were created for the non-verbs at Cue Levels 0, 1, and 2, but an equivalent to the verbs' Cue Level 3 was not possible. Non-verbs of the type used in this experiment do not have an intervening letter (*e* or any other) between their two final consonants (compare *crossed* and *frost*; *lined* and *blind*). Because the verbs and non-verbs needed to be counterbalanced across conditions, a different Cue Level was developed for non-verbs, which consisted of only the word's onset. To ensure that the numbering of the Cue Levels remained comparable between verbs and non-verbs, this new type of cue is referred to as "Cue Level ½". The Cue Levels for both types of word are explained in Table 3.2.

Table 3.2 Description and examples for Cues Levels 0, ½, 1, 2, and 3, for regular past verbs and matched non-verbs

		Example	
Cue Level	Letters included	Regular past verbs	Non-verbs
0	None	(no cue)	(no cue)
½	Onset	--	*gr* for *ground*
1	Onset and peak	*gri* for *grinned*	*grou* for *ground*
2	All but final *-ed*[1] or *t/d*	*grin* for *grinned*	*groun* for *ground*
3	All but final *-d*	*grinne* for *grinned*	--

As in Experiment 1, the spelling cues presented at Cue Level 2 constituted the stem morpheme of the non e-stem verbs but not the e-stem verbs, whereas the spelling cues at Cue Level 3 constituted the stem morpheme of the e-stem verbs, but not the non e-stem verbs.

The experimenter gave the participants three practice words to spell before presenting the experimental words. Each child was presented with four e-stem verbs and four non e-stem verbs, two of each ending in /t/ and two in /d/, at Cue Levels 0, 1, 2, and 3. Each child also saw eight matched non-verbs, four with a final /t/ sound and four with a final /d/ sound, at Cue Levels 0, ½, 1 and 2. The assignment of words to each Cue Level was systematically varied, so that an equal number of children saw each of the words at each of the four Cue Levels. The experimental words were presented in a different order for each group of children tested.

3.3. Results

3.3.1. Correct spellings of the experimental words

The participants' representations of the experimental words' endings were coded and scored as in the previous experiment. Spellings considered to be correct were *-ed* for verbs and phonetic spellings (*-t* or *-te* for /t/, *-d* or *-de* for /d/) for non-verbs. The mean number of

[1] As in the previous experiment, if a verb's stem ended in a single consonant that was doubled in its past form (e.g., *grin-grinned*), the spelling cue showed only the single consonant.

times that the participants used a correct ending to complete the regular past verbs and the non-verbs at each Cue Level is shown in Table 3.3. As before, these means are collapsed across End Sound.

Table 3.3 Mean number of correct spellings (out of 8) used to end verbs (e-stem and non e-stem, out of 4) and non-verbs across Cue Levels. Standard deviations in parentheses.

Word Type	Cue Level	Stem Type (out of 4)		Overall (out of 8)
Verbs		e-stem	non e-stem	
	0	1.46 (1.73)	1.34 (1.61)	2.80 (3.28)
	1	1.49 (1.66)	1.31 (1.63)	2.80 (3.22)
	2	1.49 (1.79)	1.49 (1.71)	2.98 (3.43)
	3	2.91 (1.23)	2.88 (1.05)	5.78 (2.12)
Non-verbs				
	0			6.42 (1.69)
	½	(not applicable)		6.52 (1.61)
	1			6.51 (1.50)
	2			6.18 (1.86)

It is clear from the table that the children produced correct endings much more often for the non-verbs than for the regular past verbs. This was to be expected, on the basis of both the results of the previous experiments, and of previous research, which has shown that it takes children several years of writing experience before they shift from spelling word-final /t/ and /d/ according to their sound, to using morphologically appropriate spellings.

There appears to be only a slight difference between the number of correct endings provided for the e-stem and non e-stem verbs. For both these types of verbs, the number of -*ed* spellings does not seem to have changed much across Cue Levels 0, 1, and 2. However, a large increase is evident at Cue Level 3. These results agree with those of Experiment 1.

These children used the *-ed* inflection correctly less often than the children in Experiment 1 (see Table 2.4). However, it is interesting to note that the correct use of *-ed* at Cue Level 3 was very nearly the same in both experiments. The presentation of all but the last letter of the verb to be spelled obviously had a particularly dramatic effect on the *-ed* use of the children in the present experiment. Finally, the children's correct spelling of non-verb endings does not appear to have changed much across Cue Levels, although there are slightly fewer at Cue Level 2 than at the other three Levels.

These children seemed to be much poorer spellers than those in the previous experiment. Although the spelling ages of the children in the present study were not available, a comparison could be made between the number of verbs spelled correctly overall here and the number spelled correctly overall in Experiment 1 (the words were the same in both cases). The children in the present experiment were, on average, about four months older than those in Experiment 1. However, the mean numbers of verbs spelled correctly by the present experiment's participants was 11.3 (out of 32) respectively, compared with 19.6 in Experiment 1.

Separate analyses were carried out on the number of correct endings provided for verbs and non-verbs in the present experiment. It was not possible to analyse the two Word Types together, because the verbs were divided according to Stem Type (e-stem and non e-stem), but the non-verbs could not be thus divided. Also, the four Cue Levels were not the same for the two Word Types.

3.3.1.1. Verbs

The first analysis of variance (ANOVA) assessed differences in the number of *-ed* spellings produced correctly for verbs, across conditions. The analysis had two within-subjects repeated measures, Stem Type (e-stem or non e-stem), and Cue Level (0, 1, 2, and 3). End Sound was not included as a term in the analysis, since dividing the responses by this factor as well as by Stem Type and Cue Level would leave only two means per cell, which is not sufficient to justify an ANOVA.

As in Experiment 1, there was no significant effect for Stem Type. Whether or not a verb's stem required a final *-e* did not affect the overall number of *-ed* endings written. There was a significant main effect of Cue Level. However, as in the previous experiment, this effect violated the assumption of sphericity, and a Greenhouse-Geisser (GG) correction was therefore applied to the degrees of freedom for this effect. Nevertheless, the effect of Cue Level remained significant, $F(1.6,100.9)=82.1$, $p<0.01$. The mean number of *-ed* endings given to verbs presented at Cue Level 3 was 5.78 (out of 8), but this dropped across the other Cue Levels to 2.98 at Level 2, 2.80 at Level 1, and 2.80 at Level 0.

Newman-Keuls post-hoc tests showed that this effect was caused by the children writing significantly more *-ed* endings for verbs presented at Cue Level 3 than for verbs presented at any other Cue Level ($p<0.01$, for all). There were no other significant differences between Cue Levels in the number of *-ed* endings given.

As in Experiment 1, the interaction between Cue Level and Stem Type did not reach significance. Thus, even when non-verbs were re-introduced to the experimental design, the children's use of the *-ed* inflection was not affected by the morphological status of the spelling cues. Even the length of the spelling cues affected *-ed* use only in the most extreme situation, when all but the last letter of the word was presented as a cue.

3.3.1.1.i. Effects of end sound?

It is possible that much or all of this elevated use of *-ed* at Cue Level 3 came from the participants just adding the phonetic ending *-d* to verbs with a final /d/ sound (e.g., *snore* for *snored*). Thus, it was necessary to compare the mean number of *-ed* endings written for verbs ending in /d/ with the mean number written for verbs ending in /t/. To be able to make this comparison statistically, we included End Sound as a term in a new ANOVA, but collapsed the means across Stem Type, since the previous ANOVA had shown this not to have a significant effect. This meant that there were four, rather than only two, means per cell. This new ANOVA thus had two within-subjects factors; End Sound (/t/ or /d/) and Cue Level (0, 1, 2, or 3).

There was a main effect of End Sound, $F(1,64)=29.1$, $p<0.01$. The children produced significantly more correct *-ed* endings for verbs with a final /d/ sound (mean=7.95, out of 8), 1 than for verbs with a final /t/ sound (mean=6.42). There was also a main effect of Cue Level, but this was the same as that found in the previous ANOVA, and will not be explained again. More important is the finding that End Sound also interacted significantly with Cue Level, $F(1.9,119.3)=29.4$, $p<0.01$ (with GG correction). The means for this interaction are shown in Figure 3.1.

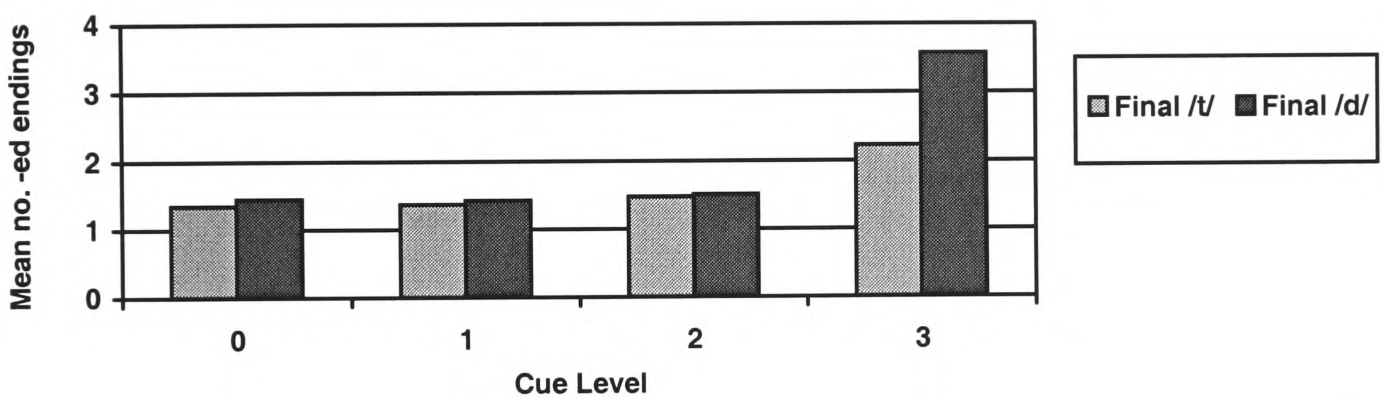

Figure 3.1 Mean number of *-ed* endings (out of 4) written for verbs with a final /t/ sound and a final /d/ sound, across the four Cue Levels.

Post-hoc Newman-Keuls tests showed that at Cue Level 3, the number of correct *-ed* endings produced for verbs with a final /d/ was significantly greater than the number produced for verbs with a final /t/ ($p<0.01$). There were no significant differences between the /t/ and the /d/ verbs at the other Cue Levels. This suggests that at least some children achieved the correct spelling fortuitously for verbs ending in /d/ at Cue Level 3, just by adding phonetic *-d* to the final *-e* of the spelling cue (e.g., *-d* to *snore-*).

However, the pattern of significant differences across Cue Levels was the same for both types of verb. For both verbs ending in /t/ and verbs ending in /d/, the number of correct *-ed* endings written for verbs presented at Cue Level 3 was significantly greater than the number written at any other Cue Level ($p<0.01$). There were no further significant differences across Cue Levels. Since an *-ed* spelling could not have been achieved by adding a phonetic ending to the verbs with a final /t/ sound, this suggests that for at least some children, the Level 3 cues served as a reminder to use the correct *-ed* ending, and did not just allow the fortuitous achievement of *-ed.*

<u>*3.3.1.1.ii. Individual differences in the use of* -ed</u>

The raw data were inspected to see how many of the children had actually been able to use the *-ed* inflection in their spelling. Twelve children achieved an *-ed* spelling only for verbs ending in /d/ presented at Cue Level 3 (e.g., *rule* for *ruled*; *rolle* for *rolled*). It seems likely that these children produced an *-ed* ending for these verbs not deliberately, but fortuitously, simply by having added the phonetic ending *-d* to the *-e* provided at the end of the cue. The remaining 53 children wrote *-ed* spontaneously at least once. The number of *-ed* responses ranged from 4 to 53, but 75% of those children used it between 5 and 40 times. (Since there were only 32 regular past verbs, children who used *-ed* more than 32 times were overgeneralising the spelling pattern to non-verbs as well).

Thus, over 80% of the participants in this experiment were familiar with the *-ed* spelling as a way of representing word-final /t/ or /d/, but were still in the process of learning the appropriate circumstances under which to apply it.

In this experiment there were only two instances of over-rigorous application of the *-ed* ending, resulting in the spellings *creaseed* and *snoreed.* Only five children omitted to make any representation of the *-ed* ending (one to three times each), and this was about the same as the number of times that a non-inflectional ending (*-t* or *-d*) was omitted (by six children, one to three times each).

We now turn to the analysis of the number of correct endings produced for non-verbs.

<u>3.3.1.2. Non-verbs</u>

Because the non-verbs could not be categorised into two different Stem Types, this analysis was able to include the End Sound factor and still retain enough means per cell to justify an analysis of variance. Thus, the ANOVA for these means had two within-subjects factors, End Sound (/t/ or /d/) and Cue Level (0, ½, 1, and 2). Its dependent variable was the mean number of correct phonetic endings that the children provided for the non-verbs. The means considered in this analysis are shown in Figure 3.2.

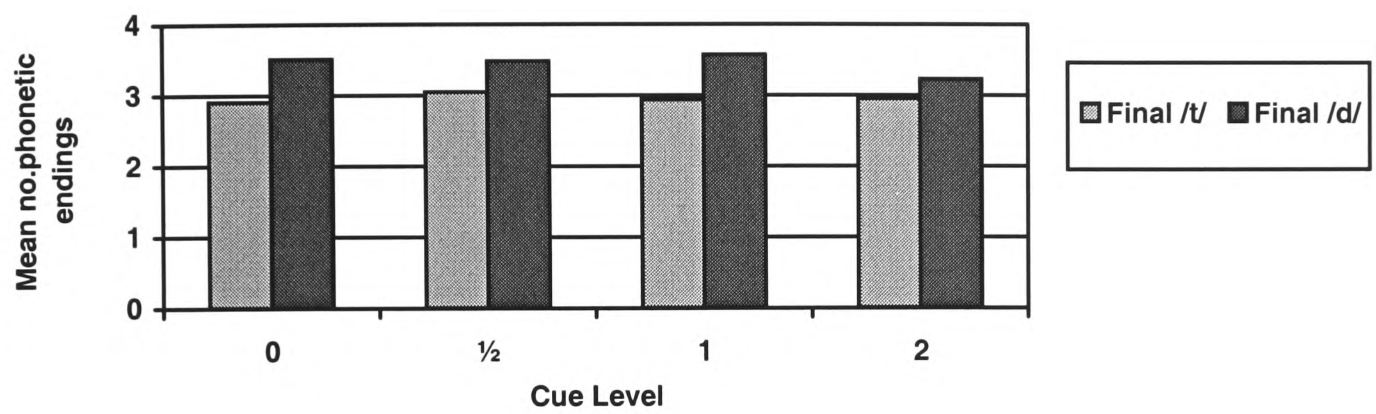

Figure 3.2 Mean number of phonetic endings (out of 4) written for non-verbs with a final /t/ sound and a final /d/ sound, across the four Cue Levels.

The only significant effect for this analysis was for End Sound, $F(1,64)=13.2, p<0.01$. The children produced significantly more correct phonetic endings for non-verbs ending in /d/ (mean=13.8, out of 16), than for non-verbs ending in /t/ (mean=11.9). The children's use of correct phonetic endings for non-verbs did not differ significantly across Cue Levels, and nor was there any significant interaction between End Sound and Cue Level.

3.3.2. Incorrect spellings of the experimental words

The mean number of times that each type of experimental word was completed with an incorrect ending (a phonetic spelling for the regular past verbs, or an *-ed* ending for the non-verbs) was also counted. However, as in the previous experiment, if the children did not use a correct ending, they usually used one of these incorrect endings instead. Thus, most of the main effects, interactions, and post-hoc tests from an analysis of variance conducted on these means were essentially the "opposite" of those discussed for the "correct" analysis.

One exception to this was that there was no significant difference between the number of phonetic endings given to verbs ending in /t/ and verbs ending in /d/ (despite there being significantly more *-ed* endings give to verbs ending in /d/ than in /t/). This discrepancy was caused by the children producing a number of endings for verbs ending in /t/ which were categorisable neither as *-ed* spellings nor as phonetic spellings, such as *-edt* and *-etd.*

The other deviation from the pattern of results found for the "correct" words was that the children showed a difference in their use of *-ed* across Cue Levels (which interacted with End Sound), which they had not shown in terms of their phonetic spellings. This was caused by the children writing significantly more *-ed* endings for non-verbs ending in /d/ presented at Cue Level 2 (e.g., *groun* for *ground*) than for any other type of non-verb. Perhaps some of the children thought that *-ed* was just an alternative spelling of /d/, and were most likely to think of it when the spelling cue made them produce a spelling just for that sound.

3.4. Discussion

This experiment replicated the design of Experiment 1, but included non-verbs as well as past regular verbs to ensure that the participants would have to decide between a phonetic and a rule-based spelling for each word ending. Despite this change, the children's use of *-ed* across different types of spelling cues was the same as in Experiment 1.

There was no significant interaction between whether nor not verb stems ended in *-e* and the type of spelling cue presented. The children used *-ed* more often to complete regular past verbs only when presented with spelling cues which revealed all but the verb's final *-d.* There were no differences in the number of times that *-ed* was used across the other Cue Levels. Thus, these results do not support the "morphological understanding" hypothesis, nor its contention that children in the first few years of school actively analyse regular past verbs into their constituent morphemes of stem and inflectional ending.

As discussed in section 2.4., it is possible that the elevated number of *-ed* spellings produced at Cue Level 3 was caused by participants simply adding the phonetic ending *-d* to the cues presented for verbs with a final /d/ sound (e.g., *rolle* for *rolled*, *rule* for *ruled*).

However, an "End Sound" comparison revealed that the children wrote the *-ed* inflection significantly more often at Cue Level 3 than at any other Level for verbs ending in /t/ as well as for verbs ending in /d/. (This is what was found for the Poorer spellers in Experiment 1, and presumably reflects the lower spelling ability of the participants in the present experiment.) As in Experiment 1, the difference between Cue Level 3 and the other Levels was greater for the verbs ending in /d/. However, the fact that it held for /t/ verbs as well shows that the presence of the *-e* in the Level 3 cues did remind at least some of the participants to use the *-ed* spelling. It did not simply come from the fortuitous achievement of an *-ed* ending by children who added a phonetic *-d* to /d/ verbs presented at this Level.

Thus, it seems that these children were not actively aware of the stem-plus-inflection structure of regular past verbs, and that they did not use this structure in their spelling. However, they were probably beginning to become aware that the endings of regular past verbs are spelled in a way that does not conform to normal spelling-sound rules, and the final *-e* of the Level 3 spelling cues was able to remind them to use this distinctive spelling pattern.

The children's performance in spelling the endings of the non-verbs should also be mentioned. The children usually used the correct (phonetic) endings for these words, and their performance did not differ significantly across Cue Levels. This result could reflect the fact that the cues did not differ in morphological structure, and that therefore the children could not use their understanding of morphological structure to complete some of these non-verbs better than others. An alternative explanation is that since a phonetic spelling strategy is the first one to be used by beginning writers, completing the non-verbs correctly might have been too easy a task to be influenced by Cue Level. This second explanation seems to fit in better with the present results. Although the children's performance did not reach ceiling, they did get most of the non-verb endings correct, regardless of the proportion of the words presented as spelling cues.

One interesting result from the "incorrect" spellings is that the children in this experiment overgeneralised the *-ed* inflection significantly more often to non-verbs ending in

/d/ presented at Cue Level 2 (e.g., *groun* for *ground*) than to any other type of non-verb. As mentioned in section 3.3.2., this could suggest that some of the children thought of *-ed* simply as an alternative spelling for the sound /d/, and were most likely to use it when the spelling cue forced them to think of a spelling for /d/ alone. This would constitute further evidence against the idea that the children considered *-ed* as a morphological unit. However, it should be noted that the participants did not show a similar elevation in *-ed* use at Cue Level 2 for verbs with a final /d/ (e.g., *snor* for *snored*; *purr* for *purred*), which also required the addition of an ending to represent /t/ or /d/. This makes the conclusion from the non-verbs less convincing.

In conclusion then, despite the re-introduction of non-verbs requiring a phonetic ending to this experiment, the children did not appear to be affected by the morphological status of spelling cues when completing the spelling of regular past verbs. It could be argued that the presentation of spelling cues was perhaps not a sufficiently effective way to focus the children's attention on the morphological (or non-morphological) structure of the experimental words. Further, it could be that the help provided by the longer, even if non-morphological spelling cues (e.g., *pecked* for *pecked*; *grinne* for *grinned*) was so easy to make use of that it eclipsed any smaller effect of morphological status. However, at least by using this spelling-cue design, these studies suggest that children in the first few years of school do *not* actively analyse regular past verbs into stem and *-ed* inflection when spelling. Instead, it seem that only the presence of the verbs' penultimate *-e* in the spelling cues was sufficient to remind the children of the need to write the unusual ending, *-ed*, to complete the regular past verbs.

In the next experiments, we move on to look at children's spelling of another common inflectional ending; the plural *-s*.

Chapter Four, part a): Experiment 3

Children's spelling of plural and non-plural word-final /z/: A pilot study

4a.1. Introduction

In this pilot study we examined young children's understanding of the morphological rule governing the spelling of regular English plurals. The plural inflection can be pronounced /s/, /z/, or /ɪz/, but is always written as *-s*. As discussed in section 1.3.1.1.ii., children's spelling of this inflection has received very little experimental attention, despite its high frequency in both written and spoken English. The small amount of evidence that does exist suggests that children normally use *-s* correctly for plurals from the time that they first begin to write, even when it is pronounced /z/ (e.g., Read, 1986; Treiman, 1993).

However, this does not necessarily mean that there is an early understanding of the need to represent all regular plurals with the same inflectional marker, regardless of pronunciation. It could be that children just always use the letter *s* to represent the sound /z/ in word-final position because *s* is the most common representation of /z/ (Venezky, 1970)[1]. They might refrain from using the phonetic spelling *z* instead not because they know that it is inappropriate for plurals, but merely because *z* is such a rare letter that they have not yet learned to use it in their writing.

The only way to discover whether young children understand that plurals must always be spelled with a final *-s* is to compare their spelling of the endings of plural words with their spelling of similar-sounding words which are not plurals, and which require a phonetic spelling (with *z*) instead. The only morphology-based rule about the final /z/ of (non-

[1] This is especially true in word-final position. According to the Kučera-Francis word list, there are only 153 words written with a final *-z/-zz/-ze* (plus another 743 which can be written with either *-ize* or *-ise*, such as *organise/organize*). In contrast, there are thousands of words with a final /z/ sound spelled with *-s*: the plural forms of all regular English singular nouns and the third-person singular forms of all English verbs (provided these nouns and verbs have a final vowel or voiced consonant), as well as the possessives *hers*, *yours*, etc.

inflected)[2] non-plurals is that it should never be spelled with *-s*. How it *should* be spelled depends on sound-based orthographic conventions. As explained in section 1.3.1.1.ii., one-syllable non-inflected words with a short vowel sound are spelled with a final *-z* or *-zz* (e.g., *quiz, jazz*). Those with a long vowel sound are spelled with a final *-ze* or *-se* (e.g., *daze, rose*) and these must be learned by rote; there is no rule or convention to decide which is correct.

Of course, it is possible that children may spell most examples of word-final /z/ correctly through rote learning, rather than because they understand the relevant morphological rule or orthographic convention. However, research is needed to see whether children do make mistakes when spelling word-final /z/, and if they do, what these mistakes can tell us about the children's understanding of morphological and sound-based spelling rules.

In this pilot study, therefore, we asked children in school years 2 and 3 to write two types of words with a final /z/ sound: one-syllable plurals, spelled with *-s* (e.g., *pains, fleas*), and one-syllable (non-inflected) non-plurals spelled phonetically, with *-zz* or *-ze* (e.g., *buzz, squeeze*). If these children understand the morphological rule that only only the final /z/ of inflected words (including plurals) may be spelled with *s*, then they should represent this sound with *-s* for the plurals and with *-zz* or *-ze* for the non-plurals.

If they do not understand this rule, then they could show one of two types of response. The first will occur if children have just learned that *-s* is the best way to represent word-final /z/. In this case, they should use the letter *-s* to end both plurals and non-plurals. The second will occur if children have learned that both *z* and *s* are appropriate ways to represent /z/, even in word-final position. In this case, they should use both of these letters to end plurals and non-plurals, although they may use *s* more often than *z*, because of its higher frequency.

[2] As discussed in section 1.3.1.1.ii. (and in Footnote 1), non-plurals with a final /z/ sound and which are *inflected* (third-person singular forms of verbs, possessives, and possessive pronouns) are spelled with *s*. However, all the non-plurals with a final /z/ to be used in this series of studies will also be non-inflected.

4a.2. Method

4a.2.1. Participants

The participants were 73 children (37 boys and 40 girls) aged 6;06 to 8;07, who attended a primary school in Oxford. Thirty-two were in year 2 and 41 were in year 3.

The children completed the Spelling Subtest of the Wechsler Objective Reading Dimensions (WORD) (Rust et al., 1993), and their raw scores were converted to spelling age equivalents. The children were divided into two Spelling Groups on the basis of these spelling ages. Those whose spelling age was below the median of 8;09 were allocated to the "Poorer" Spelling Group, and those whose spelling age was equal to or above 8;09 were allocated to the "Better" Spelling Group.

The means and standard deviations for the chronological ages, spelling ages and WORD standard scores of the children in each Spelling Group are shown in Table 4a.1.

Table 4a.1 Means and standard deviations for Better and Poorer spellers' chronological and spelling ages (SDs in months) and standard score on the WORD

	Poorer spellers (n=39)	Better spellers (n=34)	Overall (n=73)
Chronological age	7;06 (6.91)	7;08 (8.61)	7;07 (7.76)
Spelling age (WORD)	7;02 (5.09)	9;03 (16.72)	8;02 (17.52)
Standard score (WORD)	95.23 (7.53)	118.13 (18.96)	105.85 (15.83)

4a.2.2. Procedure

The experimenter saw each child individually in a small, quiet room within the school. She explained that she would read aloud the words to be spelled once on their own, once in a sentence, and then alone again. The child was to write them down as best as he or she could. The eight experimental words were presented a testing session which lasted between 10 and 15 minutes. They were interspersed among 28 regular past verbs and non-verbs that made up part of another experiment not discussed in this thesis.

Four of the experimental words were plurals with a final /z/ sound, and four were non-plurals with a final /z/ sound, matched for approximate frequency and sound structure. The final /z/ sound of the plurals always needed to be spelled with *-s*. The final /z/ sound of the non-plurals required *-zz* in two words, and *-ze* in two words. The words and their frequencies are shown in Table 4a.2.

Table 4a.2 Experimental words and their frequencies (Carroll et al., 1971).

Plurals	Frequency	Non-plurals	Frequency
jars	56.3	jazz	46.1
pains	55.0	buzz	46.5
fleas	45.4	squeeze	48.9
flies	61.5	prize	54.4
Mean (SD)	54.6 (6.7)	Mean (SD)	49.0 (3.8)

As the experimenter pronounced each word, she presented a corresponding coloured picture. To encourage the children to attempt to spell every word, above each picture were printed the first two letters of the experimental word, with the end of the word covered with a paper balloon (as described for Experiments 1 and 2). For example, when asked to spell "flies", the child saw a picture of some flies and the letters *fl*. The experimenter explained that the child was allowed to copy down those letters, but that he or she would have to decide how to spell the rest of the word himself or herself.

4a.3. Results

The number of times that the children spelled the /z/ of the experimental words with *-s*, *-se*, *-z*, *-zz*, or *-ze*, was counted. The spelling *-se* was included in the marking system because it is an orthographically (as well as morphologically) appropriate way to represent non-plural words with a long vowel sound, and the experiment contained two such words; *squeeze* and *prize*. The mean number of each type of spelling is shown in Table 4a.3.

Table 4a.3 Mean number of spellings (out of 4) for word-final /z/ in plural and non-plural words, as written by Poorer and Better spellers, and overall.

Word Type	Spelling written[3]	Poorer spellers (n=39)	Better spellers (n=34)	Overall (n=73)
Plurals	*s*	3.54 (0.94)	3.59 (0.56)	3.56 (0.78)
	se	0.08 (0.27)	0.29 (0.52)	0.18 (0.42)
	z/zz	0.18 (0.60)	0.06 (0.24)	0.12 (0.47)
	ze	0.02 (0.16)	0.03 (0.17)	0.02 (0.16)
Non-plurals	*s*	1.87 (1.08)	0.71 (1.00)	1.33 (1.19)
	se	0.23 (0.48)	0.41 (0.66)	0.32 (0.57)
	z/zz	1.13 (1.13)	2.03 (0.90)	1.55 (1.12)
	ze	0.10 (0.31)	0.71 (0.80)	0.38 (0.66)

We can see from the table that overall, both the Poorer and the Better spellers were very good at representing the final /z/ sound of plural words with the correct letter, -*s*. The Poorer spellers occasionally used the phonetic spelling -*z* or -*zz* instead, and the Better spellers also sometimes used -*se*, but overall both groups usually chose -*s*. However, both groups, especially the Poorer spellers, quite often used -*s* inappropriately as well, to complete the non-plural words. This suggests an incomplete understanding of the morphological rule governing the spelling of word-final /z/. If they did not use -*s* to complete the non-plural words, the children used -*z* or -*zz* much more often than -*ze*.

The four non-plural words could not all be marked according to identical criteria, because although -*se* is appropriate in terms of sound-based orthographic conventions as a way to represent the final /z/ of *prize* and *squeeze*, it is not appropriate for *buzz* and *jazz*. Thus, we decided to analyse the results in terms of the mean number of "appropriate" spellings provided for the final /z/ sounds of the experimental words. Only the letter -*s* was considered appropriate for the plural words, but for the non-plurals, any phonetic spelling (-*z*,

[3] The spellings *z* and *zz* are combined in this table and in the analyses since, in terms of both sound-based and morphology-based spelling rules, both were equally appropriate or inappropriate as representations of /z/ in the experimental words.

-zz, -ze) was considered appropriate. In addition, the spelling *-se* was considered appropriate for non-plurals with a long vowel sound. Figure 4a.1 shows these means, as well as the means for the children's use of *-s* for non-plurals, and their phonetic spellings (*-z, -zz* or *-ze*) for plurals.

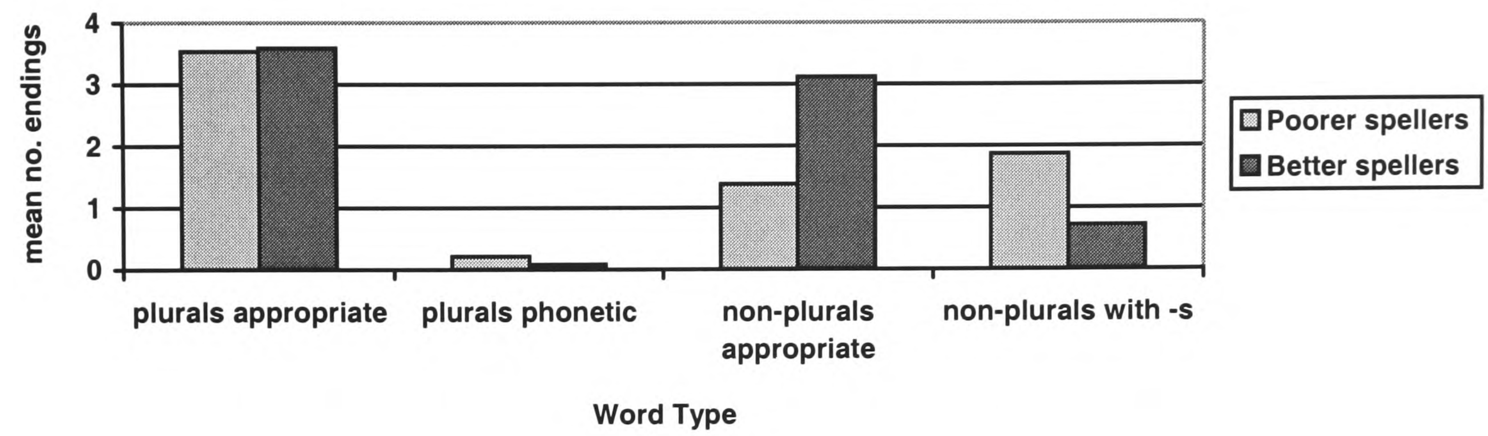

Figure 4a.1 Mean number of times (out of 4) that Poorer and Better spellers wrote plurals and non-plurals with an appropriate ending, plurals with a phonetic ending, and non-plurals with a final *-s*.

The figure clarifies the findings already discussed. It shows that both Poorer and Better spellers were very good at completing plural words with the correct spelling, *-s*. They hardly ever used a phonetic ending instead. The Better spellers were less adept at choosing an appropriate ending for the non-plural words, and the Poorer spellers were very poor indeed. If they did not use an appropriate representation of the final /z/ of the non-plurals, the children very often used *-s* instead. This was especially true of the Poorer spellers, who used *-s* to end non-plurals more often than they used an appropriate spelling of any kind.

These means were analysed in two repeated-measures analyses of variance. One had as its dependent variable the number of appropriate spellings written for word-final /z/; the other had the number of inappropriate spellings (*-s* for non-plurals or phonetic spellings for plurals). Both analyses had one between-subjects factor, Spelling Group (Poorer or Better), and one within-subjects factor, Word Type (Plural or Non-plural).

4a.3.1. Appropriate spellings

The ANOVA for appropriate spellings revealed a main effect of Spelling Group, $F(1,71)=35.4$, $p<0.01$. As expected, the Better spellers represented word-final /z/ appropriately significantly more often (mean=6.71, out of 8) than the Poorer spellers (mean=4.92). There was also a main effect of Word Type, $F(1,71)=62.8$, $p<0.01$, with more appropriate representations of /z/ for plural words (mean=3.56, out of 4) than non-plural words (mean=2.19). Finally, there was a significant interaction between Word Type and Spelling Group, $F(1,71)=25.8$, $p<0.01$. Post-hoc Newman-Keuls tests revealed that the two Spelling Groups did not differ significantly in their performance on the plural words, but on the non-plurals, the Better spellers represented /z/ appropriately significantly more often than did the Poorer spellers ($p<0.01$). The Better spellers' performance on the two Word Types did not differ significantly, but the Poorer spellers wrote /z/ appropriately significantly more often for the plural words than for the non-plurals ($p<0.01$).

4a.3.2. Inappropriate spellings

The ANOVA for inappropriate spellings also revealed a main effect for Spelling Group, $F(1,71)=16.4$, $p<0.01$. The Poorer spellers used inappropriate representations of /z/ (*-s* for non-plurals and phonetic spellings for plurals) significantly more often (mean=2.08, out of 4) than did the Better spellers (mean=0.80). The main effect for Word Type ($F(1,71)=501.2$, $p<0.01$) resulted from the children writing *-s* to complete non-plurals (mean=1.33, out of 4) significantly more often than they used phonetic spellings for plurals (mean=0.15). This shows that their use of *-s* for non-plurals did not represent just a general confusion about whether to use *s* or *z* to represent word-final /z/.

Finally, there was a significant interaction between Spelling Group and Word Type, $F(1,71)=5.65$, $p<0.05$. Post-hoc Newman-Keuls tests showed that the two Spelling Groups did not differ significantly in the number of times that they spelled plural words phonetically. For the non-plural words, the Poorer spellers used *-s* to represent word-final /z/ significantly more often than did the Better spellers ($p<0.01$). Both the Poorer and the Better spellers spelled non-plurals with *-s* significantly more often than they spelled plurals with a phonetic ending ($p<0.01$ and $p<0.05$, respectively).

4a.4. Discussion

This study provides preliminary information about how children spell the plural inflection *-s* when it is pronounced /z/, and about their spelling of the same sound at the end of non-plural words. As observed by Read (1986) and Treiman (1993), the young children nearly always spelled the plural inflection correctly, even though it was not pronounced with /s/. They scarcely ever used a phonetic ending (*-z/-zz/-ze*) instead. However, this does not necessarily mean that they were basing their spelling on the plural rule.

To ensure that the children were able to use the letter *z*, we examined their spelling of word-final /z/ in non-plural words as well. Both the Poorer and the Better spellers used *-z* and *-ze* to complete these words, which shows that they realised that the letter *z*, as well as *s*, can be used to represent word-final /z/. (They also sometimes used *-se* for *squeeze* and *prize*, which is acceptable in terms of English orthographic rules.) This use of spellings other than *-s* to represent the final /z/ of the non-plurals shows that the children distinguished between plurals and non-plurals in their writing.

However, this distinction was by no means complete. Both groups of children often used *-s* to spell the non-plural words as well. The Poorer spellers used *-s* even more than they used all the other types of spelling put together. This suggests that the children did not have a full understanding of the morphological rule that word-final /z/ must only be spelled with *-s* if it is a plural or other inflectional ending.

It is possible that the children's overuse of *s* to represent the sound /z/ at the end of words represents an overgeneralisation of the plural *-s* inflection, similar to the overgeneralisation of the regular past verb inflection *-ed* observed by Nunes et al. (1997a).

However, although the final *-ed* spelling is unique to regular past verbs, final *-s* (pronounced /z/) is also used for third-person singular verbs (e.g., *has*, *runs*) and possessives (e.g., *his*, *John's*). The children may just have noticed that *s* is by far the most frequent representation of /z/ in word-final position, and therefore have adopted it as their most frequent spelling for word-final /z/. It is not possible to tell which interpretation is correct. In either case, these children, especially the Poorer spellers, seem to have learned when *-s* should be used for word-final /z/, but have not yet properly grasped when it should not be used.

Because this experiment required children to spell the sound /z/ only in word-final position, we cannot be sure whether their tendency to overuse *s* is confined to the end of words. Are children sensitive to position-based differences in the frequency of the use of *s* and *z* to represent /z/, or do they just have a general propensity to use *s* to spell the sound /z/, regardless of word position? We need to examine how children spell the sound /z/ at the beginning and in the middle of words, as well as just at the end.

This experiment included two types of non-plural; two with a short vowel sound which required a final *-zz*, and two with a long vowel sound which required a final *-ze*. We accepted any phonetic spelling (*-z/-zz/-ze*) as appropriate for all of these words, but for the long-vowel non-plurals we also had to accept *-se*, as this is an orthographically (and morphologically) acceptable representation of /z/ under these conditions. Thus, any children who were just writing the commonest representations of /z/ (*-s*, *-se*, *-z*, *-zz*, and *-ze*) randomly would achieve spellings that were considered appropriate for the long-vowel non-plurals more often than they would for the short-vowel non-plurals or for the plural words.

Thus, in the next experiment, the words with /z/ in word-final position will be chosen to have a short vowel sound, to reduce the possibility that children will achieve an appropriate spelling for non-plural words by chance alone more often than they will for plural words.

Chapter Four, part b): Experiment 4

Children's spelling of /z/ in three word positions: A pilot study

4b.1. Introduction

The first pilot study (Experiment 3) showed that children tend to overuse *s* to spell the sound /z/ in word-final position. This second pilot study was designed to investigate whether this overuse of *s* is confined to word-final position (where *s* is especially frequent), or whether children always overuse *s* for /z/, regardless of word position. In addition to the morphological and orthographic rules governing the spelling of word-final /z/ discussed in section 4a.1., there are some orthographic conventions governing the spelling of /z/ in other word-positions as well. These are summarised in Table 4b.1.

Table 4b.1 Summary of morphological rules and orthographic conventions governing the spelling of /z/ in word-initial, word-medial (intervocalic), and word-final position

Position of /z/	What determines the spelling of /z/		Examples
	Morphological rule	Orthographic convention	
Initial	None	Always *z*[1]	*zoo*, *zip*
Medial (between two vowels)	None[2]	None. Either *s* or *z* used; spelling must be learned by rote. (*s* and *ss* about 4 times commoner than *z* and *zz*.[3])	*cousin*, *dozen*
Final	For plurals (and other inflected words), always *s*. For (non-inflected) non-plurals, never *s*.	For non-plurals: short vowel: *z* or *zz* long vowel: *ze* or *se*	*bars*, *quiz*, *buzz*, *breeze*, *rose*

In this experiment we asked children to spell words with a /z/ sound in one of these three positions. For the words with an initial /z/, only the spelling *z* was required. For the

[1] The only exceptions are *tsar* and *czar*, and a few infrequent words beginning with *x*, e.g., *xylophone*.
[2] If the word is inflected or derived, the spelling of /z/ is determined by the spelling of /z/ in the base word, e.g., *noise/noisy*, *breeze/breezy*. However, the words with medial intervocalic /z/ in these studies will all be monomorphemic.
[3] Calculated by a count of the 314 words in the Kučera-Francis list which have a medial vowel-/z/-vowel and a frequency of at least 1. 80.6% were spelled with *s/ss*, and 19.4% with *z/zz*.

words with a medial /z/ (always intervocalic), half required *s*, and half required *z/zz*. For the words with a final /z/ sound, half were plurals and required *-s*. The other half were non-plural words with a short vowel sound, and required a phonetic spelling (*-z* or *-zz*).

If the children understand both the morphological and the orthographic rules governing the spelling of /z/, then they should use *-s* for the plurals and phonetic spellings (*-z/-zz/-ze*) for the non-plurals. They should use both *s* and *z* (although *s* rather more often) in word-medial position, and only *z* in word-initial position. If the children understand the orthographic conventions, but not the morphological rule, then they should overuse *-s* (but not phonetic spellings) in word-final position. In word-medial and word-initial position they should perform as described above. Finally, if children are insensitive to both orthographic conventions and morphological rules, and just have a general tendency to overuse *s* to spell /z/, then they should use *s* much more often than *z* to spell the sound /z/ in all three word positions.

Read (1986) and Treiman (1993) noted the correct use of *-s* for plurals even in children as young as five or six years. Thus, this experiment included children in school year 1, as well as in years 2 and 3, to see if the findings from the previous experiment would hold when younger children acted as participants.

4b.2. Method

4b.2.1. Participants

Seventy children in school years 1, 2 and 3, aged 5;10 to 8;08 years (mean age 7;04 years) participated in this study. These were the same children who participated in Experiment 1, and they were divided into a group of Poorer spellers and a group of Better spellers on the basis of their spelling age, as described in section 2.2.1.

4b.2.2. Procedure

As described in section 2.2.1., the experimenter saw the children in groups of three in a small, quiet area within their school. She explained that the children should do their best to write down the words that she read aloud, which she would say once alone, once in a sentence, and once alone again. The 12 experimental words were presented in the first of two testing sessions, interspersed among the 32 regular past verbs presented as part of Experiment 1 (see section 2.2.2.). There were four words with an initial /z/, four with a medial /z/ (two of which required an *s* and two a *z* spelling), and four with a final /z/. Of these final-/z/ words, two were plurals and therefore required a final *s*, and two were non-plurals with a short vowel sound, and therefore required a final -*zz*. As far as possible, the *s* and *z* words were matched for sound structure and length, and all the words were matched as closely as possible on their frequency in written English (Carroll et al., 1971). The words and their frequencies are shown in Table 4b.1.

Table 4b.1 Experimental words and their frequencies (Carroll et al., 1971). (Frequencies listed for plurals are for those of the words' singular forms.)

	Representation of /z/			
	s		*z/zz*	
Position of /z/	Word	Frequency	Word	Frequency
Initial			zig-zag	33.2
			zip	39.4
			zebra	44.4
			zero	54.6
Medial	busy	59.5	dizzy	41.3
	museum	51.6	lizard	48.3
Final	bibs	37.2	quiz	41.1
	fibs	30.6	fizz	33.7
Mean (SD)		44.7 (13.2)		42.0 (7.2)

These words were presented as part of a larger experiment (Experiment 1) in which the number of letters of each word shown as a spelling "cue" was manipulated. To ensure that the method of presentation remained the same throughout the experiment, the letter(s) representing /z/ and the following letter (for the word-initial and word-medial /z/ words) or preceding letter (for the word-final /z/ words) were obscured with a paper balloon, as described in section 2.3.2. For example, the children saw the letters *bu-* for *busy*, and *-bra* for *zebra*, and although they could copy these letters, they had to guess how to write the rest of the word. (For the word *zig-zag*, the children saw only *–g- –g*). The experimental words were presented in a different order for each group of children tested.

4b.3. Results

The number of times that the children spelled the /z/ of the experimental words with the letter *s* or with a phonetic spelling (*z*, *zz* or *ze*) in each word position (whether correctly or incorrectly) was counted. Table 4b.2 shows the mean proportion of each of these types of spellings written by the children in word-initial, word-medial, and word-final position.

Table 4b.2 Mean proportion of representations of /z/ with *s* and with a phonetic spelling (*z, zz,* or *ze*) in word-initial, -medial, and -final position, by Poorer spellers, Better spellers, and overall. Standard deviations are in parentheses. Appropriate spellings are shown in bold.

Position of /z/	Spelling required	Spelling written	Poorer spellers (n=36)	Better spellers (n=34)	Overall (n=70)
Initial	*z*	*z*	**0.90 (0.17)**	**0.96 (0.12)**	**0.93 (0.16)**
		s	0.09 (0.16)	0.04 (0.14)	0.06 (0.15)
Medial	*s*	*s*	**0.38 (0.39)**	**0.74 (0.33)**	**0.55 (0.40)**
		z/zz	0.42 (0.39)	0.19 (0.30)	0.31 (0.36)
	z/zz	*z/zz*	**0.47 (0.38)**	**0.72 (0.35)**	**0.59 (0.38)**
		s	0.47 (0.41)	0.16 (0.32)	0.32 (0.40)
Final	*s*	*s*	**0.93 (0.21)**	**0.94 (0.16)**	**0.94 (0.19)**
		z/zz/ze	0.06 (0.20)	0.04 (0.14)	0.05 (0.17)
	z/zz	*z/zz/ze*	**0.60 (0.43)**	**0.94 (0.21)**	**0.76 (0.38)**
		s	0.28 (0.40)	0.03 (0.17)	0.16 (0.34)

The results in this table should be interpreted with caution since, for words with /z/ in medial and final position, there were only two words spelled with *s* and two with *z/zz* (and for the words with /z/ in initial position, there were four spelled with *z*). This means that there was not enough variance for any statistical analysis to be conducted. The differences observed here will have to be confirmed in a larger-scale study. Nevertheless, these means suggest that the Poorer spellers' overuse of *s* (compared with their overuse of *z/zz/ze*) was more frequent in word-final position than in word-initial or word-medial position. The Better spellers did not appear to overuse *s* more than *z/zz*.

In word-initial position, both the Poorer and the Better spellers almost always used the correct letter, *z*, to spell /z/ in word-initial position, and used *s* instead only very rarely. They never used the other rare but possible representations for word-initial /z/; *cz*, *ts* or *x*.

In word-medial position they were much poorer at choosing the correct representation of /z/, but wrote both *s* and *z* approximately equally. This was true for both Spelling Groups, although the Better spellers used *s* and *z* correctly much more often than the Poorer spellers, who used them incorrectly (*s* instead of *z/zz* or *z/zz* instead of *s*) just as often as they used them correctly.

When writing /z/ in word-final position, the children were better at choosing an appropriate spelling than in word-medial position. The pattern of results was similar to that in the previous experiment. Both the Poorer and the Better spellers nearly always used *s* correctly to complete the plural words, and hardly ever used a phonetic spelling instead. The Better spellers' performance was just as good on the non-plural words, and they hardly ever used *s* for these. The Poorer spellers, however, incorrectly used *s* to complete the non-plurals almost half as often as they used a phonetic ending.

Thus, the proportion of times that the children wrote *s* and *z* in word-initial, word-medial, and word-final position generally reflected the frequencies with which these two spellings are used in written English.

4b.4. Discussion

The results from this second pilot study come from only a few words, and therefore may not be a reliable indication of children's spelling of the sound /z/. Nevertheless, they showed that the overuse of *s* to represent /z/ was confined word-final position, and occurred only among the Poorer spellers. This suggests that the Poorer spellers, at least, did not properly understand the morphological rule governing the spelling of plurals and non-plurals. However, both groups of spellers appeared to have quite a reasonable grasp of the orthographic conventions governing the representation of /z/ in various word positions.

When writing word-initial /z/, the children nearly always used *z* to represent word-initial /z/, and only very rarely used *s* instead. When writing word-medial /z/, the Poorer spellers used *s* and *z* incorrectly (e.g., writing *buzy* for *busy* or *disy* for *dizzy*) almost as often as correctly. The Better spellers used *s* and *z* correctly much more often, and only sometimes used *s* when *z* was required, or vice versa. However, despite these differences in the number of times that they represented /z/ correctly, both the Poorer and Better spellers used *s* approximately as often as they used *z*. This does not exactly reflect the actual frequencies in written English; as noted in section 4b.1, the spelling *s/ss* is used in approximately 80% of words with a medial /z/ between two vowels, whereas the spelling *z/zz* is used in approximately 20%. However, it does suggest some understanding of the fact that *s* and *z* are both used reasonably often in this position.

In word-final position, both the Poorer and the Better spellers almost always used *-s* correctly to complete the plural words, and very rarely used a phonetic spelling (*-z/zz/ze*) instead. When completing the non-plural words, the Better spellers were just as good at correctly choosing a phonetic spelling and very rarely used *-s* instead. The Poorer spellers, however, were not so good at spelling non-verbs with a phonetic ending, and used *s* instead relatively often. These results, like those of the previous experiment, suggest that even by the third year of formal schooling, many children still have an incomplete understanding of the morphological basis for spelling plurals and non-plurals.

However, the Poorer spellers' overuse of *s* for non-plurals could instead stem from a lack of understanding of the more general morphological rule that only inflected words may be spelled with a final *-s* (see section 1.3.1.1.ii.). It is not so surprising that they did not know what <u>should</u> be used to spell these words, because non-inflected non-plurals with a short vowel sound and a final /z/ (the words used here) are quite rare. The Poorer spellers, especially, might not have had sufficient exposure to such words to learn the orthographic convention governing their spelling. It is not possible to tell whether the Better spellers' usually correct use of phonetic spellings for these words resulted from their knowledge of orthographic conventions alone, or whether they also knew the morphological rule that non-inflected non-plurals must never be spelled with *-s*.

Even if their awareness of morphological rules was not perfect, the performance of both the Poorer and the Better spellers across word positions suggests that they had quite a sophisticated understanding of the position-based orthographic conventions for the spelling of /z/.[4] Thus, they were sensitive to the frequency with which /z/ is represented as *s* or as *z* in different word positions. This finding suggests that we must consider the possibility that children spell plurals correctly with *-s* not because of their developing understanding of the morphological rule, but because they have noticed the high frequency with which *-s* occurs in certain word-final combinations. In English, if a word ends in a final consonant plus /z/, then that /z/ is virtually always spelled with *-s*.[5] The two plural words used in this experiment, *bibs* and *fibs*, both ended in this combination. Thus, the children might have just learned to

[4] It could be argued that the children had simply rote-learned the spelling of the words in which they spelled /z/ correctly. However, this argument is not convincing. The children's errors in word-medial position followed the same pattern as their correct spellings. Further, although the children were almost always correct for word-initial /z/, these words were matched for frequency with the rest, and thus should have been just as difficult. This suggests that the children would not just have known all of these words by rote, but that they had to use their knowledge of orthographic conventions to spell at least some of them correctly.
[5] There are only four exceptions: *adze*, *bronze*, *cleanse*, and *flense*, and it is unlikely that children in the first three years of school would be familiar with the spelling of any of these words.

use *-s* to represent the final /z/ of these words because of this sound-based conditional rule, with no understanding of the morphological rule.

However, it should be noted that two of the four plural words used in Experiment 3 (*fleas* and *flies*) had a long vowel sound, rather than a consonant, preceding their final /z/. There is no orthographic convention to decide how to spell these words. Since even the Poorer spellers used *-s* correctly nearly 89% of the time in that experiment, this suggests that the children must have had some idea of the morphological rule for spelling the final /z/ of these words. However, data from more words will be necessary before we can properly decide the extent to which children make use of morphological and/or orthographic rules when spelling the sound /z/.

The next experiment will therefore compare children's spelling of /z/ in word-medial and in word-final position, but with more words than in this pilot study. To examine whether children's correct use of the plural *-s* is affected by the sound structure as much as by the morphological status of the words that they are asked to write, the final /z/ sound of half the plurals will be preceded by a consonant (e.g., *queens*), and, in the other half, by a long vowel sound (e.g., *queues*). In order to reduce the number of words that the children have to write, words with an initial /z/ will not be included, since the results from this study showed that even Poorer spellers nearly always correctly used the letter *z* for these words. Finally, the children's morphological awareness (in terms of their ability to transform singular to plural nouns orally) will be examined, and related to their ability to spell plural and non-plural words with morphologically appropriate endings.

Chapter Five: Experiment 5

Children's spelling of /z/: Sound-structure- or morphology-based rules?

5.1. Introduction

The findings of (pilot) Experiments 3 and 4 agree with the observations of Read (1986) and Treiman (1993) that children in the first few years of school almost always spell plural words correctly with a final *-s*, even when it is pronounced as /z/. However, this finding does not seem to reflect a full understanding of the morphological rule governing the spelling of word-final /z/ in all the children. When writing non-plurals with a final /z/ sound, the Poorer spellers did not always use the appropriate phonetic spelling, but quite often used *-s* instead. Experiment 4 suggested that this overuse of *s* to represent /z/ was confined mostly to word-final position. In word-initial and -medial position, the children's choice of representations of /z/ largely reflected the frequencies of these representations in written English.

If children are sensitive to these position-based orthographic conventions, we must consider the possibility that they are also sensitive to other conditional orthographic conventions, such as those that are conditional on sound structure. Children may be able to spell plurals correctly with *-s* not because they understand the morphological rule, but because they have noticed that after a consonant, word-final /z/ is virtually always written with *-s* (see section 4b.4). We refer to this as a (sound-structure-based) "conditional rule".

In this experiment, we examined whether children make use of this conditional rule when they write word-final /z/. As in the pilot studies, we included two types of words with a final /z/; plurals, which required a final *-s*, and non-plurals with a short vowel sound, which required a phonetic spelling, *-z* or *-zz* (e.g., *fizz*). The plurals were of two types.

One type ended in a consonant plus /z/ (e.g., *fibs*). These plurals were labelled "PC", because they can be spelled correctly via the morphology-based Plural rule (all regular plurals require *-s*) *or* the sound-structure-based Conditional rule (virtually all words ending in consonant plus /z/ require *-s*). The second type of plural ended in a long vowel sound plus /z/

(e.g., *fleas*). These plurals were labelled "P-", because they can only be spelled correctly via the Plural rule. The conditional rule is of no help in spelling these words, and sound-based orthographic conventions allow several representations of /z/: *-s* as in *fleas*, *-se* as in *please*, or *-ze* as in *breeze*. Clearly, not all of these are appropriate endings for plural words.

A similar distinction could not be made for the non-plural words. Whether the final /z/ of a non-plural is preceded by a short or a long vowel, the speller can never rely solely on orthographic conventions to determine the appropriate spelling, and to avoid overusing *-s*. For example, in terms of these conventions, the long-vowel word *breeze* could acceptably be written as *breeze*, *breese*, or *brees*. Only an understanding of the plural rule allows the speller to reject the use of *s* to complete non-plurals. For non-plurals with a short vowel, too (the type used in this experiment) orthographic conventions (which allow the use of *-s* or of *-z/zz*) are of no use alone. The speller would not know whether to write *has* or *hazz*, or *jas* or *jazz*. A more general morphological rule restricts the use of *-s* to inflected words only (e.g., *was*)[1]. Thus, avoiding the incorrect use of *-s* to complete the non-plurals in this study probably depends mostly on an understanding of this morphological rule.

We first had to confirm that children are able to use any type of rule at all when deciding how to represent /z/. As well as asking the children to spell plural and non-plural words with a final /z/, we asked them to spell words with a medial /z/. For the latter words, there are no rules, either morphological or sound-structure-based, to decide whether *s* or *z* is the appropriate spelling[2]. If children are unable to make use of either type of rule in their spelling of /z/, then they should not spell /z/ any better in word-final than in word-medial position. If, however, children are able to use the conditional rule and/or morphological rules (the plural rule and the more general rule about inflections) when spelling /z/, then their spelling should be significantly better in word-final than in word-medial position.

[1] There are two exceptions to this: *his* (which could be seen as an inflected form of *him*) and *as*.
[2] Unless, as noted in section 4b.1, the words are derived or inflected from some base word, e.g., *noise/noisy*. However, the words in these studies were chosen to be monomorphemic.

Second, in order to discover whether children do use the conditional rule as well as or instead of morphological rules when deciding how to represent /z/, we compared their performance on PC plurals, P- plurals, and non-plural words. If children decide how to spell /z/ on the basis of their knowledge of morphological rules, then the sound structure of the words should not affect them, and they should be equally good at completing PC and P- plurals correctly with *-s*, and at avoiding the use of *-s* for the non-plurals. If children instead base their decision on the conditional rule, then they should use the correct ending significantly more often for PC plurals than for P- plurals. Their lack of morphological knowledge should mean that they have difficulty in completing the non-plurals appropriately, and should use *-s* more often than *-z/zz*. This is because although the number of such words spelled with *-s* (e.g., *his*, *has*) is about the same (approximately six) as the number spelled with *-z/zz* (e.g., *quiz, jazz*), the former occur much more frequently.

Finally, we wished to measure the children's ability to transform plural nouns to singular nouns and vice versa, in an oral sentence analogy task of morphological awareness. If children do use their knowledge of morphological rules to spell word-final /z/, then we would expect a significant relation between this spelling performance and scores on the sentence analogy task, beyond any contribution of chronological age or spelling age. If, however, children are more reliant on their knowledge of the conditional rule to spell word-final /z/, then this spelling should not correlate significantly with sentence analogy score.

5.2. Method

5.2.1. Participants

Eighty-two children in school Years 1 to 3 participated in the experiment. All attended a large infant and junior school in Solihull. There were 43 girls and 39 boys, ranging in age from 5;10 to 8;09, with a mean age of 7;06. Fourteen of the children were in year 1, 34 were in year 2, and 34 were in year 3. (Another 12 children in year 1 attempted the tasks, but found the spelling task too difficult. Thus, only 14 year 1 children could be included.)

The participants' spelling ages were determined by their performance on the Spelling Subtest of the Wechsler Objective Reading Dimensions (WORD) (Rust et al., 1993). The participants whose spelling age was less than or equal to the median of 7;04 were placed in the Poorer spelling group. The participants whose spelling ages were above the median were placed in the Better spelling group. Table 5.1 shows the children's mean chronological ages, mean spelling ages, and standard scores on the WORD.

Table 5.1 Mean chronological and mean spelling age (in years and months) and mean standard scores on the Spelling subtest of the WORD for Poorer spellers, Better spellers, and overall. Standard deviations in parentheses.

	Poorer spellers (n=40)	Better spellers (n=42)	Overall (n=82)
Chronological age	7;02 (9.6)	7;10 (7.5)	7;06 (9.5)
Spelling age	6;11 (4.6)	9;06 (20.0)	8;03 (21.3)
WORD std score	101.9 (10.8)	117.3 (13.0)	109.8 (14.2)

5.2.2. Procedure

Each child was seen twice, in testing sessions about three days apart, in a small private area within the school.

5.2.2.1. Session 1: Experimental spelling task

In the first testing session, the experimenter asked groups of four to six children to write down 30 words which she read out. She said each word once on its own, once in a sentence, and once on its own again. This task took between 12 and 20 minutes to complete, depending on the ability of the children participating. The words were presented in one of six different orders for each group. Each of the 30 test words contained a /z/ sound in either word-medial or word-final position. The words were as follows:

- *Medial /z/*: 12 words with a /z/ sound in the middle.
  - 6 required an *s* to represent the /z/ sound (e.g., *daisy*)
  - 6 required a *z* or a *zz* (e.g., *crazy, dizzy*)
- *Final /z/*: 18 words with a /z/ sound at the end.

- 6 "PC" plural nouns, whose singular form ended in a consonant, and which required an *s* to represent the /z/ sound (e.g., *queens*)
- 6 "P-" plural nouns, whose singular form ended in a vowel sound, and which required an *s* to represent the /z/ sound (e.g., *queues*)
- 6 singular nouns which required a *z* or *zz* to represent the /z/ sound (e.g., *quiz*)

The words and their frequencies are shown in Table 5.2.

Table 5.2 Words with medial and with final /z/ sound, requiring an *s* or a *z/zz* spelling, and their frequencies (Carroll et al., 1971).

	Representation of /z/			
	s		z	
Position of /z/	Word	Frequency	Word	Frequency
Medial	daisy	40.0	crazy	50.6
	cousin	52.1	dozen	55.9
	prison	51.5	dizzy	41.3
	poison	50.6	razor	43.7
	pleasant[3]	56.8	bulldozer	41.2
	raisin	40.5	wizard	42.6
	Mean (SD)	48.6 (6.80)	Mean (SD)	45.9 (6.02)
Final	queens	55.6	quiz	41.1
(incl. PC plurals)	jewels	44.7	jazz	46.1
(correct spelling can	fibs	30.6	fizz	33.7
be achieved via	fins	46.0	fuzz	38.6
Plural *or*	buns	35.9	buzz	46.5
Conditional rule)	wigs	36.4	(gee) whizz	44.1
	Mean (SD)	41.5 (9.0)	Mean (SD)	41.7 (4.9)
(incl. P- plurals)	queues	34.8		
(correct spelling can	jaws	48.1		
be achieved via	fleas	41.5		
Plural	fees	45.0		
rule only)	drawers	47.9		
	wares	37.9		
	Mean (SD)	42.5 (5.4)		

The words were chosen to be as similar as possible in terms of complexity, length, and frequency in the language (Carroll et al., 1971). A one-way analysis of variance confirmed

[3] It proved difficult to find enough suitable monomorphemic words, and so we had to include one bimorphemic word: *pleasant* is actually derived from *please*. However, this is a rather opaque relationship and it was thought unlikely that children in the first three years of school would make this connection and use it to decide to use *s*.

that there was no significant difference in frequency between the five types of word (medial *s*, medial *z/zz*, PC plurals, P- plurals, and non-plurals), $F(4,29)=1.31$, $p=0.29$.

5.2.2.2. Session 2: Tests of spelling ability and of morphological awareness

In the second testing session, the experimenter saw each child individually, for 12 to 15 minutes. She first administered the spelling subtest of the WORD.

The experimenter then gave the child a sentence analogy task with the support of two hand-puppets (as in Experiment 1). This task assessed his or her ability to recognise the transformation of singular to plural nouns, and vice versa, and to make these transformations himself or herself. The child was introduced to the two hand-puppets and told that the first puppet would "say" a sentence and the second would repeat it, making a change to one of the words. The first puppet then said a second, very similar sentence, using a different word. The child was then asked to say what the second puppet should say, by making the same change to the word in the second sentence that this puppet had made to the first.

There were eight sentence analogies for the child to complete, preceded by two practice analogies for which explanation and feedback were provided as required. Four of the test analogies required a transformation from singular to plural, and four from plural to singular. There were two analogies with a regular model and a regular test word, two with a regular model and an irregular test word, two with an irregular model and a regular test word, and two with an irregular model and an irregular test word. The analogies were as follows:

Practice analogies:

a) I want to see the big mountain. I want to see the big hill.	I want to see the big mountains. ____________________.
b) Look at the old buildings. Look at the old houses.	Look at the old building. ________________.

Test analogies:

1. I found the pretty leaf in the woods. I found the pretty box in the woods.	I found the pretty leaves in the woods. ____________________.
2. I like the cat from next door.	I like the cats from next door.

I like the mouse from next door.	______________________.
3. The women cooked a cake.	The woman cooked a cake.
The boys cooked a cake.	______________________.
4. I hurt my feet on the way here.	I hurt my foot on the way here.
I hurt my teeth on the way here.	______________________.
5. I like eating chocolate cake.	I like eating chocolate cakes.
I like eating chocolate pudding.	______________________.
6. I saw the cow on the farm.	I saw the cows on the farm.
I saw the sheep on the farm.	______________________.
7. The geese swam on the river.	The goose swam on the river.
The swans swam on the river.	______________________.
8. Look at the people over there.	Look at the person over there.
Look at the children over there.	______________________.

The order in which the test analogies were administered was varied for each child.

Many of the children, especially the younger ones, regularised the two irregular plurals that they were required to produce, responding "mouses" and "sheeps" for analogies 2 and 6. When any child in year 1 or 2 produced such an error, the experimenter said at the end of the testing session (after the spelling test), "There's just one more thing I want to ask you". She then presented a picture of two mice and/or two sheep (depending on which the child had got wrong), and said "This is a picture of two…", and the child would give his or her response. Those children who said "mice" and/or "sheep" were marked as incorrect for having said "mouses" and/or "sheeps" in the analogy task, but those children who could still only produce the regularised form were marked as correct on the analogy task.

5.3. Results

5.3.1. Experimental words

5.3.2.1. Spelling /z/ in word-medial and word-final position

The first question to answer was whether the children used any rules at all to spell word-final /z/. We therefore compared their spelling of /z/ in word-medial position, where there are no rules, to word-final position, where there are always morphological rules and sometimes conditional rules as well. For these first analyses, the means for the PC and P-plurals were combined, so that we could compare the children's spelling of /z/ in the two positions overall. We counted the number of times that the children represented /z/ with *s* or with a phonetic spelling (*z/zz/ze*) appropriately and inappropriately, in both positions.

"Appropriate" spellings are those for which *s* was used where *s* was required, and for which a phonetic spelling (*z/zz/ze*) was used where a phonetic spelling was required. "Inappropriate" spellings are those for which *s* was used instead of a phonetic spelling, or for which a phonetic spelling was used instead of *s*. Non-English letter combinations, such as *sz* and *zs*, and phonologically incorrect spellings, such as *c* and *n*, are not included. The mean proportions of each are shown in Table 5.3.

Table 5.3 Mean proportions of appropriate and inappropriate uses of *s* and of phonetic spellings to represent /z/ in word-medial and -final position, by Poorer and Better spellers, and overall. Standard deviations in parentheses. Appropriate spellings shown in bold.

Position of /z/; wd type	Spelling required	Spelling written	Poorer spellers (n=40)	Better spellers (n=42)	Overall (n=82)
Medial	*s*	*s*	**0.60 (0.32)**	**0.78 (0.23)**	**0.69 (0.29)**
		z/zz	0.33 (0.30)	0.19 (0.22)	0.26 (0.27)
	z/zz	*z/zz*	**0.50 (0.33)**	**0.83 (0.20)**	**0.67 (0.31)**
		s	0.43 (0.32)	0.14 (0.17)	0.28 (0.30)
Final					
Plurals	*s*	*s*	**0.75 (0.20)**	**0.89 (0.14)**	**0.82 (0.19)**
		z/zz/ze	0.10 (0.16)	0.03 (0.07)	0.07 (0.13)
Non-plurals	*z/zz*	*z/zz/ze*	**0.55 (0.35)**	**0.96 (0.10)**	**0.76 (0.33)**
		s	0.28 (0.31)	0.01 (0.04)	0.14 (0.26)

The means in Table 5.3 show that the children generally wrote /z/ appropriately more often in word-final than in word-medial position. This suggests that they were making use of morphological and/or conditional rules to spell word-final /z/. In contrast to the findings from Experiment 4, the Poorer spellers do not seem to have overused *s* to represent *z/zz* (compared to their overuse of *z/zz* to represent *s*) any more word-final than in word-medial position. In word-medial position, both Spelling Groups used *s* and *z/zz* appropriately approximately equally often. When they chose the wrong spelling, they used *z/zz* instead of *s* just as often as they used *s* instead of *z/zz*. However, this pattern appears to vary with spelling ability: the Poorer spellers tended to use *s* slightly more than *z/zz*, whereas the Better spellers tended to use *z/zz* slightly more than *s*.

In word-final position, the children's representation of /z/ was rather better. They usually spelled the plural words correctly with *s*, and only occasionally used a phonetic spelling instead. The Better spellers were even better at ending non-plurals with an appropriate (phonetic) spelling, and hardly ever used *s* instead. The Poorer spellers, however, were not very good at using phonetic spellings for the non-plurals, and completed them with *s* quite often. This suggests that they did not know the general morphological rule that *s* can only be used to complete inflected words with a short vowel.

These results were examined in two repeated-measures analyses of variance; one based on the proportion of appropriate spellings, and the other on the proportion of inappropriate spellings. As shown in Table 5.3, the means for the PC and P- plurals were combined for these analyses. Both had two within-subjects factors, Position (of /z/; medial or final) and Letter (required to represent /z/; *s* or *z/zz*), and one between-subjects factor, Spelling Group (Poorer or Better). The mean proportions of appropriate spellings included in the first ANOVA are shown in Figure 5.1.

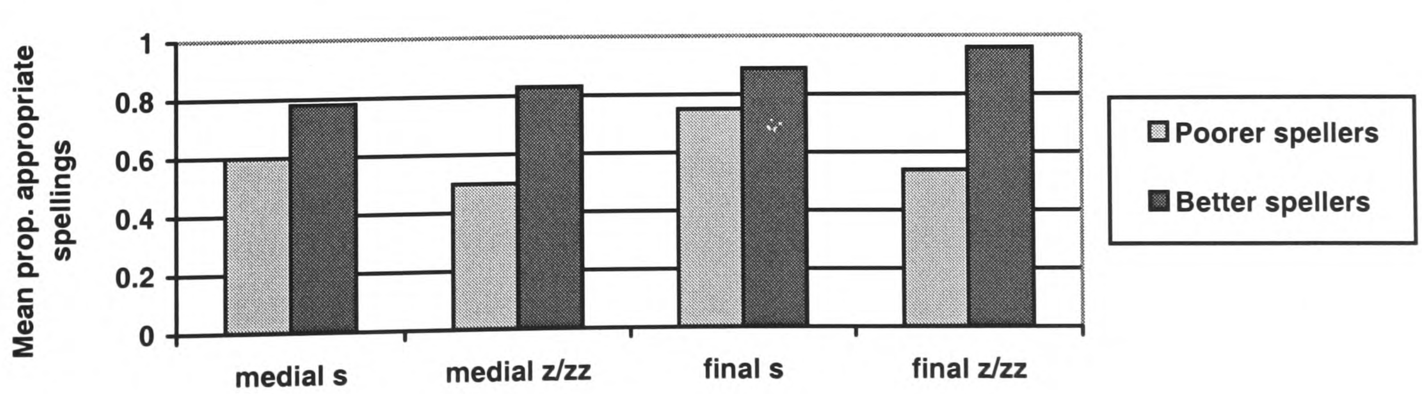

Figure 5.1 Mean proportion of times that /z/ was spelled appropriately with *s* and with *z/zz/ze* in word-medial and word-final position, by Poorer and Better spellers

This analysis found a main effect of Spelling Group ($F(1,80)=122.2$, $p<0.01$). The Better spellers wrote appropriate spellings (mean proportion=0.87) significantly more often than the Poorer spellers did (mean proportion=0.60). A main effect of Position ($F(1,80)=32.6$, $p<0.01$) showed that the children used significantly more appropriate spellings for /z/ in final position (mean proportion=0.79) than in medial position (mean proportion=0.68). This suggests that they were using rules of some kind to decide the most appropriate spelling of /z/.

Finally, there was an interaction between Letter and Spelling Group ($F(1,80)=7.56$, $p<0.01$). Newman-Keuls post-hoc tests showed that the two Spelling Groups were equally good at using *s* appropriately, but that the Better spellers were significantly better than the Poorer spellers at using phonetic spellings appropriately ($p<0.01$).

The second ANOVA compared the proportions of inappropriate spellings written: the use of *s* when *z/zz* was required, and the use of phonetic spellings (*z/zz/ze*) when *s* was required. These means are shown in Figure 5.2.

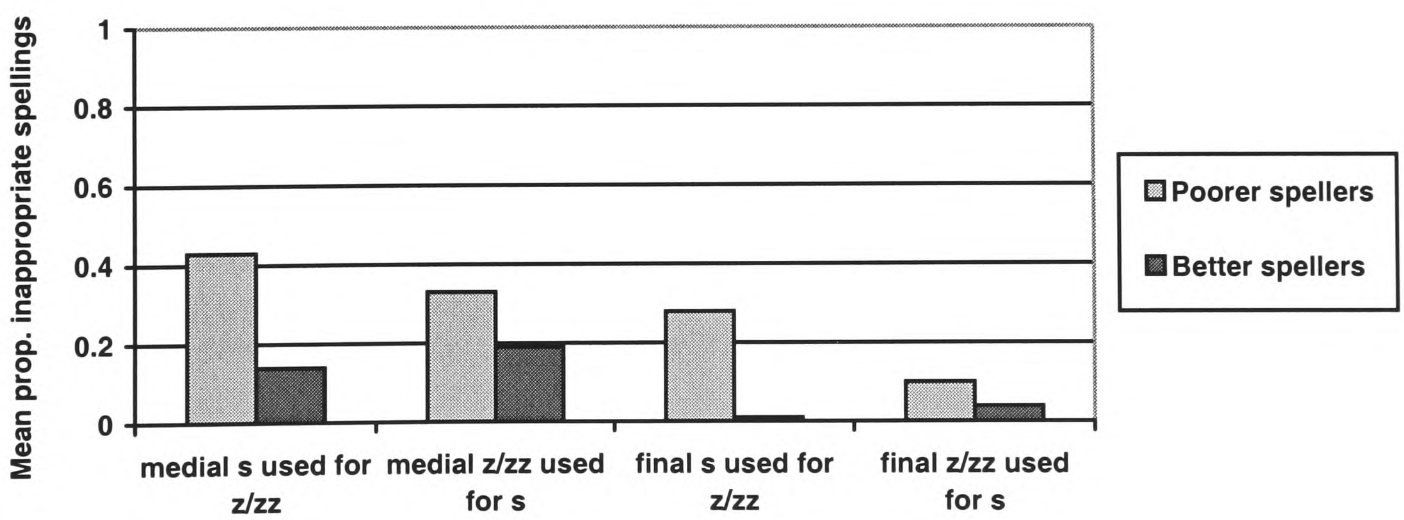

Figure 5.2 Mean proportion of times that /z/ was spelled inappropriately with *s* and with *z/zz* in word-medial and word-final position, by Poorer and Better spellers

This ANOVA showed a main effect of Spelling Group, $F(1,80)=99.4$, $p<0.01$, with the Poorer spellers writing inappropriate representations of /z/ (mean proportion=0.28) significantly more often than the Better spellers (mean proportion=0.10). There was also a main effect of Position, $F(1,80)=96.0$, $p<0.01$. The children wrote significantly more inappropriate representations of /z/ in word-medial position (mean proportion=0.27) than in word-final position (mean proportion=0.11). Finally, there was a significant interaction between Letter and Spelling Group, $F(1,80)=6.65$, $p<0.05$. Newman-Keuls post-hoc tests indicated that the Poorer spellers used *s* when a phonetic spelling was required significantly more often than the Better spellers did ($p<0.01$), but that the two Spelling Groups did not differ significantly in the proportion of times that they used phonetic spellings when *s* was required. Finally, the interaction between Position and Letter did not reach significance. This means that the children's overuse of *s* for *z/zz* in word-final position was no greater than their overuse of *s* for *z/zz* in word-medial position (as suggested in Experiment 4).

These analyses suggest that the children were using morphological and/or conditional rules to decide how to represent /z/ in word-final position, which they could not use in word-medial position. The analyses in the next section attempt to resolve which of these types of rules the children were using in their spelling.

5.3.1.2. Spelling /z/ in PC plurals, P- plurals, and non-plurals

The second question was whether the children did use the conditional rule, in addition to any use of morphological rules, to complete plural words. The various spellings that the children used to represent the final /z/ sound of the PC plurals, P- plurals and non-plurals (*s*, *ss*, *se*, *z*, *zz*, and *ze*) were counted. The mean numbers of each type of spelling for each type of word are presented in Table 5.4.

Table 5.4 Mean number (out of 6) of various representations of /z/ at the end of PC plurals, P- plurals, and non-plurals, by Poorer spellers, Better spellers, and overall. Standard deviations in parentheses. Correct spellings are shown in bold.

Word Type	Spelling required	Spelling written[4]	Poorer spellers (n=40)	Better spellers (n=42)	Overall (n=82)
PC plurals	*s*	*s*	**5.13 (1.28)**	**5.81 (0.51)**	**5.48 (1.02)**
(can be spelled		*ss*	0.05 (0.22)	0.00 (0.00)	0.02 (0.16)
correctly via		*se*	0.20 (0.46)	0.05 (0.22)	0.12 (0.36)
Plural *or* Con-		*z/zz*	0.23 (0.70)	0.05 (0.22)	0.13 (0.52)
ditional rule)		*ze*	0.08 (0.47)	0.02 (0.15)	0.05 (0.35)
P- plurals	*s*	*s*	**3.85 (1.59)**	**4.90 (1.36)**	**4.39 (1.56)**
(can be spelled		*ss*	0.28 (0.55)	0.05 (0.22)	0.16 (0.43)
correctly via		*se*	0.75 (1.10)	0.43 (0.80)	0.59 (0.97)
Plural rule		*z/zz*	0.65 (1.05)	0.24 (0.58)	0.44 (0.86)
only)		*ze*	0.20 (0.85)	0.12 (0.50)	0.16 (0.69)
Non-	*z/zz*	*z/zz*	**2.87 (2.08)**	**5.60 (0.94)**	**4.27 (2.10)**
plurals		*ze*	0.37 (0.90)	0.17 (0.70)	0.27 (0.80)
		s	1.70 (1.86)	0.07 (0.26)	0.87 (1.54)
		ss	0.32 (0.73)	0.09 (0.37)	0.21 (0.58)
		se	0.40 (1.06)	0.05 (0.22)	0.22 (0.77)

The table shows that when writing PC plurals, the children were very good at using the plural inflection -*s* correctly, and only occasionally chose incorrect spellings instead. The Better spellers were correct more often than the Poorer spellers, but even they performed well on these words. When writing the P- plurals, however, both the Better and the Poorer spellers were worse at choosing the correct ending, *s*, to represent their final /z/ sound. This difference between the two types of plurals suggests that the children did use the sound-based conditional rule when spelling plurals.

[4] The spellings *z* and *zz* are combined, since (in terms of morphological and phonological rules) both were equally appropriate or inappropriate as representations of /z/ in the experimental words. The spellings *s* and *ss* are reported separately, since *s* is morphologically appropriate where *ss* is not.

It appears that the children also made at least some use of the plural rule. Both Poorer and Better spellers used *s* correctly to end the P- plurals more often than they used all the incorrect spellings put together. However, this cannot be tested statistically, as we do not know whether the children would have used *s* just as often to complete non-plural words with a long vowel sound preceding their final /z/.

Finally, the two spelling groups performed quite differently on the non-plural words. The Better spellers were nearly as adept at choosing an appropriate spelling for these as they had been for the PC plural words. The Poorer spellers, however, represented the /z/ of these words correctly only about half the time. As found in the pilot studies, their most common error was to use the most frequent representation of word-final /z/; -*s*. These results suggest that only the Better spellers had a reasonable grasp of the general morphological rule governing the spelling of /z/ after a short vowel (-*s* can only be used for inflected words).

These means were analysed in a repeated-measures analysis of variance, with one within-subjects factor, Word Type (PC plural, P- plural, or non-plural), and one between-subjects factor, Spelling Group (Poorer or Better). The dependent variable was the number of appropriate spellings given to these words. The only appropriate spelling for the two types of plurals was *s*, but for the non-plurals we accepted the phonetic spellings *z*, *zz* and *ze* as appropriate (since the children had avoided incorrectly using *s* for these). The means included in the first ANOVA are shown in Figure 5.3.

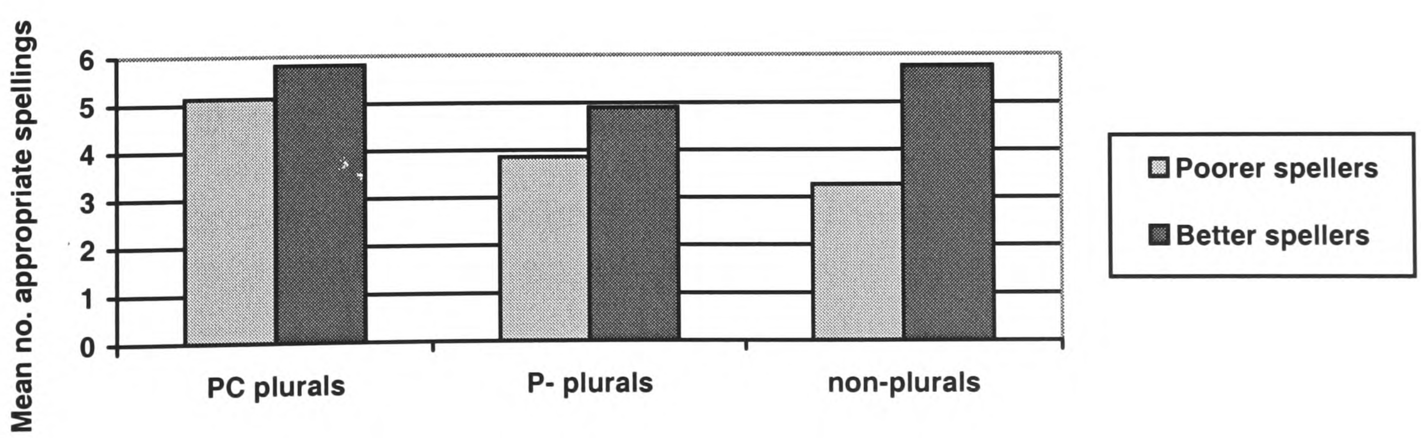

Figure 5.3 Mean number of times (out of 6) that /z/ was spelled appropriately with *s* for PC and P- plurals, and with phonetic spellings for non-plurals, by Poorer and Better spellers.

There was a significant main effect of Spelling Group ($F(1,80)=60.7$, $p<0.01$), which showed that the Better spellers produced significantly more appropriate spellings of word-final /z/ (mean=16.5, out of 18) than the Poorer spellers (mean=12.3). The main effect for Word Type violated the assumption of sphericity, and is therefore is reported with its degrees of freedom adjusted with the Greenhouse-Geisser (GG) correction factor: $F(1.5, 118.2)=16.8$, $p<0.01$. Newman-Keuls post-hoc tests revealed that the children represented /z/ appropriately significantly more often in the PC plural words (mean=5.48, out of 6) than in the non-plurals (mean=4.55, $p<0.01$) and in the P- plurals (mean=4.39, $p<0.01$), which did not differ significantly from each other. This suggests that children were making use of the sound-based conditional rule to spell plural words.

Finally, there was a significant interaction between Word Type and Spelling Group, $F(1.6,123.8)=10.8$, $p<0.01$ (with GG correction). Newman-Keuls post-hoc tests showed that the two Spelling Groups were equally good at completing the PC plurals correctly with *s*, but that the Better spellers wrote significantly more appropriate endings than the Poorer spellers for the P- plurals and the non-plurals ($p<0.01$). The Poorer spellers represented /z/ appropriately significantly more often at the end of PC plurals than of P- plurals and non-plurals ($p<0.01$ for both), between which there was no significant difference. The Better spellers represented /z/ appropriately significantly more often at the end of both PC plurals and non-plurals than of P- plurals ($p<0.05$ for both), but did not differ significantly in their performance on PC and non-plurals. Thus, both Spelling Groups relied on the conditional rule to complete plural words, but it seems that only the Better spellers had learned the morphological rule for completing non-plurals with a short vowel sound.

5.3.3. Morphological awareness

The number of sentences on which the children successfully transformed the target noun from singular to plural or from plural to singular was counted. The Poorer spellers achieved a mean score of 4.80 out of 8 (SD=1.81), and the Better spellers achieved 5.57 (SD=1.21). A one-way analysis of variance showed this difference to be significant, $F(1,80)=5.17$, $p<0.03$.

5.3.4. Correlations

Finally, correlation coefficients were calculated between the children's scores on the sentence analogy task of morphological awareness and their chronological age, spelling age, standard score on the WORD, and the mean number of times that they had appropriately represented the final /z/ sound of the PC plurals, P- plurals, and non-plurals in the spelling task. If the children relied heavily on their understanding of morphological rules to spell word-final /z/ in the spelling task, then their score on this task should be significantly related to their score on the morphological awareness task, beyond any differences in their age and spelling ability. However, if the children based their spelling of /z/ on the conditional rule as much as, or even more than on morphological rules, then their spelling may not be significantly related to their morphological awareness score. The correlation coefficients are shown in Table 5.5.

Table 5.5 Correlations between children's scores on the morphological awareness task, chronological age, spelling age, standard score on WORD, and the mean number of appropriate spellings written for the word-final /z/ of the PC, P- and non-plural words.

	Analogy score	Chron. age	Spelling age	SS on WORD	PC plurals	P- plurals	Non-plurals
Analogy score	--						
Chron. age	0.17	--					
Spelling age	0.20**	0.39**	--				
SS on WORD	0.08	-0.20	0.72**	--			
PC plurals	0.16	0.20	0.28**	0.19	--		
P- plurals	0.16	0.03	0.34**	0.31*	0.48**	--	
Non-plurals	0.11	0.39*	0.55**	0.46**	0.44**	0.23*	--

**$p<0.01$, *$p<0.05$

Table 5.5 shows that the only variable with which the appropriate spelling of all three types of word correlated significantly was spelling age. The children's standard score on the WORD correlated significantly with their spelling of the P- plurals and the non-plurals, and their chronological age only with their spelling of non-plurals. However, the children's performance on the morphological awareness task did *not* correlate significantly with their ability to represent word-final /z/ appropriately for any of the three types of word. This suggests that the children did not rely strongly on morphological rules when spelling word-final /z/.

5.4. Discussion

The results of this experiment largely confirm the findings from the two pilot experiments (3 and 4). First, children in the first few years of school do appear to use some kind of rule-based strategy to decide how to represent the ambiguous sound /z/ where possible. Their spelling of /z/ was significantly better in word-final position, where there are morphology-based rules and sometimes also a sound-structure-based conditional spelling rule to indicate the correct spelling, than in word-medial position, where no such rules exist. However, the children's tendency to overuse *s* when a phonetic spelling was required was no greater in word-final than in word-medial position (as suggested in pilot Experiment 4). This is further evidence that children make use of spelling rules where these exist.

A comparison was then made of the spellings written for the final /z/ sound of the three types of word tested: PC plurals (for which both the morphology-based plural rule and the sound-structure-based conditional rule specified the appropriate spelling *s*), P- plurals (for which only the plural rule specified the appropriate spelling *s*), and non-plurals (for which a general morphological rule specified that *s* is inappropriate, and orthographic convention specified the appropriate spelling *z/zz*). This comparison was designed to test whether children rely on morphological rules or on a rule conditional on sound structure to decide how to represent word-final /z/.

Both the Poorer and the Better spellers correctly wrote *-s* to complete the PC plurals significantly more often than the P- plurals. The PC and P- plurals were of approximately equal frequency in the written language, and their sentence contexts made it equally clear that they were plural words. The only difference between them was in their sound structure. This constitutes strong evidence that children make use of the conditional rule when spelling plural words.

It could be argued that the children did know the plural rule, and were even aware of the singular-plus-*s* structure of plural words. The sound structure might merely have affected the ease with which they could decompose the words according to this structure. The penultimate consonant of the PC plurals might have signalled the division between the two morphemes more clearly than the penultimate vowel sound of the P- plurals, and thus made it easier for the children to complete the PC plurals correctly with *-s*.

However, this interpretation relies on the children being able to use the morphology-based plural rule, and the results of this experiment cannot tell us with certainty whether the children did use this rule. Both the Poorer and the Better spellers used the appropriate spelling *s* to end the P- plurals more than they used all the inappropriate spellings put together, which suggests that they were making at least some use of the plural rule. However, we do not know how often the children would have used *s* to complete non-plural words with the same sound structure (i.e., with a long vowel sound preceding their final /z/), so we can draw no definite conclusions about the children's use of morphology in spelling the plural words. The next experiment will attempt to answer this question.

The Better spellers in this experiment were quite good at spelling the non-plurals appropriately. This suggests that they mostly understood the general morphological rule that the final /z/ of non-inflected non-plural words must not be spelled with *-s*. However, the words with a short vowel that are inflected and therefore do require *-s* (*is*, *was*, *has*, *does*, *his* and the non-inflected exception *as*) are very few, and are grammatically distinctive. Four are very common third-person singular forms irregular verbs, one is a possessive pronoun and one a conjunction. The Better spellers' morphological understanding may have been limited to an awareness that the non-plural words included in this experiment (just ordinary nouns) were of a "different type" from those distinctive words, and that therefore they required a different final spelling. They had presumably come across enough non-inflected non-plurals to have learned that these always require a phonetic ending.

The Poorer spellers, in contrast, were quite poor at spelling the non-plural words, and they used *-s* incorrectly reasonably often, as also found in pilot Experiments 3 and 4. This suggests that they had not fully understood the morphological rule governing the spelling of these non-plural words, or at least that they had not noticed that these words were of a different type from the nouns included in this experiment. Also, they may not have had enough experience with print to have come across many non-inflected non-plurals (since these are relatively rare), and therefore had not had much of a chance to learn how they should be spelled.

Finally, we consider the children's ability to transform plural to singular and singular to plural words by analogy to the sentences provided by two puppets, and the correlations between this morphological awareness performance and their age, spelling age, and ability to spell the endings of the PC, P-, and non-plural experimental words correctly. The children's ability to spell all three types of word was significantly related to their spelling age, but only their ability to use phonetic spellings correctly to complete the non-plurals was related to their chronological age.

However, the correlations of theoretical interest were between the children's morphological awareness scores and their correct spelling of /z/ in the three word types. If the children were using morphological rules to spell these word endings, then we would expect a significant correlation between the number of correct spellings and score on the morphological awareness task. However, if, as the analyses of variance suggest, the children were relying more on the sound-structure-based conditional rule to spell the word endings, we would expect there to be no relationship between the spelling of the word endings and morphological awareness score. This is what we found, and it constitutes further evidence for the idea that children's spelling of word-final /z/ depends more on an understanding of sound-structure-based rules than of morphological rules.

It should be noted that there is an intrinsic limitation to testing children's ability to transform plural and singular nouns by analogy. Nunes et al.'s (1997a) original task required the transformation of verbs, which meant that there were several forms which would make sense in the sentence context (e.g., "The dog *chases/chased/is chasing* the cat"). Success on that task could only be achieved if the child fully understood the model analogy and the transformation required. In the present version, there was usually only one form that the noun could take other than the form presented in the model sentence (e.g., the only forms of the word *mouse* are *mouse* and *mice*, apart from such rare words as *mousy*). Thus, the task could have relied on the ability to recall specific vocabulary items as much as on the ability to understand the analogy and thus the need to transform the test word into its plural or its singular form. Nevertheless, the conclusions drawn from the correlations between scores on this analogy task and the children's ability to represent word-final /z/ correctly do agree with the main conclusion of the experiment.

As all in studies of the spelling of real words, one can never be sure how many of children's correct spellings of the segment of interest result from rote learning of the whole word, how many result from the use of rules or strategies, and how many were achieved through a lucky guess. The next experiment will attempt to overcome this limitation by asking children to spell pseudowords with a /z/ sound, and will look for evidence of the use of sound-based and/or morphology-based rules in the spellings written. Finally, it will examine the relationship between the children's spelling of word-final /z/, and their ability on the same oral task of morphological awareness as used in the present experiment.

Chapter Six: Experiment 6

Children's spelling of /z/ in pseudowords: Sound-structure- or morphology-based rules?

6.1. Introduction

The previous experiment suggested that children in the first few years of school are able to use spelling rules to help them to determine the appropriate representation of the sound /z/ in word-final position, compared to in word-medial position, where no such rules exist. Further, it seems that when deciding how to represent the final /z/ sound of plural words, children rely quite heavily on the words' sound structure. It was not clear from Experiment 5 whether the children also made use of the morphological rule that all regular plurals require a final *-s*. More data are needed on this, and also on the strategies that children use to decide how to represent the final /z/ sound of non-plurals.

This study aimed to confirm and extend the findings of the previous studies by examining children's representations of medial and final /z/ in pseudowords, rather than real words. With real words, it is never clear which correct spellings were achieved simply through rote learning of the entire word, and which through the use of rules or strategies, or even a lucky guess. We used pseudowords (based on the real words used in Experiment 5) in an attempt to overcome this limitation. Each pseudoword was presented in a sentence context which indicated the pseudoword's morphological status.

As in the previous experiment, the experimental words included plurals which ended in a consonant plus /z/ (e.g., *pleens*). These were called "PC" plurals because they could be spelled on the basis of either the morphology-based Plural rule that all plurals end in *-s*, *or* the rule Conditional on sound-structure that word-final /z/ preceded by a consonant is virtually always spelled with *-s*. There were also non-plurals which ended in a short vowel plus /z/ (e.g., *prizz*). It was more difficult to label these words. A knowledge of a general Morphological rule (that only *inflected* words with this sound structure may be spelled with -

s) was needed to avoid spelling them incorrectly with *-s*. However, as noted in the previous experiment, the few inflected words with this structure are so distinctive that children might just need a general idea of them as a "different type" of word to avoid spelling them with *-s*, without a full understanding of the morphological rule. A knowledge of the sound-structure-based Conditional rule for these non-inflected words (after a short vowel, final /z/ is spelled with *z* or *zz*) might be sufficient for children to avoid spelling them with *-s*. Thus, these pseudowords were labelled "M/C", to recognise the possibility that children might use one rule or the other (or both) to spell these words.

The experiment also included pseudowords which ended in a long vowel plus /z/. Half were presented as plurals (e.g., *prees*), and half as non-plurals (e.g., *preeze/preese*). Sound-based rules were of no help in spelling the endings of these pseudowords correctly. Only the morphology-based Plural rule indicated which pseudowords required a final *-s* and which did not. Thus, these were labelled as P- plurals and P- non-plurals.

The use of pseudowords rather than real words in this experiment meant that we could not code the use of *s* or of *z/zz* in word-medial position as "correct" or "incorrect", since either spelling was appropriate. This made them less useful for inclusion in the experimental analyses. Nevertheless, these medial-/z/ pseudowords were included to allow some idea of how children would spell /z/ in another word position, for which there are no morphological or conditional rules.

The first question was whether children use sound-structure based conditional rules when spelling pseudowords. If they use the conditional rule for plural words (consonant plus /z/ is almost always spelled with *-s*), as suggested in Experiment 5, then they should use *-s* correctly significantly more often to complete the PC than the P- plural pseudowords. The predictions for the non-plurals are less straightforward, as they depend on whether the children know the general morphological rule that only inflected words (with the exception of the non-inflected word *as*) may have their final /z/ spelled with *-s*. The results from Experiment 5 suggest that poorer spellers may not have this knowledge. If the children do know this general morphological rule, then they should be able to spell the M/C non-plurals via their sound-based conditional rule (/z/ after a short vowel is spelled with *z/zz*). Thus, they should use non-*s* spellings significantly more often for these M/C non-plurals than for the P- non-plurals (for which there are no sound-based rules).

If they do not know the general morphological rule, then the children should use non-*s* spellings significantly more often for the P- non-plurals (for which the endings *-s*, *-se* and *-ze* are all reasonably common) than for the M/C non-plurals (for which *s* is the most common spelling, since inflected forms such as *has* and *is* are so frequent).

The second question (which we could not answer on the basis of the results of Experiment 5) was whether children use the plural rule at all when spelling pseudowords. If they know that all plurals, regardless of sound structure, should be spelled with *-s*, then children should use *-s* to complete the P- plurals significantly more often than the P- non-plurals. Similarly, they should use plausible alternative spellings (such as *-z*, *-ze* and *-se*) significantly more often for P- non-plurals than for P- plurals. If they do not know the plural rule, then they should not distinguish between P- plurals and P- non-plurals in their use of *s* and of non-*s* spellings.

This experiment also included the same sentence analogy task of morphological awareness that was developed for the previous experiment. If children do use their understanding of the morphological rules governing the representation of word-final /z/ to spell the experimental pseudowords, then we should expect a relationship between their ability to spell these pseudowords and their scores on this sentence analogy task, over and above any effects of age and spelling ability.

6.2. Method

6.2.1. Participants

The participants were 82 children in school years 2, 3, and 4. We could not include children in year 1, as this experiment was carried out at the beginning of the school year, and most of the year 1 children were not yet able to write more than a few simple words. There were 23 children in year 2 (including one bright child of year 1 age), 28 in year 3, and 31 in year 4. Twenty-six of the children attended a first school in Oxford; the other 56 attended an infant and junior school in Solihull. There were 43 girls and 39 boys, ranging in age from 5;11 to 9;02, with a mean age of 7;09.

The participants' spelling ages were determined by their performance on the Spelling Subtest of the Wechsler Objective Reading Dimensions (WORD) (Rust et al., 1993). The participants whose spelling age was less than or equal to the median of 8;00 were placed in the Poorer spelling group. The participants whose spelling age was above 8;00 were placed in the Better spelling group. Table 6.1 shows the children's mean chronological age, mean spelling age, and standard score on the WORD.

Table 6.1 Mean chronological and mean spelling age (in years and months) and mean standard scores on the Spelling subtest of the WORD for Poorer spellers, Better spellers, and overall. Standard deviations in parentheses.

	Poorer spellers (n=41)		Better spellers (n=41)		Overall (n=82)	
Chronological age	7;04	(10.8)	8;01	(8.1)	7;09	(10.5)
Spelling age	7;00	(6.6)	9;07	(15.6)	8;04	(19.5)
WORD std score	96.6	(13.5)	115.1	(12.5)	105.8	(15.9)

6.2.2. Procedure

The experimenter saw each child twice, in testing sessions about three days apart, in a small private area within his or her school.

6.2.2.1. Session 1: Experimental spelling task

In the first testing session, the experimenter explained to groups of three to six children that they would be asked to write down some words on the lined paper in front of them. However, these would not be real words that they had heard before, but new words that the experimenter had made up. The children were to do their best to write down each new word as they heard it. The experimenter also explained that they would hear each word pronounced once on its own, once in a sentence, and once on its own again. This task took between 18 and 25 minutes to complete, depending on the age, skill and concentration levels of the children participating.

The pseudowords were presented in one of six different orders for each group. Each of the 36 pseudowords contained a /z/ sound in either word-medial or word-final position. The structure of the pseudowords was based on the real words used in the previous experiment, as follows:

- *Medial /z/*: 12 pseudowords with a /z/ sound in the middle. Either *s* or *z* could be used to represent the /z/ sound of each of these words (e.g., *glizy/glisy*, *aizer/aiser*); neither spelling was more or less correct than the other.
- *Final /z/*: 24 pseudowords with a /z/ sound at the end. The sentence contexts (described in more detail shortly) made each word's morphological status clear.

- 6 "PC" plurals; plural nouns whose singular form ended in a consonant, and which required an *s* to represent the final /z/ (e.g., *pleens*).

- 6 "M/C" non-plurals; 3 singular nouns and 3 verb stems with a short vowel sound which required a *z* or *zz* to represent the /z/ sound (e.g., *prizz*).

- 6 "P-" plurals; plural nouns whose singular form ended in a vowel sound, and which required an *s* to represent the final /z/ (e.g., *prees*).

- 6 "P-" non-plurals; 3 singular nouns and 3 verb stems with a long vowel sound whose final /z/ could be spelled with *ze* or *se* (e.g., *preeze/preese*).

The P- pseudowords were divided into two lists, A and B. These were counterbalanced such that half the participants heard the List A words presented as P- plurals and the List B words as P- non-plurals, and the other half heard the List B words presented as P- plurals and the List A words as P- non-plurals. The 36 pseudowords are presented in Table 6.2.

Table 6.2 (Arbitrary representations of) experimental pseudowords for the spelling task.

Position of /z/				
Medial	Final			
	PC Plurals	M/C Non-plurs	P- Plurals	P- Non-plurs
			List A	**List A**
bizer/biser	pleens	prizz	prees	preeze
vozer/voser	stogs	flazz	grues	gruze
aizer/aiser	vills	tezz	vaws	vorze
parzy/parsy	chabs	shuzz	thays	thaize
moozy/moosy	podes	gizz	coes	coze
glizy/glisy	fooms	mozz	pars	parze
nizen/nisen				
berzen/bersen			**List B**	**List B**
guzon/guson			droes	droze
fozol/fosol			blies	blize
hizing/hising			terrs	terze
jozing/josing			foos	fooze
			kays	kaize
			moys	moize

The intended morphological status of the pseudowords was not important for the pseudowords with a medial /z/, since both *s* and *z* were appropriate for all of these words. For the pseudowords with a final /z/ sound, however, the sentence context was crucial. This context indicated whether the pseudoword was intended to be a plural, and therefore required a final *s*, or a non-plural (either a singular noun or a verb stem), and therefore required a final *z*, *zz*, *ze* or *se*. Examples of the sentence contexts used are presented in Table 6.3.

Table 6.3 Examples of sentence context used to convey intended morphological status of the experimental pseudowords

Position of /z/	Morphological status	Example of sentence context
Medial	Adjective	He was feeling very *moozy* last night.
	Gerund	My baby sister is *hizing* in her bath.
Final	Plural	How many *prees* can you see up there?
	Non-plural	
	Singular noun	He keeps a big *preeze* in his cupboard.
	Verb stem/infinitive	Dad wants to *tezz* on our roof.

During the administration of this spelling task, the experimenter noticed that many of the participants, especially the poorer spellers, paid little or no attention to the sentence context when attempting to spell the pseudowords. For example, if the experimenter read out the sentence "My uncle bought three big *vaws* at the shop", many of the children would ask, "What was it again? /vɔz/? /vɔz/?" and then repeat the pseudoword to themselves while writing it down, seemingly having forgotten the sentence context presented with it. Thus, in the second testing session, an extra task was introduced to attempt to focus children's attention more strongly on the morphological status of some of the pseudowords, and to see how this affected their spelling of word-final /z/.

6.2.2.2. Session 2: Tests of spelling ability and of morphological awareness, and a second attempt at presenting the P- pseudowords

In the second testing session, the experimenter saw each child individually, for 15 to 20 minutes. She first administered the Spelling subtest of the WORD. The second task was an oral test of morphological awareness, using sentence analogies to test the child's ability to detect and produce transformations of singular nouns to plural nouns and vice versa. This test was the same as the one administered in the previous experiment (see section 5.2.2.2.).

The final task was an attempt to overcome the problem of children not paying attention to the sentence contexts in Session 1. Since our time with the children was limited, this task included just the 12 P- pseudowords, for which the sentence context provided the only clue to how to spell their final /z/ sound. The children had to write down the 12 P- pseudowords again, but only after extracting the required form of each word from a sentence, in a task similar to the "Wug Test" devised by Berko (1958) (see section 1.3.1.1.i.b.).

For each pseudoword, the experimenter read out a sentence in which the pseudoword was either a singular noun (e.g., *grue*) or an inflected verb (e.g., *gruzing*, *vorzed*). The child was then required to complete the sentence orally with the form of the pseudoword that fitted the context. It was clear from the context whether the plural form needed to be created from the singular (e.g., *grue*) or the stem form from the inflected verb (e.g., *gruze*, *vorze*)[1]. Table 6.4 shows two examples.

Table 6.4 Examples of sentences for which children were required to produce a plural form of a singular pseudoword, or a stem forms of an inflected verb pseudoword

Transformation required	Sentence provided	Pseudoword form required
Singular to plural	I saw one *grue* in the pond, but my sister saw two of them. She saw two...	*grues*
Inflected verb to verb stem/infinitive	Our cat *vorzed* at the birds last night. Whenever she sees a bird she likes to...	*vorze*

Even the youngest children had little or no difficulty in providing the correct form of the missing pseudowords. Each child was then asked to write down the pseudoword that they had just provided orally. In order to avoid asking the children to write down the same forms of the pseudowords as they had in Session 1, those who had previously had the List A words presented as plurals now had them as non-plurals, and vice versa. The same changes were made for the List B words.

6.3. Results

6.3.1. Experimental pseudowords

Counts were made of the number of times that the children represented /z/ appropriately or inappropriately with *s* or with other spellings (*z*, *zz*, *ze*, or *se*) for each type of pseudoword. The mean proportions of these responses are shown in Table 6.5.

[1] The non-plurals in this task were all verb stems, rather than a mixture of verb stems and singular nouns, as was the case in Session 1. To include singular nouns, we would have had to ask the children to extract singular forms from plural forms such as *gruzes* and *vorzes*. It was thought that the presence of two /z/ sounds close together would have made this task more difficult than the task of creating plurals, which just required the addition of a /z/ sound to a singular pseudoword.

Table 6.5 Mean proportions of appropriate and inappropriate uses of *s* and of other spellings to represent /z/ in medial and final position, by Poorer spellers, Better spellers, and overall. Standard deviations in parentheses. Appropriate spellings shown in bold.

Position of /z/; word type	Spelling required	Spelling written	Poorer spellers (n=41)	Better spellers (n=41)	Overall (n=82)
Medial	*s* or *z*	*s*	**0.52 (0.30)**	**0.27 (0.20)**	**0.39 (0.28)**
		z/zz	**0.31 (0.30)**	**0.70 (0.22)**	**0.50 (0.33)**
Final					
PC plurals	*s*	*s*	**0.66 (0.24)**	**0.83 (0.27)**	**0.74 (0.27)**
		z/zz/ze/se	0.19 (0.19)	0.17 (0.27)	0.18 (0.23)
M/C non-plu.	not *s*	*z/zz/ze/se*	**0.43 (0.34)**	**0.89 (0.18)**	**0.66 (0.36)**
		s	0.40 (0.31)	0.05 (0.12)	0.23 (0.29)
P- plurals	*s*	*s*	**0.46 (0.33)**	**0.28 (0.25)**	**0.37 (0.31)**
		z/zz/ze/se	0.39 (0.34)	0.70 (0.26)	0.55 (0.34)
P- non-plu.	not *s*	*z/zz/ze/se*	**0.39 (0.30)**	**0.83 (0.20)**	**0.61 (0.34)**
		s	0.49 (0.29)	0.15 (0.19)	0.32 (0.30)

The table shows that the children used both *s* and *z/zz* to represent word-medial /z/, but that the choice of letter varied with spelling ability. The Poorer spellers used *s* more often than they used *z/zz*, and the Better spellers used *z/zz* much more often than they used *s*.

Their representation of /z/ was different in word-final position, and differed also between the types of plural and non-plural. The Poorer and especially the Better spellers used *s* correctly more often for the PC plurals than for the P- plurals, which suggests that they were using the sound-structure-based conditional rule to write these words. When writing the two types of non-plurals, the Poorer spellers did quite badly on both and the Better spellers did quite well. An explanation for this pattern of results is not immediately clear.

The means for the P- words varied with spelling group. The Poorer spellers appear to have made no use of the morphological plural rule at all: they used *s* to complete non-plurals as often as plurals, and other spellings to complete plurals as often as non-plurals. The Better spellers may have made limited use of the plural rule: to some extent they used *s* more often for plurals than for non-plurals, and other spellings more often for non-plurals than for plurals. We now turn to the statistical analyses of these results.

6.3.1.1. The use of rules based on sound structure and/or morphology

In order to confirm whether the children had used rules conditional on sound structure to spell word-final /z/ (as suggested by the means above), we compared the number of times that they used *-s* correctly to complete the PC plurals and the P- plurals. A repeated-measures analysis of variance was conducted, with one within-subjects factor, Plural Type (PC or P-), and one between-subjects factor, Spelling Group (Poorer or Better). The dependent variable was the proportion of uses of the correct ending for these words; *s*.

There was a main effect of Plural Type, $F(1,80)=133.0$, $p<0.01$. The children used *s* significantly more often to complete the PC plurals (mean proportion=0.74) than the P-plurals (mean proportion=0.37). Plural Type also interacted significantly with Spelling Group, $F(1,80)=31.8$, $p<0.01$. According to Newman-Keuls post-hoc tests, both Groups performed better on the PC than the P- plurals ($p<0.01$). This shows that both the Poorer and the Better spellers made use of the conditional rule when spelling plurals.

The post-hoc tests also showed that the Better spellers used *s* significantly more often to complete the PC words than the Poorer spellers did ($p<0.01$). This could result from the Better spellers having a better understanding of the relevant conditional and/or morphological rule than the Poorer spellers. However, the Poorer spellers used *s* significantly more often to complete the P- words than the Better spellers did ($p<0.01$). Possible reasons for this became clearer in subsequent analyses (see below).

We also attempted to discover whether the children spelled M/C non-plurals via a strategy (the general morphological rule about inflections or the sound-based conditional rule), or whether they would perform no better on these words than on the P- non-plurals, for which only the morphological plural rule was of any help. This analysis had one within-subjects factor, Non-Plural Type (M/C or P-), and one between-subjects factor, Spelling Group (Poorer or Better). The dependent variable was the proportion of appropriate spellings (spellings other than *s*: *z/zz/ze/se*) given to these words. There was a main effect of Spelling Group, $F(1,80)=71.8$, $p<0.01$. The Better spellers used non-*s* spellings significantly more often (mean proportion=0.82) than the Poorer spellers (mean proportion=0.36).

There was also a main effect of Non-plural Type, $F(1,80)=5.4$, $p<0.05$. The children wrote non-*s* spellings significantly more often for the M/C non-plurals (mean proportion=0.66) than for the P- non-plurals (mean proportion=0.61). This suggests that they made some use of the general morphological rule and/or the sound-based conditional rule when writing non-plurals with a short vowel sound. There was no significant interaction with Spelling Group.

6.3.1.2. The use of the plural rule

The analyses above show that the children made use of the sound structure, and perhaps of a general morphological rule, to spell the endings of plurals and non-plurals. However, they do not tell us whether or not they used the specific morphological rule that all regular plurals require a final *-s*. In order to answer that question, we compared the proportion of times that the children used *-s* to complete P- plurals and P- non-plurals. The analysis of variance was a repeated-measures one, with one within-subjects factor, Word Type (Plural or Non-plural) and one between-subjects factor, Spelling Group (Poorer or Better). The dependent variable was the proportion of uses of *-s* to represent the final /z/ of these words.

There was a significant main effect of Spelling Group, $F(1,80)=24.0$, $p<0.01$. The Poorer spellers used *s* significantly more overall (mean proportion=0.48) than the Better spellers (mean proportion=0.22). The main effect for Word Type was not significant. This suggests that overall, the children did *not* use the plural rule to spell plural pseudowords.

However, there was a significant interaction between Word Type and Spelling Group, $F(1,80)=9.3$, $p<0.01$. Newman-Keuls post-hoc tests showed that the Poorer spellers used *s* significantly more often than the Better spellers for both plurals and non-plurals ($p<0.01$). However, the Poorer spellers did not distinguish between the plurals and the non-plurals; they wrote *s* about equally often for both. The Better spellers, in contrast, wrote *s* significantly more often to complete the plurals than the non-plurals ($p<0.01$). This suggests that they made some use of the plural rule. However, this use was only very limited: it should be borne in mind that the Better spellers used *-s* correctly for P- plural words little over a quarter of the time.

We also tested whether the children had used spellings other than *s* (*z*, *zz*, *ze* and *se*, but not non-English representations such as *sz*, *zzz* or *c*) significantly more often for the P- non-plurals than for the P- plurals. The repeated-measures analysis of variance had one within-subjects factor, Word Type (Plural or Non-plural) and one between-subjects factor, Spelling Group (Poorer or Better). The dependent variable was the proportion of non-*s* spellings.

There was a significant main effect of Spelling Group. The Better spellers wrote non-*s* spellings significantly more often (mean proportion=0.44) than the Poorer spellers (mean proportion=0.53).

This time the effect of Word Type was significant, $F(1,80)=6.1$, $p<0.05$. Overall, the children used non-*s* spellings significantly more often for the non-plurals (mean proportion =0.61) than for the plurals (mean proportion=0.55). The significant interaction between Word Type and Spelling Group, however ($F(1,80)=6.9$, $p<0.05$) showed the same pattern as in the previous analysis. Newman-Keuls post-hoc tests showed that the Better spellers wrote non-*s* representations of /z/ significantly more often than the Poorer spellers ($p<0.01$). The Poorer spellers wrote exactly the same proportion of non-*s* spellings for the plurals as for the non-plurals. The Better spellers, however, wrote non-*s* spellings significantly more often for the non-plurals than for the plurals ($p<0.01$). These results constitute further evidence that the Poorer spellers did not use the plural rule to distinguish between these two types of word, but that the Better spellers did, although only to a limited extent.

6.3.1.3. Spelling /z/ at the end of P- pseudowords and in word-medial position

Although the Better spellers did appear to make limited use of the plural rule in their spelling, it is clear that in most cases they, like the Poorer spellers, did not distinguish between the P- plurals and the P- non-plurals. Overall, the Poorer spellers wrote *s* about half the time and alternative spellings a little less than half the time. The Better spellers wrote *s* up to about a quarter of the time, and alternative spellings about three-quarters of the time. These patterns of responses are remarkably similar to the patterns that the two Spelling Groups showed when writing /z/ in word-medial position (see Table 6.5), where there were no rules to guide the choice of spelling for /z/.

We did not analyse these differences statistically, as the children's spelling of /z/ in the absence of spelling rules in the middle of these pseudowords was not necessarily comparable with their spelling of /z/ in the absence of knowledge of the plural rule at the end. However, the similarity between the children's representation of medial /z/ and of final /z/ for the P-pseudowords is interesting to note. It seems to suggest that in most cases they spelled these final /z/ sounds in accordance with their overall bias towards *s* (Poorer spellers) or *z* (Better spellers), rather than on the basis of any spelling rules.

6.3.1.4. Spelling /z/ in the P- pseudowords in Session 2

The children wrote the P- pseudowords again the second testing session after producing their correct forms in an oral morphological task modelled after Berko (1958) (see section 6.2.2.2.). The proportions of appropriate and inappropriate uses of *s* and other spellings (*z/zz/ze/se*) for these pseudowords are shown in Table 6.6. Non-English representations such as *sz*, *zs* and *c* were not included.

Table 6.6 Mean proportions of appropriate and inappropriate uses of *s* and of other spellings to represent /z/ in P- pseudowords in Session 2, by Poorer spellers, Better spellers, and overall. Standard deviations in parentheses. Appropriate spellings shown in bold.

Word Type	Spelling required	Spelling written	Poorer spellers (n=41)	Better spellers (n=41)	Overall (n=82)
P- Plurals	*s*	*s*	**0.65 (0.26)**	**0.73 (0.22)**	**0.69 (0.24)**
		z/zz/ze/se	0.22 (0.25)	0.24 (0.20)	0.23 (0.20)
P- Non-plurs	not *s*	*z/zz/ze/se*	**0.44 (0.31)**	**0.84 (0.26)**	**0.64 (0.35)**
		s	0.47 (0.27)	0.11 (0.24)	0.29 (0.31)

The table shows that the Poorer spellers used *s* to complete plural pseudowords more often than non-plural pseudowords. The Better spellers made the correct distinction between plurals and non-plurals to an even greater extent. The pattern was the same for the children's use of non-*s* spellings: the Poorer spellers, and especially the Better spellers used these more often correctly for non-plurals than incorrectly for plurals. These means suggest that once the children focused more strongly on the morphological status of the pseudowords, they were better able to make use of the morphology-based plural rule. It is clear that they performed better than in Session 1, when they wrote the same pseudowords to dictation (see Table 6.5).

However, the children's performance in Session 2 could not justifiably be compared statistically to their performance in Session 1. The words were presented in a different way, and it would not have been clear how much improvement was due to the task itself, and how much simply to practice effects.

We analysed the children's use of *s* in a repeated-measures ANOVA. It had one within-subjects factor, Word Type (Plural or Non-plural) and one between-subjects factor, Spelling Group (Poorer or Better). There was a significant main effect of Spelling Group, $F(1,80)=10.4, p<0.01$. As in the first testing session, the Poorer spellers used *s* significantly more overall (mean proportion=0.65) than the Better spellers (mean proportion=0.42).

There was also a significant main effect of Word Type, $F(1,80)=143.4$, $p<0.01$. The children used *s* correctly to complete the plurals (mean proportion=0.69) significantly more often than they used it incorrectly to complete the non-plurals (mean proportion=0.29).

Word Type interacted significantly with Spelling Group, $F(1,80)=42.3$, $p<0.01$. Post-hoc Newman-Keuls tests indicated that the two Spelling Groups used *s* equally often for the plurals, but that the Poorer spellers used *s* significantly more often than the Better spellers for the non-plurals ($p<0.01$). Most importantly, both the Poorer and the Better spellers used *s* for the plurals significantly more often than for the non-plurals ($p<0.01$). This suggests that both Spelling Groups made use of the morphological plural rule to spell the P- pseudowords in the second testing session.

Second, we analysed the children's use of non-*s* spellings for the two types of P-pseudowords. This ANOVA, like the previous one, had one within-subjects factor, Word Type (Plural or Non-plural) and one between-subjects factor, Spelling Group (Poorer or Better). The dependent variable was the proportion of non-*s* spellings. There was a significant main effect of Spelling Group, $F(1,80)=19.3$, $p<0.01$. As in the first testing session, the Better spellers wrote significantly more non-*s* spellings (mean proportion=0.54) than the Poorer spellers (mean proportion=0.33).

There was a significant main effect of Word Type, $F(1,80)=165.9$, $p<0.01$. The children used more non-*s* spellings for the non-plurals (mean proportion=0.64) than for the plurals (mean proportion=0.23). Finally, there was a significant interaction between Word Type and Spelling Group, $F(1,8)=38.6$, $p<0.01$. Post-hoc Newman-Keuls tests showed that the Spelling Groups did not differ significantly in their use of non-*s* spellings for the plurals, but that the Better spellers used non-*s* spellings significantly more often than the Poorer spellers for the non-plurals ($p<0.01$). Both Spelling Groups wrote non-*s* spellings significantly more often for the non-plurals than for the plurals ($p<0.01$). This is further evidence that the children used the plural rule to spell the final /z/ of these pseudowords.

6.3.2. Morphological awareness

The number of sentences in the morphological awareness task in which the children successfully transformed the target noun from singular to plural or from plural to singular was counted. The Poorer spellers achieved a mean score of 4.95 out of 8 (SD=1.77), and the Better spellers scored a mean of 6.51 (SD=5.73). A one-way analysis of variance showed this difference to be significant, $F(1,80)=21.5$, $p<0.01$.

6.3.3. Correlations and regression analyses

Pearson correlation coefficients were calculated between the children's scores on the sentence analogy task of morphological awareness task and their chronological age, spelling age, standard score on the WORD, and the mean number of times that they represented /z/ appropriately in word-final position in the two testing sessions. If children use their morphological awareness to help them decide how to represent word-final /z/ in a morphologically appropriate way, then their scores on the sentence analogy task should correlate significantly with their ability to use *s* to end plural words, and *z/zz/ze/se* to end non-plural words. The correlation coefficients are shown in Table 6.7 (see over the page).

The table shows that the children's scores on the sentence analogy task were significantly and positively correlated with the number of appropriate spellings with which they completed the non-plural words (M/C and P- in Session 1, P- in Session 2). However, sentence analogy score did not correlate significantly with the appropriate spelling of the endings of the plural words. This suggests that awareness of the relationship between singular and plural words, at least as measured on this task, is not strongly linked to the ability to spell the endings of plural and non-plural words in a morphologically appropriate way.

Supporting evidence that the children did not rely heavily on the morphology-based plural rule to spell word-final /z/ comes from the finding that the children's appropriate spellings for each type of word did not correlate significantly and positively with each other type of word.

Table 6.7 Correlations between children's scores on the morphological awareness task, chronological age, spelling age, standard score on the WORD, and the mean number of appropriate spellings that they wrote for the word-final /z/ of each type of word.

	Analogy score	Chron. age	Spelling age	SS on WORD	PC plurals	M/C non-plurals	P- plurals S1	P- non-plurals S1	P- plurals S2	P- non-plurals S2
Analogy score	--									
Chron. age	0.19	--								
Spelling age	0.46**	0.48**	--							
SS on WORD	0.43**	-0.21	0.69**	--						
PC plurals	0.11	0.16	0.27*	0.24*	--					
M/C non-plurals	0.44**	0.40**	0.65**	0.48**	0.13	--				
P- plurals, S1	-0.12	-0.34**	-0.24*	-0.05	0.28*	-0.34**	--			
P- non-plurals, S1	0.37**	0.45**	0.56**	0.33**	0.12	0.74**		--		
P- plurals, S2	0.07	0.19	0.21	0.13	0.15	0.12	-0.47**	0.06	--	
P- non-plurals, S2	0.45**	0.31**	0.65**	0.53**	0.18	0.67**	-0.30**	0.66**	-0.01	--

$^{**}p<0.01$, $^{*}p<0.05$. S1=Session 1, S2=Session 2.

Spelling age, like analogy score, correlated significantly and positively with the children's ability to spell non-plural endings appropriately. However, its correlations with the correct spelling of plural endings were more variable. It is possible that the correlations between analogy score and the correct spelling of non-plurals were determined solely by differences in spelling age, rather than by differences in morphological awareness. To check this, we conducted two regression analyses. Their outcome measures were the appropriate spelling of the M/C and the P- non-plurals in the first testing session. Chronological age, spelling age, and analogy score were entered into the analysis in a fixed order. The results of the analysis are shown in Table 6.8.

Table 6.8 Multiple regression analysis for outcome measures of appropriate spelling of word-final /z/ for M/C and P- non-plurals presented in the Session 1. Chronological age, spelling age, and analogy score entered in fixed order.

Outcome measure	Appropriate spelling of /z/							
	M/C non-plurals				P- non-plurals			
Order entered	r^2 change	B	S.E. B	beta	r^2 change	B	S.E. B	beta
1. Chron. age	0.161**	0.026	0.020	0.123	0.246**	0.058	0.019	0.299
2. Spelling age	0.275**	0.058	0.012	0.513	0.139**	0.037	0.011	0.353
3. Analogy score	0.025	0.232	0.121	0.179	0.018	0.180	0.118	0.150

$^{**}p<0.01$

Table 6.8 shows that both chronological age and spelling age made significant contributions to the children's appropriate completion of the M/C and P- non-plurals presented in Session 1. However, once these had been controlled for, the contribution of the children's score on the sentence analogy task of morphological awareness was no longer significant.

Thus, the significant correlations observed between sentence analogy score and non-plural spelling are probably due just to differences in the preferred representation of /z/ by the two Spelling Groups. Analogy score correlated significantly with spelling age, and the means in section 6.3.1 showed that Better spellers were more likely to represent /z/ with non-*s* spellings than the Poorer spellers, who were more likely to represent it with *s*. Thus, the Better spellers (and therefore those with the best analogy scores) were more likely to achieve appropriate representations of word-final /z/ of the non-plurals.

In the second testing session, both Spelling Groups showed signs of using the morphology-based plural rule to spell the P- pseudowords. We conducted a third regression analysis to determine whether analogy score would still be related to the children's appropriate spelling of the P- non-plurals in Session 2 (when their attention had been focused on the morphological status of these words) after controls were made for chronological age and spelling age. The results of this analysis are shown in Table 6.9.

Table 6.9 Multiple regression analysis for outcome measures of appropriate representation of word-final /z/ for P- non-plurals presented in the Session 2. Chronological age, spelling age, and analogy score entered in fixed order.

	Outcome measure	Appropriate spelling of /z/ in P- non-plurals			
Order entered		r^2 change	*B*	S.E. *B*	beta
Step 1	Chronological age	0.097**	0.002	0.019	0.008
Step 2	Spelling age	0.330**	0.061	0.011	0.563
Step 3	Analogy score	0.029*	0.235	0.115	0.191

*p<0.05, **p<0.01

Table 6.9 shows that in the second testing session, like the first, chronological and spelling age significantly predicted appropriate spelling of the final /z/ of the P- non-plurals. However, the children's scores on the sentence analogy task of morphological awareness now contributed significantly to the prediction of the appropriate spelling of these non-plurals after the controls for chronological age and spelling age. This is evidence that when the children were encouraged to consider the morphological status of the pseudowords, they relied on their morphological awareness to make use of the morphology-based plural rule in their spelling.

6.4. Discussion

This experiment with pseudowords largely confirms the results gained from the previous experiments with real words. First, it supports the conclusion from Experiment 5 that children in the first few years of school use a rule conditional on sound structure to spell plurals correctly with *-s*. Both the Poorer and the Better spellers used *-s* correctly significantly more often to complete PC plurals (which could be spelled correctly via the morphology-based plural rule *or* the sound-strucutre-based conditional rule) than P- plurals (which could be spelled correctly only via the plural rule). It remained possible that the sound structure of the PC words just made the application of the plural rule easier (see section 5.4.), but a later set of results effectively rules this out as a tenable explanation (see below).

The results of this experiment also showed that both the Poorer and the Better spellers used appropriate non-*s* spellings significantly more often to complete M/C non-plurals than P- non-plurals (for which the incorrect use of -*s* could only be avoided via knowledge of the plural rule). One explanation for their avoidance of the incorrect use of -*s* for the M/C words is that they knew the general morphological rule that final /z/ after a short vowel sound may only be spelled with -*s* if the word is inflected.

However, since the inflected words of this sound structure are so frequent and so distinctive, the children may simply have considered them too different from the M/C pseudowords (presented as singular nouns and verb stems) to generalise from. They may have chosen their spelling of these pseudowords on the basis of a developing knowledge that infrequent words with this sound structure should be spelled with a final -*z/zz*. Our results cannot determine which is the correct interpretation. Nevertheless, they suggest that the children had some knowledge of the type of short-vowel words which require a final -*s* and the type which do not.

The second important question was whether children rely only on sound-based conditional rules to spell plurals, or whether they are able to use the morphology-based plural rule as well. We found that the Poorer spellers seemed not to make any use of the plural rule when writing the P- pseudowords, for which only the plural rule could determine the correct spelling of /z/. They wrote -*s* no more often to complete the P- plurals than the P- non-plurals, and non-*s* spellings no more often to complete the P- non-plurals than the P- plurals. The Better spellers did make some use of the plural rule. They wrote -*s* significantly more often for the P- plurals than the P- non-plurals, and non-*s* spellings significantly more often for the P- non-plurals than the P- plurals. However, this use was extremely limited; they used -*s* correctly for the P- plurals little more than a quarter of the time.

It is interesting to note that the representations of /z/ at the end of the P- pseudowords by both the Poorer and the Better spellers were very similar to their representations of /z/ in word-medial position, where there are no rules to determine which spelling to use. It seems to suggest that in most cases they spelled the final /z/ sounds of the P- words in accordance with the bias that they showed in word-medial position (the Poorer spellers mostly used *s* and the Better spellers mostly used *z* Better spellers), rather than on the basis of any spelling rules.

In summary, it seems that children in the first few years of school are able to use the rule conditional on sound structure when deciding how to represent the final /z/ of pseudowords presented in a sentence context. However, only the better spellers among them seem able to use the plural rule, and even then only to a limited extent. This goes against the claim of several of the spelling models presented in section 1.2.1. that children learn to spell simple inflectional endings from quite early on in their writing development. It also suggests that the early correct usage of the plural *-s* observed by Read (1986) and by Treiman (1993) may well have resulted from clues provided by the sound structure of the words written, rather than from a precocious understanding of their morphological status and of the need to complete them with the invariable inflectional marker *-s*.

However, it should be borne in mind that these results do not prove that children are completely unaware of the plural rule. They may simply not have realised that the sentence context indicated the morphological status of each pseudoword. This in itself suggests a limited understanding of the rule, but it does not preclude the existence of any understanding at all. It was for this reason that we tested the children's spelling of the P- pseudowords again in the second session, after attempting to focus their attention more strongly on the pseudowords' morphological status (see section 6.2.2.2.).

On this second attempt, both the Poorer and the Better spellers wrote *-s* correctly significantly more often to complete the P- plurals than they wrote it incorrectly to complete the P- non-plurals. Similarly, they both used non-*s* spellings correctly significantly more often to complete the P- non-plural than they used them incorrectly to complete the P-plurals[2]. This suggests that when they were encouraged to focus on the pseudowords' morphological status, even the Poorer spellers were able to use the plural rule to some extent, although neither group of spellers approached ceiling. The results from this second testing session emphasise the importance of designing tasks which allow children to demonstrate their ability to the maximum extent possible. However, the results also show that the children's correct application of the plural rule was far from complete. Further, they did not use this rule very much spontaneously, but more when they were forced to consider the morphological status of the pseudowords that they are asked to write.

It thus seems that Poorer spellers rely solely, and Better spellers mostly, on sound-structure-based rules to spell plurals in a pseudoword dictation task. This conclusion can explain the lack of consistently significant correlations between the number of correct spellings of word-final /z/ and the children's scores on the sentence analogy task of morphological awareness. Regression analyses showed that sentence analogy score did not predict the correct spelling of word-final /z/ after controls were made for chronological age and spelling age.

However, sentence analogy score did predict (albeit modestly) the children's use of appropriate (non-*s*) spellings to complete the P- non-plurals in the second testing session. This suggests that the children's morphological awareness aided their use of the morphology-based plural rule when they were spelling pseudowords whose morphological status they were encouraged to consider.

If the children in this experiment relied mostly on sound-structure-based rules to spell word-final /z/, it is presumably because they were too young to have yet fully learned the relevant morphological rules, and so were obliged to rely on sound structure instead.

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[2] It is worth noting that both groups of spellers wrote appropriate spellings for the P- pseudowords more often than they had in the first testing session. However, this could have been due entirely to practice effects, and thus cannot be considered as a convincing extra piece of evidence for the efficacy of the oral morphological task.

Although it is not clear how long it takes for an understanding of these morphological rules to develop fully, we would probably expect that it would be before adulthood. The spelling models presented in section 1.2. which specifically mention the acquisition of the ability to spell inflectional endings describe this acquisition as occurring by the end of primary school.

Thus, we would expect that a group of adults asked to spell these same pseudowords would be able to glean the morphological status of these pseudowords from their sentence context, and to use their understanding of morphological rules to represent their final /z/ sound in an appropriate way. The next experiment will examine the validity of this expectation.

Chapter Seven: Experiment 7

Adults' spelling of /z/ in pseudowords: Sound-structure- or morphology-based rules?

7.1. Introduction

The results from Experiments 3 to 6 suggest that when deciding how to represent the final /z/ of real words and of pseudowords, children generally rely on the words' sound structure more than, or even instead of, their morphological status. This strategy works well with words whose sound structure points fairly unambiguously to the appropriate spelling. However, the sound structure of other words is less helpful, and on these words the better spellers appeared mostly unable, and the poorer spellers completely unable, to use morphological rules to achieve the appropriate representation of /z/. Since the oldest children tested were only nine years of age, it seems reasonable to assume that they still had several years to develop their understanding of the always-reliable morphological rules governing the spelling of word-final /z/. This would mean that they would no longer have to depend on sound-structure-based rules, which are often unreliable.

The models of spelling development seem to predict that by adulthood, spellers should fully understand the morphological rules, and thus would use these instead. However, this prediction may be unjustified. Young spellers might just continue to use sound-structure-based rules to spell word-final /z/ until they have learned so many words by sight that they no longer have to rely on a spelling strategy, but just spell words to "look right" (e.g., as *husbands* does, but as *husbandz* does not). If they ever have to spell an unfamiliar word with a final /z/, they will usually be right if they rely on sound structure. If they get it wrong, they will not necessarily be corrected as they would have been at school, and may never feel the need to discover if there is some easy way of deciding how to spell this sound in new words.

Therefore, in this experiment, we asked a group of adults to spell the same pseudowords as the children in the Experiment 6 had written. Adult participants in psychology experiments, including those which test the reading or writing of pseudowords, are very often undergraduate students. Such adults are usually intelligent and, although they may vary in their reading and writing ability, will normally have above-average literacy skills. This is quite different from the range of skills found in the classroom, where child participants are usually selected at random. Unfortunately we did not have the time or the resources to test the intelligence, general level of literacy, or spelling ability of our adult participants. However, we made sure that we included participants who had not attended university, as well as those who had. We hoped to gain some preliminary information on whether this had any effect on their ability to use sound-structure- and morphology-based rules to spell /z/.

7.2. Method

7.2.1. Participants

The participants were 26 British and 34 Australian adults, of whom 32 were female and 28 male. They all agreed to participate in the experiment after being asked by the experimenter, and provided their age and information about the level of education that they had attained or were studying towards (secondary or tertiary). The mean and median ages and their ranges, for these two groups and overall, are shown in Table 7.1.

Table 7.1 Descriptive statistics for chronological age (in years) of participants with a secondary and with a tertiary education, and overall.

Chronological age (yrs)	Secondary educated (*n*=41)	Tertiary educated (*n*=19)	Overall (*n*=60)
Range	24 - 70	18 - 56	18 - 70
Mean (SD)	51.6 (10.3)	27.3 (12.6)	43.9 (15.8)
Median	54	21	50

7.2.2. Procedure

The testing sessions were conducted with three to ten participants at a time, during a pre-arranged 10- to 15-minute period at the end of lectures, social gatherings, or society meetings. The experimenter explained briefly what the task involved, and those who were willing to participate stayed behind to do so. Each participant was provided with a piece of paper and a pen, and told that they would be asked to write down some made-up words, or pseudowords. The experimenter explained that the task was designed to investigate the different ways in which people chose to spell such pseudowords, and that they should attempt to spell each one as they thought best. The experimenter read aloud each pseudoword alone, in a sentence context, and then alone again, and allowed time for each participant to write down each word before going on to the next one. The pseudowords and the sentences were the same as in the previous experiment (see section 6.2.2.1).

7.3. Results

We counted the number of times that the participants represented /z/ appropriately or inappropriately with *s* or with other feasible spellings (*z, zz, ze, se*) for each type of pseudoword. The mean proportion of each type of spelling is shown in Table 7.2.

Table 7.2 Mean proportion of use of *s* and other spellings to represent /z/ in word-medial and -final position, by adults with a secondary or tertiary qualification, and overall. Standard deviations in parentheses. Appropriate spellings are shown in bold.

Position of /z/; word type	Spelling required	Spelling written	2° educated (n=41)	3° educated (n=19)	Overall (n=60)
Medial	*s* or *z*	*s*	**0.31 (0.25)**	**0.37 (0.28)**	**0.33 (0.26)**
		z/zz	**0.65 (0.27)**	**0.62 (0.28)**	**0.64 (0.27)**
Final					
PC plurals	*s*	*s*	**0.88 (0.21)**	**0.97 (0.06)**	**0.91 (0.18)**
		z/zz/ze/se	0.10 (0.18)	0.03 (0.06)	0.08 (0.16)
M/C non-plu.	*z/zz*	*z/zz/ze/se*	**0.81 (0.14)**	**0.93 (0.14)**	**0.85 (0.25)**
		s	0.14 (0.22)	0.05 (0.14)	0.11 (0.20)
P- plurals	*s*	*s*	**0.43 (0.31)**	**0.64 (0.35)**	**0.50 (0.33)**
		z/zz/ze/se	0.56 (0.31)	0.36 (0.35)	0.49 (0.33)
P- non-plu.	*Se/ze*	*z/zz/ze/se*	**0.79 (0.23)**	**0.89 (0.15)**	**0.82 (0.21)**
		s	0.19 (0.23)	0.11 (0.15)	0.17 (0.21)

The proportions do not always add up exactly to 1.00 because the participants occasionally used representations of /z/ not included in our marking system. Some of these appeared to result from mis-hearings of the pseudowords (e.g., *berthen* for *berzen*), but others involved the use of non-English combinations such as *sz* or *zs*.

The table shows that when writing /z/ in word-medial position, the participants used *z* nearly twice as often as *s*. There are no striking differences between the adults with a secondary and those with a tertiary education.

In word-final position, the participants did not use the same proportions of *s* and *z* as they had in medial position. They appear to have made use of the sound-structure-based conditional rule when spelling the plurals: they wrote *s* correctly much more often to complete PC plurals than to complete P- plurals. For both types of plurals, but especially the P- plurals, the adults with a tertiary education used *s* correctly more often than those with a secondary education.

Both groups of spellers used spellings other than *s* approximately equally for the M/C non-plurals and the P- non-plurals. This probably reflects an equal knowledge of the rules governing the spelling of the two types of word. To complete the M/C non-plurals appropriately, the participants would have to know the general morphological rule that word-final /z/ can be spelled with *-s* (virtually) only if the word is inflected. Alternatively, they could just know that *z/zz* is the correct spelling for all words with a short vowel expect for a handful of highly frequent and distinctive words. For the P- non-plurals, they would have to know the plural rule to avoid using *-s* .

It appears that the participants did make at least some use of the plural rule when spelling the experimental pseudowords. They used *s* more often to spell P- plurals than P- non-plurals, and they used non-*s* spellings more often to spell P- non-plurals than P- plurals. The better performance of the adults with a tertiary education suggests that these participants made more use of the plural rule than those with a secondary education. However, it should be noted that neither group performed at anywhere near ceiling levels: even the tertiary-educated adults used *s* correctly for the P- plurals only 64% of the time.

In our first set of statistical analyses, we examined the participants' use of sound-based conditional rules to spell pseudowords with a final /z/ sound.

7.3.1. The use of a rule based on sound structure for plurals

We conducted a repeated-measures analysis of variance to compare the participants' correct use of *-s* at the end of the two types of plural pseudoword. The analysis had one within-subjects factor, Plural Type (PC or P-), and one between-subjects factor, Education Level (Secondary or Tertiary).

There was a significant main effect for Education Level, $F(1,58)=6.7$, $p<0.05$. Those with a tertiary education completed plurals correctly with *-s* significantly more often (mean proportion=0.97) than did those with a secondary education (mean proportion=0.88). There was also a significant effect of Plural Type, $F(1,58)=87.4$, $p<0.01$, showing that the participants had used *-s* correctly to complete PC plurals significantly more often (mean proportion=0.91) than to complete P- plurals (mean proportion=0.50). This shows that they made use of the rule conditional on sound structure to spell the final /z/ sound of these words, over and above any use that they may have made of the plural rule.

7.3.2. The use of a rule based on sound structure and/or morphology to spell non-plurals

We also compared the participants' use of spellings other than *s* to complete the M/C non-plurals and the P- non-plurals, in an ANOVA with the same structure as the one described above. The use of non-*s* spellings was found not to differ significantly between the M/C non-plurals (mean proportion=0.85) and the P- non-plurals (mean proportion=0.82).

As suggested earlier, this lack of significant difference probably results from the participants having an approximately equally-developed knowledge of the rules governing the spelling of the two types of word.

7.3.3. The use of the plural rule

In order to confirm whether the participants had made use of the plural rule when spelling the pseudowords, we first compared their (correct) use of *-s* to complete the P- plurals with their (incorrect) use of *-s* to complete the P- non-plurals. We conducted a repeated-measures ANOVA with one within-subjects factor, Word Type (Plural or Non-plural) and one between-subjects factor, Education Level (Secondary or Tertiary). There was a significant effect of Word Type, $F(1,59)=55.0, p<0.01$. The adults wrote *-s* correctly (mean proportion=0.50) significantly more often than incorrectly (mean proportion=0.17). This shows that they did spell these P- pseudowords according to the plural rule.

Word Type also interacted significantly with Education Level, $F(1,58)=74.1, p<0.01$. Post-hoc Newman-Keuls tests revealed that both groups of spellers used *-s* correctly to complete plurals significantly more often than they used *-s* incorrectly ($p<0.01$). Those with a tertiary education used *-s* correctly for plurals significantly more often than did those with a secondary education ($p<0.05$). The two groups did not differ significantly in terms of the proportion of times that they used *-s* incorrectly to complete non-plural words.

We also compared the participants' use of non-*s* spellings for the same two types of word, with a similar ANOVA. Here, too, there was a significant effect of Word Type, $F(1,58)=70.7, p<0.01$. The participants used non-*s* spellings significantly more often (mean proportion=0.82) for P- non-plurals than for P- plurals (mean proportion=0.49). This supports the conclusion that the participants used the plural rule to guide their spelling of the pseudowords, if only to a limited extent.

Word Type interacted significantly with Education Level, $F(1,58)=10.7, p<0.01$. Newman-Keuls post-hoc tests showed that both groups of spellers used non-*s* spellings significantly more often to complete non-plurals (correctly) than to complete plurals (incorrectly), $p<0.01$. Those with a tertiary education used non-*s* spellings to complete non-plurals significantly more often than did those with a secondary education, who in turn used non-*s* spellings to complete plurals significantly more often than did those with a tertiary education ($p<0.05$ for both).

7.4. Discussion

The results of this experiment caution against the assumption that the ability to spell all inflectional endings correctly is fully acquired even by adulthood. The adults tested here were very good at using the correct ending, -*s*, to complete PC plurals (e.g., *pleens*), which could be spelled correctly via knowledge of the rule conditional on sound structure *or* knowledge of the plural rule. They were significantly worse at completing the P- plurals (e.g., *prees*), which could be spelled correctly only via familiarity with the plural rule. This shows that these adults, like the children tested in Experiment 6, relied to at least some extent on the pseudowords' sound structure to decide whether or not to complete them with a final -*s*.

When spelling the M/C non-plurals (e.g., *prizz*), the participants usually chose an appropriate non-*s* ending. They may have achieved this through knowledge of the general morphological rule that word-final /z/ after a short vowel sound may (virtually) only be spelled with -*s* if the word is inflected. However, as suggested in sections 5.4. and 6.4., it is also possible that they saw the handful of high-frequency inflected words with this sound structure as a distinctive set of words whose spelling should not be generalised. In this case, the participants may have used their knowledge of the sound-based conditional rule that /z/ after a short vowel is written with -*z* or -*zz*.

We also wished to know whether adults used the plural rule to spell plural pseudowords, or whether they relied exclusively on the sound-structure-based conditional rule. They were found to use -*s* significantly more often to complete P- plurals than P- non-plurals, and to use spellings other than *-s* significantly more often to complete P- non-plurals than P- plurals. This is evidence that the participants did use the morphology-based plural rule to spell plural pseudowords, and that they did not rely solely on the pseudowords' sound structure to decide how to spell word-final /z/.

However, this result should not be taken to mean that the participants were consistently correct in their use of the plural rule. When writing the P- plurals, they used *-s* correctly only half the time. Further, they used *-s* incorrectly to complete P- non-plurals 17% of the time. This suggests that these adults did not necessarily possess a complete understanding of what is generally considered to be a very simple inflectional spelling rule. It appears that their good performance on the PC plurals relied to a large extent on their use of the words' sound-structure, rather than of the plural rule. These findings have implications for theories of spelling development. Researchers should take care not to assume that all morphological spelling rules (and other spelling rules as well) will be perfected by adulthood.

Although we did not end up including the participants' spelling of word-medial /z/ in the analyses, it was interesting to observe that they chose *z* or *zz* to represent this sound nearly twice as often as they chose *s*. This pattern of responses does not reflect the pattern in the English orthography. The number of words in which word-medial, intervocalic /z/ is represented with *s* or *ss* is about four times as great as the number of words (of the same frequency) in which it is represented with *z* or *zz* (see Footnote 3, section 4b.1). It is interesting that the adults' tendency to use *z/zz* more than *s* for word-medial /z/ was similar to that of the Better spellers in Experiment 6. It may be that both the Better spellers of that experiment and the adult spellers of the present experiment overused the spelling *z/zz* in this position (where there were no morphological or sound-based rules to guide the choice of letter) because it is a more "unusual" letter than *s*, and the pseudowords were thought to be "unusual" words.

We asked the participants in this experiment to indicate whether they had a secondary-school education or whether they had received, or were studying for, a university qualification. There were some interesting differences between the performance of the two groups. The participants with a tertiary education used *-s* correctly to complete the both the PC and the P- plurals significantly more often than the participants with a secondary education did. Since the tertiary-educated adults did not out-perform the secondary-educated adults on the PC plurals alone, it seems that there was no difference between the two groups in their ability to use the spelling rule conditional on sound structure to achieve the correct spelling of *s*. The result instead suggests that the tertiary-educated adults had a better understanding of the plural rule than did the secondary-educated adults.

This experiment's findings need to be replicated in a study in which the sizes of the two groups are more equal. Also, in this experiment the participants with a tertiary education were mostly younger than those without, so the possibility that the effects obtained were due instead to differences in age cannot be ruled out. However, this possibility seems rather unlikely. The ability to spell inflectional endings seems intuitively to be one that would not deteriorate with normal ageing, especially not by the age of 70 (the age of the oldest participant in the present study). It is not like the ability to solve quadratic or chemical equations, for example, which might be learned at secondary school but quickly forgotten through disuse. However, there are no data available to support this view, and future experiments should control for age as well as level of education.

Whether or not one has gone to university is clearly a very crude measure of literary ability. A tertiary degree does not guarantee good reading or spelling skills, any more than a lack of such education means a lack of ability in these areas. Nevertheless, the differences observed between the ability of the two groups to apply the plural rule when writing pseudowords suggest that there may well be substantial variation in the understanding of spelling rules even among "normal" adult spellers.

Further research with adults is not really within the scope of this thesis, which is focused on much earlier development in spelling. However, future experiments with older spellers are obviously needed to clarify the extent of this variation, not only for the plural rule, but for other spelling rules as well. These experiments would do well to take standardised measures of spelling and reading ability, and to control for other factors such as age and general intelligence. Further, they should explore other methods of presenting the pseudowords. Like the children in Experiment 6, the adults in the current experiment may have not paid sufficient attention to the sentence contexts, although not necessarily because they found the pseudowords so difficult to write. Several adult participants reported having decided how to spell the experimental pseudowords on the first, isolated hearing, without waiting to hear the pseudoword pronounced in a sentence.

The final set of experiments will start by examining children's representation of derivational, rather than inflectional, morphology.

Chapter Eight: Experiment 8

Children's use of base words to spell derived words

8.1. Introduction

This experiment aimed to provide preliminary data on children's use of base word spellings to spell these words' derived forms. As discussed in section 1.3.2.3., Treiman et al. (1994) found that 4- to 7-year-old children chose the correct letter (*t* or *d*) to represent the American flapped /ɾ/ of two-morpheme words, such as *dirty* (from *dirt*) more often than of similar one-morpheme words, such as *city*. The authors concluded that even very young children can use their knowledge of the spelling of base words to spell an ambiguous sound in derived and inflected words. This finding goes against the widely-held view that children rely on a purely phonetic strategy when they first begin to write (see section 1.2.).

An examination of children's representation of the sound /ɾ/ could not be carried out in this country, as British children do not pronounce word-medial *t* and *d* as a flap. The present experiment aimed instead to extend Treiman et al.'s findings by asking British children to spell a sound that is ambiguous in British, as well as in American English; /z/. The spelling of /z/ is ambiguous in both word-medial and word-final position; it can be represented with *s* or with *z*. This is different from *t* and *d*, whose spelling is ambiguous only in word-medial position because of their flapped pronunciation. In word-final position they are not flapped, and are spelled as they are pronounced, with *t* or with *d*. This lack of ambiguity meant that Treiman et al.'s participants nearly always represented the final /t/ and /d/ sounds of the base words correctly. Thus, the question in that experiment was whether the children would transfer their knowledge of the spelling (or of the sound) of the base words to improve their spelling of the ambiguous flap in their derived forms. Since the spelling of /t/ and /d/ is unambiguous in word-final position, it is not clear whether the children transferred their knowledge of the base words' *sound* (/t/ or /d/) or of their *spelling* (*t* or *d*).

The present experiment asked children in the first few years of school to spell base words ending in /z/ (e.g., *noise*, *breeze*), the derived forms of these words, with a medial /z/ (e.g., *noisy*, *breezy*), and one-morpheme control words with a medial /z/ (e.g., *busy*, *dizzy*). The relative difficulty of the base words' endings meant that the participants needed to be older than the 4- and 5-year-olds tested by Treiman et al. Even so, we could not be certain that the children would be able to represent the final /z/ of the base words correctly in every case.

This experiment therefore needed to do more than just to see if children transferred their knowledge of the base words' representation of /z/ to spell the ambiguous /z/ in these words' derived forms. It first needed to examine the children's spelling of /z/ at the end of the base words, and to establish whether this is better than their spelling of medial /z/ in the one-morpheme control words. If it is, we can then ask whether the children are able to transfer their knowledge from base to derived forms. Since the spelling of /z/ is ambiguous in word-final position, children will need to rely on its spelling, rather than on its sound, if and when they transfer their knowledge in this way.

Treiman et al.'s hypothesis, that even young children can recognise and capitalise on the links of meaning between words to aid their spelling, would predict that the children should spell /z/ correctly significantly more often in the derived words than in the control words. On the basis of these authors' previous results, it was also expected that the children's spelling of /z/ in the derived words would not be as good as in the base words, because the children's transfer of spelling knowledge from base to derived words would be incomplete. In Treiman et al.'s terms, they would not be able to make use of the base words to the maximum extent possible.

If Treiman et al. are wrong in their contention that children are able to use morphological relations between words to aid their spelling (at least when they have to rely on the base words' spellings), there should be no significant difference between the number of times that they spell /z/ correctly in the base, derived and control words.

8.2. Method

8.2.1. Participants

The participants in this experiment were the same 65 children in school years 2 to 4 who participated in Experiment 2 (see section 3.2.). Their age range was between 6;06 and 9;00 years, with a mean age of 7;09 (SD=7.85 months). As described in section 3.2., none of the year 1 children initially tested was able to complete all the experimental words. Thus, this experiment's participants were slightly older than had been planned. Also, time constraints during testing meant that it was not possible to measure the participants' spelling ages. Thus, the participants' responses were initially analysed all together.

8.2.2. Procedure

The experimental words were presented in the same two testing sessions as the regular past verbs and non-verbs described in Experiment 2, and were interspersed amongst those words. The experimenter read out each word alone and in a sentence context for the children to write, as described in section 3.2. Of the 82 words presented overall, 18 constituted the experimental words for the present study. Each of these words included the sound /z/, spelled either with *s* or with *z*. There were six "Base" words, six "Derived" words, and six "Control" words, with the following characteristics:

- *Base words*: one-morpheme, one-syllable words ending in a /z/ sound. Three required a final *-se* ending to spell this /z/ sound (e.g., *noise*), and three required a final *-ze* or *-zz* (e.g., *froze*).
- *Derived words*: two-morpheme, two-syllable words with a medial /z/ sound, derived from the base words. Three required a medial *s* to spell the /z/ sound (e.g., *noisy*), and three required a medial *z* or *zz* (e.g., *frozen*). Four ended in *-y*, and two in *-en*.
- *Control words*: one-morpheme, two-syllable words with a medial /z/ sound, matched as closely as possible to derived words for complexity, length and

frequency. As with the derived words, three required a medial *s* to spell the /z/ sound (e.g., *busy*), and three required a medial *z* or *zz* (e.g., *dozen*).

These words and their frequencies (Carroll et al., 1971) are shown in Table 8.1.

Table 8.1 Frequencies for Base, Derived and Control words (Carroll et al., 1971)

	Letter Required			
	s		*z*	
Word Type	Word	Frequency	Word	Frequency
Base	noise	58.4	fizz	33.7
	chose	53.5	froze	44.5
	rose	58.9	breeze	53.6
	Mean (SD)	56.9 (2.99)	Mean (SD)	43.9 (9.96)
Derived	noisy	52.0	fizzy[1]	–
	chosen	56.1	frozen	55.3
	rosy	44.4	breezy	46.9
	Mean (SD)	50.8 (5.94)	Mean (SD)	51.1 (5.94)
Control	busy	59.5	dizzy	41.3
	cousin	52.1	dozen	55.9
	easy	62.2	crazy	50.6
	Mean (SD)	57.9 (5.23)	Mean (SD)	49.3 (7.39)

It would have been preferable for the frequency of the Base words to be higher than that of the Derived and Control words, to increase the children's opportunity to transfer their knowledge of the spelling of Base words to Derived words. However, it proved impossible to find enough appropriate words whose characteristics and frequencies were ideal, and an analysis of variance showed there to be no significant difference between the mean frequencies of the Base, Derived, and Control words ($F(2,16)=0.28$, $p>0.05$).

[1] The word *fizzy* is not listed in the Carroll et al. frequency book, but it was included in this experiment, as British children are familiar with this word and its meaning.

Another limitation was that the words which required an "s" spelling were overall more frequent (mean=55.23) than the words which required a "z" spelling (mean=47.72), $F(1,16)=5.53$, $p=0.03$.

It should be noted that two of the "control" words, *easy* and *crazy*, are actually derived forms (of *ease* and *craze*). However, they were treated as control words, since they are relatively frequent (and familiar to children), and their base forms are relatively rare. The experimenter asked some children from each year group (6 from year 2, 12 from year 3 and 11 from year 4) if they had ever heard of the words *ease* and *craze*, and the answer was "no" in nearly all cases. Two children in year 2 said that they knew the word *ease*, but when asked what it meant, both explained that it was "lots of letter *e*'s". Thus, it seemed reasonable to define these words as non-derived for the purposes of this study. It should also be noted that two of the six derived words, *chosen* and *frozen*, can function either as past participles or attributively as adjectives (Weiner, 1983). The sentence contexts in which these words were pronounced presented them as adjectives, and so they were seen to constitute derived, rather than inflected, forms.

The experimental words were presented within Experiment 2, which manipulated the number of letters of each word that was shown as a spelling "cue". The method of presentation remained the same throughout the study: the 18 words were presented visually with some of their letters covered up by a paper balloon, as described in section 3.2. Each time, the crucial *s* or *z/zz* spelling and any following letters were covered, so that the children had to guess how to represent the /z/ sound (as well as the remaining sounds).

8.3. Results

8.3.1. Experimental words

Throughout this chapter, any representation of the sound /z/ which includes *s* (e.g., *s, ss, se, sse*) is referred to as an "s" spelling. Similarly, any representation which includes *z* (e.g., *z, zz, ze, zze*) is referred to as a "z" spelling. An "s" spelling produced for a word which requires an "s" spelling is considered *appropriate*, even if the child's attempt is not conventionally correct (e.g., *noissy* for *noisy*). The use of "z" for "s" spellings, and vice versa, is considered *inappropriate*. The use of *sz* and *zs*, and any other non-English combinations, were not included in the analyses. The number of times that the children used "s" and "z" spellings to represent the /z/ sound appropriately and inappropriately was computed. The means are shown in Table 8.2.

Table 8.2 Mean number of appropriate and inappropriate spellings written for Base, Derived, and Control words, requiring "s" and "z" (out of 3) and overall (out of 6). Appropriate spellings are shown in bold.

Word Type	Spelling written	"s" spelling required	"z" spelling required	Overall
Base	Appropriate	**2.66 (0.67)**	**1.83 (1.04)**	**4.49 (1.23)**
	Inappropriate	0.28 (0.63)	1.06 (1.00)	1.34 (1.16)
Derived	Appropriate	**2.32 (0.97)**	**1.89 (1.03)**	**4.21 (1.40)**
	Inappropriate	0.46 (0.81)	0.83 (0.93)	1.29 (1.13)
Control	Appropriate	**2.05 (1.12)**	**1.74 (1.06)**	**3.79 (1.57)**
	Inappropriate	0.78 (1.04)	0.98 (0.89)	1.76 (1.26)

We can see from the table that for each type of word, the children represented /z/ with an appropriate spelling more often than with an inappropriate one. However, as expected, and in contrast to Treiman et al.'s findings, they did not perform at ceiling on the Base forms. Nevertheless, the table shows that the children's performance on these Base forms was better than on the Control words, which means that there was room for them to transfer their knowledge of the spelling of the Base words to their Derived forms.

In accordance with Treiman et al.'s prediction, it does seem that at least some transfer occurred: overall, the children wrote /z/ appropriately more often in Derived than in Control words. However, if such transfer did occur, it seems that (as in Treiman et al.'s study) it was not complete. The mean number of appropriate spellings for Derived words was less than that for Base words.

Although this general pattern holds for the words requiring "s", the differences across Word Types for the words requiring "z" appear to be very small. The number of appropriate spellings written for "z" Base words was not much higher than the number written for "z" Control words. Thus, even if the children were able to transfer completely their knowledge of the Base words' spelling to the Derived forms, their performance could not be much better than their performance on the Control words. For the words requiring a "z" spelling, /z/ was represented appropriately just as often in the Derived as in the Base words. For the words requiring an "s" spelling, /z/ was represented appropriately less often in the Derived words than in the Base words. This suggests that the transfer of spelling knowledge from Base to Derived forms was incomplete for the "s" words, but complete for the "z" words. The table also shows that when children did not use an appropriate spelling, they very often used an inappropriate spelling (as defined above) instead. Occasionally they wrote non-English combinations such as *sz* and *zs*, or *c*, to represent the sound /z/, but for the most part their inappropriate spellings resulted in broadly the "opposite" pattern of means when compared to their appropriate spellings.

A repeated-measures analysis of variance was conducted on the means for "appropriate" spellings, to determine which differences were significant. The analysis had two within-subjects variables, Word Type (Base, Derived, and Control) and Letter (the spelling required to represent /z/; "s" or "z"). A similar analysis was conducted on the means for "inappropriate" spellings. However, since the main effects and interactions were close to being "mirror images" of those of the appropriate spellings, to avoid repetition the results of this analysis will not be reported here.

The ANOVA on the appropriate means showed a significant effect of Word Type, $F(2,128)=10.6$, $p<0.01$. Post-hoc Newman-Keuls tests confirmed that the number of appropriate representations of /z/ was significantly greater in Base than in Derived words ($p<0.05$), and significantly greater in Derived than in Control words ($p<0.01$). The difference between Base and Control words was also significant at $p<0.01$. This confirms the prediction made by Treiman et al.'s hypothesis.

There was also a significant main effect of Letter, $F(1,64)=14.5$, $p<0.01$. The /z/ sounds of words which required an "s" spelling were written appropriately significantly more often (mean=7.03, out of 9) than the /z/ sound of words which required a "z" spelling (mean=5.46). Letter also interacted significantly with Word Type ($F(2,128)=4.27$, $p<0.05$). Post-hoc Newman-Keuls tests indicated that for words that required an "s" spelling, the number of appropriate representations of /z/ was significantly higher in Base words than in Derived words ($p<0.05$), and in Derived words than in Control words ($p<0.01$). For words that required a "z" spelling, in contrast, there were no significant differences across Word Types.

The post-hoc tests also showed that there was no significant difference between the number of "s" and "z" Control words whose /z/ was spelled appropriately. However, for both Base and Derived words, /z/ was spelled appropriately significantly more often when an "s" spelling was required than when a "z" spelling was required ($p<0.01$).

8.3.2. Relationship between word frequency and children's performance

It could be argued that the differences in the number of times that the children spelled /z/ appropriately across Word Types depended on the familiarity of each word as a whole (as indexed by their frequencies in Carroll et al., 1971), rather than on any transfer of knowledge between Base and Derived words. For example, the words which required an "s" spelling were overall more frequent than those which required a "z" spelling, and the children's representation of /z/ in the "s" words was overall better than in the "z" words.

However, there were as many differences as there were similarities between word frequencies and the children's performance. For example, although the frequencies of the "s" Derived words and the "z" Derived words were almost the same, the children's spelling of /z/

was significantly better in the "s" than in the "z" Derived words. Also, although the "s" Control words were more frequent than the "z" Control words, the children's spelling of /z/ did not differ significantly between these two types of word.

Thus, it seems that the children's ability to represent the /z/ sound appropriately cannot be attributed merely to variations in the frequency of the experimental words.

8.3.3. Differences between children of different ability levels?

In Treiman et al.'s series of experiments, it quite often happened that the younger participants showed differences that the older participants did not. Thus, our analysing the responses of all the children together might have obscured any differences between the performance of children of different levels of spelling ability. Initial attempts to group the children by school year revealed that performance on most variables increased from year 2 to year 3, but that there was not much further improvement by year 4. However, the number of participants was not distributed equally between year 2 and years 3 and 4, and there was much variation within year groups as well. There was also too much variation within age groups for age to be a meaningful grouping variable.

The children had already written a number of regular past verbs and matched non-verbs in the first part of this study (Experiment 2; see section 3.2.). In Experiment 1, the number of experimental words spelled correctly overall correlated very highly with spelling age (p=0.85). Thus, we decided to group the children into "Poorer" and "Better" spellers on the basis of the number of these verbs and non-verbs (out of 64) that they had spelled entirely correctly. The children were split at the median score of 7. Those who got 7 or fewer experimental words correct were assigned to the "Poorer" spelling group, and those who got more than 7 correct were assigned to the "Better" spelling group.

The mean chronological ages, and mean number of verbs and non-verbs spelled correctly, by the Poorer and Better spellers, are shown in Table 8.3.

Table 8.3 Means and standard deviations for Poorer and Better spellers' chronological ages (SDs in months) and number of regular past verbs and matched non-verbs spelled correctly overall (out of 64).

	Poorer spellers (n=33)	Better spellers (n=32)	Overall (n=65)
Chronological age	7;06 (7.91)	7;11 (7.06)	7;09 (7.85)
Mean no. words correct	4.03 (1.72)	18.69 (6.29)	11.25 (8.67)

As discussed in section 3.3.1., these children were relatively poor spellers for their age. Their spelling of the regular past verbs was worse than that of a similar group of slightly younger spellers. The mean number of times that the children in these two Spelling Groups used "s" and "z" appropriately to spell the present experiment's Base, Derived and Control words, is shown in Figure 8.1.

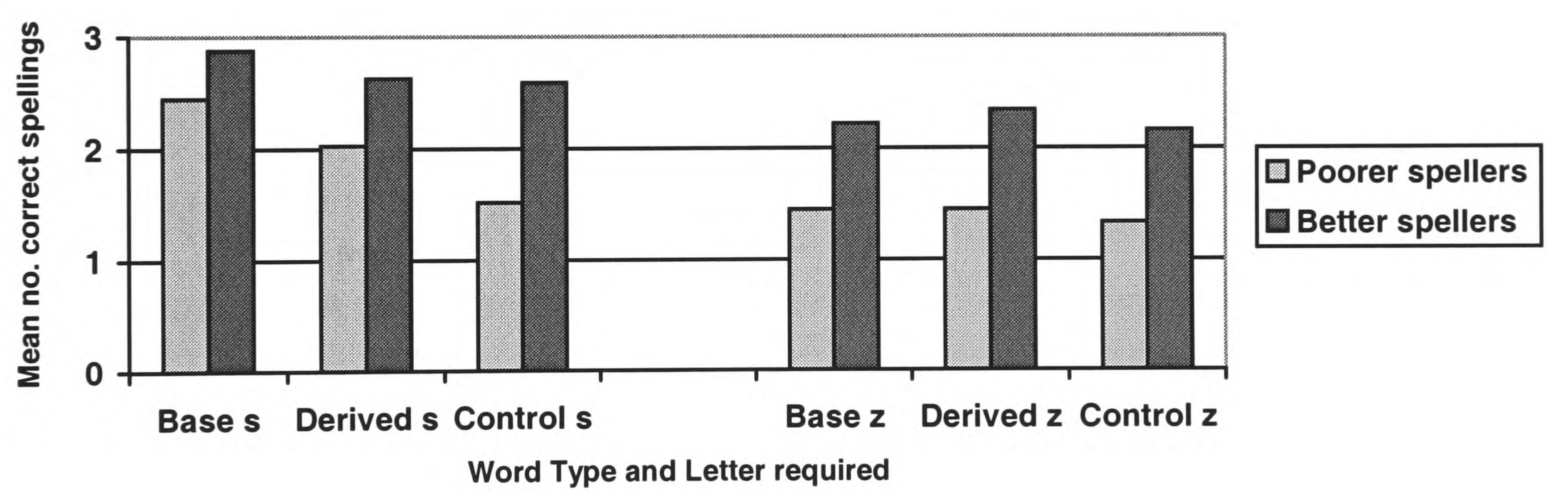

Figure 8.1 Mean number of correct spellings of /z/ (out of 3) for Base, Derived, and Control words which require an "s" or a "z" spelling, by Poorer and Better spellers.

The figure shows that, unsurprisingly, the Better spellers used appropriate representations of /z/ more often than the Poorer spellers for each type of word and letter. However, despite this difference, both Spelling Groups appear to show a similar pattern of results. When writing words which required an "s" spelling, both Groups represented /z/ with the appropriate spelling more often for Base than for Derived words, and more often for Derived than for Control words (although this last difference was very small for the Better spellers). When writing words which required a "z" spelling, however, the Poorer spellers were the same, and the Better spellers slightly better, at representing the /z/ in Derived words compared to Base words. They were still better at representing /z/ appropriately in Derived than in Control words, but this difference was quite small.

To check for differences between the two Spelling Groups, an ANOVA was carried out on the mean number of appropriate representations of /z/. It had the same two within-subjects factors as in the previous ANOVA (Word Type and Letter), but also included the between-subjects factor of Spelling Group (Poorer or Better).

This analysis revealed a main effect of Spelling Group, $F(1,63)=43.2$, $p<0.01$. As expected, the Better spellers provided more appropriate spellings (mean=15.1, out of 18) than the Poorer spellers (mean=9.82). The main effects of Word Type and Letter, and the interaction between these two factors, were the same as in the earlier analysis. However, this new analysis did not reveal any significant interactions with Spelling Group. Thus, the Poorer and Better spellers' appropriate use of /z/ across Word Types and Letters did follow the same pattern. Their correct use of "s" was greater in Base than in Derived words, and in Derived than in Control words, but their correct use of "z" did not differ significantly across Word Types.

8.3.4. Consistency of spelling

The previous analyses provided information about how children spelled the /z/ of Base and Derived words overall, but did not specify whether children represented /z/ in the same way within each Base-Derived pair. To examine this, we counted the number of times that the 65 participants had written the three "s" and the three "z" Base words with an appropriate spelling, and the number of times that they had written them with an inappropriate spelling ("s" for "z" or "z" for "s").

We then calculated the proportion of times that each of these appropriate and inappropriate spellings in the Base words was followed by the *same* representation of /z/ in its

Derived form. This indicated how often the children were consistent (e.g., *noise-noisy, noize-noizy*) in their representation of the sound /z/ within each Base-Derived pair. Since Spelling Group had not interacted significantly with any other factor in the analyses above, we examined the spelling of all the children together. The results of these calculations are shown in Table 8.4.

Table 8.4 Children's consistency in representing /z/ Derived words (maximum=195) when they spelled the /z/ of the Base words appropriately or inappropriately with "s" and with "z"

Spelling of /z/ in Base words	Total number of these spellings	Number of times Base spelling kept consistent in Derived form	Example	Proportion of times Base spelling kept consistent in Derived form
"s" appropriate	173	145	*noise-noisy*	0.84
"z" for "s"	18	9	*noize-noizy*	0.50
"z" appropriate	119	92	*fizz-fizzy*	0.77
"s" for "z"	69	23	*fis-fissy*	0.33

Table 8.4 shows that overall, the children's transfer of their knowledge of the Base words' spelling to the Derived words was never entirely complete. In Treiman et al.'s terms, they did not use this knowledge to the maximum extent possible when writing Derived words. This clarifies the findings from section 8.3.1. (where it looked as though the transfer from Base to Derived "z" words *was* complete), and confirms the conclusions in Treiman et al.'s (1994) experiment. However, the extent of transfer of spelling knowledge from Base to Derived words appears to have depended on whether the Base word was spelled appropriately in the first place. The children were consistent in their representation of /z/ in both Base and Derived forms quite often when they had spelled /z/ appropriately in the Base form. When they had represented /z/ inappropriately in the Base form, however, the children were much less consistent. They went on to choose the same inappropriate spelling for the Derived form only half the time for the "s" words and only one-third of the time for the "z" words.

No statistical analysis could be carried out on these data because of the ambiguity of scores of zero. For example, a child who spelled 3 "s" base words incorrectly with *z*, but who did not spell any of their derived forms with *z*, would get a score of 0 for the *noize-noizy* example. A child who did not use *z* incorrectly for any of the 3 "s" base words, however, would not be able to spell any of their derived forms consistently with *z*, and would therefore also score 0 for these pairs of words.

8.4. Discussion

Before the predictions made for this experiment could be tested, two questions had to be answered. The first concerned the children's ability to spell the /z/ sound of the base words. As discussed in section 8.1., the children in Treiman et al.'s study had very little difficulty in spelling the end sounds of the base words correctly, because these just had to be spelled as they sounded, with *t* or *d*. Here, however, it was not obvious from the final /z/ of the base words whether they required an "s" or a "z" spelling, and so the children had to be familiar with the base words to represent their final /z/ sounds correctly. The correct choice of letter was not always made, and the base words requiring "z" proved especially difficult. The children in this experiment therefore started out with an incomplete knowledge of how to spell the /z/ sound of the base words.

The second question was whether there was any basis for the children to transfer, to the derived words, the knowledge that they had of the base words' spelling. When writing the words which required an "s" spelling, the children represented /z/ appropriately significantly more often in the base words than in the one-morpheme control words. This meant that there was an opportunity for the children to transfer their knowledge of the base words' spelling to the derived words. When writing the words which required a "z" spelling, however, the children did not differ significantly in the number of times that they represented /z/ appropriately in the base words and in the control words. Thus, no matter how well the children transferred their knowledge from the base to the derived words, we could draw no conclusions about how much this had helped their spelling of the derived words, since their performance could be no better on these than on the control words.

The relative difficulty of the "z" base words thus meant that it was impossible to answer the question which had been asked in Treiman et al.'s study, for the words which required a "z" spelling. This question is whether children are able to transfer their knowledge of the spelling of base words to improve their spelling of derived words, compared to one-morpheme control words. For the words requiring a "z" spelling, there were no significant differences in the number of appropriate representations of /z/ across the three word types.

However, for the words which required an "s" spelling, Treiman et al.'s prediction was upheld. The children represented word-medial /z/ with an appropriate spelling significantly more often in derived words such as *noisy* (from *noise*) than in control words such as *busy*. Since /z/ can be written as *s* or as *z* in word-final, as well as in word-medial position, this result suggests that children can make use of the <u>spelling</u>, rather than just the <u>sound</u>, of a section of a base word whose spelling is ambiguous in the derived form. As mentioned in section 8.1., this distinction had not been clear in Treiman et al.'s study.

It appeared from this analysis that the extent to which the children transferred their knowledge of the spelling of the base words to their derived forms also depended on whether the words required an "s" or a "z" spelling. For the "s" words, the children wrote /z/ appropriately significantly more often in the base than in the derived words, which suggests that, as Treiman et al. found, their transfer of knowledge was incomplete. For the "z" words, however, the children represented /z/ appropriately just as often in the derived as in the base forms, which suggests that they used their knowledge of the base words' spelling to the maximum extent when writing derived words.

There was no difference in the response patterns of the Poorer and Better spellers in this experiment. This is in contrast to the results from several studies in the series carried out by Treiman et al., in which the younger participants chose the correct letter more often for two-than for one-morpheme words, but the older participants showed no difference between word types. In most cases this could be ascribed to the Better spellers' performance approaching ceiling levels. It seems that the words in the present experiment were reasonably difficult even for the Better spellers, so that they, as well as the Poorer spellers, had to rely on the base words to help them to spell the derived words. However, it seems strange that the Better spellers were not more accomplished at using this strategy than the Poorer spellers.

Finally, we consider the consistency with which the children represented /z/ in each base-derived word pair. This was a more precise way of measuring the completeness of transfer of spelling knowledge, as it examined the children's spelling between each pair of related words, rather than between the means for each set of words, and considered inappropriate as well as appropriate representations of /z/. This comparison showed that the children's transfer of knowledge from base to derived words was never entirely complete. This supports the conclusions from Treiman et al.'s (1994) experiment. The extent of transfer of spelling knowledge seemed to depend on whether the base word was spelled appropriately in the first place. When they had spelled a base word with an appropriate representation of /z/, the children usually spelled its derived form consistently, with the same representation of /z/. When they had spelled a base word with an inappropriate representation of /z/, however, they were consistent only at chance levels, or at even below chance.

Of course, it is not necessarily true that every instance of a correctly spelled base *and* derived word represents the transfer of knowledge from the base to derived spelling. The children could just have known how to spell some of the derived words anyway. However, it appears from the previous analyses that some transfer was occurring, as overall the children performed better on the derived than on the control words.

The reason that the children were more often consistent when they had spelled the base form correctly than when they had spelled it incorrectly might stem from differences in confidence of having used the right letter. It could be that the more confident the children were about the correctness of their representation of /z/ in the base words, the more likely they would be to transfer their knowledge of this representation to the words' derived forms.

When the children spelled a base word appropriately, it is probable that this was usually because they were familiar with the word's spelling, rather than because they had made a lucky guess. Thus, they would be fairly certain that this was the correct way to represent /z/, and would be confident in using the same spelling for the word's derived form. It was often obvious that children were aware when they did not how to spell an experimental word – they would repeat the word several times, stare at the paper, make false starts, and eventually write down an attempt, saying "I'm not really sure about that one", or "I know that's wrong". Thus, when they wrote the base words with an inappropriate representation of /z/, it is quite likely that the children were often conscious that their attempt was not necessarily correct. They would therefore lack the confidence to use that same representation in the derived form of the word (if indeed they knew what letter they would use in the base form), and would not show much consistency within that base-derived pair.

These results come from children's spelling of only three words of each type, and need to be confirmed with a study including more words. The relatively difficult base words meant that the participants in this experiment had to be older than those tested by Treiman et al. However, these children also turned out to be rather poor spellers. The next experiment therefore needs to include younger spellers who can cope better with the spelling task.

Chapter Nine: Experiment 9

Children's use of base words to spell derived words

9.1. Introduction

The previous experiment showed that 6½- to 9-year-old children wrote "s" correctly to represent /z/ more often in one-morpheme base words than in two-morpheme, derived words, and in these derived words more often than in one-morpheme control words. These results support Treiman et al.'s (1994) contention that young children can use their knowledge of the spelling of base words to spell a difficult portion of those words' derived forms. Experiment 8 showed that children can use this knowledge even when they have to rely on the spelling, rather than the sound, of the ending of the base words. However, this finding held only for words whose /z/ sound required an "s" spelling, not for those which required a "z" spelling, probably because of the relative difficulty of the "z" base words. This limited the extent to which the children's spelling of the "z" derived words could be improved, compared to their spelling of the "z" control words.

Both the base words which required a final "s" and those which required a final "z" were much more difficult to spell than the unambiguous final /t/ and /d/ sounds of Treiman et al.'s base words. To ensure that our participants knew how to spell most of the base words (so that they had the opportunity to benefit from this knowledge when spelling derived forms), we had to choose children who were several years older than those in Treiman et al.'s studies. It is not surprising that they were able to spell the derived words better than the control words, presumably by using their knowledge of the derived words' base forms.

However, as mentioned in section 8.3.3., the participants in Experiment 8 seemed to be quite poor spellers for their age, so it was impossible to know whether younger, but slightly better, spellers would respond in the same way. Thus, this ninth experiment set out to replicate the previous study, but to include children in year 1 as well as years 2 to 4. It also included an increased number of experimental words, since in the previous study there had been only three examples of each type of word.

Further, this experiment aimed to investigate the relationship between children's tendency to preserve spellings between base and derived words, and their morphological awareness; specifically, their awareness of derivational relationships. To this end, the experiment included two tests of explicit awareness of derivational morphology. One was a sentence analogy task (similar to that of Nunes et al., 1997a), and the other a task requiring children to extract base words from their derived forms (similar to a test used by Rubin, 1988). If children preserve the spelling of /z/ between base and derived forms of a word, this can be interpreted to reflect their understanding that the two words are related in meaning and therefore need to be spelled with the same letter. If such consistency in spelling does reflect an awareness of morphological relations, then children's consistency scores should be correlated with their scores on the two oral measures of morphological awareness. Further, the children's scores on these two tasks should be significantly correlated with each other.

9.2. Method

9.2.1. Participants

Seventy-four children in years 1 to 4 participated in the experiment. Fifty-two were pupils at a first school in Oxford; the remaining 22 attended a first school in Worcester. There were 39 boys and 35 girls, ranging in age from 5;09 to 9;10, with a mean age of 7;07. Thirteen of the participants were in year 1, 23 were in year 2, 21 were in year 3, and 17 were in year 4.

The children were divided into two Spelling Groups on the basis of their spelling age, as measured on the spelling sub-test of the Wechsler Oral Reading Dimensions (WORD) (Rust et al., 1993). Those whose spelling age was below the median of 7;07 were allocated to the Poorer spelling group; those whose spelling age was equal to or more than the median were allocated to the Better spelling group. Table 9.1 shows the mean chronological and spelling ages for the Poorer and Better spellers, and overall.

Table 9.1 Mean chronological and mean spelling ages (in years and months) and mean standard scores on the Spelling subtest of the WORD for Poorer spellers, Better spellers and overall. Standard deviations in parentheses (SDs in months for age data).

	Poorer spellers (n=38)	Better spellers (n=36)	Overall (n=74)
Chronological age	7;06 (13.79)	7;10 (10.53)	7;07 (12.39)
Spelling age	6;10 (5.32)	9;08 (20.56)	8;03 (22.58)
WORD std score	92.2 (14.68)	117.3 (12.31)	104.5 (15.01)

9.2.2. Procedure

Each child participated in two testing sessions, conducted about a week apart. These sessions took place in a quiet, private area within the children's school, and lasted between 10-25 minutes, depending on the age and skill of the children involved.

9.2.2.1. Session 1: Experimental spelling task

In the first session, the experimenter saw the children in groups of three, four, or five. She explained that they would be doing some writing, and that they should write down each word as best they could on the lined paper provided. The children in years 1 and 2 were also told that some words might be a bit difficult, but that they should still have a go at spelling each one. The experimenter pronounced each of the 24 words once its own, once in a sentence, and once on its own again.

The words presented in this session were the 12 Derived and 12 Control words. The 12 Base words were administered in the second testing session, but for the sake of clarity they are included in the following description:

- *Base words*: one-morpheme, one-syllable words ending in a /z/ sound. Six required a final *-se* to spell the /z/ sound, and six required a final *-ze* or *-zz* (e.g., *lose*, *buzz*).

- *Derived words*: two-morpheme, two-syllable derived words with a medial /z/ sound. Six required a medial *s* to spell the /z/ sound, and six required a medial *z* or *zz*. Six ended in *-y*, two in *-en*, three in *-er*, one in *-est*[1] (e.g., *loser*, *buzzer*).
- *Control words*: one-morpheme, two-syllable control words with a medial /z/ sound, matched as closely as possible to Derived words for complexity, length and frequency. Six required a medial *s* to spell the /z/ sound, and six required a medial *z* or *zz* (e.g., *poison*, *razor*).

The words and their frequencies (Carroll et al., 1971) are shown in Table 9.2.

Table 9.2 Frequencies for Base, Derived and Control words (Carroll et al., 1971)

	Letter Required			
	s		*z*	
Word Type	Word	Frequency	Word	Frequency
Base	nose	59.6	breeze	53.6
	rose	58.9	freeze	49.8
	noise	58.4	sneeze	46.8
	lose	56.8	buzz	46.5
	wise	56.3	froze	44.5
	chose	53.5	fizz	33.7
	Mean (SD)	57.3 (2.22)	Mean (SD)	45.8 (6.73)
Derived	nosy	--	breezy	46.9
	rosy	44.4	freezer	38.4
	noisy	52.0	Sneezy	--
	loser	40.1	buzzer	36.2
	wisest	43.4	frozen	55.3
	chosen	56.1	fizzy	--
	Mean (SD)	47.2 (6.61)	Mean (SD)	44.2 (8.62)
Control	daisy	40.0	crazy	50.6
	easy	62.2	bulldozer	41.2
	busy	59.5	wizard	42.6
	poison	50.6	razor	43.7
	pleasant	56.8	dozen	55.9
	raisin	40.5	dizzy	41.3
	Mean (SD)	51.6 (9.60)	Mean (SD)	45.9 (6.02)

As in Experiment 8, it proved impossible to find enough words with the ideal characteristics and frequencies. We had wanted the Base words to have a higher mean

[1] As in Experiment 8, the words *chosen* and *frozen* were presented as adjectives, not past participles. The *-est* word, *wisest*, was actually inflected rather than derived, but we were unable to find any further suitable derived words.

frequency than the Derived and Control words, but the three types of words did not differ significantly in frequency ($F(2.32=1.38, p=0.27)$. This was true for both the words which required an "s" spelling, and those which required a "z" spelling. It was more difficult to find suitable "z" words than suitable "s" words, and so the mean frequency of the "z" words chosen for this experiment (45.4) was significantly less than of the "s" words (52.3) ($F(1,32)=1.38, p=0.01$).

Because of the difficulty of finding suitable control words, five of those chosen were, strictly speaking, derived words. *Crazy* is derived from *craze*, *razor* from *raze*, *easy* from *ease*, *pleasant* from *please*, and, arguably, *bulldozer* from the verb *to bulldoze*. However, four of these base forms are very much rarer than the derived forms used here, and seemed unlikely to be known by most of the children tested. The fifth, *please*, is clearly a well-known word, but its connection to *pleasant* was thought not to be obvious to young children. These assumptions proved well-grounded when we later asked children to identify the base words in these derived forms, and found that virtually none identified the base forms of these five words (see section 9.3.3.1.).

Finally, three of the experimental words (*nosy*, *Sneezy* (one of Snow White's dwarves) and *fizzy*) did not feature in the Carroll et al. list, so no frequencies could be given. However, it proved impossible to find alternative words which were included in this list. The experimenter asked the children in the first four groups tested (all in year 1 or 2) if they had heard of these words, and all were able to give adequate definitions, or to use them correctly in a sentence. Thus, these words were retained. The experimental words were administered in a different order to each group of children.

9.2.2.2. Session 2: Tests of spelling ability, spelling of base words, and morphological awareness

In the second session the experimenter saw the children individually, for about 25 minutes at a time. She first administered the spelling sub-test of the WORD to each child.

This was followed by a "base-extraction" task, a spelling test of the Base words presented in the first session, and a sentence analogy test of awareness of derivational morphology (using a different set of words). These tasks are now described in more detail.

9.2.2.2.i. "Base-extraction" task and spelling of base words

The "base-extraction" task tested the children's ability to identify the Base words within the Derived words spelled in Session 1. The experimenter read aloud the 12 Derived and 12 Control words, and asked the child to decide whether each of these words had "a smaller word hidden inside it" that "meant something like it". Each child was presented with the words in one of ten different orders. Before administering the test words, the experimenter took care to explain that some words have a true base word, related in meaning to the derived form (e.g., *mud* in *muddy*) and that some words do not (e.g., *ugly, pretty*). Special attention was drawn to words which sound as though they have a base word in them, but actually do not, because the "hidden" word has no meaning relation to the longer word (e.g., *win* in *window*). Each child completed three practice items before hearing the 24 experimental words.

Every time a child identified a Base word, the experimenter asked him or her to write it down. This procedure was followed whether the Base word identified was correct (e.g., *froze* in *frozen*) or incorrect (e.g., *does* in *dozen*), to avoid giving feedback. At the end, to ensure that a complete record was obtained of each child's spelling of the 12 Base words, the experimenter asked the child to write down (to dictation) any of the Base words that had not been correctly identified. Hardly any of the children appeared to notice that these were words that they should have identified in the preceding task.

Although it would have been preferable to administer the base-extraction and base-spelling tasks in different sessions, the experimenter was limited to seeing each child for two short sessions only, and to present both as separate tasks within the same session may have resulted in confounding of the results. A child asked if there was a smaller word hidden in *noisy* might think of *noise* unusually easily if he had written it ten minutes before. Conversely, a child asked to spell *noise* ten minutes after thinking about the word *noisy* (and possibly identifying *noise* within it) might be influenced by his memory of how *noisy* should be spelled. It was hoped that the combined task that was administered would avoid these problems.

9.2.2.2.ii. Sentence Analogy test of morphological awareness

This test was based on Nunes et al.'s (1997a) sentence analogy test of morphological awareness, which assesses children's ability to transform verbs between past and present tense, and which was employed in the first study (see section 2.2.). Here, the same puppets provided similar analogical sentences, but this time the task was to transform base words into derived words. As described in section 2.2., the experimenter introduced each child to two hand-puppets, and explained that every time the badger said something, the hippopotamus would copy him, but change it a little bit.

For each item the badger would say two sentences, one including a base word (noun, adjective or verb), and the other, a derived form of this word. The hippopotamus would respond with a sentence similar in structure to the badger's first sentence but containing a different base word, and the beginning of a second sentence similar in structure to the badger's second sentence. The child was asked to provide the missing derived form (and, if he or she wanted to, any following words) of this second sentence. Because the base and derived words constituted different parts of speech, the sentences within each pair had to be different, rather than very similar, as in Nunes et al.'s original task. Requiring the child to provide only the derived form meant that he or she did not have to try to remember the structure of the second sentence of the pair.

For all but the first practice analogy, the two base forms were chosen so that they were derived in different ways (with different suffixes or other change). This was to ensure that the children were not just copying the change made in the first pair of sentences, as might have occurred if the words were, for example, *run-runner* and *teach-teacher*. Three practice trials were given, with feedback and with help if necessary, and then the eight test items (in a systematically varied order for each child). The analogies were as follows:

Practice Analogies:
The sun is shining. It's a sunny day.
There's fog all around. It's a _________ (day).

Betty is very good at cooking. She's a good cook.
Sue is very good at reading. She's a good _____________.

Ben likes building things. He wants to be a builder.
Laura likes nursing sick people. She wants to be a ___________.

Test analogies:

1. That man comes from France. He is French.
   That man comes from England. He is _______________.
2. That lady is good at dancing. She's an excellent dancer.
   That lady is very good at acting. She's a famous __________.
3. Everyone talks about how good Bill is at music. They say he is very musical.
   Everyone talks about Angela's beauty. They say she is very _________.
4. He's going to count along two. It's the second one.
   He's going to count along four. It's the _________ (one).
5. I sometimes feel full of anger. Then I am angry!
   I sometimes feel full of fury. Then I am ________!
6. John likes to cycle along the road. He's a keen cyclist.
   Jack likes to run in the park. He's a keen ______________.
7. Tim is better at maths than anyone else in the class. He's the best at maths.
   Jill is faster at running than anyone else in the class. She's the ______ (at running).
8. My mother told me about all the colours in the painting. She said it's very colourful.
   My mother told me about the dangers if you climb that wall. She said it's very ____.

9.3. Results

9.3.1. Experimental words

As in the previous chapter, any representation of the sound /z/ which includes *s* is referred to as an "s" spelling, and any which includes *z* is referred to as a "z" spelling. *Appropriate* spellings are uses of "s" ("z") where an "s" ("z") spelling is required (e.g., either *noisy* or *noissy* for *noisy*). Non-English representations of /z/ such as *sz*, *zs*, and *c* were not included in the analyses. The number of times that the children used "s" and "z" spellings to represent the /z/ sound appropriately in each word was computed. The means are shown in Table 9.3.

Table 9.3 Means and standard deviations for "s" and "z" spellings used appropriately by Better and Poorer spellers and overall, for Base, Derived, and Control words. Means are out of 6, for all but the final column, where they are out of 12.

Word Type	Spelling required	Poorer spellers (n=38)	Better spellers (n=36)	Overall (n=74)	Overall, "s" & "z" combined
Base	"s"	4.00 (2.12)	5.41 (0.98)	4.70 (1.79)	8.84 (2.59)
	"z"	3.22 (2.10)	5.05 (1.33)	4.14 (1.97)	
Derived	"s"	2.62 (2.29)	4.84 (1.09)	3.73 (2.10)	8.05 (2.46)
	"z"	3.68 (2.04)	4.97 (1.38)	4.32 (1.85)	
Control	"s"	2.32 (2.04)	4.49 (1.37)	3.41 (2.04)	7.32 (2.40)
	"z"	3.24 (2.01)	4.59 (1.57)	3.92 (1.91)	

We can see from the table that overall, as in the previous experiment, the children's representation of /z/ in the Base words was not at ceiling. However, their performance on the Base forms was better overall than on the Control words, which means that there was room to transfer their knowledge of the spelling of the Base words to the Derived forms. As in the previous study, it appears that at least some transfer occurred: overall, the children wrote /z/ appropriately more often in Derived than in Control words. As before, though, this transfer does not appear to have been complete: the number of appropriate spellings is less in Derived words than in Base words.

Another similarity with the previous experiment is that this pattern of results holds for the words requiring an "s" spelling, but not for those requiring "z". The children wrote /z/ appropriately for the "z" Base words only slightly more often than for the "z" Control words. This means that there was hardly any opportunity for them to use their knowledge of the Base words' spelling to improve their spelling of the Derived words above the level that they had already attained for the Control words. The results gained for the "z" words also suggest that the question about the extent to which the children transferred their knowledge of the spelling of Base words to Derived words may need to be reformulated. The children provided appropriate representations of /z/ to Derived words slightly *more* than to Base words, so there must be more going on than a simple transfer of knowledge from Base to Derived words.

The children's relatively frequent appropriate use of "z" in the Derived words, and to a lesser extent, in the Control words meant that their appropriate use of "z" was higher than of "s" for both of these types of words. This is the opposite pattern from what was found in the Base words, where the children used "s" appropriately more often than "z". This result is puzzling, and will be explored in the statistical analyses.

Finally, there appear to be some slight differences between the performance of the Poorer and Better spellers, other than the expected finding that the Better spellers used appropriate spellings for /z/ more often than did the Poorer spellers. The two groups performed similarly when writing words which required an "s" spelling, but for the "z" words the Poorer spellers were slightly better at representing /z/ appropriately in the Derived words than in either the Base or the Control words, on which they performed virtually equally. The Better spellers, in contrast, performed approximately equally on the Base and Derived words, and better on these than on the Control words.

As in the previous experiment, when the children did not use an appropriate representation of /z/, they nearly always used the "alternative" letter instead (an "s" spelling when "z" was required, and vice versa). Thus, the pattern of means was mostly the "opposite" of that found for the appropriate spellings. For example, the mean number of inappropriate representations of /z/ was 2.65 (out of 12) for Base words, 3.33 for Derived words, and 4.18 for Control words.

9.3.1.1. Analysis of appropriate spellings overall

A repeated-measures analyses of variance was conducted on the means for the number of appropriate representations of /z/. The analysis had one between-subjects variable, Spelling Group, and two within-subjects variables, Word Type (Base, Derived or Control), and Letter (the spelling required to represent /z/; "s" or "z"). The same type of ANOVA was conducted on the inappropriate representations of /z/, but as its results were mostly the "mirror image" of the appropriate ANOVA, for the sake of efficiency they will not be reported here.

The analysis of appropriate spellings revealed a significant effect of Spelling Group, $F(1,72)=107.7$, $p<0.00$. The Better spellers represented /z/ with an appropriate spelling significantly more often (mean=29.37, out of 36) than the Poorer spellers (mean=19.34). There was also a main effect of Word Type. The means for this factor violated the assumption of sphericity, so the degrees of freedom are reported after Greenhouse-Geisser (GG) corrections. The effect for Word Type remained significant; $F(1.8,127.8)=23.0$, $p<0.01$. Newman-Keuls post-hoc tests confirmed that the number of appropriate spellings was significantly higher in Base words (mean=8.84, out of 12) than in Derived words (mean=8.05), and significantly greater in Derived words than in Control words (mean=7.33), $p<0.01$ in all cases. This suggests that overall, the children were able transfer their knowledge of the spelling of the Base words to the Derived words to at least some extent.

The only other significant effect was an interaction between Word Type and Letter, $F(1.6,115.6)=8.67$, $p<0.01$ (with GG correction). The means for this interaction are shown in Figure 9.1.

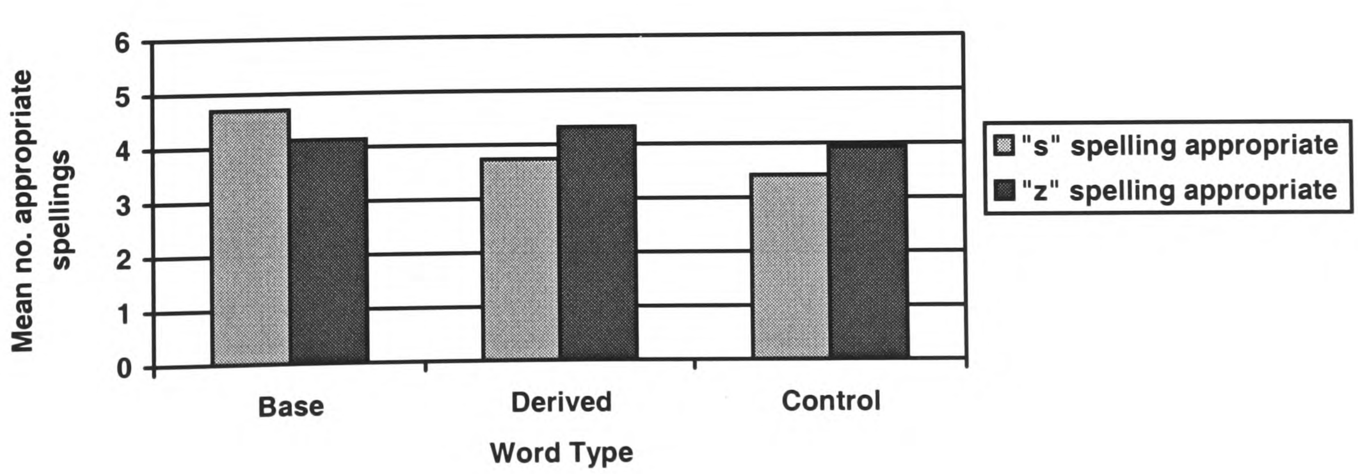

Figure 9.1 Mean number of appropriate spellings (out of 6) written for Base, Derived, and Control words whose /z/ sounds required an "s" or a "z" spelling.

Post-hoc Newman Keuls tests revealed that despite the differences between the means noted in Table 9.3, the differences between the number of "s" and "z" spellings used for each of the three Word Types were not significant. For the words which required an "s" spelling, the number of appropriate representations of /z/ written for Base words was significantly higher than for both Derived and Control words ($p<0.01$), but the difference between Derived and Control words did not reach significance. For the words which required a "z" spelling, however, there were no significant differences across Word Types in the number of appropriate representations of /z/. Thus, when the Word Types were broken down by Letter, the overall difference found between Derived and Control words was no longer significant, and the difference between Base and Derived words was significant only for "s" words. This makes it less easy to draw clear-cut conclusions.

9.3.1.2. Differences between individual words of different frequencies?

In section 9.2.2.1., it was noted that there were no frequency data available for three of the experimental words, as they were not cited in Carroll et al.'s (1971) book of word frequencies. We therefore compared the mean number of appropriate spellings provided for these words with the words for which frequency data were available, in case the children found the words with no listed frequency particularly easy or particularly hard. Table 9.4 shows the mean number of appropriate spellings (out of 1) for each of the 12 Derived words, since the three words with no frequency data were all Derived.

Table 9.4 Means (out of 1) and SDs for the number of appropriate spellings written for Derived words. Words for which frequency data unavailable shown in bold.

Words with "s"	**nosy**	rosy	noisy	loser	wisest	chosen
Appropriate spellings	**0.68 (0.47)**	0.68 (0.47)	0.61 (0.49)	0.66 (0.48)	0.43 (0.50)	0.68 (0.47)
Words with "z"	breezy	freezer	**Sneezy**	buzzer	frozen	**fizzy**
Appropriate spellings	0.72 (0.45)	0.72 (0.45)	**0.65 (0.48)**	0.77 (0.43)	0.70 (0.46)	**0.78 (0.42)**

Table 9.4 shows that *nosy* was spelled with the appropriate representation of /z/ about as often as the other words; *Sneezy* rather less often and *fizzy* slightly more. Thus, there appears

to have been no consistent tendency for the words for which no frequency data were available to be easier or harder to spell appropriately than the other words. It is interesting that the one inflected word included, *wisest*, was spelled appropriately less often than any other word. Both inflected and derived words will be included in the next experiment, and examined separately.

9.3.2. Consistency of spelling

The analysis reported in section 9.3.1. provided information about the children's representation of /z/ in the Base and Derived words overall, but it could not specify whether they had been consistent in representing /z/ within each Base-Derived word pair. Thus, as in the previous experiment, we counted the number of times that the 74 participants had written the six "s" and the six "z" Base words with an appropriate or an inappropriate spelling ("s" for "z", or "z" for "s"). We then calculated the proportion of times that each of these appropriate and inappropriate spellings in the Base forms were followed by the same representation of /z/ in their Derived forms. This indicated how often the children were consistent in their representation of /z/ within each Base-Derived pair. As in the previous experiment, we analysed the spellings of all the children together, since the previous analyses had revealed no significant interaction between Spelling Group and any other factor. Table 9.5 shows the results.

Table 9.5 Children's consistency in representing /z/ Derived words (maximum=444) when they spelled the /z/ of the Base words appropriately or inappropriately with "s" and "z"

Spelling of /z/ in base words	Total number of these spellings	Number of times Base spelling kept consistent in Derived form	Example	Proportion of times Base spelling kept consistent in Derived form
"s" appropriate	348	251	*noise-noisy*	0.72
"z" for "s"	83	55	*noize-noizy*	0.66
"z" appropriate	306	254	*fizz-fizzy*	0.83
"s" for "z"	113	57	*fis-fissy*	0.50

The table shows that, as in Experiment 8, the children's transfer of their knowledge of the Base words' spelling to the Derived words was never entirely complete. Also, whether or not their spelling of /z/ was consistent across each word's Base and Derived forms seemed to depend on whether they represented /z/ appropriately in the Base word. The pattern of results is similar to that in the previous experiment. If the children spelled a Base word appropriately, they were more likely to use that same appropriate spelling in the word's Derived form as well. In contrast, if they spelled a Base word inappropriately, they were less likely to use that inappropriate spelling again in the word's Derived form. When they used "z" inappropriately they were still more likely to be consistent than inconsistent. When they used "s" inappropriately they were consistent in using "s" again only at chance levels.

9.3.3. Tests of morphological awareness

9.3.3.1. Base-extraction task

When the experimenter asked if each word in this task contained a smaller, related Base word, the correct response to the control words was a simple "no". However, to achieve a correct response to the derived words, the child had to answer "yes", and also provide the right Base word. Thus, indiscriminate "no" responses would result in a higher score than indiscriminate "yes" responses. To counter this, Rubin's (1988) "two-pronged" system was used to score performance on this task. Each derived word was paired with the control word most similar to it in phonological structure, as shown earlier in Table 9.2 (e.g., *chosen-raisin*, *fizzy-dizzy*). To score one point, a child had to reply "yes" and provide the correct Base form to the derived word, *and* reply "no" to the matched control word,. Thus, each child received a score out of 12.

As mentioned in section 9.2.2.1., five of the Control words are actually derived from infrequent Base words. The children were considered correct if they responded "no" to these words. None of the children identified *please* or *bulldoze* as Base forms of *pleasant* and *bulldozer*, but some identified *ease*, *craze* and *raze* (*raise*?) as Base forms of *easy*, *crazy* and *razor*. However, it was unclear whether they had really recognised these words as related Base forms, or just responded with the first syllable of the word that they heard. To control for this, the identification of *ease*, *craze*, and/or *raze* was not considered correct if the child had also identified the following (incorrect) "Base" words in at least four of the remaining seven control words: *day* or *days* in *daisy*, *biz* in *busy*, *poi* or *poise* in *poison*, *ray* or *rays/raise* in *raisin*, *whizz* in *wizard*, *does* in *dozen*, or *dizz* in *dizzy*. Once this control was made, only three of the children were considered to have responded correctly when they identified *ease* and *craze* (none correctly identified *raze*). This finding supports the labelling of these as "control" words for the purposes of this experiment.

The overall mean score on this base-extraction task was 6.68 out of 12 (SD=3.00). A one-way ANOVA showed that the Better spellers' mean score of 7.70 (SD=2.60) was significantly better than the Poorer spellers' mean score of 5.65 (SD=3.06), $F(1,73)=9.69$, $p<0.01$.

9.3.3.2. Sentence analogy task

The number of sentences in the sentence analogy task in which children successfully transformed the target word was counted. The mean score out of 8 was 6.34 overall (SD=1.98), with Better spellers gaining a mean of 7.16 (SD=1.34) correct transformations and Poorer spellers, a mean of 5.51(SD=2.18). A one-way analysis of variance confirmed that this difference was significant ($F(1,73)=15.3$, $p<0.01$).

9.3.4. Correlations and regression analyses

Finally, Pearson correlations were calculated to examine how strongly the children's scores on the two tasks of morphological awareness (the base-extraction and sentence analogy tasks) and their chronological and spelling ages were related to their consistency in representing /z/ between Base and Derived words. This spelling consistency was seen as the best measure of children's ability to represent the link between Base and Derived words. If we had just included the number of appropriate representations of /z/ in both Base and

Derived forms, we would have eliminated any children who knew to retain the spelling of /z/, but who did not spell it correctly in the Base word. The correlations are shown in Table 9.6.

Table 9.6 Correlations between children's chronological and spelling ages, spelling consistency, and measures of morphological awareness.

	Chron. age	Spelling age	Spelling consistent	Sentence analogy	Base-extraction
Chron. age	--				
Spelling age	0.30*	--			
Spelling consistent	0.27*	0.52**	--		
Sentence analogy	0.19	0.47**	0.29*		
Base-extraction	0.09	0.42**	0.16	0.39**	--

*p<0.05, **p<0.01

We can see from the table that although the children's chronological age correlated significantly with their spelling age and spelling consistency, their spelling age was the only variable to correlate significantly with all other variables. It was strongly linked with spelling consistency and with scores on both tasks of morphological awareness.

The children's consistency in representing /z/ in Base-Derived pairs was correlated significantly with their performance on the sentence analogy task. This supports the contention that spelling a letter sequence consistently between related words is associated with a good general understanding of such morphological links. The finding that the children's scores on the sentence analogy task and the base-extraction task were also significantly correlated is also encouraging. It suggests that both of these tasks tap the same awareness of base-derived relations. However, it is puzzling that the scores on the base-extraction task did not correlate significantly with consistency of spelling, especially since these two measures involved the same pairs of words.

A regression analysis was conducted to see whether any relationship between score on the base-extraction task and spelling consistency would be revealed if controls were made for chronological age and spelling age. However, base-extraction score did not account for any of the variance in spelling consistency, whether it was entered as the third step in the analysis (after chronological and spelling age) or as the second step, as shown in Table 9.7.

Table 9.7 Regression analysis for the number of consistent spellings of /z/ in Base-Derived pairs, with chronological age, spelling age, and score on base-extraction entered in fixed order

	Outcome measure	Spelling consistency			
Order entered		r^2 change	*B*	S.E. *B*	beta
Step 1	Chronological age	0.072*	0.029	0.025	0.123
Step 2	Base-extr. score	0.020	-0.062	0.108	-0.064
Step 3	Spelling age	0.198**	0.066	0.015	0.512

*p<0.05, **p<0.01

The next regression analysis examined whether the children's scores on the sentence analogy task still predicted spelling consistency after controls were made for chronological and spelling age, in that order. The results of this analysis are shown in Table 9.8.

Table 9.8 Regression analysis for the number of consistent spellings of /z/ in Base-Derived pairs, with chronological age, spelling age, and score on analogy task entered in fixed order

	Outcome measure	Spelling consistency			
Order entered		r^2 change	*B*	S.E. *B*	beta
Step 1	Chronological age	0.072*	0.029	0.025	0.122
Step 2	Spelling age	0.214**	0.059	0.015	0.459
Step 3	Analogy score	0.002	0.081	0.168	0.055

*p<0.05, **p<0.01

Table 9.8 shows that although chronological age accounted for a significant amount of the variation in the children's consistency in spelling /z/ in Base-Derived pairs, their spelling age accounted for the rest, and there was no further significant contribution from scores on the sentence analogy task. Perhaps the nature of the spelling consistency variable makes it inevitable that spelling age should account for nearly all the variance if entered before analogy score. Although consistent spelling was taken to indicate the children's understanding of the link of meaning between Base and Derived words, it is obviously also closely tied to spelling ability. Good spellers could achieve high consistency scores by happening to know how to spell both words in each Base-Derived pair, regardless of the level of their morphological awareness. Thus, we decided to carry out another regression analysis, the same as the previous one, except that analogy score was entered before spelling age. The results of this analysis are shown in Table 9.9.

Table 9.9 Regression analysis for the number of consistent spellings of /z/ in Base-Derived pairs, with chronological age, score on analogy task, and spelling age, entered in fixed order

	Outcome measure	Spelling consistency			
Order entered		r^2 change	*B*	S.E. *B*	beta
Step 1	Chronological age	0.072*	0.029	0.025	0.122
Step 2	Analogy score	0.061*	0.081	0.168	0.055
Step 3	Spelling age	0.155**	0.059	0.015	0.459

*p<0.05, **p<0.01

We can see from Table 9.9 that when analogy score is entered as the second step of the regression, it accounts for a significant amount of the variance in spelling consistency. Spelling age still accounts for more of the variance, but this analysis shows that the children's ability to manipulate base and derived forms in an oral task is significantly related to their ability to preserve spellings between related base and derived words, over and above changes in chronological age.

9.4. Discussion

The results of this experiment are similar to those of the previous, smaller study. The children were unable to spell the final /z/ sound of the base words perfectly. As in Experiment 8, the children found the base words which required a "z" spelling particularly difficult, and their performance on these was not much better than on the control words which required a "z" spelling. Thus, no matter how well the children had transferred their (incomplete) knowledge of the "z" base words to the "z" derived words, it would have been difficult to improve their spelling of the derived words above the level that they had already attained for the control words. In contrast, for the words which required an "s", the children's spelling of the base words was significantly better than their spelling of the control words. Thus, the opportunity existed for the children to transfer their (incomplete) knowledge of how to spell the "s" base words to improve their spelling of the "s" derived words beyond the level attained for the "s" control words.

As in the previous experiment, and as predicted by Treiman et al.'s (1994) hypothesis, the children represented the sound /z/ with an appropriate spelling significantly more often overall in the derived words than in the control words. This suggests that they did sometimes transfer their knowledge of the conventional spelling of /z/ in the base words to help decide how to represent /z/ in the derived words. However, there was a significant interaction between this effect of word type, and of the spelling required to represent /z/. When the difference between derived and control words was examined separately for words which required "s" and for words which required "z", it was no longer significant for either. Thus, although the differences were in the right direction, neither remained significant when examined alone. Nevertheless, the overall effect still supports Treiman et al.'s (1994) hypothesis.

As found in the previous experiment, the children's spelling of /z/ in the "s" derived words was significantly poorer than it was in the "s" base words. Treiman et al. showed a similar result, and concluded that although their participants had made use of their knowledge of the base words to spell their derived forms, they had not done so to the maximum extent possible. However, this explanation seems less appropriate for the words which required a "z" spelling. The number of times that /z/ was spelled appropriately in "z" derived words was actually slightly (although not significantly) higher than in "z" base words. It is probable that spelling facilitation can go in both directions, depending on which form of a word is more familiar to the speller. Thus, rather than only using their knowledge of base words to spell derived forms, children who were more familiar with the spelling of the derived words could use this knowledge to improve their spelling of these words' base forms. However, the fact that the children spelled the /z/ of the base and derived words only slightly better than the /z/ of the control words in this experiment meant that these conclusions can only be tentative ones.

As in the previous experiment, but in contrast with the results of Treiman et al. (1994), the present study found no difference in the response patterns of the Poorer and Better spellers. Although the Better spellers' representation of /z/ was superior to that of the Poorer spellers on all word types, the Better spellers still performed below ceiling levels. Thus, both the Poorer and the Better spellers had reason to make as much use of their knowledge of the base words' spellings as they could when writing the derived words. It may be that children possess a basic level of understanding of base/derived relationships from quite early on, but that this understanding does not begin develop to a more sophisticated level until closer to the age of 9 or 10, as suggested in the models of spelling development discussed in Chapter 1.

We also examined the consistency with which the children represented /z/ in each base-derived pair, rather than just at the means for each set of words as a whole. As in the previous experiment, the extent of transfer of spelling knowledge seemed to depend on whether the base word was spelled appropriately. When the children represented the final /z/ of a base word appropriately, they usually used this same appropriate spelling in the word's derived form. When they represented the final /z/ inappropriately, however, they were less likely to be consistent and to use this same inappropriate spelling in the word's derived form. When the inappropriate spelling used was "z", the children were still more likely to be consistent than inconsistent, but when the inappropriate spelling was "s", they were consistent only half the time.

As suggested in section 8.4., there may have been many cases in which the children happened to know the spelling of /z/ in the derived word already. We cannot assume that every time a child spelled /z/ correctly in a derived word after spelling it correctly in its base form, she was transferring her knowledge. Nevertheless, since there was an overall difference between derived and control words, it seems that some transfer did occur. As also suggested in section 8.4., it is probable that the more confident the children were that they were spelling /z/ correctly, the more likely they would be to use this same spelling in both base and derived forms of the experimental words. In contrast, when they spelled the base word incorrectly, they may have just had to guess whether to use "s" or "z", and therefore would have had to guess again when writing the derived form. This would result in the less consistent representation of /z/ observed between base and derived forms when the base forms were spelled inappropriately.

Finally, we computed the relationship between the children's spelling consistency and their scores on two tasks of explicit awareness of base-derived morphological relations. If indeed children make use of their understanding of the morphological relations between base and derived words to enhance their spelling, then the extent to which they do this (measured by their spelling consistency) should be related to their morphological awareness. This contention was confirmed. Children's spelling consistency was significantly correlated with their performance on a sentence analogy task of morphological awareness, which required them to transform base words to derived words orally. However, their consistency in representing /z/ in base-derived word pairs was not significantly correlated with performance on a base-extraction task, which required the children to identify any base forms within the derived words – the same words from which this consistency score was calculated.

The reason for this lack of significant correlation could stem from differences in the level of explicitness of morphological awareness required to preserve the spelling of /z/ from base to derived forms of a word, and to succeed in the base-extraction task compared to in the sentence analogy task. Children who are consistent in their spelling of /z/ in base/derived pairs may realise that the words' common sequence of sounds should be spelled with a common sequence of letters, but they might not necessarily have an explicit understanding that this sequence constitutes a "base"; a unit of sound, spelling, and meaning. In contrast, the ability to identify base words in derived forms (and to note the lack of base words in non-derived forms) requires a very explicit understanding of the relationship between base and derived words, and of the base word as a unit. The children certainly found the base-extraction task more difficult than the sentence analogy task (the mean percentage of correct responses for the former was 56%, and for the latter, 79%).

The sentence analogy task was also designed to require explicit morphological awareness. However, the version of the task developed for this experiment probably relied on a less explicit awareness than that required in the original task, which involved the transformation of verbs (Nunes et al., 1997a). Because English verbs can take a number of forms and still make sense in a sentence (e.g., "The dog *chases/chased/is chasing* the cat"), success on the original task could only be achieved if the child fully understood the analogy and thus the transformation required. In the version of the task used here, there was only one form that each word could take and still make sense in the sentence context (e.g., "He's a keen *runner*", but not "He's a keen *run*"). Thus, the task probably relied on the ability to recall specific vocabulary items as much as on the ability to understand the analogy and thus the need to derive the base word given[2].

[2] It should be noted that this does not represent a weakness in the design of the experimental task; it is an unavoidable result of the relative dearth of derivational endings in the English language, and will affect any task which requires children to manipulate base and derived forms.

General linguistic ability (including vocabulary size and word retrieval speed/ease) therefore probably played an important role in children's performance on this version of the sentence analogy task of morphological awareness. This could explain why analogy task score contributed significantly to spelling consistency (beyond the contribution made by chronological age) only when it was entered as a step in a regression analysis before, but not after, spelling age. A relatively high spelling age is usually part of high general linguistic ability. Thus, when spelling age was entered as a step before analogy score, it accounted for so much of the remaining variance that analogy score could no longer make a significant contribution.

It could be, then, that the base-extraction task relied on too explicit a level of morphological awareness, and the sentence analogy task on too implicit a level of morphological awareness, for their scores to make a significant and specific contribution to explaining the variance in the children's spelling consistency. Nevertheless, the conclusion drawn from the evidence from the children's spelling, that they were able to use their knowledge of base words to improve their spelling of related derived forms (and vice versa), is generally confirmed by the findings from these tasks of morphological awareness.

A limitation to drawing conclusions based on children's spelling of real words is that one can never be sure whether correct spellings result from rote learning, from the use of rules or strategies, or simply from a lucky guess. This turned out to be of particular concern in the present and the previous experiment, in which the children found the base words' final /z/ more difficult to spell than we had expected. One way to avoid this problem would be to ask children to spell ostensibly related base and derived pseudowords, and to compare their representation of /z/ in these with their representation in control pseudowords, in a design similar to that of Experiments 8 and 9. Experiment 10 will employ base, derived (and inflected) and control pseudowords to make such a comparison.

Chapter Ten: Experiment 10

Children's use of base pseudowords to spell derived and inflected pseudowords

10.1. Introduction

Experiments 8 and 9 showed that overall, children in the first few years of school represented the ambiguous sound /z/ correctly significantly more often in base words than in their derived forms, and more often in these derived forms than in non-derived control words. This was taken to show that children were able to use their knowledge of the spelling of the more familiar of a pair of morphologically related words to spell an ambiguous part of the less familiar word.

Discrepancies in the relative difficulty of the base words which required an "s" spelling and those which required a "z" spelling meant that there were discrepancies in the children's representation of /z/ across word types for the words which required "s" and the words which required "z". Further (as discussed in section 9.4.), among the words in which the children represented /z/ correctly, it is impossible to distinguish which were achieved through the use of spelling strategies and which through the rote learning of the spelling of the entire word, or merely through a lucky guess between "s" and "z".

One way to make such a distinction is to use pseudowords instead of real words. Children could be exposed to "base" pseudowords, to see if they retained these pseudowords' representation of /z/ more often when they are asked to spell "derived" forms of these pseudowords, than when they are asked to spell non-related control pseudowords. Since none of the children could know how to spell the pseudowords already, the only way that they could achieve "correct" spellings of /z/ would be if they recognised and attempted to represent any putative base-derived relations.

This method could be used to test children's understanding of the morphological structure of inflected, as well as of derived words. Children could be exposed to a "base" form of a pseudoword which contains the sound /z/, and then given its plural or past form to spell. If the children retained the base word's spelling of /z/ more often in the inflected pseudowords than in non-related control pseudowords, then this would constitute evidence for an understanding of the relation of meaning between base and inflected forms of words, and the need to represent this relation in spelling. Such understanding has been suggested by the experiments of Rubin (1988) and of Treiman and Cassar (1996) (see section 1.3.2.3.).

This experiment will therefore examine children's representation of /z/ in derived and inflected pseudowords, whose relation to visually-presented base pseudowords will be made clear by the sentence contexts in which they are presented. It is possible that children might preserve the spelling of the base words not because they are attempting to represent the link of meaning between these words and their derived/inflected forms, but simply because they are replicating the most recent spelling of /z/ that they have seen. To control for this, we will also ask children to spell pseudowords to which the "clue" word in the sentence context is apparently *not* related. Finally, to assess the extent to which children are actually attending to the sentence context, some sentences will include an example of the very derived/inflected pseudowords that they are asked to write (so that it will be possible just to copy out the word).

The previous experiment provided evidence that children's consistency in representing /z/ in related words was associated with their ability to identify and transform base and derived forms of words in an oral task of morphological awareness. This experiment will also test morphological awareness. Its results should clarify those from the children's spelling of the pseudowords. If the children preserve the spelling of /z/ from base to derived/inflected words because they have understood the apparent link of meaning between these words, then their preservation of /z/ should be related to their morphological awareness score, even after controls for chronological and spelling age. Children's preservation of the spelling of /z/ from apparently non-related words, or when they are just copying out the derived/inflected word, however, should not be related to morphological awareness score after controls have been made for chronological and spelling age.

10.2. Method

10.2.1. Participants

The pseudoword spelling task was initially administered to children in school years 1 and 2, but they found the pseudowords too difficult to spell and gave up after only a few attempts. Further, their reading skills were not advanced enough for them to read the sentence contexts spontaneously. Thus, the task was instead administered to children in school years 3 and 4. There were 75 participants overall, of whom 30 attended a first school in Oxford, and 45 attended an infant and junior school in Solihull. There were 33 girls and 42 boys, ranging in age from 7;10 to 9;10, with a mean age of 9;00. Seventeen of these children were in year 3, and 58 were in year 4.

The participants' spelling ages were determined by their performance on the Spelling Subtest of the Wechsler Objective Reading Dimensions (WORD) (Rust et al., 1993). The children whose spelling age was less than or equal to the median of 9;00 were placed in the Poorer spelling group. The children whose spelling age was above the median were placed in the Better spelling group. Table 10.1 shows the children's mean chronological ages, spelling ages, and standard scores on the WORD.

Table 10.1 Mean chronological and mean spelling age (in years and months) and mean standard scores on the Spelling subtest of the WORD for Poorer spellers, Better spellers, and overall. Standard deviations (in months for age data) in parentheses.

	Poorer spellers (n=36)		Better spellers (n=39)		Overall (n=75)	
Chronological age	8;11	(6.35)	9;02	(4.80)	9;00	(5.78)
Spelling age	8;01	(7.98)	11;07	(24.38)	9;11	(27.86)
WORD std score	92.03	(8.13)	112.59	(8.87)	102.72	(13.36)

10.2.2. Procedure

Each child participated in two testing sessions conducted about three days apart, in a small private area within his or her school.

10.2.2.1. Session 1: Experimental spelling task

The first testing session was conducted with groups of four to six children at a time. The experimenter handed out worksheets on which were printed 48 sentences, each with one word missing (represented by a line). She said that for each sentence she would say the missing word by itself, then read out the whole sentence, including the missing word, and then repeat the word by itself. The children should then fill in this word on the line provided.

The experimenter explained that these missing words would not be real words that the children had heard before, but new words that she had made up. The children were to do their best to write down each new word when they heard it, even if it seemed difficult. The pseudowords were described as "new" rather than "pretend" words, because past experience had shown that children tend to adopt more bizarre spellings (e.g., using multiple *z*s or repetitive combinations of *s* and *z*) if they are told that they will be asked to write "pretend" words. The sentences were presented in a different order for each group of participants. The task took 15 to 20 minutes to complete.

The pseudowords were all derived from "base" forms which ended in a /z/ sound and which could plausibly be spelled with either a final *-se* or a final *-ze* (e.g., *mease/meaze*). These "base" forms were then all transformed into the pseudowords to be used in the study, by adding one of four suffixes:

- 24 of the "base" forms were given an inflectional morpheme
  - 12 were given a final *-s* (e.g., *meases, fizes*)
  - 12 were given a final *-ed* (e.g., *jaised, chized*)
- 24 of the "base" forms were given a derivational morpheme
  - 12 were given a final *-y* (e.g., *bosy, nizy*)
  - 12 were given a final *-er* (e.g., *hiser, pazer*)

These pseudowords were presented in one of three types of sentence context. There were 16 sentences of each type:

- Base provided: the missing pseudoword's "base" form was included in the sentence.

e.g., "Mum's going to buy a mease for tea. I love ____________!" (missing word pronounced /mizɪz/, but could plausibly be spelled as *meases* or as *meazes*, or as *meeses*, *meezes*, etc.). This was designed to test the children's ability to use the spelling of the ambiguous /z/ sound in the base form (*s* or *z*) to decide how to spell the /z/ sound in the inflected or derived pseudoword.

- Copy word: the missing pseudoword was presented in the sentence.

e.g., "I wish you'd neazed yours as well as Jane ____________ hers!" (missing word pronounced /nizd/, but could plausibly be spelled as *neased* or *neazed* (or *neesed*, *neezed*, etc.)). This was to check whether the children were paying enough attention to the sentence (both visually and aurally) to make use of the clues given.

- Pseudoclue: the sentence contained a "pseudoclue": a real word with the same suffix and similar structure as the missing pseudoword, which contained a /z/ sound spelled either with *s* or with *z*, e.g., "He sneezed so loudly that the cat __________ out of the room." (missing word pronounced /fəʊzd/, but could plausibly be spelled as *fosed* or as *fozed* (or as *foased*, *foazed*, etc.)). We used a real word rather than a different pseudoword because we thought that including two different pseudowords in one sentence would be too confusing for the children. These sentences were designed to test whether the participants were preserving the spelling of /z/ that they saw in the "clue" word because they recognised its apparent link of meaning to the missing pseudoword, or whether they were just using the most recent representation of /z/ that they had seen, without being aware of the role of meaning at all.

All the children heard, and spelled, the same 48 missing pseudowords. However, the "clues" (base pseudowords, pseudowords to be copied, and pseudoclues) that they saw for each missing pseudoword were systematically varied. For the "Base provided" sentences, two lists of clues were developed, so that half the children saw the Base pseudowords from List 1, and half from List 2. The /z/ sounds of half the Base pseudowords were spelled with *s* in List 1 (e.g., *nease*) and with *z* in List 2 (e.g., *neaze*). The /z/ sounds of the other half were spelled with *z* in List 1, and with *s* in List 2. To counterbalance the spelling of /z/ in the "Pseudoclue" sentences, List 1 was further divided into Lists 1a and 1b, and List 2 into Lists 2a and 2b. A missing pseudoword which was preceded by a pseudoclue spelled with *s* in Lists 1a and 2a would be preceded by a pseudoclue spelled with *z* in Lists 1b and 2b. For example, the missing pseudoword *mosed/mozed* would be preceded by *pleased* in Lists 1a and 2a, but by *amazed* in Lists 1b and 2b. The 48 pseudowords, as presented in List 1a, are shown in Table 10.2.

Table 10.2 Clues (presented visually and orally; shown here in italics) and missing pseudowords (presented orally) for the three types of sentences.

Type of suffix	Suffix	"Base provided" sentences: Clue	Pseudowd	"Copy word" sentences: Clue	Pseudowd	"Pseudoclue" sentences: Clue	Pseudowd
Inflect-ional	-s	*mease*	meases	*zoses*	zoses	*noses*	jises
		pluse	pluses	*oises*	oises	*dozes*	bizes
		ploze	plozes	*fizes*	fizes	*roses*	doises
		coize	coizes	*reazes*	reazes	*sizes*	foozes
	-ed	*jaise*	jaised	*chised*	chised	*pleased*	mosed
		drease	dreased	*steesed*	steesed	*amazed*	truzed
		oze	ozed	*bazed*	bazed	*closed*	preazed
		wuze	wuzed	*neased*	neased	*sneezed*	fosed
Derivat-ional	-y	*kaise*	kaisy	*thaisy*	thaisy	*busy*	naisy
		glise	glisy	*toozy*	toozy	*breezy*	foizy
		boze	bozy	*tazy*	tazy	*easy*	nisy
		fruze	fruzy	*moozy*	moozy	*lazy*	wozy
	-er	*taise*	taiser	*beaser*	beaser	*loser*	keaser
		hise	hiser	*cluser*	cluser	*buzzer*	aizer
		moize	moizer	*pazer*	pazer	*laser*	voser
		woze	wozer	*bleezer*	bleezer	*bulldozer*	drazer

Approximately one-quarter of the participants saw the clues provided as described in the table. The children who were instead presented with List 1b saw the same clues for the "Base provided" and "Copy word" sentences, but different "pseudoclues", as just described (e.g., *jises/jizes* was preceded by *dozes* rather than by *noses*). One-quarter of the children saw List

2a, which had the same pseudoclues as shown in the table, but all the other clues which are spelled below with *s*, were spelled instead with *z*, and vice versa. The final quarter of the children, who were given List 2b, saw the same clues for the "Base provided" and "Copy word" sentences as the List 2a children, but the same "pseudoclues" as the List 1b children.

It should be noted that the /z/ sounds in the pseudowords in Table 10.2 are spelled as the children were expected to spell them if they had made use of the sentence clue, but they could just have well been spelled in another way instead.

10.2.2.2. Session 2: Tests of spelling ability and of morphological awareness

In the second testing session, the experimenter saw each child individually, for about 15 minutes, and administered the spelling sub-test of the WORD and a task of morphological awareness. This task used analogies to see how well the children could recognise the morphological transformation of words and perform these transformations themselves. The transformations were designed to test the children's ability to transform words of the grammatical categories to which the pseudowords in the spelling task belonged (regular plurals, regular past verbs, adjectives, and agentive nouns).

10.2.2.2.i. Sentence analogy task

This task investigated children's ability to recognise and make changes to the plurality of nouns (from plural to singular and vice versa – the "Plurals" sub-task) and to the tense of verbs (from past to present or present continuous tense and vice versa – the "Verbs" sub-task). As in Experiments 1, 5, 6, and 9, the children were introduced to two hand-puppets. The first would "say" a sentence and the second would repeat it, making a change to the noun or verb of interest. The first puppet then said a second, very similar, sentence using a different noun or verb. The child was then asked what the second puppet should say, and thus to make the same change to the word in this second sentence as the puppet had made to the first.

There were four sentence analogies in each sub-task, each preceded by two practice analogies, for which explanation and feedback were provided as required. In the Plurals sub-task, there were two trials in which the noun had to be changed from plural to singular, and two where it had to be changed from singular to plural. In the Verbs sub-task, there were two trials in which the verb had to be changed from present to past tense, one in which it had to be changed from past to present, and one from past to present continuous.

For both sub-tasks, one trial had a regular model and a regular test word, one had a regular model and an irregular test word, one had an irregular model and a regular test word, and one an irregular model and an irregular test word. The analogies were as follows:

<u>Plurals</u>[1]

Practice analogies:

a) I want to see the big mountain. I want to see the big mountains.
I want to see the big hill. ______________________.

b) Look at the children over there. Look at the child over there.
Look at the trees over there. ______________________.

Test analogies:

1. I found the pretty leaf in the woods. I found the pretty leaves in the woods.
I found the pretty box in the woods. ______________________.

2. I like the cat from next door. I like the cats from next door.
I like the mouse from next door. ______________________.

3. The women cooked a cake. The woman cooked a cake.
The boys cooked a cake. ______________________.

4. I hurt my feet on the way here. I hurt my foot on the way here.
I hurt my teeth on the way here. ______________________.

<u>Verbs</u>

Practice analogies:

a) I talk to my friends. I talked to my friends.
I play with my friends. ______________________.

b) I heard a bird in the tree. I hear a bird in the tree.
I saw a bird in the tree. ______________________.

Test analogies:

1. He walks a long way. He walked a long way.
He runs a long way. ______________________.

2. Jane threw the ball over the wall. Jane throws the ball over the wall.
Jane kicked the ball over the wall. ______________________.

[1] These analogies were taken from the larger task developed for Experiment 5.

3. The dog scratched the chair. The dog chased the cat.	The dog is scratching the chair. ____________________.
4. Bob gives the ball to Anne. Bob sings a song to Anne.	Bob gave the ball to Anne. ____________________.

10.2.2.2.ii. Word analogy task

This task assessed the children's ability to recognise and make changes transforming verbs to nouns and vice versa (the "Nouns" sub-task), and nouns to adjectives and vice versa (the "Adjectives" sub-task). We were unable to use a sentence analogy format for these words, as it proved impossible to create pairs of sentences which shared the same structure but differed in their target word (as had been possible for the "Verbs" and "Plurals" sub-tasks). Neither an adjective and a noun, nor a verb and a noun, can be interchanged meaningfully in a sentence. Thus, word analogies were used instead. The first puppet said a word, and the second puppet transformed it. The first puppet would then say a second word, and the child would be asked what he or she thought the second puppet should say.

As above, there were four of each type of transformation, and each block of four was preceded by two practice items, with explanation and feedback as required. The "Noun" analogies all involved agentive nouns and their related verbs. There were two trials in which the word had to be changed from verb to noun, one from noun to verb, and one from noun to another noun (*musician-music*), because we could not find another type of word-ending. For the "Adjective" analogies, there were two trials in which the word had to be changed from noun to adjective, and two from adjective to noun. Since there is no one "regular" way for these types of words to be formed, the words were chosen to have a variety of endings, half common, and half unique or rare. The items were as follows:

Nouns	Adjectives
Practice analogies:	*Practice analogies:*
a) teacher – teach	a) wonder – wonderful
singer – ______	fame – ______

b) reading – reader

cooking – _______

Test analogies:

1. act – actress

   dance – _______

2. runner – run

   cyclist – _______

3. ballerina – ballet

   musician – _______

4. serve – servant

   build – _______

b) luck – lucky

hope – _______

Test analogies:

1. wooden – wood

   dirty – _______

2. happiness – happy

   strength – _______

3. warm – warmth

   high – _______

4. danger – dangerous

   colour – _______

Half the children received the Sentence Analogies first, and half received the Word Analogies first. To avoid confusing the children about what kind of answers were required, the items within each task were presented in a block. Half the children received one sub-task first; the other half received the other sub-task first. Within each sub-task, the order in which the test items were presented was varied systematically.

Between the Sentence Analogy and Word Analogy tasks, the experimenter administered the spelling sub-test of the WORD.

10.3. Results

10.3.1. Experimental pseudowords

The representation given by each participant to each word's /z/ sound was coded and categorised as "correct" or "incorrect".

10.3.1.1. Correct spellings

"Correct" representations were those which preserved the spelling of /z/ in the form of the pseudoword given in the sentence context (e.g., "Mum's going to buy a *mease* for tea. I love *meases*!"). Because all the pseudowords (as well as their base forms) were pronounced with a long vowel sound, and all the printed base clues ended in *-se* or *-ze*, only *s* or *z* (but not *ss* or *zz*) were counted as an appropriate representation of the pseudowords' medial /z/ sound. We also labelled as "correct" the children's preservation of the spelling of /z/ in the pseudoclues when writing apparently unrelated inflected and derived words (e.g., "He *sneezed* so loudly that the cat *fozed* out of the room"). Of course, there was no reason, morphological or otherwise, for the children to preserve the spelling of /z/ in the pseudoclues. The term "correct" was used for the purposes of comparison with the other words, rather than to imply a judgement about how these "pseudoclued" pseudowords should have been spelled. The mean number of times that the children preserved the spelling of /z/ given in the base pseudoword, inflected/derived pseudoword, or pseudoclue, broken down by letter (*s* or *z*) is shown in Table 10.3.

Table 10.3 Mean number of times (out of 4) that the representation of /z/ in the clue/pseudoclue was retained in the experimental pseudowords, by Poorer spellers, Better spellers, and overall

Sentence type and Word type	Spelling provided in clue	Poorer spellers (n=36)	Better spellers (n=39)	Overall (n=75)
Base Provided				
Inflected	s	3.20 (1.26)	3.67 (0.58)	3.44 (0.99)
	z	3.06 (1.22)	3.59 (0.68)	3.33 (1.00)
Derived	s	3.00 (1.29)	3.54 (1.00)	3.28 (1.17)
	z	3.20 (1.24)	3.36 (0.93)	3.28 (1.08)
Copy Word				
Inflected	s	3.06 (1.24)	3.54 (0.92)	3.31 (1.11)
	z	3.20 (1.14)	3.59 (0.79)	3.40 (0.99)
Derived	s	3.14 (1.36)	3.36 (0.93)	3.26 (1.15)
	z	3.23 (1.07)	3.64 (0.78)	3.44 (0.95)
Pseudoclue				
Inflected	s	1.78 (1.45)	1.62 (1.12)	1.70 (1.22)
	z	1.92 (1.44)	1.77 (1.11)	1.84 (1.28)
Derived	s	1.53 (1.16)	1.59 (1.25)	1.56 (1.20)
	z	1.95 (1.29)	2.41 (1.05)	2.19 (1.18)

It can be seen from the table that overall, the children were very good indeed at making use of the base pseudowords provided as clues in the printed sentence contexts, to decide how to spell the /z/ of their missing inflected and derived forms. Their performance was just as high as when they could simply copy down the inflected or derived forms from the sentence. However, it appears that the children did not just replicate the most recent representation of /z/ that they had seen. The representation of /z/ in the unrelated pseudoclues had no effect on how the children spelled /z/ when they wrote the missing pseudowords. This suggests that they knew to preserve the spelling of /z/ only when the clue and the missing pseudoword seemed to be related by meaning.

There does not seem to be any consistent effect of Word Type. The children were just as likely to preserve the representation of /z/ correctly for inflected words as derived words, although the inflected words enjoyed a slight advantage over the derived words in the "Base Provided" sentences. The children appear to have preserved the spelling *s* about as often as the spelling *z*, although there was more use of *z* than of *s* in the Pseudoclue sentences. Finally, although both groups of spellers performed well, the Better spellers consistently achieved more correct spellings than the Poorer spellers when writing the missing pseudowords in the Base Provided and Copy Word sentence contexts.

A repeated-measures analysis of variance was conducted on these data. It had one between-subjects factor, Spelling Group (Poorer or Better), and three within-subjects factors; Sentence Type (Base Provided, Copy Word, and Pseudoclue), Word Type (inflected or derived), and Letter (the letter in the clue or pseudoclue, *s* or *z*). The dependent variable was the number of times that the children represented /z/ in the same way – "correctly" – as it had been represented in the clue or pseudoclue.

There was a significant main effect of Spelling Group, $F(1,73)=7.89, p<0.01$. The Better spellers represented /z/ correctly significantly more often (mean=35.7, out of 48) than the Poorer spellers (mean=32.3). There was also a significant effect of Sentence Type. This factor violated the assumption of sphericity, and its degrees of freedom are corrected with the Greenhouse-Geisser (GG) correction factor: $F(1.8,129.2)=167.2$, $p<0.01$. Post-hoc Newman-Keuls tests showed that the mean number of correct spellings provided for the pseudowords presented in the "Base Provided" sentences (mean=13.4, out of 16) did not differ significantly from that of the pseudowords presented in the "Copy Word" sentences (mean=13.3). However, both of these were significantly greater than the mean number of times that the spelling of /z/ was preserved in the "Pseudoclue" sentences (mean=6.6), $p<0.01$. This confirms that the children preserved the spelling of /z/ only of clues that were apparently related to the missing pseudowords.

There was no significant effect of Word Type, which confirms that the children were no more likely to preserve the spelling of inflected than of derived words. Sentence Type interacted significantly with Letter, $F(1.6,120.0)=3.61$, $p<0.05$ (with GG correction). Newman-Keuls post-hoc tests indicated that there were no significant differences between the number of times that *s* and *z* were preserved correctly in the "Base Provided" and "Copy Word" sentences. However, both of these were significantly greater than the number of times that either *s* or *z* was preserved in the "Pseudoclue" sentences, ($p<0.01$ in all cases). In the Pseudoclue sentences, the children showed a near-significant tendency to preserve the spelling *z* more than the spelling *s* ($p=0.05$). This fits with the finding from Experiments 8 and 9, that older children are more likely to choose *z* than *s* to represent word-medial /z/.

Finally, there was a significant interaction between Word Type and Letter, $F(1,73)=5.31$, $p<0.05$. Newman-Keuls post-hoc tests revealed that in inflected words, *s* and *z* were preserved about equally often, but that in derived words, *z* was preserved significantly more than *s*, $p<0.01$. The letter *s* was preserved significantly more in inflected than derived words, and the letter *z* was preserved significantly more often in derived than inflected words, $p<0.05$ for both. The reasons for these findings are not clear.

10.3.1.1.i. Differences within inflected and derived words?

It is possible that the children may have preserved the spelling of /z/ less often for one type of inflected word than the other, or for one type of derived word than the other. We therefore compared the mean number of correct spellings of /z/ for each of the four types of word (plurals, regular past verbs, adjectives, and agentive nouns), instead of grouping them into inflected and derived words. The relevant means, for the sentence contexts in which the clue word was related to the pseudoword, are shown in Table 10.4. Since the previous analysis showed no important effects of Letter, and no interactions involving Spelling Group, the means are collapsed across *s* and *z* words, and across Poorer and Better spellers.

Table 10.4 Mean number of representations of /z/ preserved in the spelling of missing pseudowords, for the two types of inflected, and two types of derived, pseudowords.

	Sentence Type	
Word Type	Base Provided	Copy Word
Plural (*-s*)	3.36 (0.91)	3.43 (0.93)
Past verb (*-ed*)	3.41 (0.74)	3.28 (0.92)
Adjective (*-y*)	3.31 (1.07)	3.35 (0.86)
Agentive noun (*-er*)	3.25 (0.90)	3.35 (0.89)

A repeated-measures analyses of variance with two within-subject variables, Sentence Type (Base Provided, Copy Word) and Word Type (Plural, Past verb, Adjective, Agentive) showed that there were no significant differences in the number of times that the children preserved /z/ across the different types of pseudowords and sentence contexts.

10.3.1.2. Incorrect spellings

We also examined the ways in which the children represented the /z/ sound of the inflected and derived pseudowords when these were not the same as the representation in the sentence clue or pseudoclue. In almost every case, these "incorrect" spellings consisted of *s* when *z* was required, or of *z* when *s* was required. The Poorer spellers were more likely than the Better spellers to use other spellings, for example, *sz*, *zs*, *c* or *x*, but for the most part the children used the "alternative" letter to the one given in the clue or pseudoclue in the sentence context. This was especially striking in the Pseudoclue sentences. As shown in Table 10.3, when the sentence context contained a pseudoclue spelled with *s*, the children spelled the missing pseudoword with *s* only about half the time. The same held for pseudoclues spelled with *z*. Our examination of the children's "incorrect" spellings confirmed that the other half of the time, the children usually used the "alternative" letter – *s* instead of *z*, or *z* instead of *s*.

10.3.2. Morphological awareness

The number of times that the children successfully transformed the target word in each of the tasks of morphological awareness was counted. The mean proportion of correct transformations for each of the four sub-tasks, and overall, for both Spelling Groups, is shown in Table 10.5.

Table 10.5 Mean proportions of words correctly transformed in each of the four sub-tasks of grammatical awareness, and overall, by Poorer and Better spellers, and overall. Standard deviations in parentheses.

Type of analogy		Mean proportions correct (and SDs)		
		Poorer spellers (n=36)	Better spellers (n=39)	Overall (n=75)
Sentence analogies				
Plurals	(out of 4)	0.81 (0.19)	0.92 (0.17)	0.86 (0.19)
Verbs	(out of 4)	0.59 (0.78)	0.85 (0.18)	0.73 (0.26)
Combined	(out of 8)	0.70 (0.20)	0.89 (0.13)	0.80 (0.19)
Word analogies				
Nouns	(out of 4)	0.54 (0.29)	0.76 (0.22)	0.65 (0.28)
Adjectives	(out of 4)	0.47 (0.25)	0.51 (0.20)	0.49 (0.23)
Combined	(out of 8)	0.50 (0.21)	0.63 (0.18)	0.57 (0.20)
Overall	(out of 16)	0.60 (0.18)	0.76 (0.13)	0.68 (0.17)

The table shows that the children performed better overall on the Sentence Analogy tasks than the Word Analogy tasks. It also seems that they found some sub-tasks easier than others; performance on Plurals was better than on Verbs, and performance on Nouns was better than on Adjectives. The Better spellers transformed more words correctly than the Poorer spellers in ever case.

Two repeated-measures analyses of variance were carried out on these data; one for the Sentence Analogy tasks and one for the Word Analogy tasks. They both had one between-subjects factor, Spelling Group (Poorer or Better), and one within-subjects factor, Sub-task.

The first ANOVA was based on the two Sentence Analogy sub-tasks (Plurals and Verbs). There was a main effect of Spelling Group ($F(1,73)=23.9, p<0.01$). The Better spellers transformed significantly more words correctly overall than did the Poorer spellers. There was also a main effect of Sub-task ($F(1,73)=24.5, p<0.00$). The children performed significantly better on the Plurals sub-task than on the Verbs sub-task. Finally, Sub-task and Spelling Group interacted significantly, $F(3,219)=7.2, p<0.01$. Newman-Keuls post-hoc tests showed that the performance of the Better spellers was significantly superior to that of the Poorer spellers on both the Plurals ($p<0.05$) and the Verbs sub-tasks ($p<0.01$). The Better spellers performed equally well on the two sub-tasks, but the Poorer spellers transformed more words correctly on the Plurals than on the Verbs sub-task ($p<0.01$).

The second ANOVA was based on the two Word Analogy sub-tasks (Nouns and Adjectives). There was a main effect of Spelling Group ($F(1,73)=8.4, p<0.01$. Again, the Better spellers transformed significantly more words correctly than did the Poorer spellers. A main effect of Sub-task ($F(1,73)=21.2, p<0.01$) was caused by the children's significantly superior performance on the Nouns than on the Adjectives sub-task. Finally, here too, there was a significant interaction between Sub-task and Spelling Group, $F(1,73)=7.6, p<0.01$. Newman-Keuls post-hoc tests showed that on the Nouns sub-task, the Better spellers made significantly more correct transformations than the Poorer spellers ($p<0.01$), but that on the Adjectives sub-task, there was no significant difference between the groups. The Better spellers performed significantly better on the Nouns that the Adjectives sub-task ($p<0.01$), but the Poorer spellers' performance did not differ significantly between sub-tasks.

10.3.3. Correlations and regression analyses

Finally, correlations were calculated between performance on the analogy tasks of morphological awareness, and chronological age, spelling age, and the children's correct spelling of the /z/ sound in inflected and derived pseudowords presented in "Base given" and "Copy word" sentences. These correlations are shown in Table 10.6. (Only the correlations of interest are shown; those within the analogy sub-tasks and the spellings of /z/ are not reported.)

Table 10.6 Correlations between children's chronological and spelling ages, their performance on the Sentence and Word Analogy tasks, and their correct spelling of /z/ for inflected and derived pseudowords in "Base provided" and "Copy word" sentence contexts.

				Correct letter provided in sentence type:			
				Base provided		**Copy word**	
Analogy Type		Chron. age	Spelling age	Inflected pseudowd	Derived pseudowd	Inflected pseudowd	Derived pseudowd
	Chron. age	--		0.26*	0.24*	0.15	0.04
	Spell. age	0.33**	--	0.26*	0.23*	0.25*	0.07
Sentence	Plurals	0.08	0.25*	0.24*	0.17	0.16	0.19
analogies	Verbs	0.23*	0.41**	0.35**	0.34**	0.17	0.23
(inflected)	Combined	0.20	0.45**	0.36**	0.32**	0.20	0.25*
Word	Adjs	0.08	0.17	0.16	0.30**	0.07	0.07
analogies	Nouns	0.14	0.43**	0.29*	0.31**	0.39**	0.27*
(derived)	Combined	0.15	0.42**	0.29*	0.39**	0.31**	0.23*
Analogies overall		0.19	0.49**	0.37**	0.40**	0.29*	0.27*

*$p<0.05$, **$p<0.01$

The table shows that the children's chronological age correlated significantly with their performance on only one sub-task of morphological awareness; the Verbs sub-task. In contrast, their spelling age correlated significantly with their performance on all but the Adjectives sub-task. As in the previous experiments, therefore, morphological awareness is not necessarily strongly related to age. Both chronological and spelling age correlated significantly with the correct spelling of inflected and derived pseudowords in the "Base provided", but mostly not in the "Copy word" sentences. This confirms that the older and better spellers were more adept at making use of the Base pseudowords to spell the inflected and derived forms of the test pseudowords than the younger and poorer spellers. This pattern was not so strong for the sentences in which the children just had to copy the pseudoword provided; even the younger and poorer spellers could manage this, and ability did not increase with age.

The table also shows that the children's overall performance on the analogy tasks was significantly correlated with their correct representation of /z/ for both inflected and derived pseudowords, in both "Base provided" and "Copy word" sentences. However, more interesting patterns are revealed if we examine the correlations between performance on specific analogy sub-tasks and the spelling of specific types of pseudowords. For the "Base provided" sentences, correct representation of /z/ for inflected words correlated most strongly with performance on both the Sentence Analogy sub-tasks, which required the transformation of inflected words. Further, correct representation of /z/ for derived words correlated most strongly with performance on both the Word Analogy sub-tasks, which required the transformation of derived words.

This pattern of significant correlations did not hold for the words in the "Copy word" sentences. For the inflected words, correct representation of /z/ correlated significantly only with performance on the Nouns sub-task, and thus with Word Analogy performance overall. For the derived words, correct representation of /z/ correlated significantly with performance on the Nouns and thus the Word Analogy sub-tasks, and also with Sentence Analogy performance.

We conducted regression analyses firstly to determine whether the links between scores on the Sentence Analogy sub-tasks (which required the manipulation of *inflected* words) and the children's representation of /z/ in inflected pseudowords would remain once controls were made for chronological and spelling age. Table 10.7 shows the results for the regression analyses of the Sentence Analogy scores and the children's spelling of /z/ in inflected pseudowords.

Table 10.7 Multiple regression analysis for outcome measures of correct representation of /z/ for inflected words in "Base provided" and "Copy word" sentences, with chronological age, spelling age, and score on the Sentence Analogy sub-tasks entered in fixed order

Outcome measure	/z/ correct in inflected pseudowords							
	"Base provided" sentences				"Copy word" sentences			
Variable and order entered	r^2 change	B	S.E. B	beta	r^2 change	B	S.E. B	beta
1. Chron. age	0.066*	0.043	0.028	0.176	0.023	0.020	0.034	0.073
2. Spelling age	0.035	0.004	0.006	0.069	0.044	0.010	0.008	0.177
3. Sent. an. score	0.070*	0.281	0.115	0.297	0.008	0.110	0.138	0.103

$^{**}p<0.01$, $^{*}p<0.05$

Table 10.7 shows that the children's chronological age, but not their spelling age, accounted for a significant amount of the variance in the number of times that they spelled /z/ correctly in inflected pseudowords presented in "Base provided" sentences. However, even after these controls, the children's Sentence Analogy score still accounted for a significant amount of variance in their preservation of the spelling of /z/ from base to inflected words. In the "Copy word" sentences, in contrast, the children's Sentence Analogy score did *not* account for a significant amount of the variance in their spelling of /z/ after controls for chronological and spelling age. Thus, the children's ability to transform inflected words orally predicted their preservation of /z/ only when this relied on a recognition of links of meaning between base and inflected words, not when the inflected word could just be copied out.

We then carried out similar regression analyses to determine whether the links between scores on the Word Analogy sub-tasks (which required the manipulation of *derived* words) and the children's representation of /z/ in derived pseudowords would remain once controls were made for chronological and spelling age. Table 10.8 shows the results for these analyses.

Table 10.8 Multiple regression analysis for outcome measures of correct representation of /z/ for derived words in "Base provided" and "Copy word" sentences, with chronological age, spelling age, and score on the Word Analogy sub-tasks entered in fixed order

Outcome measure	/z/ correct in derived pseudowords							
	"Base provided" sentences				"Copy word" sentences			
Variable and order entered	r^2 change	*B*	S.E. *B*	beta	r^2 change	*B*	S.E. *B*	beta
1. Chron. age	0.055*	0.055	0.036	0.176	0.001	0.003	0.032	0.011
2. Spelling age	0.026	0.002	0.008	0.027	0.004	-0.002	0.007	-0.030
3. Word. an. score	0.100**	0.396	0.134	0.348	0.047	0.225	0.120	0.238

$^{**}p<0.01$, $^{*}p<0.05$

Table 10.8 shows similar results to Table 10.7. Even after controls were made for chronological and spelling age, score on the Word Analogy sub-tasks accounted for a significant amount of the variance in children's correct representation of /z/ in derived pseudowords presented in "Base provided" sentences. Spelling age made no significant contribution. For the "Copy word" sentences, in contrast, none of chronological age, spelling age, or Word Analogy score (when entered in the order shown above) accounted significantly for the variance in the correct spelling of /z/ in derived pseudowords presented in these sentences. Again, it seems that the extent of children's morphological awareness was related to their spelling of /z/ when they had to make use of a base pseudoword to decide how to spell its derived form, but not when they simply had to copy out the derived form.

10.4. Discussion

This experiment again supports the hypothesis that children are able to make use of the spelling of base words to spell derived forms, even when these words are unfamiliar ones. Further, it shows that children are equally good at using the spelling of base words to spell unfamiliar inflected words. When the printed sentence contexts provided the opportunity simply to copy the missing inflected or derived pseudoword, the participants retained the spelling of /z/ in the copied word (*s* or *z*) over 80% of the time. When only the base form of the test pseudoword was provided in the sentence context, however, the children's correct choice of letter for its inflected or derived form was just as good (more than 80%). This suggests that the children made use of the base word's spelling to represent the /z/ in its inflected or derived form every time that they noticed its presence in the sentence context.

When the sentence context included a real word containing a /z/ sound, the spelling of this sound had no influence on whether the children chose to use *s* or *z* to represent the /z/ of the test pseudoword. They used *s* and *z* approximately equally, regardless of how the "pseudoclue" was spelled. This shows that the children were not just using the most recent representation of /z/ that they had seen to spell the /z/ of the test pseudowords. Rather, they made use of the most recent representation only when it appeared to be related by meaning to the test pseudoword. Thus, it does seem that the children recognised the apparent links of meaning between the base and inflected/derived pseudowords, and represented these links in their consistent spelling of /z/ in related forms.

These results are in agreement with the findings of Rubin (1988) and Treiman and Cassar (1996) for the inflected words, and of Treiman et al. (1994) for the derived words. Some caution is necessary in making this interpretation. It is possible that the children noticed that the base pseudowords were spelled in a way that would be appropriate for the first part of the inflected and derived experimental pseudowords, and that therefore they just copied out that spelling, without thinking about links of meaning. (This would not occur to the same extent with the "pseudoclues", which had only their /z/ sound in common with the experimental pseudowords.)

However, the results from the children's performance on the oral tasks of morphological awareness suggest that this caution is not needed, and that the children really were aware of the morphological relations between the base and the inflected/derived pseudowords that they wrote. The tasks used word analogies and sentence analogies to test the children's ability to transform inflected/derived words to non-inflected/non-derived words and vice versa. Regression analyses revealed that the children's scores on the Sentence Analogy tasks (which required the transformation of inflected words) significantly predicted their preservation of the spelling of /z/ in inflected pseudowords presented in "Base provided" sentences, even after controls for chronological and spelling age. Similarly, the children's score on the Word Analogy tasks (which required the transformation of derived words) significantly predicted their preservation of the spelling of /z/ in derived pseudowords presented in "Base provided" sentences after these same controls. The children's preservation of the spelling of /z/ in the "Copy word" sentences also correlated significantly with morphological awareness score. However, regression analyses showed that once controls were made for chronological and spelling age, Sentence Analogy score no longer predicted the ability to preserve /z/ in inflected pseudowords, and Word Analogy score no longer predicted the ability to preserve /z/ in derived pseudowords.

These findings suggest that children were able to copy the spelling of the test pseudoword in the "Copy word" sentences without much need to rely on their morphological awareness. However, when they had to rely on the base form of the test pseudoword, in the "Base provided" sentences, to decide how to represent /z/ in a related form, the extent of their morphological awareness now played an important role. Those children who were good at transforming inflected words orally were also good at spelling inflected forms of pseudowords. Similarly, those who were good at transforming derived words orally were also good at spelling derived forms of pseudowords. Both of these relationships held regardless of chronological age and spelling ability.

This is an interesting finding, and gives further support not only to the contention that children understand and make use of morphological patterns in their spelling (e.g., Treiman & Cassar, 1996; Treiman et al., 1994), but also to the idea that children's morphological awareness is linked to their spelling of morphological spelling patterns (Nunes et al., 1997a).

In terms of the children's spelling of /z/ in the inflected and derived pseudowords, the findings from this experiment differ in some ways from those of Experiments 8 and 9, which looked at children's spelling of real words. In contrast to those in the previous experiments, the present participants were no more likely to make use of base words if their /z/ sound was represented with *s* than if it was represented with *z*. This suggests that the differences found in the previous experiments stemmed not from any particular reluctance to use the less common letter, *z*. It instead confirms the interpretation that it resulted from the children's relative unfamiliarity with the *z* base words compared with the *s* base words. In the present experiment, the children were presented with the base pseudowords, and in this case they were just as likely to make use of those spelled with *z* as those spelled with *s*.

The Better spellers were significantly more likely to preserve the spelling of /z/ in the clue word than were the Poorer spellers. This suggests that the ability to recognise and make use of the links between base and inflected/derived words (as well as to notice and use the version of the word which could just be copied) increases with increasing spelling ability. In the previous two experiments we had not found a significant difference between the two Spelling Groups. It may be that children have a certain basic level of understanding of base-derived and base-inflected relations during their first few years of writing, but that after three or four years their understanding begins to increase more rapidly[2]. Since this experiment

[2] This may be the stage at which the spelling models discussed in section 1.2.1. recognise the emergence of the ability to represent derivational relations.

involved children in school years 3 and 4, the Better group had probably reached this more rapid rate of learning, and therefore performed significantly better than their Poorer peers.

Both groups of spellers were equally able to preserve the spelling of /z/ in the derived words as in the inflected words. This finding goes against the widespread belief that derivational relations are not recognised or represented until several years after inflectional relations, and perhaps not until the end of primary school (see, for example, the spelling models in section 1.2.1.). However, it supports Treiman and Cassar's (1997) contention that derivational links are not intrinsically difficult to understand, provided that we ask children to spell simple, rather than complex, derivational pairs. Our findings suggest that children are aware of the need to represent the common part of related words in writing, regardless of whether their relationship is inflectional or derivational.

Perhaps it is not so surprising that the children performed so well in this experiment, on both the inflected and the derived words, for two reasons. The first is to do with the way that the base pseudowords were presented. In the previous studies, when children were asked to spell derived words, it required some effort for them to make use of the related base forms. They would have to know that a related base form exists, and then remember it, and its representation of /z/, before they could use this same representation in the derived word that they wished to write. In the present experiment, the children heard the base forms and saw their spellings at the same time as they were being asked to write the inflected/derived pseudowords, so the process of using the base word's spelling of /z/ was made much easier.

The second reason is that the participants in this experiment were relatively old compared to the 4- and 5-year-old children that Treiman et al. (1994) claimed to be able to use derivational relations in their writing. Most were also older than the 6- to 8-year-old children in the first two series of experiments. As mentioned in section 10.2.1., we did attempt this task with 6- and 7-year-old children, but the words proved too difficult for them. Further, these children did not read well enough to read the printed sentence contexts spontaneously. They just listened to the test pseudoword and put all their effort into trying to decide how to represent that word, without attempting to read the sentence context. An easier version of the task will need to be developed before the ability of younger children to use base pseudowords in their spelling can be tested.

Chapter 11: Discussion

Overview

The experiments in this thesis were designed to answer two main questions. The first was whether children learn to represent morphological patterns in their spelling relatively "early" (from when they first begin to learn to write), or relatively "late" (only after they have mastered phonetic spelling, which may take several years). However, through the course of the experiments, and through consideration of the theoretical background, it has become apparent that this question is too broad. Children seem to acquire different morphological spelling patterns at different phases in their development. The clearest division seems to be between the acquisition of the ability to represent affixes (in our experiments, inflectional suffixes) consistently correctly despite changes in pronunciation, and the ability to preserve the spelling of a stem or base word when writing its inflected or derived form. Thus, in this final chapter, we attempt to answer our first question in two parts; discussing first the findings about children's spelling of inflectional endings, and then the findings about children's spelling of word stems in different word forms. The implications of our results for the theories of spelling development presented in section 1.2. are also noted.

The second main question was whether children's morphological awareness, as measured by analogy-based oral tasks, is related to their ability to represent morphological patterns in their spelling. We review our findings, again distinguishing between children's spelling of inflectional endings and of word stems, and we see how they relate to previous research in the field.

Later in the chapter, we discuss the implications of our findings for school instruction, and also note some of the weaknesses and limitations of the experiments conducted for this thesis. Finally, we discuss future directions for the current research.

11.1 When do children learn to represent morphological spelling patterns?

11.1.1. When do children learn to represent inflectional endings?

The experiments in this thesis examined children's ability to spell two morphological affixes, both inflectional endings: the regular past verb inflection *-ed*, and the regular plural inflection *-s*. We discuss the findings from each of these in turn.

11.1.1.1. The regular past verb inflection *-ed*

Several studies have shown that children start off representing the English regular past verb inflection phonetically, and that it takes at least a year before they even begin to use the *-ed* spelling (e.g., Beers & Beers, 1992; Zutell, 1980; see section 1.3.1.1.i.). More detailed work by Nunes, Bryant and Bindman (1997a; 1997b) has shown that it is not until they are 9 or 10 years old that most children are able to use *-ed* entirely correctly. The correct use of *-ed* presumably requires some understanding that this ending may only be applied to a specific type of word unit: the stem morpheme[1]. Thus, this body of evidence seems to suggest that children do not fully understand the morphological basis for using *-ed* until they have been writing for several years.

Other researchers have examined children's understanding of the morphological structure of regular past verbs directly, and have used a different scoring system (e.g., Rubin, 1988; Treiman & Cassar, 1996). Instead of looking at children's correct use of *-ed*, these researchers have considered the inclusion of a critical letter from the stem to indicate an understanding of the presence of the stem of these words. Using this scoring system, even beginning writers appear to have some understanding of the structure of these words.

The results from Experiments 1 and 2 support the conclusions drawn from the first type of studies mentioned, in that they largely confirmed these studies' findings about children's

[1] Experiments with pseudowords, e.g., Bryant, Nunes, & Snaith (2000) suggest that children do not merely rote-learn the entire spelling of regular past verbs.

ability to spell the endings of regular past verbs and matched non-verbs. The poorer spellers sometimes used *-ed* correctly but often completed the verbs with phonetic endings instead, and the better spellers, although able to use *-ed* correctly more often, did not yet apply this spelling pattern consistently correctly. As predicted by the stage model of Nunes et al. (1997a), some overgeneralisation of *-ed* to non-verbs was observed, especially among the better spellers.

The use of varied levels of "spelling cues" in the first two experiments also allowed more direct examination of the children's understanding of the morphological structure of the experimental words. We attempted to direct the children's attention towards the structure of these words by presenting them with a printed spelling cue that constituted a verb stem (e.g, *peck* for *pecked*, *poke* for *poked*), and to divert their attention from this structure through spelling cues which consisted of a meaningless fragment of the stem that was either longer (e.g., *pecke*) or shorter (e.g., *pok*, *po*) than the stem itself.

The children were no more likely to use *-ed* correctly to complete regular past verbs when presented with cues which constituted a verb stem than when presented with cues that did not. This was true for both poorer and better spellers, and regardless of whether the experimental words were all verbs (Experiment 1), or verbs mixed with an equal number of non-verbs (Experiment 2), so that the endings required were not all the same. In both of these experiments, the children's correct use of *-ed* increased significantly only when the spelling cues consisted of all but the final *-d* to be spelled (e.g., *pecke*, *poke*). The results from the non-verbs in Experiment 2 suggest that this finding cannot be due simply to the relative length of these cues. The correct completion of these non-verbs (with *-t* and *-d*) did not improve with increasing cue length (and nor did it ever reach ceiling).

Most of the children tested had the *-ed* pattern in their spelling repertoire, even if they used it only rarely and/or incorrectly. They were obviously beginning to build up some idea of when, and when not, to use it, as their overall use of *-ed* was significantly greater for verbs than for non-verbs, but this understanding was still far from perfect. Thus, it is likely that the final *-e* of cues such as *pecke* was often sufficient to remind the children of the existence of the *-ed* ending, and to encourage them to use it when completing the regular past verbs. The morphological status of the spelling cues made no difference.

The first two experiments thus suggest what has already been suggested in a number of other studies: that children take a long time to learn how to use the *-ed* inflection correctly, probably because they take so long to develop a full understanding of <u>why</u> *-ed* is appropriate in some cases and not in others. This implies that the understanding of the stem-plus-inflection structure of regular past verbs is not present from the outset and available to help with spelling, but that it is built up over several years of reading and writing experience. A way of resolving the seeming discrepancy between this conclusion and that of Treiman and colleagues is suggested in section 11.1.3.

Of course, there is always the possibility that the spelling cue design employed in these experiments did not adequately focus the children's attention on, or divert it from, the morphological structure of the regular past verbs that they were asked to write. In our studies, the children saw each cue word on a card, and wrote down the whole word on their own paper. An alternative method would be to provide the cues on the children's answer sheets, and to require them just to fill in the letter(s) that they thought were missing. We had originally decided against this method in case it discouraged the children from thinking about the spelling of each individual word, and encouraged them just to add the same ending to each word as they went down the list. However, this method might result in a stronger focus on the morphological status of the cues provided. Another possible method, and one that would be particularly suitable for younger children, would be to have each spelling cue (e.g., *pecke*) and a range of possible endings printed on separate small cards (e.g., *ed*, *d*, *t*, *td*). The children could then be given the "cue" card, and asked to choose the appropriate "ending" card to match it with to create the desired word.

One of the difficulties in designing Experiment 2 was that we could not match all the verb and non-verb cues for length. It was impossible to create non-verb cues as long as those for the longest "e-stem" non-verbs (e.g., *crease*, for *creased*), because similar-sounding non-verbs (e.g., *feast*) never have a vowel between their two final consonants. However, there do exist some inflected words with an orthographic structure similar to that of some non-inflected words. Children could be asked to spell comparatives such as *taller* and matched words such as *ladder*, or superlatives such as *cutest* and matched words such as *forest.* The spelling cues (*tall-*, *ladd-*, *cut-*, *for-*, or *talle-*, *ladde-*, *cute-*, *fore-*) could then be matched for length much better than for the verbs and non-verbs in Experiment 2. If children are aware of the stem-plus-inflection structure of the inflected words, then they should be better at adding the correct ending to these words than to their non-inflected counterparts.

A problem remains, however, in that the *-er* and *-est* endings can be spelled correctly by sound-based rules. It does not require morphological understanding to get them right, as with the *-ed* inflection. Several of the children in Experiment 1 made errors such as *faceed* or *creaseed* for *faced* and *creased.* Perhaps the only way to look for evidence of understanding of the *-er* and *-est* endings as inflectional units would be to see whether there were more errors of this type for the inflected words (e.g., *talleer*, *cuteest*) than for the non-inflected words (e.g., *laddeer*, *foreest*). Better experimental methods are obviously still needed before the question of children's understanding of the morphological structure of regular past verbs can be answered adequately.

11.1.1.2. The regular plural inflection *-s*

The limited amount of research that has been conducted on children's spelling of plurals has suggested that children are able to spell the regular plural *-s* inflection from when they first begin to write, regardless of its pronunciation (Beers & Beers, 1992; Read, 1986; Treiman, 1993). However, because none of these studies examined children's spelling of non-plural words with similar endings, it is not clear whether beginning spellers understand the need to use *-s* for all plural words, or whether they simply use *-s* for *all* word-final /s/ and /z/ sounds (or perhaps even all /s/ and /z/ sounds in general, regardless of word position).

Experiments 3 to 7 revealed that children do not just use *s* to represent the sound /z/. They use *z* as well. Further, they vary their spelling of /z/ according to its word position. Even the children in year 1 used *z* almost exclusively to represent word-initial /z/, *s* and *z* approximately equally in word-medial position, and *s* more than *z* in word-final position. These response frequencies largely reflect the frequencies of these spellings in these word positions in the English orthography.

These positional frequency effects were unexpectedly strong, and suggest that children are able to use quite sophisticated spelling conventions in their writing from much earlier than is commonly believed (the implications for models of spelling development are discussed in section 11.2.3.). These findings fit in with some experimental findings on this "orthographic knowledge" by Cassar and Treiman (1997). These authors tested children in kindergarten, grades 1, 2, 3, 6, and 9, and adults, on their knowledge of a range of spelling conventions. One type of task assessed the participants' knowledge of the phonetic environment for doubling consonants. For example, they were shown the pseudowords *salip* and *sallip* and asked to choose which one best represented the pronunciation /sælɪp/ (or which best represented /seɪlɪp/). Only the participants in grade 6 and above could reliably choose the correct spelling. Another test was one of position. The participants were shown two pseudowords with an initial or final doublet (e.g., *nnus* and *nuss*), and asked to choose which looked more like a real word. Other participants heard the word pronounced, and were asked to choose which looked like the most appropriate spelling for it. On these tasks, even children in kindergarten performed above chance. Cassar and Treiman concluded that although some aspects of orthographic knowledge do not develop until late in the primary school years, there are other aspects that emerge very early in the course of spelling acquisition. Our findings give particularly strong support to this conclusion, since our participants were required to write the experimental words themselves, rather than just to choose the most appropriate of two printed words.

However, our main question was not whether children are able to represent /z/ correctly according to spelling conventions, but whether they are able to use the plural rule to write all plurals correctly with *-s*, and the more general morphological rule to write all non-inflected non-plurals with an appropriate, non-*s* spelling. The pilot experiments (3 and 4) suggested that better spellers mostly understood these morphological rules, but that poorer spellers had only a shaky grasp of them, as they often used *-s* to end non-plurals as well as plurals. Experiment 5 compared children's spelling of plurals whose final /z/ sound was preceded by a consonant (e.g., *queens*) with plurals whose final /z/ was preceded by a long vowel sound (e.g., *queues*). The former plural words could be completed correctly via knowledge of a rule conditional on sound structure (final /z/ preceded by a consonant is virtually always written with *-s*) *or* via knowledge of the morphology-based plural rule (all regular plurals must be written with *-s*). The latter plural words could be completed correctly only via knowledge of the plural rule. Both better and poorer spellers used *-s* correctly significantly more often for the former words than the latter ones, which suggests that they relied heavily on the sound-structure-based conditional rule to spell these plurals.

Experiment 6 supported this conclusion using pseudowords (e.g., *pleens, prees*). This experiment also looked at children's spelling of non-plural pseudowords with a long vowel sound (e.g., *preeze*). The poorer spellers used *-s* just as often to complete these non-plurals as to complete plurals with the same sound structure (e.g., *prees*). This suggests that they did not make use of the plural rule at all. The better spellers did distinguish between these two types of pseudoword in their use of *-s*. However, this distinction (and thus their use of the plural rule) was very limited: they used *-s* correctly to complete plural pseudowords little more than a quarter of the time.

Finally, Experiment 7 showed that even adult spellers relied heavily on sound-based conditional rules to complete plural pseudowords correctly, and used the plural rule correctly only about half the time.

These results suggest that, contrary to the tentative conclusions of Read (1986) and of Treiman (1993), the plural rule is learned neither quickly nor easily. Although children are able to spell many plural words correctly from relatively early on, careful attention to the types of plurals spelled has revealed that sound structure seems to provide more help than does morphological status in the decision to use *-s*. One reason that this effect may not have been noticed in Read's and Treiman's naturalistic studies is that nouns ending in a voiced consonant are much more common than those ending in a vowel sound[2]. It is especially interesting that the reliance on sound structure to spell plural endings was observed even in adulthood. Although the adults used the plural rule to complete pseudowords about twice as much as did the better spellers in the experiment with children, this use was still by no means perfect. Thus, Experiments 3 to 7 suggest that it takes at least several years of writing experience before children even begin to learn the plural rule, and that they never learn it fully, but rely mostly on spelling rules conditional on sound structure instead.

However, it is possible that the uniformly poor performance in Experiments 5 to 7 was caused at least partly by the way that the experimental words and pseudowords were presented. In Experiment 6 it was noted that many of the children did not seem to be paying much attention to the sentence context when trying to write the pseudowords. When an attempt was made to focus their attention on the morphological status of the pseudowords via a Berko-type task (see section 6.2.2.2.), both the poorer and the better spellers showed evidence of using the plural rule in their spelling. Future experiments should investigate the extent to which children make use of the contexts and clues provided to them.

Similar experiments will be necessary for adult spellers. A number of the participants in Experiment 7 reported that they had decided how to spell the pseudowords when they initially heard them pronounced alone, instead of waiting to hear the sentence context and to consider whether this might have any bearing on the best way to spell the pseudowords. It

[2] A computerised search of the Kučera-Francis psycholinguistic database revealed 310 monosyllabic nouns ending in a vowel sound, but 1067 monosyllabic nouns ending in a voiced consonant.

does seem, however, that even if these hasty spelling decisions reduced performance, they probably did not disguise a full understanding of the morphological rules governing the spelling of word-final /z/. If participants did have this understanding, then surely they would have revised their written response once they had heard the sentence context, and paid attention to the contexts of the subsequent pseudowords. Further, the initial isolated presentation of the experimental pseudoword in Experiment 10 did not prevent the (child) participants in that study from making use of the clue word present in the sentence context.

A simple way of testing whether the method of testing did disguise an intact understanding of the morphological status of the experimental pseudowords would be to re-run the experiments, but to present the pseudowords only within sentence contexts, never alone. For example, instead of "*Prees*. How many *prees* can you see up there? *Prees.*", the experimenter would say "How many *prees* can you see up there? How many *prees* can you see up there?".

11.1.1.3. Conclusions about when children learn to represent inflectional endings

The results of Experiments 1 and 2 and Experiments 3 to 7 support the hypothesis that the ability to represent morphology in spelling is acquired relatively "late" in development. The children in Experiments 1 and 2, who were in school years 1 to 4, were mostly unable to apply the regular past verb inflection *-ed* consistently correctly. They did not appear to have a full understanding of the fact that this inflection must be applied always and only to verb stems. At least according to the experimental technique employed here, it seems that these children were not fully aware of the stem-plus-inflection structure of regular past verbs.

The ability to use the regular plural inflection *-s* consistently correctly also appears to be acquired quite late. Further research with varied presentation methods will still be required to confirm the results gained here. However, it seems from our experiments with both real words and pseudowords that even after three or four years at school, children have a great deal of difficulty in applying the plural rule to use *-s* correctly, and that even adults apply this rule correctly only about half the time. This suggests that understanding the stem-plus-inflection structure of regular plurals might be even more difficult than understanding that structure in regular past verbs.

However, these results do not mean that we should therefore assume that children are late in acquiring the ability to represent all aspects of morphology in their spelling. The results of Experiments 8 to 10, combined with the results of the studies discussed in sections 1.3.2.3. and 1.3.2.4. suggest that the recognition of the need to preserve the spelling of a word base, or stem, between its varied forms may be acquired much earlier on. This possibility is discussed in the next section.

11.1.2. When do children learn to preserve the spelling of base words?

Experiments 8, 9 and 10 investigated whether children in the first few years of primary school can use their knowledge of the spelling of base words to help their spelling of derived forms of these words. Experiment 10 also looked at the preservation of the spelling of base words in inflected forms. We describe the preservation of the spelling of base words in their derived forms first.

11.1.2.1. Base and derived words

Almost all the researchers who have looked at this question have concluded that children do not begin to represent base-derived relations in their spelling until about grade 4 at school (about age 10), and that this skill takes at least several more years to develop fully, if indeed it ever does (see section 1.3.1.2.). However, Treiman et al. (1994) present results which lead to a contrasting conclusion: that if derivational links are sufficiently simple, then even beginning writers can recognise them, and can use their knowledge of the spelling of base words to improve their spelling of these words' derived forms.

Experiments 8 and 9 aimed to test Treiman's claim with another type of spelling; the ambiguous sound /z/, which can be represented with *s* or with *z*. We examined the representation of /z/ in base words and their transparently related derived forms (e.g., *noise-noisy*) by children in school years 1 to 4. The main problem with comparing the results with those of Treiman et al. (1994) is that the end sounds of the base words in our experiments (e.g., *noise*) turned out to be much more difficult to spell correctly than the end sounds of Treiman et al.'s base words (e.g., *dirt*). Thus, there was not so much scope for the children to make use of their knowledge of the spelling of the base words (those which required a "z" spelling were found to be especially difficult). However, overall they represented /z/ correctly significantly more often in these derived words than in one-morpheme control words (e.g., *busy*). These results suggest that to at least some extent, the children were able to make use of what knowledge they had of the spelling of /z/ in the base words to aid their spelling of /z/ in these words' derived forms. Even though the relative difficulty of the base words meant that our participants could not be as young as the 4- and 5-year-olds tested by Treiman et al., the evidence still supports these authors' contention that children are able to make use of morphological relations in their spelling from much earlier than is widely believed.

This conclusion was also supported in Experiment 10, which examined whether children in years 3 and 4 would realise that they could make use of the spelling of "base" pseudowords when asked to write "derived" forms of these pseudowords. The participants indeed recognised and exploited the derivational links between the pseudoword pairs. They were as likely to represent /z/ "correctly" in a derived word when they were given the base form of that word as when they could simply copy out the derived word. It is unfortunate that this experiment could not also be conducted with younger children, but the sentence contexts (which contained the base and derived pseudoword clues) proved to be too difficult to read spontaneously for children in years 1 and 2.

One way of making this pseudoword experiment more suitable for younger children would be to make the method of presentation more appealing than the black-and-white printed pages employed in Experiment 10. Each sentence context could be printed in large letters on a separate page of a ring-binder, perhaps with the clue word printed in bold or in a contrasting colour (e.g., "Mum's going to buy a **mease** for tea. I love...!"), and with a fanciful picture to illustrate the sentence. The experimenter could point to each word of the sentence as she read it aloud before asking the child to write down the missing pseudoword (e.g., *meases*). These changes to the method might make the task too easy for children in school years 3 and 4, but would probably encourage children in years 1 and 2 to participate.

The conclusions reached by Treiman et al. (1994), and supported by the current results, are in conflict with the conclusions of most other studies on the age at which children are able to represent derivational relationships in their writing. However, the *results* that led to these opposing conclusions are not necessarily themselves in conflict. If we consider the types of words employed in each experiment, we can see that the seemingly discrepant results can probably be explained in terms of differences in the nature of these words. Almost all of the studies have used base-derived word pairs whose relation is relatively opaque, such as *combine/combination* (Zutell, 1980), and some did not check whether the children knew the meanings of the base words and/or of the derived words formed from them (see section 1.3.1.2.i.). It seems clear that it takes a long time to learn to recognise and to represent such complex relationships.

However, researchers should be more cautious in generalising this conclusion to derived words in general. The few studies to have used more transparently related base-derived pairs have found evidence of understanding of this relationship in younger children. Carlisle (1988) varied the transparency of the relations between her base-derived words, and found that her grade 4 children spelled the common stem of word pairs consistently if this stem underwent no phonological or orthographic change in its derived form (e.g., *warm-warmth*). However, it is possible that the children were just spelling both types of word phonetically, without understanding their link of meaning, as she concluded (see section 1.3.1.ii.).

The method of using derived words with an ambiguous middle sound, whose spelling can be disambiguated by knowledge of these words' base forms, and of a more lenient scoring system, has been able to overcome this difficulty of interpretation. The results of

Experiments 8, 9, and 10 provide support for the view that children understand the morphological structure of some derived words from several years earlier than popularly thought, provided that the derived words on which they are tested are relatively simple in structure and transparent in meaning.

11.1.2.2. Base and inflected words

Experiment 10 also tested children's ability to preserve the representation of /z/ in "base" pseudowords when writing *inflected* forms of these pseudowords. It showed that children did retain the *s* or *z* of the base pseudowords when writing inflected (regular past and plural) forms, and that they did so no more often than when they wrote derived forms. This supports the findings of Rubin (1988) and of Treiman and Cassar (1996) (see sections 1.3.2.3. and 1.3.2.4.). However, perhaps it is not so surprising that our participants were able to recognise and represent the links of meaning between base and inflected words, since, at the ages of 8 and 9, they were much older than the 4- to 6-year-olds studied by those authors. Further, the links of meaning between the base and inflected words were emphasised by the sentence contexts, and the spelling of the base words was provided, rather than having to be recalled by the participants when they were writing the inflected forms.

Nevertheless, the experimental procedure was exactly the same for the inflected words as it was for the derived words. Thus, the results from Experiment 10 provide evidence that there is not necessarily anything intrinsically more difficult about understanding derivational than inflectional relations between words. It is just that the relations between derived and base forms are often more complex and opaque than between inflected and base forms, and that most research has employed derivational forms whose relations to their base forms are relatively opaque. However, as we have been discussing here, not all derivational relations are complex, and many are just as simple as inflectional relations. Most people ignorant of grammarians' definitions would probably agree that the (derivational) relationship between *heal* and *health* is rather obscure. Perhaps because of the difference in the pronunciation of the base word, this does not seem to be a connection that everyone recognises. However, they would probably not identify the (also derivational) relationship between *heal* and *healer* as being any less obscure than the (inflectional) relationship between *heal* and *healed.* Researchers must therefore make clear the *type* of derivational relationships that they have investigated before drawing conclusions about children's general ability to represent derivational relations in their writing.

11.1.2.3. Conclusions about when children learn to preserve base spellings

The results from Experiments 8 to 10 suggest that children learn to preserve the spelling of base words in their inflected and derived forms from relatively "early" in their writing experience. This supports the conclusion of Treiman and her colleagues, who argue strongly that children recognise the relationship of meaning and spelling between base and inflected/derived words from the time when they first begin to write (e.g., Treiman & Cassar, 1996; Treiman et al., 1994). However, this interpretation paints a much more optimistic picture of children's understanding of the morphological structure of inflected words than we gained in Experiments 1-7.

How can we reconcile these apparently conflicting interpretations? A suggestion is made in the following section.

11.1.3. Conclusions about when children learn to represent morphological spelling patterns

Whether it is concluded that children acquire the ability to represent morphology "early" or "late" in their writing experience seems to depend on whether an experiment has concentrated on the spelling of free (stem/base) morphemes, or of bound (inflectional or derivational) morphemes. Children seem to have some skill at recognising and representing the common morphemic units of base and inflected words from relatively early on. This is in itself an impressive achievement. However, an understanding that shared sequences of sounds with a shared meaning should be represented with a common sequence of letters does not necessarily imply an understanding that this common unit constitutes anything as structured as a "stem". Similarly, it does not imply that children are therefore aware of the stem-plus-inflection structure of this type of word in written English. This can explain why the children in Experiments 1 and 2 were not encouraged to use *-ed* by the visual presentation of verb stems, whereas the children in Experiment 10 successfully retained the spelling of /z/ in base words when writing their inflected forms.

It seems to take several more years before children learn to recognise that inflectional morphemes also have consistent meanings across words and, like stem morphemes, require consistent spelling across words regardless of changes in pronunciation. For example, children may recognise from an early age that "tree" has the same meaning in both *tree* and *trees* and should therefore be spelled the same in each word. However, they seem to find it much more difficult to discover that the final sound /z/ also shares a common meaning and, just as importantly, requires a common spelling (*-s*) in many other related words. These words may not be so obviously related as *tree* and *trees*, but they all have "pluralness" in common. Children appear to find it difficult to learn that these words should be written with the same inflectional ending whether they are pronounced with a final /s/ or a final /z/. Further, they seem to find it hard to understand that this plural inflectional ending should only be attached to singular nouns to change them to plurals, and not used just as another way to represent word-final /z/ in any word.

Overall, then, it seems simplistic to try to define children's acquisition of the ability to represent morphological patterns in their spelling as occurring "early" or "late". At least in terms of the findings discussed in this thesis, it appears that children understand, and are able to represent, some aspects of morphology (such as simple relations between base and inflected/derived words) from very early in their spelling experience. Other aspects (such as the inflectional endings of regular past verbs and of regular plurals) do not seem to be represented – either spontaneously or with the aid of spelling cues or morphology-based tasks

– until relatively late. Thus, the terms "early" and "late" might be better applied individually, to the acquisition of specific aspects of morphology, than to the ability to represent morphological aspects of spelling in general.

11.2. Implications for the models of spelling development

In section 1.2.1. we presented a number of models of spelling development, and their accounts of when children acquire the ability to represent morphological patterns in writing. Most of these models describe children as beginning to spell using a purely phonetic strategy, learning to represent simple inflectional patterns and some conventional spelling rules after a year or two, and starting to symbolise some derivational relations after several more years. The predictions made by the models of children's acquisition of the ability to spell the morphology of regular past verbs, plurals, and derived words (as well as of orthographic conventions) are summarised in Table 11.1.

Table 11.1 Summary of the stages at which various spelling models postulate that children acquire the ability to represent the spelling rules tested. Ages are given where possible.

	Acquisition of ability to represent:			
Author	*-ed* inflection	*-s* inflection	Orthographic conventions	Derivational relations
Read (1986)	Represented phonetically for at least the first year of writing.	Usually correct even in beginning writing. Morphology understood?	Ignored in favour of phonetic spelling for at least the first year of writing.	Represented phonetically for at least the first year of writing.
Marsh et al. (1980)	Represented phonetically at about 6-7 years. Development of correct spelling not specified.		Ignored in favour of phonetic spelling at first. Conventions such as "magic *e*" and "soft *c*" learned from about 7-9 years.	Represented at about age 10, by using analogy.

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Author	*-ed* inflection	*-s* inflection	Orthographic conventions	Derivational relations
Frith (1985)	Represented in logographically-written words, then spelled phonetic-ally. Correct spelling learned in third and final stage.	Not specifically mentioned, but presumably develops similarly to *-ed*.	Ignored in favour of logographic, then phonetic spelling. Once these are mastered, conventions such as "magic *e*" and "soft *c*" are learned. More complex patterns (e.g., *-ight*, *-ough*) learned in final stage.	Represented in logographically-written words at first, then spelled phonetically. Represented correctly in final stage.
Ehri (1986)	Represented phonetically at about 6 years, then correctly from about 7 years.	Not specifically mentioned, but presumably develops similarly to *-ed*.	Ignored in favour of phonetic spelling at about age 6. Convent-ions such as "magic *e*" learned from about age 7; more complex conventions developed throughout life.	Correct representation emerges gradually out of skills which begin to develop from about age 7.
Gentry (1982)	Not specifically mentioned, but presumably spelled phonetically at first, then correct spelling learned from about 7 years.	Represented phonetically at first, but among the first inflectional endings to be represented correctly.	Ignored in favour of phonetic spelling at first. Then conventions such as vowel digraphs and "magic *e*" learned, then eventually rules such as those based on stress and on morphemic boundaries.	Represented phonetically at first. Correct represent-ations begin to emerge after basic spelling conventions and inflections are mastered.
Henderson (1985)	Represented phonetically at first. The first inflection to emerge correctly, at age 8-9.	Not specifically mentioned. Presumably develops after *-ed*?	Ignored in favour of phonetic spellings until patterns such as "magic *e*" are learned at age 7, then from 8-9 years positional rules and patterns such as *-ight* begin to emerge.	Represented phonetically until towards the end of primary school. Ability to represent these develops throughout life.

It must be noted that these models set out to provide descriptions, based on naturalistic and experimental data, of when children typically begin to represent morphological spelling patterns, including those of regular past verbs, plurals, and derived words. They do not make any claims about when children actually begin to understand the morphological structure of these types of words.

11.2.1. Acquisition of the *-ed* inflection

As just mentioned, none of the spelling models describes when or how children begin to show signs of understanding the stem-plus-*ed* structure of regular past verbs. Thus, we cannot evaluate the models in terms of our findings about children's understanding of this structure. Instead, we can compare our results with their claims about the age at which children learn to use the *-ed* inflection correctly, and about the nature of the incorrect representations that they use before they get to this correct stage.

The results from our first two experiments agree with virtually all other research on the topic, and thus with all of the spelling models except that of Frith (1985). Children at a less advanced stage of spelling development mostly represented the *-ed* phonetically, but children with a higher spelling age were often or usually able to spell it correctly, regardless of its pronunciation. There was no evidence of the poorest spellers using *-ed*, as would be expected if children started off spelling words logographically, as Frith's model claims.

However, although our participants were aged up to 9 years, only a few of them were able to use the *-ed* inflection entirely correctly. This agrees more with Nunes et al.'s (1997a) conclusion that the consistently correct use of *-ed* is usually not achieved until the age of 9 or 10 years. The inclusion of irregular past verbs and non-verbs in Nunes et al.'s experiments, and of non-verbs in ours reveals that just because some children always complete regular past verbs with *-ed* does not necessarily mean that they fully understand its use. They may use *-ed* to complete irregular verbs and non-verbs as well. It appears that none of the authors of the spelling models checked their participants' spelling of irregular and non-verbs. Thus, the three models which specifically mention the typical age of acquisition (those of Ehri, Gentry, and Henderson) may well be overly optimistic about the age at which children correctly employ the *-ed* inflection (see Table 11.1). The results of this thesis suggest that for most children, the ages of acquisition are not from 7 or 8-9 years, but from 9-10 years.

11.2.2. Acquisition of the plural *-s* inflection

The results of our middle series of experiments (3 to 7) provide evidence against the descriptions that the spelling models provide of children's ability to use *-s* to complete plural words. Gentry's is the only model to mention the *-s* inflection specifically, but the other models presumably include it in the same stage as *-ed*, but have just chosen *-ed* as their example of the type of simple inflectional endings that children are seen to acquire at this time.

The idea that the correct use of *-s* emerges after a phonetic stage of spelling seems to be inaccurate, not only in terms of the evidence gained in our experiments, but from the observations of Beers and Beers (1992), Read (1986), and Treiman (1993). Children do not appear to go through an initial period of spelling regular plurals phonetically; instead they tend to use *-s* nearly exclusively from when they first begin to write.

Does this constitute evidence for an initial logographic strategy, as suggested in Frith's model? It seems not. Only one model (that of Gentry, 1982) explicitly mentions the development of the correct use of *-s*. It seems likely that his evidence came mostly from representations of plurals whose singular form ended in a consonant, since these are the most common type of plurals (see Footnote 2). Our studies suggest that children usually rely on rules based on sound structure rather than on morphology to complete plural words. This reliance on sound structure is revealed only when they have to write (rarer) plurals whose singular form ends in a vowel sound. Our participants seemed to make more use of morphological rules when they were forced to focus on the morphological status of the plural and non-plural words that they were writing. However, even then their performance was not at ceiling.

Thus, it seems that the spelling models have been wrong to describe the correct use of *-s* (if we presume that this is included with other simple inflectional endings) as emerging out of a phonetic stage at the age of about 7 (or even 8 or 9) years. Further, although spellers may have some understanding of the morphological rules governing the spelling of this inflection from the age of 6 or 7, our studies suggest that they do not use these rules spontaneously in their spelling. Even adults do not appear to use the plural rule spontaneously to its full extent to spell word-final /z/ correctly, at least when writing pseudowords.

11.2.3. Acquisition of orthographic conventions

The orthographic conventions that children (and adults) seem to use instead to represent the sound /z/ appear to be understood at a rather earlier age, and with somewhat more sophistication, than is described by the models of spelling development. English has so many orthographic conventions that it would be difficult for any model to describe exactly when each one develops. The commonest examples given are the "magic *e*" and the "soft *c*" rules, but also mentioned are conventions ranging from alternative ways of lengthening vowels (e.g., digraphs such as *ou* and *ea*), to position-based rules (e.g., /eɪ/ is usually written *ai* within words, but *ay* at the end) to the conventions governing the joining of inflections to stems (e.g., *hoping* vs. *hopping*). However, all the models describe children as acquiring the ability to represent such conventions only some time after having mastered phonetic spelling. In contrast, our studies show that children are familiar with the quite sophisticated orthographic conventions that determine the representation of the sound /z/, even before they have completely mastered the ability to spell by sound.

The children varied their spelling of /z/ appropriately with word position (see section 11.1.1.2.). This ability was shown even by children in the first year of school, who still did not have phonetic spelling mastered completely. Thus, it seems that the spelling models should acknowledge that children's familiarity with at least some orthographic conventions may develop alongside their ability to spell phonetically, rather than coming as a separate, later stage in their spelling development.

11.2.4. Acquisition of the ability to represent derivational relations

Finally, we discuss the implications for the spelling models of our findings on children's ability to represent derivational relations in their spelling. Like the experimental studies discussed in section 1.3.1.2., the models all see derivational relations as the most difficult aspect of morphology to acquire, and describe the ability to represent these relations as the final stage in children's spelling development. However, most of the models do not give any examples of the derivational relations to which they refer. The two which do give examples, in common with the experimental studies, are based on research which has focused on children's spelling of relatively complex/opaque derivational relations. Marsh et al. (1980) base their evidence on children's ability to spell pseudowords by analogy to such real-word pairs as *critical/criticise*. Henderson and Templeton (1986) give one reasonably simple example of the type of derivational relations that children must learn to represent: *sail/sailor/sailboat*, but then concentrate on such complex pairs as *sign/signal*, *local/locality*, and *graph/biography*. It is therefore not surprising that these authors have not found evidence for the representation of derivational links in children much younger than 10 years of age. Our results, like those of Treiman, are based on much simpler and more transparent base-derived relations, and suggest that children are able to represent the links of meaning between words from very early on in their writing experience, well before they are able to represent the words completely correctly.

Models of spelling would therefore do well to be more specific about the type of derivational relations that they mean when they allocate their acquisition to the final stage of spelling development. Although a large amount of evidence agrees that children do not learn to represent complex derivational relations until towards the end of primary school, models of spelling development should also consider the acquisition of simpler relations. More empirical support will still be needed to confirm that even beginning spellers are able to represent simple derivational relations in their writing. However, our results, like those of Treiman et al. (1994) suggest that investigating only complex relations might lead to an underestimation of young children's understanding of morphological relations.

11.2.5. Alternatives to stage-based models of spelling development?

Our results, coupled with those of Treiman and colleagues and those of the other researchers discussed in section 11.1., suggest that if the course of children's spelling development is to be described with accuracy, then theorists should concentrate more specifically on the development of individual spelling patterns. They should take into account the increasing body of evidence on children's spelling of various orthographic sequences, rather than basing their postulated stages solely on findings from their own research. One example of the dangers of generalising from one's own, necessarily limited, research is Gentry's (1982) claim that children learn to represent inflectional endings such as *-s*, *-'s*, *-est* and *-ing* all at about the same time, in his Transitional stage. It seems clear from the data discussed in both the introductory and the experimental chapters of this thesis that just because linguists group these "simple inflectional endings" together does not mean that children will learn to represent them all at the same time. Since *-ing* and *-est* are spelled as they sound, there seems to be no reason why these should not have been acquired in the previous, Phonetic stage. (The same argument applies to Ehri's inclusion of *pre-* and *-ing* in her final (post-phonetic) Orthographic stage.) Further, the results in this thesis suggest that children do not always use the *-s* inflection correctly spontaneously, even by the age of 9, and the evidence discussed in section 1.3.1.1.iv.a. shows very clearly that *-'s* is among the very last spelling patterns to be mastered, if indeed it ever is.

Of course, much of the evidence discussed in this thesis was produced *after* the development of these spelling models. Few, if any, major new models seem to have been published since the 1980s. Seymour (1992) presents a tentative cognitive model of the spelling process, with a single system for generating orthographic output, governed by constraints at a morphemic level (lexical/semantic constraints) and at a sub-morphemic level (syllabic/phonemic constraints). However, this model does not set out to describe the development of the "literagraphic lexicon" in the first place; it is just an attempt to describe, in cognitive terms, how the generation of letter sequences occurs.

Varnhagen et al. (1997) suggest that the best way to learn more about children's spelling progress is to adopt Treiman's approach of identifying an interesting development through naturalistic observation, and then testing hypotheses through further observation and through empirical research. This was also the approach taken by Nunes et al. (1997a), in their development of a stage model of children's spelling of the *-ed* inflection, and of the other authors who have developed stage models for the acquisition of specific spelling patterns (see section 1.2.1.). Such research has shown that children do not progress through the same series of stages (e.g., phonetic spelling, increasingly specific overgeneralisation, correct spelling) for all inflectional endings at once. They learn one, then have to go through the same kind of process again as they learn other inflections and other patterns. For example, English-speaking children appear to perfect their use of the *-ed* inflection well before the apostrophe (see section 1.3.1.), and the experiments in this thesis suggest that the correct spelling of the plural *-s* inflection also develops after the *-ed* inflection. This seems to constitute strong evidence against the simpler stage theories, such as those of Ehri (1986) and Frith (1985), and their contention that children progress through qualitatively distinct stages in which they adopt an exclusively "phonetic" or "morphemic" strategy across all word types.

More recently, Ehri (1992) has acknowledged that the stages of spelling development might be better defined in terms of sets of features, rather than in terms of single (and perhaps simplistic) features. Perhaps we should see the development of spelling as occurring in "overlapping waves" (Siegler, 1995) instead of in qualitatively distinct stages. Siegler developed his overlapping waves model to account for the development of children's thinking in Piaget's classic number conservation task, but the same idea could be applied to the development of spelling skill. The model recognises that children possess multiple ways of thinking (multiple strategies for spelling) at any one time, but that the frequency of these ways of thinking (spelling strategies) changes over time as old ways are abandoned and new ways developed.

11.3 Morphological awareness and its relation to the representation of morphological spelling patterns

There is a growing body of evidence that children's morphological awareness is closely linked to their reading and writing ability (see section 1.4.). More recently, a particularly strong relationship has been identified between morphological awareness and the ability to write morphological spelling patterns correctly. The specific patterns for which such a relationship has been found include the inflectional ending *-ed* and the representation of some base-derived relationships. In many of the experiments of this thesis, we included a task of morphological awareness, designed to test the children's ability to manipulate the same kinds of morphemes that they were being asked to spell. We used word analogy and sentence analogy tasks based on those of Nunes et al. (1997a), since these are largely free of semantic confounds, require a reasonably explicit level of awareness for success, and have been shown to predict children's spelling of some morphological patterns for up to two years. A more explicit "base-extraction" task, based on Rubin (1988) was also included for one of the base-derived studies. Because ours were cross-sectional rather than longitudinal studies, we cannot draw conclusions about the direction of causality between morphological awareness and spelling ability. Thus, in each of the following sections, we discuss our findings in terms of the strength of the relationships observed, rather than in terms of causality.

11.3.1. Morphological awareness and the spelling of inflectional endings

11.3.1.1. Verbs

In Experiment 1, the children were administered Nunes et al.'s (1997a) Sentence Analogy task of morphological awareness, which requires the transformation of verbs from one tense to another by analogy to the sentences provided by two hand-puppets. Regression analysis showed that even after controls for chronological age, the children's scores on this task significantly predicted their ability to write *-ed* correctly to complete the spelling of regular past verbs. This prediction also held after controls for spelling age, but only when spelling age was entered as a step in the analysis *after* the morphological awareness score, but not before.

This might reflect a less specific relationship than in Nunes et al.'s (1997a) study, in which the morphological awareness score significantly predicted the number of times that *-ed* was spelled correctly, even after controls for age, IQ and each child's spelling ability in the original testing session. However, Nunes et al. did not include reading age as a step in their regression analyses, because they saw this partly as the product of the development being tracked in their stage model of *-ed* development. Since children's spelling ability is usually related to their reading ability (Gough, Juel, & Griffith, 1992), it may not be meaningful to try to separate spelling age from the ability to spell word-endings correctly. This could explain why this ability was predicted by the morphological awareness score only when this score was entered as a step in the regression analysis *after* spelling age.

11.3.1.2. Plurals

For experiments 5 and 6, a version of the Sentence Analogy task was devised in which the children had to change regular and irregular plural words to their non-plural form, and vice versa. It was hypothesised that children's scores on the morphological awareness task – which assessed their ability to apply such rules to plural words – should be significantly correlated with their ability to spell plurals correctly with *-s*, and non-plurals correctly with a phonetic spelling. Further, it was hypothesised that morphological awareness scores should predict the ability to represent word-final /z/ correctly even after controls for chronological age. Neither hypothesis was supported. In Experiment 5, the children's morphological awareness scores correlated significantly with their spelling age, but not with their ability to represent -/z/ correctly, when writing "PC" plurals (which could be spelled via a rule based on sound-structure or via the plural rule), "P-" plurals (which could be spelled via the plural rule alone), or non-plurals.

This finding supports the conclusions drawn from Experiment 5 about the strategies that the children were using to decide how to spell /z/ at the end of the experimental words. As described in section 11.1.1.2., we interpreted our results to show that both the better and the poorer spellers had relied on spelling rules conditional on sound structure rather than on morphological rules, to spell these /z/ sounds. This hypothesis makes sense of the fact that the children's morphological awareness scores were not related to their correct spelling of /z/.

However, it may be that children's morphological awareness *is* related to their ability to spell word-final /z/ appropriately, and that our task just failed to test morphological awareness adequately. This possibility is discussed in more detail in section 11.3.2.2.

In Experiment 6, we tested our hypothesis again, with the same Sentence Analogy task. This time we were looking children's spelling of the /z/ at the end of *pseudowords* of various types: "P-" plurals and non-plurals, "PC" plurals, and "M/C" non-plurals, which could be spelled via a general morphological rule or perhaps just through a knowledge of spelling conventions. We found that morphological awareness scores did not correlate significantly with the number of appropriate representations of final /z/ of any of the *plural* words. They did correlate significantly with children's appropriate representations of the final /z/ of *non-plural* pseudowords.

However, regression analyses revealed that when controls were made for chronological age and spelling age, morphological awareness score no longer predicted the ability to represent /z/ at the end of non-plurals. This was true even when the morphological awareness score was entered into the equation before spelling age. These findings are further evidence in support of our conclusion that even good spellers do not make use of the plural rule to decide how to represent word-final /z/, at least in this pseudoword dictation task. Overall, the better spellers were much more likely to use the letter *z* to represent /z/ (an appropriate ending for the non-plural words) than the poorer spellers, who were more likely to use *s*. Since the better spellers also did better on the morphological awareness task than the poorer spellers, this can explain the high correlations between morphological awareness score and the appropriate spelling of non-plural endings.

In the second testing session of Experiment 6, we gave the children a task that encouraged them to focus on the morphological status of the same set of "P-" pseudowords, and asked them to write these words again. Regression analysis revealed that the children's morphological awareness scores did predict their ability to use *-s* correctly to spell these pseudowords in this second session, even after controls for chronological age and spelling age. This suggests that although the children did not use their knowledge of the morphology of plural and non-plural words when spelling in a dictation task, they did appear to rely on this knowledge to some extent when they were encouraged to think about the words' morphological status before spelling them.

11.3.2. Morphological awareness and the preservation of base word spellings

11.3.2.1. Base and derived words

For the experiments examining the children's spelling of base and derived words, we attempted to measure morphological awareness with a version of the Sentence Analogy task, but also with a Word Analogy task, and a Base Extraction task. In Experiment 9, the comparison was with the number of word pairs in which the children had represented the sound /z/ consistently in the base and derived form of the word in question (e.g., *noise-noisy*, *noize-noizy*). Such consistency was taken to indicate an understanding of the link of meaning between these pairs of words. We hypothesised that the children's performance on the Sentence Analogy task (which requires the transformation of base words to their derived forms, and vice versa) would be significantly correlated with their spelling consistency. This correlation was indeed found to be significant. However, regression analyses showed that when chronological and spelling age were entered as steps of the analysis before Sentence Analogy score, this score no longer accounted significantly for any of the variance in the children's spelling consistency. The reason for this is probably the same as discussed for regular past verbs in section 11.3.1.1: the ability to spell a specific morphologically-based pattern may be so closely linked with general spelling ability that it does not make sense to try to separate the two statistically.

When Sentence Analogy score was entered after chronological age but *before* spelling age, it did significantly predict the children's consistency in representing /z/ in each base-derived pair (just as it predicted the representation of *-ed*, as discussed in section 11.3.1.1.). Thus, it seems that children's ability to use analogy to transform base and derived forms orally can account in part for their understanding of the need to preserve spellings between related base and derived words.

Experiment 9 also tested children's ability to extract base words from their derived forms (e.g., *noise* from *noisy*), using the same words that the children had earlier been asked to spell. Scores on this Base-extraction task were significantly correlated with scores on the Sentence Analogy task, which suggests that both tasks were tapping the same underlying ability to recognise base-derived relationships. However, the children's Base-extraction scores did not correlate significantly with their consistency in representing /z/, even though these two tasks involved the same words. Although this result seems puzzling at first, it is not completely unexpected in light of previous research using this kind of highly explicit task of morphological awareness.

Rubin (1988) did not actually report the strength of the relationship between the children's performance on the base-extraction task (on which our task was based) and her participants' representation of base morphemes. Smith (1987, cited in Derwing et al., 1995) found some tendency for children who spelled base and derived words in the same way to do better on a similarly explicit task of morpheme recognition, but his results were significant on only some of the items (see section 1.4.1.). Derwing et al. (1995) conducted a similar study with college students, using more complex word pairs. Some pairs of words did provide evidence for a strong relationship between the tendency to spell base and derived words consistently and the ability to identify the derived words' base forms. Again, however, this relationship was observed only for some pairs of words. Perhaps we would have observed a stronger relationship if we had required children to spell the whole of the base word consistently in its derived form, instead of just looking at the consistency of their representation of the crucial sound /z/.

It appears that the highly explicit level of morphological awareness required for good performance on the base-extraction task is relatively difficult to develop. As discussed in section 9.4., it seems that children understand enough to represent relations of meaning between base and derived words some time before their awareness becomes sufficiently explicit for them to be able to extract the base from the derived form in an oral task.

The level of morphological awareness required for the base/derived version of the Sentence Analogy task seems to be somewhat less explicit. As discussed in section 9.4., there was often only one other form of the target base/derived word that would be semantically appropriate in the sentence context. For example, the only form of the target word *dangers* that would fit the context "She said it's very _______" is *dangerous*. Thus, success on this task probably depended to some extent on the children's vocabulary and their word-retrieval skills. However, as in Carlisle's (1995) Morphological Production task, the children also had to analyse the sentence, and so some level of explicit awareness was probably also required.

Experiment 10 compared children's tendency to preserve the spelling of /z/ from "base" to "derived" pseudowords with their ability to transform base and derived real words in a Word Analogy task. It also made the same comparison with their tendency to preserve the spelling of /z/ when the opportunity was provided for them just to copy out the derived word from the sentence context.

Regression analyses showed that for the pseudowords in the "Base provided" sentences, Word Analogy scores significantly predicted the ability to spell /z/ consistently in base and derived forms, even after controls were made for chronological and spelling age. For the pseudowords in the "Copy word" sentences, however, Word Analogy score no longer significantly predicted the consistent representation of /z/ after controls were made for chronological age and spelling age. It seems that when children were able just to copy the spelling of the missing pseudoword, their consistency increased with increasing chronological and spelling age, but did not depend on their morphological awareness. However, when they had to recognise the morphological relationship between base and derived pseudowords to be consistent in their spelling of /z/, then morphological awareness was important. This is further support for the idea that children are aware of the links of meaning between base and derived words, and the need to represent these in specific spelling patterns, from a younger age than is commonly suggested by researchers and in models of spelling development.

11.3.2.2. Base and inflected words

Experiment 10 also examined the relationship between children's morphological awareness scores and their preservation of the base spelling in inflected pseudowords. In this experiment, we compared children's ability to transform base and inflected real words in a Sentence Analogy task with their tendency to preserve the spelling of /z/ from "base" (e.g., *jise*) to "inflected" (e.g., *jised*) pseudowords. (These inflected words, and the Sentence Analogy task, included both regular past verbs and regular plural nouns.) We made the same comparison with their tendency to preserve the spelling of /z/ when the opportunity was provided for them just to copy out the inflected word from the sentence context.

The results were equivalent to those found for the base and derived pseudoword pairs discussed in the previous section. Regression analyses showed that for pseudowords in the "Base provided" sentences, Sentence Analogy score predicted the children's tendency to preserve the spelling of /z/ in the base words' derived forms, even after controls for chronological and spelling age. In contrast, for the pseudowords in the "Copy word" sentences, Sentence Analogy score no longer significantly predicted the consistent representation of /z/ after these controls were made. Thus, when the children were able just to copy the spelling of the missing pseudoword, the likelihood of their doing so increased with chronological and spelling age, but did not depend on their morphological awareness. It was only when they had to recognise a morphological relationship (in the "Base provided" sentences) in order to preserve the spelling of /z/ that morphological awareness had a specific, significant role to play.

It should be noted that there is an intrinsic limitation to the versions of the Sentence Analogy task developed to test children's ability to transform plural nouns, compared with the original task requiring the transformation of verbs. It is to do with the limited number of linguistic forms that nouns may take, compared with the more numerous forms for verbs (and is thus similar to the limitation discussed for base-derived analogy tasks in the previous section).

In the original, verb-based version of the task, several forms of each target verb would make sense in the context given (e.g., "The dog *chased/chases/is chasing* the cat"). A child can produce the correct form only if she fully understands the transformation that she is required to make. In this noun-based version, however, usually only one other form of the given noun exists, and even if it does have alternative forms, these forms would usually not make sense in the context provided. For example, if the child is required to transform the word *mouse* by analogy to the transformation *cat – cats*, there is not much choice about which form of the word *mouse* to choose. The only other reasonably common forms are *mice* and *mousy* (as in "mousy brown hair"), and only *mice* makes sense in the context. Thus, this version of the Sentence Analogy task may measure the ability to recall specific items of vocabulary as much as the ability to understand the analogies and the transformations required. Nevertheless, the conclusions that we drew from the children's performance on this task did fit in with our conclusions from their performance on the spelling tasks. Thus, this version of the sentence analogy task does seem to be worth using in future experiments.

11.3.3. Differences between real words and pseudowords

There seems to be a difference in the specificity of the relationship between morphological awareness score and the ability to represent morphological spelling patterns in real words, compared to pseudowords. This difference seems to be true whether the morphological pattern of interest is the correct spelling of an inflectional ending, or the correct preservation of the spelling of the base section in a derived word. (The plural *-s* inflection is not included here, since children's correct spelling of this ending did not correlate significantly with their morphological awareness score).

In the experiments with real words, the children's morphological awareness scores predicted the correct spelling of the *-ed* inflection (Experiment 1), and the preservation of the spelling of base words in their derived forms (Experiments 8 and 9), but only when the morphological awareness score was entered *before* spelling age as a step in the regression equation. In the experiment with pseudowords, however (Experiment 10), morphological awareness score predicted the preservation of the spelling of base words in their inflected and their derived forms even when spelling age was entered into the regression equation after morphological awareness score.

It is likely that children did not always write regular past verbs correctly with *-ed* or choose the correct spelling of /z/ in an inflected or derived form because they were aware of the morphological status of these words and used their morphological knowledge to achieve the correct spelling. Instead, they might simply already have known how to spell some of these words correctly as rote-learned wholes. Thus, it is not surprising that their correct spelling of these inflectional morphemes and of a section of the stem morphemes was strongly related to their spelling age.

However, since the children could not have already known how to spell any of the pseudowords in Experiment 10, the only reason that they would have to preserve the spelling of /z/ would be if they recognised the putative link of meaning between the base and inflected/derived words. Unsurprisingly, the ability to recognise this link appears to depend more on morphological awareness than on spelling ability.

11.3.4. Conclusions about morphological awareness and morphological spelling

As mentioned at the beginning of section 11.3, the cross-sectional design of the studies in this thesis precludes any interpretations based on causality. Nevertheless, our findings agree with those of other researchers in showing that there is generally a strong relationship between scores on reasonably explicit tasks of morphological awareness, and the ability to represent morphological spelling patterns correctly (e.g., Carlisle, 1988; Nunes et al., 1997a). The development of versions of Nunes et al.'s Word and Sentence Analogy tasks, which concentrate on children's awareness of particular types of words (e.g., base and derived words, plurals and non-plurals) has revealed even more specific relationships. It appears that the ability to recognise and transform specific morphological patterns in an oral task is often related to children's ability to represent these particular patterns in writing, even when controls are made for chronological and spelling age.

Finally, the use of several types of morphological awareness task in this thesis has highlighted the importance of choosing or developing tasks of an appropriate level of explicitness. Previous research has suggested that children may not be able to represent morphological spelling patterns correctly until they have gone beyond an implicit level of morphological awareness to gain a more explicit understanding (see section 1.4.1.). However, it seems that if tasks are too difficult, and require too explicit a level of morphological awareness (for example, the base-extraction task), then they are not very useful for predicting children's spelling of morphological patterns. Children seem to learn to represent many such patterns before they reach the explicit level awareness required for success on the base-extraction task, or on the morpheme recognition task of Derwing et al. (1995).

Obviously there can be no clear-cut definition of what constitutes "implicit" or "explicit" morphological awareness, and there will always be varying grades of implicitness and explicitness. However, if researchers wish to continue to explore the relationship between morphological awareness and the ability to represent morphological relations in writing, it seems that they must take care to consider the level of awareness that they are attempting to test. If their task requires a level morphological awareness that is so implicit or so explicit that children's scores on it are not related to their skill in representing morphology in their writing, then the task will be of little practical or predictive value.

11.4. Educational implications of the present research

Many of the results in this thesis support the "late" acquisition of morphology hypothesis. It seems to take children several years, if not longer, to learn how to use the *-ed* and *-s* inflections correctly. Further, although we observed the apparent transfer of the spelling of base words to derived and inflected words in relatively young spellers, this transfer was never complete, even in the 8- and 9-year-olds tested. It therefore seems likely that children might benefit from some extra instruction to aid their ability to use morphological patterns correctly in their writing.

Both children and adults did poorly in spelling plural words whose sound structure provided no clue to the correct representation of /z/ (see Experiments 6 and 7). However, the children did show some use of the plural rule in their spelling after an attempt was made to focus their attention on the morphological status of these words. This suggests that children do have some idea about the morphology-based plural rule, but that they normally just rely on rules based on sound structure instead, because these usually (but not always) work. If this is the case, then school instruction should focus not only on explaining the plural rule, but also on making it clear that this rule is the only one that will always result in the correct spelling, and that sound-based rules are sometimes unreliable. Children should be given a variety of plural and non-plural words to write, and provided with prompt feedback about whether they are correct or incorrect in their spelling of the final sound, and why.

Training children to write other morphological patterns might prove more difficult. A number of researchers, over a number of years, have suggested that training in morphological awareness might improve children's understanding of the structure of language, and also their ability to represent morphologically complex words. For example, Hanna, Hodges, and Hanna (1971) recommended that students practise separating words into their component morphemes, and putting morphemes together to create new words, as a means of improving their spelling power. Wiig, Semel, and Crouse (1973) suggested that younger and poorer spellers, particularly, might benefit from a more general and intensive instruction in the morphemic structure of words. Carlisle (1988) noted that explicit instruction in morphological relationships, including phonological and orthographic transformations, might enhance students' ability to spell derived words.

However, there seem to be very few studies that have actually attempted such training in morphological awareness. One is by Robinson and Hesse (1981), who assessed the effects of a morphemically based spelling programme administered to American seventh-grade students over an 8-month period. This programme taught students to analyse multi-morphemic words into their component morphemes (e.g., *un-help-ful*) and to combine stem morphemes with inflectional and derivational morphemes (e.g., *swim* + *er* makes *swimmer*)[3].

At the end of the training period, the children whose general spelling ability had initially been low or average had improved significantly in their ability to analyse and to spell multi-morphemic words, compared to children of initially equal spelling ability who had not undergone the training programme. (The children of initially high spelling ability did not improve very much, probably because they already mastered two-thirds of the words in the training programme before receiving instruction in it.) Although the low and average spellers' performance on morphologically complex words improved with the intervention, this improvement did not transfer to their general spelling ability, which was no better than

[3] Strictly speaking, this latter task constitutes training in spelling conventions rather than in the representation of morphological relations.

that of children who had not received the intervention. These results suggest, not surprisingly, that training in morphological awareness (strongly linked to its representation in writing) should be tailored to the ability levels of participants to be of any value. Further, they confirm that such training is helpful for improving the spelling and understanding of multi-morphemic words, but not necessarily for improving general spelling ability.

Elbro and Arnbak (1996) report data from a pilot study on the effects of training in morphological awareness on dyslexic and non-dyslexic Danish readers aged 9 to 12. Their participants were given training in dealing with compounds (segmenting compound words and changing the order of their component morphemes), derivational affixes (specifying their role and meaning) and inflectional endings (specifying their meaning, and the several possible uses of, for example, the present tense). This training programme had small but significant positive effects on the accurate spelling of morphologically complex words, but also on the reading of coherent text.

There appears to be very little research on the effects of morphological awareness training in younger spellers. Nunes, Bryant, & Olson (2000) have conducted such a longitudinal intervention study with 7- and 8-year-olds, using a variety of morphological awareness tasks, including classifying words according to their grammatical category, and making morphological analogies. For some children, this morphological training was given alone; for others it was linked to written representations. (Other groups were given training in phonological awareness instead, with or without linking it to writing.)

Preliminary results suggest that morphological awareness training can boost some aspects of children's reading and spelling, although these effects are not always specific, and differ according to whether or not the training has been linked with writing. Further, the results suggest that morphological awareness can contribute to literacy skills only if phonological awareness is fairly well mastered. These findings are encouraging and could have important implications for the teaching of both phonology and morphology in the classroom, but it is clear that there is a need for much future research. (Directions for such research are discussed in more detail in section 11.6.)

11.5. Limitations to the present research

Some of the more specific weaknesses and limitations of the research carried out in this thesis have already been pointed out in sections 11.1. and 11.3. Where possible, we have made suggestions for changes to the experimental procedures which may help to clarify ambiguities or to provide further evidence for (or against) our conclusions. However, there are also some limitations shared by most of the experiments conducted for this thesis.

First, nearly all our studies required children to write down words in the form of a list. Even though the words were presented in sentence contexts, the children had to write down only one word at a time, and were therefore able to consider each word in isolation when deciding which letters to use. Children are often required to write down lists of words to dictation by their class teacher, and are accustomed to this as a way of testing their spelling ability.

However, the spellings that children choose for unfamiliar or semi-familiar words in this situation might be different from those that they would use if they were writing those same words in a sentence or a story of their own. There, children's spelling might be slightly worse because their attention is taken up by deciding which word or what idea to put next.

There is some evidence that examining naturalistic spelling can result in a lower estimation of children's abilities than examining their responses to single dictated words in an experimental study. As discussed in section 1.3., Treiman (1993) concluded from her analyses of the naturalistic spelling of first-graders that these children were unable to represent the common spelling of base and inflected words, and of base and derived words. In contrast, her later, experimental studies, which required children to write down words in list form (Treiman & Cassar, 1996; Treiman et al., 1994) provided evidence that children *can* represent base/inflected and base/derived relationships in grade 1 and even earlier. Thus, our results are not necessarily generalisable to children's spelling of words in a naturalistic context. Future studies should perhaps compare children's spelling of target words in list-dictation tasks and in more natural contexts.

One way of examining children's spelling in a more natural context is to collect stories or essays from a school class and to look for examples of the spelling pattern of interest (e.g., Sterling, 1983; Treiman, 1993; Varnhagen et al., 1997). However, the children will not necessarily produce enough examples of that spelling pattern for statistical analysis. Also, only the better spellers may attempt to spell particular types of words, so there will be little or no indication of how poorer spellers might tackle such patterns.

Another, more precise, method is to ask children to write a set of words to dictation, but to ask them also to make up and write a sentence context for each word (e.g., Treiman & Cassar, 1996, Study 3). The disadvantage of this method is that younger and poorer spellers, especially, find it difficult and time-consuming to think of, and write, suitable sentences for the experimental words. However, perhaps this method could be used with a smaller number of participants and a subset of the target words, to check the generalisability of the results from the dictated list of words. Treiman and Cassar (1996) actually found no differences between children's performance on the two types of task when they made such a comparison. Nevertheless, there could well be differences with other types of words, and ascertaining whether children's spelling varies with the context in which it occurs might have implications for teaching. For example, a child might usually be able to spell the *-ed* of regular past verbs correctly when he writes them in isolation, but when he writes them in a story he might tend to revert to using phonetic spellings instead. If the teacher had this information, she would know that the number of errors in the child's stories could be reduced by directing his attention towards those particular words, rather than having to teach him the *-ed* pattern and its role "from scratch".

A second limitation to the present research is also related to its non-naturalistic design. In some studies, the spelling pattern or sound of interest was present in all the experimental words – for example, all the pseudowords in Experiment 10 contained the sound /z/. It is quite possible that having to decide how to represent /z/ so many times in a row caused the children to respond on the basis of something other than the morphology of the pseudowords in question. For example, some children might have realised after a while that they were having to decide how to write /z/ a lot, and that they had better start being consistent in their spelling, instead of using *s* some of the time and *z* some of the time. Others, aware that both *z* and *s* are appropriate ways of representing /z/, might have realised that they had used *z* quite a few times in a row, and had therefore better swap to using *s* for a while. Even if these tendencies account for some of the children's responses, however, the patterns of results of this experiment (and others) suggest that they cannot account for all responses. Further, the very similar results from Experiments 1 (in which children wrote only regular past verbs) and 2 (in which children wrote both regular past verbs and non-verbs) show that children's responses do not necessarily always depend on the variety of words that they are required to write.

Research in schools is usually constrained by time, as well as by the limits of the children's concentration, and it is difficult to include many filler words without compromising the number of experimental words tested. Nevertheless, it might be advisable in future studies to guard against the possibility of the children's responses being biased by too many similar words, and to include as many filler words as possible.

The third limitation to the present research is that it was not always possible to choose experimental words which exactly fitted the ideal criteria of frequency, structure, etc. This was a particular problem in Experiments 8 and 9, and probably contributed to the relative difficulty that the children experienced in writing the base words which required a "z" spelling (e.g., *fizz*, *breeze*). This limitation is the result of the nature of the English orthography, and could not be overcome, at least for these words. Obviously a wider range of suitable words is available if less distinctive words are required for an experiment. Fortunately, however, our results with less-than-ideal real words were confirmed in studies using pseudowords, whose characteristics could be chosen more carefully.

A final obvious limitation is a more general one. Mostly because of time constraints, the experimenter was not able to ask the teachers of the participants in these experiments to provide information about how much (if anything) the children had already been taught about the morphological spelling patterns tested. Without this information we cannot be sure, for example, that our participants preserved the spelling of base words in their derived forms spontaneously. They may have had a lesson explaining this spelling strategy the previous week, month, or year. Of course, not all children would remember such lessons equally well, but it would be valuable to know the extent to which they had received instruction in representing the morphological patterns being studied.

At the time of testing the teachers did not always know what the children had been taught in previous years, and often only said that some of the children had been taught a bit about *-ed*, for example. However, the teachers did not have time to explain the nature or extent of this teaching. With the introduction of a highly structured, nation-wide Literacy Hour, however, experimenters should find it much easier to discover exactly what children have already been taught, both in the year of testing and in previous years.

11.6. Directions for future research

Future research is needed on the development of children's spelling both of morphemic endings (inflectional and derivational) and of stem morphemes in base, inflected and derived forms of words. Some possible directions for such research are now discussed.

11.6.1. The spelling of morphemic endings

In section 11.1.1.1. we made several suggestions for further ways of investigating children's spelling of *-ed* as a way of testing their understanding of the morphological structure of regular past verbs, as alternatives to the presentation conditions employed in Experiments 1 and 2.

It is especially clear that more research is needed on the spelling of the plural inflection *-s*, by both children and adults. It will be important to determine whether the pessimistic picture painted by Experiments 3 to 7 of spellers' understanding of how to represent the final /z/ of plurals and non-plurals is realistic, or whether their performance was inhibited by the nature of the tasks given. Experiment 6 showed that children were better able to use the plural *-s* inflection when their attention was focused explicitly on the morphological status of these words in a Berko-type task. This finding shows that we need to investigate further the extent to which the spelling of plural inflections depends on how explicitly the speller's attention is drawn to the morphological structure of the plurals and non-plurals that he or she is asked to write.

In section 11.1.1.2. we suggested that presenting plural and non-plural pseudowords only in sentence contexts, and not alone, might give a better idea of participants' ability to represent the morphological status of these pseudowords. Another method of drawing spellers' attention to the morphology of the pseudowords would be to include an alternative (inflected or non-inflected) form in the preceding context (e.g., "I can see one *pree* up there. How many *prees* can you see?", or "I really like *preezing*. I *preeze* every day."). This is similar to the Berko-type task used in Experiment 6. However, it would be interesting to see whether merely hearing the experimenter say the two forms of the pseudoword would be sufficient to encourage spellers to focus on the morphological status of the target word, or whether they would actually need to produce the required form of the word themselves (as in Experiment 6).

The poor performance of the adult participants in Experiment 7 makes it clear that researchers should not just assume that the spelling patterns that children find difficult will be fully acquired by adulthood. Future experiments, at least in this area, should test the spelling of older children and adults as well as of younger children. Another reason for testing adult spellers is to check the validity of the method of testing. If it is found that adults, as well as children, are unable to represent a particular spelling pattern correctly, then the problem may lie not in the difficulty of the spelling, but in a flawed or confusing experimental design. The relative effects on the spelling of children and of adults could be examined after improvements to the design.

Children's correct and incorrect spelling of word-final /z/ could also be used as a means of investigating their understanding of the stem-plus-inflection structure of plural words, perhaps using a version of the cue-level design developed for Experiments 1 and 2. This design works best with real words, and is thus especially suitable for young or poor spellers, who are often reluctant to try writing pseudowords. Children could be asked to spell plural words, such as *trees*, with the aid of spelling cues constituting singular nouns (i.e., whole word stems, such as *tree-*), morphologically meaningless fragments of these nouns (e.g., *tr-*), or no cue at all. The studies in this thesis suggest that children will not always use *-s* correctly to complete such plurals. However, if they have some understanding of the morphological structure of these words, then children should use *-s* correctly significantly more often to complete plurals for which the spelling cue constitutes a word stem than for plurals for which the cue is a word fragment, or for which there is no cue shown. The number of correct endings produced for non-inflected control words, however, should not differ significantly across cue levels (e.g., *ja-*, *j-*, and — for *jazz*, or *chee-*, *ch-*, and — for *cheese*).

Since virtually all English derivational morphemes are written as they are pronounced (e.g., *un-*, *pre-*, *-ness*, *-ly*), there is not much scope for empirical investigation of children's spelling of these patterns. Instead, the most profitable direction for future experiments in this area seems to be the continued investigation of the consistency of children's representation of base morphemes in non-derived and derived forms. This is discussed later in the following section.

11.6.2. The spelling of stem morphemes

There is scope for studies which compare children's spelling of stem morphemes in their base and their inflected/derived forms. One such study was attempted by Treiman (1993), who looked at the doubling of consonants in inflected words in the naturalistic spelling of first-graders. Children take some years to learn the conventions of consonant doubling at "syllable junctures" (Henderson, 1985), but early on their doubling (or lack thereof) could indicate whether they understand that word stems should generally be spelled consistently. If they do understand this, Treiman reasoned, then they should use double consonants more often for words such as ***called***, where the stem ends in a doubled consonant, than in words such as ***chopped***, where the stem ends in a single consonant.

In her analysis, there turned out to be no significant difference between the two types of word, but it should be noted that the number of cases was very small (23 vs. 18 words). However, several of the other comparisons between word types which showed no significant differences in Treiman (1993) did show significant differences in later, experimental studies (e.g., Treiman & Cassar, 1996; Treiman et al., 1994). Thus, future studies could compare children's spelling of inflected and non-inflected forms of stem words with and without a final doubled consonant.

It seems from the studies reviewed and the studies conducted for this thesis that children do not learn to spell all inflectional endings correctly at the same time. However, we have less information about the development of children's understanding of the need to represent stem words with the same letters in related words. Do they come to understand this for all types of words at once, or for only one type of word at a time? One way to test this would be to compare children's preservation of stem spellings for past regular verbs, as just suggested, with their preservation of stem spellings in, for example, present participles (e.g., ***chopping*** vs. ***calling***), comparatives (e.g., ***bigger*** vs. ***smaller***), agentives (e.g., ***chopper*** vs. ***caller***), or superlatives (e.g., ***biggest*** vs. ***smallest***).

Future experiments could also consider children's representation of the stem of singular and plural forms of nouns. As discussed in the previous section, Experiment 10 showed that 8- and 9-year-old children were able to retain the spelling of /z/ in base pseudowords when writing the inflected (including plural) forms of these pseudowords. However, much younger children would need to be tested to assess Treiman's claims that even beginning writers recognise and represent such morphological relations. One way of doing this would be to ask beginning spellers to write plural words such as *flies*, for which there should be a change of spelling from the singular form (*fly*), and similar non-inflected control words, such as *prize*. If the children were more likely to use the spelling appropriate for the singular words when writing the plurals (e.g., *flys*) than the control words (e.g., *pryze*), then this would constitute evidence that they were aware of, and trying to represent, the relation between the stem and inflected forms. (Obviously, the children's ability to spell the stem words would also need to be assessed.)

There is also scope for further experiments which ask children to spell the base and inflected forms of pseudowords, rather than of real words. Experiment 10 showed that children in school years 3 and 4 retained the spelling of pseudoverb stems when writing their inflected forms. However, the potentially controversial aspect of Treiman's claims (on which this experiment was based) is that children are able to represent the links of meaning between related words from when they first begin to write, from the age of 6, 5, or even 4 years. Thus, it is not of great theoretical interest to show that children aged 8 to 9 are aware of the links of meaning between base and inflected words. It would be more valuable to conduct these tests with younger children. As suggested in section 11.1.1.2., our version of the pseudoword task could be made more suitable for younger children by making the method of presentation simpler and more visually appealing.

Most research on children's preservation of the spelling of the stem form in *derived* words has focused on children's consistent and correct representation of the whole of the base morpheme. However, adopting a more lenient marking system of focusing on the representation of a single sound to decide if spellings as consistent (e.g., *dirt-dirty*, or, as in this thesis, *noise-noisy*) allows meaningful results to be gained from testing much younger children (e.g., Treiman et al., 1994; Zutell, 1980). Thus, the use of experimental words amenable to this lenient system of marking seems to be an important area for future research.

The words used in Experiments 8 and 9 of this thesis turned out to present a problem: the relatively low frequency of words with a *z* spelling in English made it difficult to choose enough appropriate words for the studies. Also, the *z* base words proved too difficult for many of the children to spell, which limited their scope for transferring the spelling of these base words to their derived forms. If the ambiguous sound /z/ is to be used for such research, it is probably more profitable to examine its use in pseudowords, as in Experiment 10. In section 11.1.2.1. we suggested some ways of modifying that pseudoword task to make it more suitable for younger children.

Another sound which could be used to examine children's consistency in representing base and derived words is the glottal stop (/ʔ/) that is used in some varieties of British English to pronounce intervocalic *t* (e.g., *bottle* /bɒʔl/, *later* /leɪʔə/). When this *t* occurs at the end of the base forms of such derived words, it is usually pronounced as it is written, with /t/[4] (e.g, *late*, /leɪt/). Thus, if children are able to identify and make use of the base forms of derived words to help their spelling, then they should spell /ʔ/ correctly with *t* or *tt* significantly more often for derived words such as *later* (by thinking of its base word *late*) than for non-derived words such as *water* (which has no base form). A limitation to using the glottal stop is that it is not an ambiguous sound (unlike /ɾ/, which can be written with *t* or *d*; or /z/, which can be written with *s* or *z*). Children might just learn that the sound /ʔ/ should always be written with *t/tt*, and therefore not have to rely on base words at all. Nevertheless, it could take some time to learn this, and so young children might be expected to use *t* more often for derived words, and to omit any representation of a medial consonant more often for non-derived words.

A more fruitful line of research might be to examine children's consistency in representing the final letter of base words when their derived forms end in /ʃən/. This ending can be represented with several spellings, including *-tion*, *-(s)sion*, and *-cian*. The correct spelling of the /ʃ/ sound is often determined by the final letter of the derived word's base form. For example, *decoration* is derived from *decorate*, *expression* from *express*, and *magician* from *magic*. There also exist a number of non-derived words with similar endings, which have no base word to determine the spelling of /ʃ/, such as *caution*, *lotion*, and *session*[5]. If children are able to recognise and capitalise on the links of meaning between base and derived words to help their spelling, then they should use the correct spelling of /ʃ/ significantly more often when writing derived than non-derived words. (In such an experiment, the children's knowledge and spelling of the base words should also be checked.)

Of course, since most of these types of words are relatively infrequent and their relationship with their base forms relatively complex, such an experiment might prove unsuitable for children in the first few years of school. It would therefore be of limited use in answering the question of whether beginning writers recognise and represent the relations between base and derived words. However, the nature of the experimental words means that children would be scored on the basis of the number of correct representations of a particular sound, rather than on the number of correct representations of the entire base segment of the stem. This experiment would pick up indications of the consistent representation of /ʃ/ from well before the children were able to spell the whole words correctly. Thus, it would help to

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[4] Some speakers may also pronounce *late* with a final glottal stop rather than a /t/, e.g., /leɪʔ/.
[5] Most, if not all, such words are ultimately derived from Greek or Latin roots, but all children and most adults would probably have no knowledge of these roots, and would just have to learn how to spell the final part of these words by rote.

determine the earliest age at which children recognise and represent relatively complex relationships between base and derived words.

If the correct spelling of a base word *is* known to most young children, then the ability to spell this whole section correctly in the word's derived form can be the criterion for a "correct" score. One method of assessing young children's understanding of simpler base-derived relationships would be to test their spelling of derived words whose base forms are familiar, but which have a distinctive irregular spelling. For example, children who know how to spell the relatively common but irregular word *talk* could be asked to spell a related word which they have heard, but do not know how to spell, such as *talkative*. If they are aware of the link of meaning between the two words and the need to preserve this in writing, their spelling should reflect this, and the first part of the derived word should be spelled as *talk*, even if there are mistakes in the second part. If children are not aware of the link or the need to represent it, they should write the word as it sounds (e.g., *torkativ*).

11.6.3. Tests of morphological awareness

It is clear that morphological awareness has an important role to play in children's acquisition of the ability to represent morphological relations in their writing. Although the cross-sectional nature of the studies in this thesis precludes any conclusions about the direction of this relationship, previous research suggests that facilitation may flow in both directions. As discussed in section 1.4., good morphological awareness may enhance children's ability to read and spell morphological spelling patterns, but also, increasing ability to read and write these patterns facilitates the development of morphological awareness.

One way to investigate the relationship between morphological awareness and the ability to represent morphology in spelling is with longitudinal research. Children's performance on oral tasks of morphological awareness should be assessed before the beginning of formal literacy instruction, and then periodically during the primary school years, in conjunction with tests of their ability to spell various morphological spelling patterns. Nunes et al. (1997a) performed such a longitudinal study focusing on the *-ed* inflection, but it would be valuable to assess the development of a number of different patterns, both inflectional and derivational.

More valuable still, although also more costly in terms of time and resources, would be a longitudinal study that included training in morphological awareness. As discussed in section 11.4., Nunes et al. (2000) have conducted such a longitudinal intervention study with children in school years 3 and 4, looking at the effects of training in phonological, as well as morphological, awareness. Future research should aim to explore the interrelations between phonological and morphological awareness in more detail, and should examine the effects of training on even younger children as well.

Finally, new ways of testing various aspects of morphological awareness should be developed. As discussed in section 11.3., researchers should think about the explicitness of awareness that their tasks require for success. Those which require a moderately explicit level of morphological awareness for success seem to be the most useful for predicting spelling and reading ability. The Sentence Analogy task developed by Nunes et al. (1997a), which requires children to transform various verb tenses seems to be a particularly good predictor of children's ability to represent correctly the past regular verb inflection *-ed.* The attempts in this thesis to develop different versions of the Sentence Analogy (and the Word Analogy) task met with some success in predicting the spelling of another morphological pattern; the base section of derived words. Future experiments should look more closely at the specificity and/or generality of such predictive relationships. Does children's morphological awareness of verbs, for example, predict only their ability to represent verbal inflections correctly? Or can it predict just as accurately their ability to represent all inflectional endings, or even all morphological spelling patterns in general? Future studies should attempt to answer some of these questions. Their answers could have implications for the most efficient ways of teaching children about spelling and grammar.

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Appendix 1

Sentence contexts for experimental words; Experiment 1

<u>Verbs ending in /t/; stems ending in *-e*</u>

Hoped. I *hoped* it would be a nice day. *Hoped.*

Smoked. Grandpa *smoked* a pipe. *Smoked.*

Taped. We *taped* ourselves singing. *Taped.*

Chased. I *chased* my brother down the street. *Chased.*

Baked. He *baked* a big chocolate cake. *Baked.*

Wiped. Mum *wiped* the table with a sponge. *Wiped.*

Poked. Ow! He *poked* me in the stomach! *Poked.*

Creased. She didn't iron her dress and it's all *creased.* *Creased.*

<u>Verbs ending in /t/; stems not ending in *-e*</u>

Hopped. The bird *hopped* around the garden. *Hopped.*

Tricked. Ha ha, I *tricked* you! *Tricked.*

Tapped. He *tapped* softly on the door. *Tapped.*

Fussed. Everybody called her a fusspot because she *fussed* all the time. *Fussed.*

Licked. I *licked* my ice cream cone. *Licked.*

Whipped. I *whipped* the cream for the cake. *Whipped.*

Pecked. The chicken *pecked* at the seeds. *Pecked.*

Crossed. We *crossed* the road at the traffic lights. *Crossed.*

<u>Verbs ending in /d/; stems ending in *-e*</u>

Lined. The children *lined* up to wait for the bus. *Lined.*

Ruled. Look, I *ruled* a nice straight line. *Ruled.*

Blamed. My sister *blamed* me for the accident. *Blamed.*

Phoned. Mum *phoned* her friend for a chat. *Phoned.*

Stared. He *stared* out the window at the rain. *Stared.*

Tamed. The brave man *tamed* a lion. *Tamed.*

Sneezed. Aaaa-choo! The girl *sneezed.* *Sneezed.*

Snored. Dad *snored* when he fell asleep in the chair. *Snored.*

<u>Verbs ending in /d/; stems not ending in *-e*</u>

Grinned. The happy boy *grinned* from ear to ear. *Grinned.*

Rolled. Mum *rolled* out the pastry for the pie. *Rolled.*

Warmed. The soup was cold, so Mum *warmed* it up again. *Warmed.*

Fanned. It was very hot, so I *fanned* myself. *Fanned.*

Stirred. I *stirred* the pot on the stove. *Stirred.*

Slammed. The naughty boy *slammed* the door. *Slammed.*

Buzzed. The bees *buzzed* among the flowers. *Buzzed.*

Purred. The kitten *purred* in my lap. *Purred.*

Appendix 2

Sentence contexts for experimental words; Experiment 2

Sentences for <u>verbs</u> the same as in Experiment 1 (see Appendix 1).

<u>Non-verbs ending in /t/</u>

Egypt. They built the Pyramids in ancient *Egypt*. *Egypt*.
Contact. Mum lost her *contact* lens. *Contact*.
Pest. My little brother can sometimes be a *pest*. *Pest*.
Chest. The gold was hidden in the treasure *chest*. *Chest*.
Fact. Tell me a *fact* about yourself. *Fact*.
Craft. My mother sewed a cushion for the *craft* show. *Craft*.
Perfect. It's a *perfect* day for a picnic. *Perfect*.
Crust. You should eat the *crust* of your bread. *Crust*.
Except. Everyone went by bus *except* me. *Except*.
Strict. The new teacher is very *strict*. *Strict*.
Quest. The brave knight went on a *quest*. *Quest*.
Vest. Mum says I have to wear my *vest* when it's cold. *Vest*.
Insect. A beetle is a type of *insect*. *Insect*.
Raft. We sailed on a *raft* made of pieces of wood. *Raft*.
Correct. He got the answer *correct*. *Correct*.
Frost. In winter there is *frost* on the grass. *Frost*.

<u>Non-verbs ending in /d/</u>

Blind. He has a guide dog because he is *blind*. *Blind*.
Shield. They used to fight with a sword and *shield*. *Shield*.
Grand. Their house is very *grand*. *Grand*.
Friend. That girl is my best *friend*. *Friend*.
Guard. They have a dog to *guard* their house. *Guard*.
Pound. This only costs one *pound*. *Pound*.
Weird. A *weird* thing happened to me this morning. *Weird*.
Sword. The prince fought with a *sword*. *Sword*.
Ground. I fell over on the *ground*. *Ground*.
Bald. My grandfather has a *bald* head. *Bald*.
Wand. The fairy waved her magic *wand*. *Wand*.
Brand. What *brand* of jam does your mother buy? *Brand*.
Third. I came *third* in the race. *Third*.
Fond. I am very *fond* of my cat. *Fond*.
Beard. He has a big black *beard*. *Beard*.
Curd. Little Miss Muffett had curds and whey… can you spell *curd*? *Curd*.

Appendix 3

Sentence contexts for experimental words; Experiment 3

Plurals

Jars. I have three *jars* of jam. *Jars*.

Pains. Poor George has *pains* in his tummy. *Pains*.

Fleas. This poor little dog has got *fleas*. *Fleas*.

Flies. Look at all the *flies* on the window. *Flies*.

Non-plurals

Jazz. I like listening to *jazz* music. *Jazz*.

Buzz. The bees in the flowers say "*buzz, buzz*". *Buzz*.

Squeeze. You can *squeeze* an orange to get orange juice. *Squeeze*.

Prize. I won first *prize* in a race. *Prize*.

Appendix 4

Sentence contexts for experimental words; Experiment 4

Words with initial /z/

Zig-zag. I drew a *zig-zag* pattern. *Zig-zag*.

Zip. I did up the *zip* on my coat. *Zip*.

Zebra. We saw a *zebra* at the wildlife park. *Zebra*.

Zero. Three-two-one-*zero*! *Zero*.

Words with medial /z/

Words spelled with *s*

Busy. I am very *busy* at the moment. *Busy*.

Museum. We saw a dinosaur skeleton at the *museum*. *Museum*.

Words spelled with *z/zz*

Dizzy. If you spin round and round you will feel *dizzy*. *Dizzy*.

Lizard. A *lizard* has scales like a snake. *Lizard*.

Words with final /z/

Words spelled with *s* (plurals)

Bibs. Babies wear *bibs* to keep them clean. *Bibs*.

Fibs. The naughty boy told *fibs* to his mother. *Fibs*.

Words spelled with *z/zz* (non-plurals)

Fizz. The can of drink went *fizz* when I opened it. *Fizz*.

Quiz. He answered all the questions on the *quiz* show. *Quiz*.

Appendix 5

Sentence contexts for experimental words; Experiment 5

Words with medial /z/

Words spelled with *s*

Daisy. The farmer has a cow called *Daisy*. *Daisy*.

Cousin. That girl is my *cousin*. *Cousin*.

Prison. The robber got sent to *prison*. *Prison*.

Poison. The wicked witch made some *poison*. *Poison*.

Pleasant. The weather is very *pleasant* today. *Pleasant*.

Raisin. Would you like to eat a *raisin*? *Raisin*.

Words spelled with *z/zz*

Crazy. Some people are a bit *crazy*. *Crazy*.

Dozen. Mum said to buy a *dozen* eggs. *Dozen*.

Dizzy. If you spin round and round you will feel *dizzy*. *Dizzy*.

Razor. Dad shaves with a *razor*. *Razor*.

Bulldozer. They dug up the road with a big *bulldozer*. *Bulldozer*.

Wizard. The *wizard* cast a spell. *Wizard*.

Words with final /z/

Words spelled with *s* (PC plurals)

Queens. All the kings and all the *queens* went to the ball. *Queens*.

Jewels. The crown was covered with precious *jewels*. *Jewels*.

Fibs. You shouldn't tell *fibs* to anyone. *Fibs*.

Fins. Fish have got *fins* to help them swim. *Fins*.

Buns. We eat hot cross *buns* at Easter. *Buns*.

Wigs. Those ladies are wearing *wigs* on their heads. *Wigs*.

Words spelled with *s* (P- plurals)

Queues. Look at the *queues* of people waiting for the bus. *Queues*.

Jaws. Dogs have strong *jaws* to help them chew. *Jaws*.

Fleas. That poor little dog has got *fleas*. *Fleas*.

Fees. At some schools you have to pay very high *fees*. *Fees*.

Drawers. He looked for it in all his desk *drawers*. *Drawers*.

Wares. The tinker is selling his *wares* in the village. *Wares*.

Words spelled with *z/zz* (non-plurals)

Quiz. He answered all the questions on the *quiz* show. *Quiz*.

Jazz. I like listening to *jazz* music. *Jazz*.

Fizz. When you open a can of lemonade, it goes "*fizz*". *Fizz*.

Fuzz. Mum picked a bit of *fuzz* off my jumper. *Fuzz*.

Buzz. The bees in the flowers go "*buzz, buzz*". *Buzz*.

Whizz. The boy said "gee *whizz*!" *Whizz*.

Appendix 6

Sentence contexts for experimental pseudowords; Experiments 6 and 7

(The spellings shown are mostly arbitrary representations of the pronunciations given to the pseudowords, which are transcribed phonetically at the end of each sentence.)

Session 1

Pseudowords with medial /z/

(Pseudowords shown written with *z*, but could just as acceptably be written with *s*.)

Bizer. A *bizer* is a kind of dog that likes to dig holes. *Bizer*. /baɪzə/

Vozer. If our washing machine breaks down, Mum will call the *vozer*. *Vozer*. /vəʊzə/

Aizer. We hung our clothes carefully over the *aizer*. *Aizer*. /eɪzə/

Moozy. He was feeling very *moozy* last night. *Moozy*. /muzi/

Glizy. Watch out for that floor; it's all *glizy*. *Glizy*. /glaɪzi/

Parzy. We polished it til it was all *parzy* and nice. *Parzy*. /pɑzi/

Nizen. Look! The *nizen* has arrived already! *Nizen*. /naɪzən/

Berzen. Would you like some *berzen* on your potatoes? *Berzen*. /bɜzən/

Guzon. Mum made a *guzon* pie for tea last night. *Guzon*. /guzon/

Fozol. Dad just bought a new *fozol* to put in the car. *Fozol*. /fəʊzol/

Hizing. We spent all afternoon *hizing* in the garden. *Hizing*. /haɪzɪŋ/

Jozing. My little sister is *jozing* in her bath. *Jozing*. /ʤəʊzɪŋ/

Pseudowords with final /z/

Pseudowords to be spelled with final *s* (PC plurals)

Pleens. Mum bought me a nice new pair of *pleens*. *Pleens*. /plinz/

Stogs. There are quite a few *stogs* in that puddle. *Stogs*. /stɒgz/

Vills. We're going to buy three little *vills* at the shop. *Vills*. /vɪlz/

Chabs. We swept many *chabs* out of the kitchen. *Chabs*. /ʧæbz/

Podes. Put the *podes* away when you've finished with them. *Podes*. /pəʊdz/

Fooms. There are pink and yellow *fooms* for sale. *Fooms*. /fumz/

Pseudowords to be spelled with final *z/zz* (P- non-plurals: 3 singular nouns and 3 verb stems/infinitives)

Prizz. I want to put some *prizz* in my drink. *Prizz*. /prɪz/

Flazz. You have to *flazz* the concrete to make it clean. *Flazz*. /flæz/

Tezz. Dad wants to *tezz* on our roof. *Tezz*. /tɛz/

Shuzz. The teacher said we have to *shuzz* our books. *Shuzz*. /ʃʌz/

Gizz. Careful you don't get bitten by a *gizz*! *Gizz*. /gɪz/

Mozz. My brother wants a *mozz* for his birthday. *Mozz*. /mɒz/

(As explained in section 6.2.2.1., P- pseudowords: Half the participants heard the hard pseudowords presented in the sentence contexts given here, and half heard them "the other way around". For example, the second half of the participants heard /priz/ presented as a non-plural ("That man keeps a big *preeze* in his cupboard"), /drəʊz/ as a plural ("I cleaned all the little *droes* with a special brush"), and so on.)

<u>Pseudowords to be spelled with final *s* (P- plurals)</u>
Prees. I cleaned all the little *prees* with a special brush. *Prees*. /priz/
Grues. There are some baby *grues* in the pond. *Grues*. /gruz/
Vaws. My uncle bought three big *vaws* at the shop. *Vaws*. /vɔz/
Thays. There are too many *thays* in this sandwich. *Thays*. /θeɪz/
Coes. All the *coes* in our garden are green. *Coes*. /kəʊz/
Pars. How many *pars* can you see up there? /pɒz/

<u>Pseudowords to be spelled with final *ze/se* (P- non-plurals: 3 singular nouns and 3 verb stems/infinitives)</u>
Droze. That man keeps a big *droze* in his cupboard. *Droze*. /drəʊz/
Blize. He stuck a piece of *blize* on the box. *Blize*. /blaɪz/
Terze. She put a pretty *terze* on the table. *Terze*. /tɜz/
Fooze. We are not allowed to *fooze* in here. *Fooze*. /fuz/
Kaze. Let's go and *kaze* the apples for Mum. *Kaze*. /keɪz/
Moize. Our cat likes to *moize* at the birds. *Moize*. /mɔɪz/

Session 2

Pseudowords and sentences given to participants in the second testing session, for them to complete with the missing form of the P- pseudoword (which they then attempted to spell). The pseudowords shown in the text are those presented to the children who had written the words in the form shown above, in the first session. The pseudowords shown in parentheses are those presented to the other half of the children, who had written the words in the "opposite" form in the first session. Answers are shown in brackets.

That man is called the *preezer* (*blizer*). He's the one who has to... [*preeze/blize*].
Those boys are *gruzing* (*foozing*) outside, even though they're not allowed to. They're not allowed to... [*gruze/fooze*].
Our cat *vawzed* (*moized*) at the birds last night. She really likes to... [*vawze/moize*] at them.
Look, they are *thazing* (*kazing*) the apples. They have to... [*thaze/kaze*] them every day.
Dad has a machine called a *cozer* (*drozer*). He uses it to... [*coze/droze*].
My friend *parzes* (*terzes*) his pencils every day. I want to... [*parze/terze*] my pencils too.
We have one green *droe* (*coe*) in our garden, but our neighbours have lots of green ... [*droes/coes*].
I cleaned one *bly* (*pree*), but my friend cleaned lots of them. He cleaned lots of... [*blies/prees*].
I can see a *terr* (*par*) up there. Now I see another one. I see two... [*terrs/pars*].

I saw one *foo* (*grue*) in the pond, but my sister saw two. She saw two... [*foos/grues*].
I only had one *kay* (*thay*) for breakfast. I don't like eating too many... [*kays/thays*].
My uncle bought a *moy* (*vaw*) from the shop, but I bought three of them. I bought three... [*moys/vaws*].

Appendix 7

Sentence contexts for experimental words; Experiment 8

Base words

Words spelled with *se*

Noise. What was that loud *noise*? *Noise*.
Chose. She *chose* the yellow balloon. *Chose*.
Rose. He bought his wife a red *rose*. *Rose*.

Words spelled with *zz/ze*

Fizz. The can of drink went "*fizz*" when I opened it. *Fizz*.
Froze. We *froze* water to make ice-blocks. *Froze*.
Breeze. There is a cold *breeze* blowing. *Breeze*.

Derived words

Words spelled with *s*

Noisy. The children next door are very *noisy*. *Noisy*.
Chosen. Have you *chosen* a book to read yet? *Chosen*.
Rosy. The children's cheeks were all pink and *rosy*. *Rosy*.

Words spelled with *z/zz*

Fizzy. Lemonade is *fizzy*. *Fizzy*.
Frozen. In winter the pond sometimes gets *frozen*. *Frozen*.
Breezy. It's a windy and *breezy* day today! *Breezy*.

Control words

Words spelled with *s*

Busy. My mother is very *busy* today. *Busy*.
Cousin. That girl is my *cousin*. *Cousin*.
Easy. It's *easy* to wiggle your fingers. *Easy*.

Words spelled with *z/zz*

Dizzy. If you spin round and round you will get *dizzy*. *Dizzy*.
Dozen. I have to buy a *dozen* eggs. *Dozen*.
Crazy. That man is absolutely *crazy*! *Crazy*.

Appendix 8

Sentence contexts for experimental words; Experiment 9

Base words

Words spelled with *se*

Nose. These are my eyes, and this is my *nose*. *Nose*.

Rose. He bought his wife a red *rose*. *Rose*.

Noise. Did you hear that *noise* outside? *Noise*.

Lose. Be careful not to *lose* your ticket. *Lose*.

Wise. I don't think it's *wise* to stay any longer. *Wise*.

Chose. I *chose* the blue shoes, not the red ones. *Chose*.

Words spelled with *zz/ze*

Breeze. A cool *breeze* is nice on a hot day. *Breeze*.

Freeze. You'll *freeze* if you don't wear your coat and hat! *Freeze*.

Sneeze. When you have a cold, you *sneeze* and cough. *Sneeze*.

Buzz. The bees in the flowers go "*Buzz, buzz*". *Buzz*.

Froze. When it was cold, the pond *froze* over. *Froze*.

Fizz. When I opened my can of drink it went "*fizz*". *Fizz*.

Derived words

Words spelled with *s*

Nosy. My new neighbour is very *nosy*. *Nosy*.

Rosy. In winter the children's cheeks are red and *rosy*. *Rosy*.

Noisy. That big digger in the road is very *noisy*. *Noisy*.

Loser. The winner got a prize, but the *loser* didn't. *Loser*.

Wisest. They say the old owl is the *wisest* bird. *Wisest*.

Chosen. I have *chosen* my favourite one. *Chosen*.

Words spelled with *z/zz*

Breezy. If it's windy outside, you can say it's *breezy*. *Breezy*.

Freezer. I put the ice-lollies in the *freezer*. *Freezer*.

Sneezy. One of Snow White's seven dwarves is called *Sneezy*. *Sneezy*.

Buzzer. I pressed the *buzzer* on the door. *Buzzer*.

Frozen. We bought a *frozen* pizza at the supermarket. *Frozen*.

Fizzy. Sometimes I'm allowed to have *fizzy* drinks. *Fizzy*.

Control words

Words spelled with *s*

Daisy. The farmer has a cow called *Daisy*. *Daisy*.

Easy. Some words are *easy* to spell. *Easy*.

Busy. My mother is always *busy*. *Busy*.

Poison. The wicked witch made some *poison*. *Poison*.

Pleasant. The weather is *pleasant* in summer. *Pleasant*.

Raisin. Would you like to eat a *raisin*? *Raisin*.

Words spelled with z/zz

Crazy. Some people are a little bit *crazy*. *Crazy*.

Bulldozer. We watched the *bulldozer* digging in our street. *Bulldozer*.

Wizard. The *wizard* wore a magic cloak. *Wizard*.

Razor. Dad shaves with a *razor* every morning. *Razor*.

Dozen. Mum said to buy a *dozen* eggs. *Dozen*.

Dizzy. If you spin round and round you'll feel *dizzy*. *Dizzy*.

Appendix 9

Sentence contexts for experimental pseudowords; Experiment 10

The text shows the written material provided on each participant's worksheet[1]. The children filled in the blank line with the missing form of the pseudoword, which was pronounced aloud (as indicated at the end of each sentence, in both normal and phonetic notation). The sentence contexts below constitute version 1a. As described in section 10.2.1, the pseudowords were counterbalanced to create lists 1b, 1a and 2a, as well.

"Base provided" sentences

Mum's going to buy a *mease* for tea. I love __________! (*meases* /mizɪz/)

I don't know whether to buy one *pluse*, or two ________________. (*pluses* /pluzɪz/)

I put my new *ploze* with all my other _________________. (*plozes* /pləuzɪz/)

There's a big *coize* upstairs, and lots of little _______ downstairs. (*coizes* /kɔɪzɪz/)

He's going to *jaise* his house today. He _________ it yesterday, too. (*jaised* /ʤeɪzd/)

Don't let the rain *drease* you. It's no fun at all to get ___________. (*dreased* /drizd/)

I don't want to *oze* any more. I _________ all day yesterday. (*ozed* /əuzd/)

She's being careful to *wuze* the cake tray. She has to make sure it's properly______. (*wuzed* /wuzd/)

She put a *kaise* on top of each cake. They're _________ cakes. (*kaisy* /keɪzi/)

Watch where you put that *glise*. You don't want to get the table all _______. (*glisy* /glaɪzi/)

I think I'm getting sick with a *boze*. I feel all ____________. (*bozy* /bəuzi/)

It tastes much better if you add a *fruze*. It makes it all warm and ___________. (*fruzy* /fruzi/)

I'm going to *taise* the plants with the special plant-___________. (*taiser* /teɪzə/

You can be the one to *hise* in this game. You can be the ______________! (*hiser* /haɪzə/)

He needs to *moize* his car. He's going to polish it with his ______________. (*moizer* /mɔɪzə/)

My dog is learning to *woze* in the garden. He's getting to be a good ______! (*wozer* /wəuzə/)

[1] The children's version of this material was printed in larger type and was more spaced-out, and the clue pseudowords were not italicised.

"Copy word" sentences

If you help Mum pick the *zoses*, you can keep three ________ yourself. (*zoses* /zəʊzɪz/)

Don't pick up the small *oises*, pick up all the big ____________! (*oises* /ɔɪzɪz/)

I've always liked eating *fizes*. I've liked eating ________ all my life. (*fizes* /faɪzɪz/)

The best *reases* you can get are the ______________ that that man makes. (*reases* /rizɪz/)

Dad and I *chised* chickens today. We ___________ four in one hour! (*chised* /tʃaɪzd/)

That's the one that Stuart *steesed*, and that's the one that I __________. (*steesed* /stizd/)

We bazed in lots of shops this morning, but we ________ in the supermarket the longest. (*bazed* /beɪzd/)

I wish you'd *neased* yours as well as Jane ___________ hers! (*neased* /nizd/)

I wished I looked as *thaisy* as Jenny. She looks ________ every day. (*thaisy* /θeɪzi/)

I felt rather *toozy* yesterday, and now I feel ___________ again today. (*toozy* /tuzi/)

Would you rather eat *tazy* pie, or some ___________ stew for dinner? (*tazy* /teɪzi/)

My poor cat is feeling *moozy*. She feels _____ when she can't catch a mouse. (*moozy* /muzi/)

Jack is the best *beaser* in our class. I want to be a good _________ too! (*beaser* /bizə/)

That man's the *cluser* for my school, and that man's the ________ for my brother's school. (*cluser* /kluzə/)

I like my yellow *pazer*, but I wish I could get a green _________ too. (*pazer* /peɪzə/)

You wear my old *bleezer* if you like, but this _______ is more comfortable. (*bleezer* /blizə/)

"Pseudoclue" sentences

Our *noses* are hurting because of all the ____________ in the air. (*bises* /baɪzɪz/)

Dad always *dozes* after lunch when we've had a big meal of ________. (*jises* /dʒaɪzɪz/)

There are *roses* growing near the tree with all the _________ on it. (*doizes* /dɔɪzɪz/)

What *sizes* do these lovely green ___________ come in? (*foozes* /fuzɪz/)

Mum is very *pleased* with me. I __________ the table really well. (*mosed* /məʊzd/)

Everyone was *amazed* that I had ___________ my book so neatly. (*trused* /truzd/)

I *closed* all the cupboards, and Susie ___________ all the desks. (*preazed* /prizd/)

He *sneezed* so loudly that the cat __________ out of the room. (*fozed* /fəʊzd/)

I'm very *busy* today. I haven't got time to make the house look _______. (*naisy* /neɪzi/)

It's rather *breezy* outside today. We're going to have some ________ weather. (*foisy* /fɔɪzi/)

It's *easy* to make this type of cake if you cook it in a ______ pan. (*nizy* /naɪzi/)

He's so *lazy* that he stayed in bed, even though it was so nice and __________ outside. (*wozey* /wəʊzi/)

In the game we played today, the *loser* was called the ____________. (*keaser* /kizə/)

I pressed the *buzzer* on the door, and the ________ came and opened it for me. (*aiser* /eɪzə/)

He fired his *laser*-gun and pulled his _____________ from its special bag. (*vozer* /vəʊzə/)

He drives a *bulldozer*. His friend drives a _____________. (*draizer* /dreɪzə/)