Electrician not electrishion? Implicit and explicit knowledge of word stem and affix morphemes for children's spelling



Lauren Burton

New College

University of Oxford

Thesis submitted to the University of Oxford for the degree of Doctor of Philosophy

Hilary Term 2019

Acknowledgements

Undertaking a DPhil at the University of Oxford has been an inspiring and enriching experience, and it would not have been possible without the overwhelming support and guidance that I have received during the process.

From an academic perspective, I would like to thank my DPhil supervisor, Professor Terezinha Nunes. I have been truly inspired by your research knowledge and expertise in the field of morphology and spelling, and I am especially grateful to you for your support in my growth and development as an academic researcher. I am also thankful for the assistance, feedback, and advice of my co-supervisor, Dr Maria Evangelou. Your precision and strong attention to detail have been invaluable.

A special thanks is also necessary to New College for providing a vibrant, welcoming, and stimulating postgraduate research environment. Serving as President of the graduate community at New College was an honour, and I intend to retain my friendships and connections with the college for many years to come. I would also like to thank Christ Church for enhancing my final years of study through the role of Junior Dean, and for the uplifting experience of singing amongst friends and colleagues in the college choir.

Appreciation is also due to the Economic and Social Research Council (ESRC) for the scholarship that I received to support my research endeavours. I would also like to acknowledge the children and Head Teachers at Park Gate Primary School, Sarisbury Junior School, and St. Nicholas' Primary School. Your enthusiastic participation enabled my research proposal to become a reality.

I would like to express my warmest gratitude to my parents for their never-ending guidance and unwavering support of my higher degree studies. Without you, this DPhil would not have been possible. I also owe special thanks to my sister, Alana, for her invaluable advice and encouragement during each stage of this process, and, perhaps, most importantly, for always believing in me. I am also thankful to Casper, not only for his continuous support, but crucially for his endless time and dedication during the write-up of my thesis. Each of you have formed a fundamental part of this process, and for that, I am immensely grateful.

Abstract

This study investigated the extent to which implicit and explicit knowledge of morphology contribute to children's spelling in English. Children acquire some understanding of morphemes for spelling through their everyday encounters with words, but this could be enhanced to a more explicit level through direct instruction. Intervention studies have reported the advantage of teaching children about morphemes for spelling, but the vast majority of this research has been restricted to affixes, with limited attention to teaching word stems or combining instruction of stems and affixes together. In response, the current study compares a child's knowledge of morphemes with implicit or explicit instruction of two related morphological spelling rules: the conservation of word stems in derived words and the distinction between the affixes of *-ion* and *-ian*.

A sample of 270 children in Years 3 and 4 from three state-supported schools participated. Three experiments were conducted: one examined implicit versus explicit teaching of the morphological rule for stems; a second investigated if explicit teaching of one morphological principle (e.g. word stems) leads to explicit knowledge of another (e.g. affixes); and a third combined instruction of stems and affixes together. A pre-test, immediate post-test, and delayed post-test design was employed for each experiment in which children were randomly assigned to one of two intervention groups or a control condition that did not receive any form of instruction. In the pre- and post-tests, the children's spelling of stems and affixes in derivatives was assessed. The interventions involved training games in which the children spelled derived words after seeing the stem forms; the explicit groups discussed the connection between the spellings whereas the implicit and control conditions did not.

Analyses of variance revealed that explicit teaching of word stems and affixes led to more significant spelling improvements than implicit or no teaching, and that this effect held at both immediate and delayed post-test. Combining instruction of stems and affixes within the same teaching session was also reported to noticeably aid a child's spelling accuracy. It was concluded that explicit teaching combined with appropriate spelling games shows a sustained effect on children's spelling. The evidence supports the integration of morphemes into current educational policy and teaching practice.

Table of Contents

Acknowledgements **1**

Abstract **2**

List of Figures **8**

List of Tables **14**

Chapter 1: Introduction **15**

1.1 The role of morphology for spelling in the English orthography 16
1.2 Do children use morphemes when they process English spellings? 18
1.2.1 Word-specific knowledge 18
1.2.2 Morphological segmentation 19
1.2.3 Combination of word-specific and morphological approaches 20
1.3 Do children acquire knowledge of morphology through their encounters with words? 20
1.3.1 Implicit knowledge 21
1.3.2 Explicit knowledge 1 22
1.3.3 Explicit knowledge 2 22
1.3.4 Explicit knowledge 3 23
1.4 Are word stem and affix morphemes teachable? 24
1.4.1 Teaching word stems may enhance children's spelling 24
1.4.2 Explicit teaching of one morpheme may lead to explicit knowledge of another 27
1.4.3 Explicit teaching of word stem and affix morphemes together 27
1.5 How are morphemes taught in the classroom? 28
1.6 Research programme 29
1.7 Organisation of the thesis 30

Chapter 2: Literature Review **32**

2.1 What knowledge do children have of morphemes? 32
2.1.1 Do children show an understanding of morphemes in oral language? 33
2.1.2 Do children show an understanding of morphemes in spelling? 35
2.1.2.1 In spelling: inflections 35
2.1.2.2 In spelling: derivations 37
2.1.3 Do children show an understanding of morphemes in reading? 41
2.1.4 Do children show an understanding of morphemes in priming studies? 43
2.2 Does morphological awareness predict a child's ability to use morphemes effectively in reading and spelling? 47
2.3 What happens if children are taught about morphemes? 52
2.3.1 Do children need explicit teaching of morphemes to acquire explicit knowledge? 58
2.3.2 Do children benefit from being explicitly taught about word stem and affix morphemes together? 59
2.4 Conclusions 62

Chapter 3: Methodology and Results for Experiment 1 – Implicit and explicit teaching of word stem morphemes for spelling **65**

3.1 Background 65
3.1.1 Word stem morphemes 65
3.1.2 Children's knowledge of word stems 65
3.1.3 Teaching children about word stems for spelling 67
3.1.4 Experiment 1 68
3.2 Method 69
3.2.1 Participants 69
3.2.2 Design 70
3.2.3 Measures 71
3.2.3.1 Pre-test and post-test assessments 71
3.2.3.2 Morphological interventions 73
3.2.3.2.1 Teaching session 73
3.2.3.2.2 Training game 75

3.3 Results 78
3.3.1 Criterion results 78
3.3.2 Intervention results 78
3.3.2.1 Pre-test scores 79
3.3.2.2 Intervention effects for word and pseudo-word stem ending spelling 79
3.3.3 Change in stem ending spellings over time 83
3.4 Discussion 88

Chapter 4: Methodology and Results for Experiment 2 – Explicit teaching of one aspect of morphology may lead to explicit knowledge of another 91

4.1 Background 91
4.1.1 Explicit teaching of word stems 91
4.1.2 Explicit teaching of affixes 91
4.1.3 Explicit teaching of one morphological principle may lead to explicit knowledge of other, related rules 92
4.1.4 Experiment 2 93
4.2 Method 94
4.2.1 Participants 94
4.2.2 Design 95
4.2.3 Measures 95
4.2.3.1 Pre-test and post-test assessments 95
4.2.3.2 Morphological interventions 96
4.2.3.2.1 Teaching session 97
4.2.3.2.2 Training game 98
4.3 Results 99
4.3.1 Criterion results 99
4.3.2 Intervention results 99
4.3.2.1 Pre-test scores 101
4.3.2.2 Intervention effects for word and pseudo-word stem ending spelling 101
4.3.2.3 Intervention effects for word and pseudo-word suffix spelling 105
4.3.2.4 Summary of the intervention effects for Experiment 2 108
4.3.3 Change in stem ending spellings over time 109
4.3.4 Change in suffix spellings over time 113

4.4 Discussion 117

Chapter 5: Methodology and Results for Experiment 3 – Explicit teaching of word stem and affix morphemes together 120

5.1 Background 120
5.1.1 Explicit teaching of word stems and affixes 120
5.1.2 Simultaneous or sequential instruction of word stems and affixes 120
5.1.3 Experiment 3 122
5.2 Method 122
5.2.1 Participants 122
5.2.2 Design 123
5.2.3 Measures 124
5.2.3.1 Pre-test and post-test assessments 124
5.2.3.2 Morphological interventions 124
5.2.3.2.1 Teaching session 125
5.2.3.2.2 Training game 127
5.3 Results 127
5.3.1 Criterion results 127
5.3.2 Intervention results 128
5.3.2.1 Pre-test scores 129
5.3.2.2 Intervention effects for word and pseudo-word stem ending spelling 129
5.3.2.3 Intervention effects for word and pseudo-word suffix spelling 133
5.3.2.4 Effect size comparisons between the stem and suffix teaching from Experiment 2 and the combined teaching from Experiment 3 137
5.3.2.4.1 Effect size comparisons for stem ending spelling 137
5.3.2.4.2 Effect size comparisons for suffix spelling 138
5.3.2.5 Summary of the intervention effects and effect size comparisons for Experiment 3 139
5.3.3 Change in stem ending spellings over time 141
5.3.4 Change in suffix spellings over time 144
5.4 Discussion 147

Chapter 6: Discussions and Conclusions **151**

6.1 Contributions of the current study 151
6.1.1 Theoretical Contributions 152
6.1.2 Contributions of Experiment 1 153
6.1.3 Contributions of Experiment 2 157
6.1.4 Contributions of Experiment 3 159
6.2 Methodological contributions 163
6.3 Limitations of the study 165
6.4 Suggestions for future research 167
6.5 Educational implications 169
6.6 Conclusions 171

References **172**

Appendices **182**

List of Figures

Figure 3.1	Example of the first part of an answer sheet for the pre-test and post-test for words	71
Figure 3.2	Example of the first part of an answer sheet for the pre-test and post-test for pseudo-words	72
Figure 3.3	Example of the Power Point slides for one of the word stem and derivative pairs administered in the explicit and implicit teaching sessions	75
Figure 3.4	Example of two trials from the Matlab training game	77
Figure 3.5	Means for the children's word stem ending spellings in derivatives for each intervention group at pre-test, immediate post-test, and delayed post-test. Error bars represent standard errors of the means	81
Figure 3.6	Means and standard errors for the children's stem ending spellings in pseudo-word derivatives for each experimental condition at the three testing occasions	82
Figure 3.7	Percentage of derived words the explicit stem group spelled with the stem ending *t* at pre-test, immediate post-test, and delayed post-test	85
Figure 3.8	Percentage of derivatives the implicit stem group wrote with the stem ending *t* at the three time points	86
Figure 3.9	Percentage of derived words the unseen control group wrote with the stem ending *t* at pre-test and the two post-tests	87
Figure 3.10	Example of the children's use of the phonological representation, *sh*, at pre-test	88

Figure 4.1	Example of the Power Point slides for one of the *-ion* and *-ian* derivative pairs that were used in the suffix teaching session.	98
Figure 4.2	Means for the children's word stem ending spellings in derivatives for each experimental condition at the three testing occasions. Error bars represent standard errors of the means	103
Figure 4.3	Means and standard errors for the children's pseudo-word stem ending spellings in derivatives for the three intervention groups at pre-test, immediate post-test, and delayed post-test	103
Figure 4.4	Means for the children's suffix spelling in word derivatives for each intervention group at pre-test, immediate post-test, and delayed post-test. Error bars denote standard errors of the means	106
Figure 4.5	Means and standard errors for the children's suffix spellings in pseudo-word derivatives for each experimental condition at the three time points	107
Figure 4.6	Percentage of derivatives the stem teaching group spelled with the *t* stem ending at the three testing occasions	111
Figure 4.7	Percentage of derived words the suffix teaching group wrote with the *t* spelling at pre-test, immediate post-test, and delayed post-test	112
Figure 4.8	Percentage of derivatives the unseen control condition spelled with the *t* stem ending spelling at pre-test and the two post-tests	113
Figure 4.9	Percentage of derivatives the suffix teaching group wrote with the suffix *-ion* at pre-test, immediate post-test, and delayed post-test	115
Figure 4.10	Percentage of derived words the stem teaching condition wrote with the suffix *-ion* at pre-test and the two post-tests	116

Figure 4.11	Percentage of derivatives the unseen control group wrote with the suffix *-ion* at the three testing occasions	117
Figure 5.1	Example of the Power Point slides for one of the derivative pairs that was used in the simultaneous teaching	126
Figure 5.2	Means for the children's stem ending spellings for words across the intervention groups at pre-test, immediate post-test, and delayed post-test. Error bars represent standard errors of the means	131
Figure 5.3	Means and standard errors for the children's stem spelling in pseudo-word derivatives for the three experimental conditions at the three time points	132
Figure 5.4	Means for the children's suffix spellings in word derivatives for each intervention group at the three testing occasions. Error bars denote standard errors of the means	135
Figure 5.5	Means and standard errors for the children's spelling of suffixes in pseudo-word derivatives for each of the experimental conditions at pre-test and the two post-tests	135
Figure 5.6	Percentage of derivatives the sequential condition spelled with the *t* stem ending at the three testing occasions	143
Figure 5.7	Percentage of derived words the simultaneous group spelled with the *t* ending at pre-test, immediate post-test, and delayed post-test	143
Figure 5.8	Percentage of derivatives that the unseen control condition wrote with the stem ending *t* at the three time points	144

Figure 5.9	Percentage of derived words the sequential group spelled with the suffix *-ion* at pre-test, immediate post-test, and delayed post-test	146
Figure 5.10	Percentage of derivatives the simultaneous condition spelled with the suffix *-ion* at the three time points	146
Figure 5.11	Percentage of derived words the unseen control group spelled with the suffix *-ion* at the three testing occasions	147
Figure D.1	The first part of a trial from the computerised Matlab spelling game	187
Figure D.2	The feedback part of a trial from the Matlab training game	187
Figure G.1	Percentage of pseudo-word derivatives the explicit stem group in Experiment 1 spelled with the stem ending *t* at the three time points	191
Figure G.2	Percentage of pseudo-words the implicit stem group in Experiment 1 wrote with the *t* spelling at pre-test, immediate post-test, and delayed post-test	191
Figure G.3	Percentage of pseudo-word derivatives the unseen control condition in Experiment 1 spelled with the *t* stem ending at the three testing occasions	192
Figure G.4	Percentage of pseudo-word derivatives the stem teaching group in Experiment 2 wrote with the stem ending *t* at pre-test, immediate post-test, and delayed post-test	192
Figure G.5	Percentage of pseudo-words derivatives the suffix teaching group in Experiment 2 wrote with the *t* spelling at the three testing occasions	193

Figure G.6	Percentage of pseudo-words the unseen control group in Experiment 2 spelled with the *t* stem ending at pre-test and the two post-tests	193
Figure G.7	Percentage of pseudo-word derivatives the suffix teaching group in Experiment 2 wrote with the suffix -*ion* at pre-test, immediate post-test, and delayed post-test	194
Figure G.8	Percentage of pseudo-words the stem teaching condition in Experiment 2 spelled with the suffix -*ion* at the three time points	194
Figure G.9	Percentage of pseudo-words the unseen control group in Experiment 2 wrote with the suffix -*ion* at the three testing occasions	195
Figure G.10	Percentage of pseudo-word derivatives the sequential teaching condition in Experiment 3 wrote with the *t* stem ending at pre-test and the two post-tests	195
Figure G.11	Percentage of pseudo-words the simultaneous teaching condition in Experiment 3 wrote with the *t* spelling at pre-test, immediate post-test, and delayed post-test	196
Figure G.12	Percentage of pseudo-words the unseen control condition in Experiment 3 wrote with the *t* spelling at the three testing occasions	196
Figure G.13	Percentage of pseudo-word derivatives the sequential condition in Experiment 3 wrote with the suffix -*ion* at pre-test, immediate post-test, and delayed post-test	197
Figure G.14	Percentage of pseudo-word derivatives the simultaneous group in Experiment 3 wrote with the suffix -*ion* at the three time points	197

Figure G.15 Percentage of pseudo-words the unseen control group in Experiment 3 wrote with the suffix -*ion* at the three testing occasions 198

List of Tables

Table 3.1	Mean (SD) number of correct stem ending spellings in word and pseudo-word derivatives by group	79
Table 4.1	Mean (SD) number of correct stem ending spellings in word and pseudo-word derivatives by group	100
Table 4.2	Mean (SD) number of correct suffix spellings in word and pseudo-word derivatives by group	100
Table 4.3	Summary of the post-hoc comparisons between the stem teaching, suffix teaching, and unseen control groups in Experiment 2	109
Table 5.1	Mean (SD) number of correct stem ending spellings in word and pseudo-word derivatives by group	128
Table 5.2	Mean (SD) number of correct suffix spellings in word and pseudo-word derivatives by group	129
Table 5.3	Summary of the post-hoc comparisons for stem and suffix spelling between the simultaneous, sequential, and unseen control conditions in Experiment 3	140
Table 5.4	Summary of the effect size comparisons between the stem and suffix teaching from Experiment 2 and the two types of combined instruction from Experiment 3	141

Chapter 1: Introduction

The aim of the current study is to investigate the relative contributions of implicit and explicit knowledge of morphology to a child's spelling in English. It involves assessing children's understanding of morphemes, which are units of meaning within words. In particular, the research investigates a child's knowledge of the spelling of words that cannot be predicted entirely on the basis of phonological, sound-based strategies, but can be more readily understood through a combination of both phonology and morphology. For instance, when children attempt to spell a word like *magic*, they can use phonology and sound out the word as /*m*/ /*a*/ /*gi*/ /*k*/, but when they are faced with a derived word like *magician*, they need to use morphology and preserve the spelling of the stem morpheme *magic* even though the vowel sound changes and the letter *c* changes in pronunciation from /*k*/ to /*sh*/. The purpose of the current research is to examine what children know about morphemes and if they would benefit from having this knowledge enhanced for spelling through some form of morphological instruction.

This chapter intially outlines the role of morphology in the English orthography and the importance of morphemes for spelling. The second part considers if children use morphemes when they approach English words, that is if they segment words into morphological components or if they memorise words as whole units "word-specifically." This is followed by a consideration of the possible stages at which children could attain morphological knowledge and if a more explicit level of understanding enhances their spelling ability. The extent to which word stem and affix morphemes are teachable is then discussed and this is followed by a consideration of how morphemes are taught in the

school classroom. The final section provides an outline of the research programme for the current study and an overview of the chapters of the thesis.

1.1 The role of morphology for spelling in the English orthography

In the English orthography, the correspondences between phonemes, units of sound, and graphemes, written letters, cannot completely determine the spelling of all words. This is primarily because there are only 26 letters in English, each of which can correspond with many different sounds. Taking the letter *o* as an example, this can represent as many as 17 different phonemes, which includes the different /*o*/ sounds in the words *glove*, *move*, and *gone* (Venezky, 1967). This has often led to the perception, since as early as the 15th century, that English has a challenging and illogical orthography that lacks a main system of order or predictability for learning to spell (Hart, 1569).

However, Venezky (1967; 1970) marked a change in thinking about English spelling and argued that the orthography is much more regular and predictable than it is often perceived to be. He upheld that viewing English from a solely "spelling-to-sound standpoint […] reveal[s] no regularity" (Venezky, 1967, p. 95), but that regularity can be readily attained from appreciating that the orthography has a "morphophonemic" structure. The point is that the orthography represents units of meaning (i.e. morphemes), as well as units of sound (i.e. phonemes) (Jaffré, 1997; Venezky, 1970), and that an understanding of phonology and morphology is of notable importance in the spelling of English words.

Morphology is important for spelling because in many words the spelling that would be predicted on the basis of morphology wins out over phonology. This is largely because

morphemes honour a principle that Venezky (1999, p. 9) called the "visual identity of meaningful word parts," which states that the same morpheme often has a consistent spelling across words in spite of changes in sound. For instance, the spelling of the inflectional morpheme -*s* is consistently used at the end of regular plural nouns irrespective of whether the word is pronounced with a final /*s*/ sound as in *cats* or a final /*z*/ sound as in *boys* (Kemp and Bryant, 2003; Kemp, Mitchell, and Bryant, 2017). This consistent spelling of morphemes across words is also evident for regular past-tense verbs as the -*ed* morpheme is added regardless of whether it is pronounced as /*t*/ in the word *kissed*, as /*d*/ in the word *killed*, or as /*id*/ in the word *waited* (Bryant, Nunes, and Aidinis, 1999; Kemp, 2006; Nunes and Bryant, 2009; Nunes, Bryant, and Bindman, 1997).

This precedence of morphemes over phonemes is not only evident when morphology contradicts the spelling predicted by phonology, it is also apparent when morphology distinguishes between two alternative spellings for the same sound. For instance, there are two ways of representing the /*un*/ sound at the end of a written English word. One is to add the letters -*ion* as in the word *discussion* and the other is to add -*ian* as in the word *magician*. This difference in spelling cannot be understood on the basis of phonology, but can be easily explained by the fact that derived words ending in the suffix -*ian* refer to a person, whereas those ending in -*ion* represent abstract nouns (Nunes and Bryant, 2006). The same applies for the words *socks* and *fox*, which both end in the sound /*ks*/, but *socks* is a plural word spelled with the -*s* morpheme and *fox* is a one-morpheme word spelled with -*x* (Mitchell, Kemp, and Bryant, 2011; Patrick, 2010).

Morphemes also take precedence over phonemes when parsing units in word reading. Venezky (1999) noted that the letters *sh* and *ph* represent one phoneme in words like *rushing*

and *elephant*, but that when these letters cross a morpheme boundary, as in the words *dis-honest* and *shep-herd*, the /*s*/ or /*p*/ sound marks the end of one morpheme and the /*h*/ represents the opening sound of the second. This clearly shows that the reading and spelling of many English words is reliant upon an understanding of morphology.

1.2 Do children use morphemes when they process English spellings?

As morphemes form an integral part of English spelling, it is important to consider if children use morphemes when they attempt to process words that cannot be understood entirely on the basis of phonology. The extent to which children use morphemes largely depends on the approach they take when they encounter a particular word. This section briefly presents three different hypotheses about the way in which children approach words whose spelling requires an understanding of morphology: they could memorise words "word-specifically" as whole units; segment words into morphological components; or combine word-specific and morphemic approaches together.

1.2.1 Word-specific knowledge

It is both possible and probable that children memorise words that flout phonology as whole units through word-specific knowledge without paying attention to morphemes. Experimental psychologists like Jensen (1962) proposed that memorising words as arbitrary strings of letters is a general strategy that children use in spelling development. Butterworth (1983) supported this rote memorisation approach as he argued that the mental lexicon of the brain is structured such that every word a person knows is listed in its whole-word form. Stage theorists of reading and spelling have also argued that during the initial stages of

learning to spell (Ehri, 1986; Frith, 1985; Gentry, 1978; Marsh, Friedman, Welch, and Desberg, 1980), children memorise complete spellings, such as their own names or familiar phrases like "Merry Christmas." Nunes and Bryant (2006) provided evidence to support word-specific knowledge as they found that children accurately spelled familiar words that contained morphemes (e.g. the *-ian* in *electrician*), but struggled to spell the same morphemes in words that were unfamiliar (i.e. pseudo-words). This suggests that children may acquire knowledge of entire words on the basis of rote memorisation rather than attending to morphemes.

1.2.2 Morphological segmentation

Although it is possible that children may recall English words by rote, acquiring word-specific knowledge of every spelling that cannot be spelled on the basis of phonology would be an almost impossible task in memorisation. Instead, it may be that through mere exposure to individual words, children recognise that words are segmented into morphological units and use this knowledge to assist their spelling. The notion that children can recognise morphological patterns aligns with primary school teachers' views in the 1960s, who argued that children "catch" spelling naturally through their regular encounters with words (Peters, 1967). Taft (1979, 1991) and Taft and Forster (1975) supported this perspective as they proposed that words are stored in the mental lexicon not only as whole units, but also in a morphologically decomposed form. For instance, in their theory, the word *unhook* is analysed in the brain by stripping off the prefix *un-* and locating the stem *hook*. Nunes, Bryant, and Evans (2010) provided evidence to support this view as they reported that children could decompose a pseudo-word with an obvious morphological structure (e.g. *unsausagish*) into the three morphological units of *un-*, *sausage*, and *-ish*. In fact, accurately

using morphemes in pseudo-words has been termed the "acid test" for assessing knowledge of morphology because if a child effectively applies morphological units to an unknown pseudo-word it suggests that they know something about morphemes because they could not have previously memorised the words by rote (Nunes and Bryant, 2006). This shows that children can segment words into morphological units for spelling.

1.2.3 Combination of word-specific and morphological approaches

Children may memorise all spellings by rote, or segment all words into morphological components, but it is also possible that children combine both of these approaches together and use each strategy depending upon the particular word they encounter. For instance, it is likely that children may memorise some words as whole units like their own name and entirely irregular words that lack any morphological or phonological structure like *yacht* and *island*. In much the same way, children may start to recognise that the *-s* morpheme is used to represent two or more of something and begin to write *-s* to indicate this plural form in spelling. Even with this combination of approaches, it is important to consider the extent to which children attain knowledge of morphemes naturally, through their everyday encounters with words, and if they would benefit from having this knowledge enhanced through some form of direct instruction.

1.3 Do children acquire knowledge of morphology through their encounters with words?

If children can acquire some understanding of morphemes through their regular encounters with words, it is beneficial to consider the different levels at which they could attain morphological understanding. Karmiloff-Smith (1986; 1992; Lorandi and Karmiloff-Smith,

2012) proposed in her "Representation Redescription Model" that there are four levels at which children could acquire knowledge of morphology: implicit, explicit 1, explicit 2, and explicit 3. She argued that as children acquire morphological information, their knowledge becomes "redescribed" to a higher level of understanding. She also proposed that a child's acquisition of knowledge arises for each aspect of morphology at different times (Lorandi and Karmiloff-Smith, 2012); a child could have implicit knowledge of the affix *-ion* at the same time as explicit understanding of the past-tense *-ed*. This section considers each level in turn to provide an outline of the possible stages at which children could attain morphological information.

1.3.1 Implicit knowledge

It is possible that children acquire some knowledge of morphology implicitly through their encounters with words. Implicit knowledge arises if a child has some understanding of morphemes in a way that is often hard to access consciously or to express (Karmiloff-Smith, 1992; Lorandi and Karmiloff-Smith, 2012). Berko (1958) upheld this view as she argued that when children start to learn their native tongue, they make connections between morphologically related words in oral language, such as *dog* and *dogs*, and infer something implicitly about how these words are connected. Her research supports this idea as she found that children could accurately produce the /*z*/ sound at the end of a plural word if they were just given the singular form. This indicates that children do acquire some morphological knowledge implicitly through their exposure to words.

1.3.2 Explicit knowledge 1

Whilst it is likely that children may acquire implicit knowledge of morphemes, it has been argued that an implicit understanding is "a [useful] stepping stone for the emergence of more explicit forms of […] knowledge" (Nunes and Hatano, 2004, p. 656). Thus, the second level at which children could acquire morphological information is a low-level of explicit understanding. At this stage, Karmiloff-Smith (1986; 1992; Lorandi and Karmiloff-Smith, 2012) proposed that children start to make greater connections between words than at an implicit level, but still struggle to verbalise this information and to access this knowledge consciously. For instance, a child may begin to use morphological units in spelling, such as the *-ed* morpheme, without being able to reflect on why they used this ending. Nunes, Bryant, and Snaith (2000) provided evidence to support this stage as they reported that children could accurately use the regular past-tense *-ed* spelling in pseudo-words (e.g. *chailed*), even though this information was not consciously accessible and they were unable to explain the rule verbally. This implies that children could start to appreciate something about morphemes at a low-level of explicit understanding.

1.3.3 Explicit knowledge 2

It is also probable that children could reach a level of explicit knowledge that is available to conscious access, even if they struggle to express this information (Karmiloff-Smith, 1986; 1992; Lorandi and Karmiloff-Smith, 2012). For instance, a child may be consciously aware of the fact that there is a similarity between words like *walked* and *hoped* even if they find it difficult to explain this association. If a child has knowledge of morphemes at a conscious level, it suggests that they have an awareness of morphology. Carlisle (1995, p. 190) defined

morphological awareness as the "ability to manipulate the morphemic structure of words." Deacon and Bryant (2005) upheld this view as they found that children could intentionally add morphological units like *-er* to the end of words like *smarter*. It has been argued that if children reach a level of morphological knowledge in which they have an awareness of morphemes that this is closely related to their ability to use morphemes effectively in reading and spelling (e.g. Nagy, Berninger, and Abbott, 2006; Nunes, Bryant, and Bindman, 2006; Sénéchal, 2000; Tong, Deacon, Cain, Kirby, and Parrila, 2011). This implies that children could reach a secondary level of explicit knowledge, which has the potential to noticeably aid their reading and spelling ability.

1.3.4 Explicit knowledge 3

The final stage at which children could acquire knowledge of morphemes is a tertiary level of explicit understanding that is both available to conscious access and can also be expressed (Karmiloff-Smith, 1986; 1992). This means that children attain a level of morphological knowledge that enables them to explicitly identify and define morphemes in words. For example, at this level, children could say that the last letter *-s* is used to represent a word that is in the plural. Sénéchal, Basque, and Leclaire (2006) provided evidence to support this stage as they found that some children, albeit not many, employed a morphological strategy, such as using a related word, to spell word stem morphemes. However, there is a distinct lack of evidence in the literature to show that children reach a high level of explicit understanding naturally through their everyday encounters with words. Instead, it may be that children benefit from having their knowledge of morphemes enhanced to this superior level through direct instruction. There is evidence in morphological intervention research to show that direct teaching of morphemes is beneficial for children's reading and spelling (see

meta-analyses by Bowers, Kirby, and Deacon, 2010; Carlisle, 2010; Reed, 2008). This indicates that children could acquire a high level of explicit knowledge through morphological teaching that noticeably enhances their spelling accuracy.

1.4 Are word stem and affix morphemes teachable?

Although children may benefit from having their knowledge of morphemes enhanced to an explicit level through instruction, it is important to note that only some aspects of morphology have been explicitly taught in morphological intervention studies. This largely results from the fact that most intervention research has focused almost exclusively on teaching children affixes for spelling, with little consideration for explicitly teaching children about word stems (e.g. Devonshire and Fluck, 2010; Nunes and Bryant, 2006; Nunes, Bryant, and Olsson, 2003). Word stems form the core part of most English words (e.g. *teach* in the word *teacher*) and affixes attach to stems either as prefixes that precede a stem (e.g. *un-* at the start of the word *unkind*) or as suffixes that follow a stem (e.g. *-ian* at the end of the word *musician*). Two types of affix morphemes can be attached to the end of stems in English; inflections that signify the grammatical status of a word (e.g. adding *-s* to the word *tree* to pluralise it) and derivations that alter a word's meaning (e.g. adding *-ion* to the stem *elect* to change the verb into an abstract noun) (Dreher, 2015; Kirby et al. 2012; Nunes and Bryant, 2006).

1.4.1 Teaching word stems may enhance children's spelling

Teaching children about word stems for spelling may have been neglected in intervention research because stem teaching is likely to be a more difficult process to that of teaching

affixes. Affixes are likely to be easier to teach than stems because they have a fixed spelling and meaning; if a person is taught that the affix spelling *-ed* is used for words in the regular past-tense, they simply need to learn the two letters *-ed* and understand its function in order to reach the correct spelling. There is not a specific spelling rule behind each individual word stem spelling in the same way as there is for affixes. Instead, there is one general principle behind all word stems, namely that the spelling of a stem (e.g. *music*) is often conserved across derived words (e.g. *musician*) in spite of changes in sound (Venezky, 1999). This means that to spell a stem accurately in a derivative, children need to know a stem's spelling and combine this with the morphological rule that word stems are conserved in derived forms. It has been argued that children use phonology to spell word stems because stem spellings often conform to phonological rules (Nunes and Bryant, 2004), but that it is also possible that children memorise stems as whole units because some stems require word-specific knowledge (e.g. *rain* and *reign* are spelled differently, but are pronounced in the same way) (Nunes and Bryant, 2009). It is also likely that teaching affixes is more manageable than teaching word stems because they are fewer in number. It has been estimated that there are 858 affixes in English (Laws and Ryder, 2014; Lobeck and Denham, 2014) and this number is considerably smaller than the approximate 54,000 word stems (Goulden, Nation, and Read, 1990). Thus, as teaching children about word stems appears to be a more challenging task to that of teaching affixes, this may explain why affixes have received much more attention in morphological intervention research.

It is also important to note that many teaching schemes that have been developed for literacy instruction focus on teaching "word families," which are formed by words with the same stem (e.g. *signed*, *signal*, and *signing*) (e.g. Bowers and Kirby, 2010). Even though this approach exposes children to word stems, it does not explicitly teach them the principle that

stems are morphological units that preserve their identity across words. Also, there is a lack of evidence to support the effectiveness of these teaching schemes. Research by the developers of such an approach has found that teaching word families enhanced a child's knowledge of stems from families that were included in the training, but was of limited benefit for their understanding of untaught stems (Bowers and Kirby, 2010). This implies that children may need to be directly taught the principle for stem conservation to acquire an appreciation of stems that can be applied to enhance their spelling of a number of words. Yet, it is important to note that implicit instruction, which increases a child's exposure to morphological units in the absence of explicit teaching, has been reported to be of some benefit for children's spelling over and above that of no morphological instruction (Nunes and Bryant, 2006). This indicates that mere exposure to morphemes could enhance a child's spelling to some extent.

However, it is possible that explicitly teaching children about word stems could lead to noticeable spelling improvements. For instance, Bryant, Nunes, and Aidinis (1999, p. 117) argued that there is a benefit in "understanding connections between words with the same stem" for spelling. It is also clear from affix-based intervention research that teaching affixes has positive effects on a child's ability to spell (e.g. Devonshire and Fluck, 2010; Nunes and Bryant, 2006; Nunes et al. 2003) and so it is feasible that similar advantages could arise as a consequence of explicit stem teaching. There is also some evidence reported in the Dutch orthography to show that explicit teaching of stems noticeably enhances a child's spelling, which indicates that a similar effect could arise in English (Kemper, Verhoeven, and Bosman, 2012). This implies that explicitly teaching children about word stems could noticeably improve their spelling accuracy.

1.4.2 Explicit teaching of one morpheme may lead to explicit knowledge of another

It may be that explicit instruction of one aspect of morphology (e.g. word stems) enables children to acquire explicit knowledge of another, related aspect (e.g. affixes) that does not receive attention. This is feasible because explicit teaching of one morphological unit inevitably exposes children to whole derived words (e.g. *magician*) (see Kemper et al. 2012; Nunes and Bryant, 2006). Alternatively, a second possibility is that explicit teaching of one word part (e.g. *magic*) detracts attention from the other *(e.g. -ian)* and leads to limited explicit understanding of the untaught morpheme. This is possible as there is evidence in priming research to show that priming Portuguese children with word stems (e.g. *tambor*) and exposing them to whole derivatives (e.g. *tamborilar*) enables them to strip the affix (e.g. -*ilar*) from the word to focus their attention on the stem (Rosa and Nunes, 2008). This indicates that explicit teaching of one morphological unit may lead children to acquire limited explicit knowledge of other, associated rules.

1.4.3 Explicit teaching of word stem and affix morphemes together

It is possible that children could benefit from being explicitly taught about both word stem and affix morphemes together. This is feasible because there is evidence in research to show that a child's ability to spell stems across words and their ability to spell morphological endings is significantly correlated with one another (Nunes et al. 2006). It may be that children benefit from receiving sequential instruction of the two principles, one after the other, or simultaneous instruction of the two word parts at the same time. Nunes and Bryant (2009) provided evidence to support sequential instruction as they found that teaching two related phonological spelling rules in sequence enhanced a child's spelling accuracy. Yet, it

is also possible that simultaneous instruction could improve a child's spelling as it would visually present the two word parts at the same time and within the same words and there is evidence in research to show that visual processing plays a role in a child's ability to spell (Plaza and Cohen, 2006). This implies that it could be worthwhile to explicitly teach children about both word stem and affix morphemes, either simultaneously or sequentially.

1.5 How are morphemes taught in the classroom?

As children could benefit from receiving explicit instruction of morphemes for spelling, it is worthwhile to consider how much morphological teaching children receive by evaluating the extent to which morphology is currently taught in the school classroom. The curriculum guidelines that regulate school practice in England do acknowledge the need to teach children about morphology. For instance, the 2013 curriculum for key stages one and two states that children should be taught to "understand relationships between meaning and spelling" and be helped "to spell words with prefixes and suffixes" (Department for Education, 2013, p. 39). However, the documentation fails to mention the terms morpheme, stem, and derivation. As the term morpheme is not stated, morphemes are not defined as units of meaning within words. This means that morphological units like *-ed* at the end of regular past-tense verbs (e.g. *showed*) are treated in the same way as strings of letters like *-dge* that are not morphological units (e.g. *edge*).

The guidelines also incorrectly note, and have done for at least 19 years (Department for Education, 2013; Department for Education and Employment Spelling Bank, 1999; Department for Education and Skills, 2008), to teach suffixes in a way that presents *-tion* and *-cian* as morphological units rather than appreciating that the *t* and *c* actually form part

of the word stem to which the affixes -*ion* and -*ian* are added. Although the curriculum does state that "strictly speaking, the suffixes are -*ion* and -*ian*" (Department for Education, 2013, p. 52), it does not attempt to teach them in this way or in direct relation to their meaning. The curriculum also fails to incorporate the morphological principle that stem spellings are often conserved in derived words in spite of changes in sound. As the wrong morpheme boundaries are often employed in the teaching (e.g. -*tion*), this could impair a child's ability to notice the role of stems across words. This clearly shows that even though the national guidelines that govern school practice acknowledge that teaching morphology could be beneficial for children's spelling, the way in which they teach morphemes is not entirely accurate and does not include explicit instruction of several aspects of morphology.

1.6 Research programme

This study examines the relative contributions of implicit and explicit knowledge of morphology to children's spelling accuracy. It investigates, through a series of three experiments, the extent to which children acquire an understanding of morphemes that is useful for spelling through their everyday encounters with words and if they would benefit from having their knowledge enhanced through some form of more direct instruction. A child's knowledge of morphemes is assessed in relation to their spelling of both word stems and affixes.

As affix morphemes have received more attention in research than word stems, the first experiment focuses on stems. The aim of this research is to assess the differential effectiveness of implicit versus explicit instruction of the principle for stem conservation on children's spelling of stems in derived words in English. This experiment examines,

arguably for the first time, if explicit stem teaching enhances a child's ability to spell. It is important to note that any exceptions to the stem-based rule (e.g. the stem *succeed*, which is not fully conserved in the derivative *succession*) are not dealt with in the current study.

The second experiment examines if explicit teaching of one aspect of morphology (e.g. word stems) enhances a child's spelling of that particular part of a derived word, and also enables children to acquire explicit knowledge of another, related aspect (e.g. affixes) in a way that is useful for spelling. The effect of explicit stem teaching is compared with explicit teaching of a particular affix-based rule (i.e. the distinction between the affixes of *-ion* and *-ian*) in relation to a child's spelling of both word stems and affixes in derivatives.

The aim of the third experiment is to examine the advantage of explicitly teaching children about both word stem and affix morphemes, in conjunction with one another. As children may benefit from receiving instruction of these two aspects of morphology simultaneously (i.e. at the same time) or sequentially (i.e. one after the other), these two teaching approaches are directly compared to assess which method is most valuable for children's spelling.

1.7 Organisation of the thesis

The next chapter (Chapter 2) provides a critical review of the literature on morphology and children's spelling. It evaluates research studies that investigate the extent to which children acquire implicit or explicit knowledge of morphemes for spelling through their everyday encounters with words. This is followed by an analysis of intervention research that assesses if children benefit from having their knowledge of morphemes enhanced through morphological instruction.

The three subsequent chapters (Chapters 3, 4, and 5) report the research experiments of the current study. Chapter 3 examines implicit and explicit teaching of word stem morphemes for spelling, Chapter 4 addresses if explicit instruction of one aspect of morphology leads children to attain explicit knowledge of another, and Chapter 5 reports the possible benefit of combining explicit instruction of word stems and affixes together. Each of these chapters provide detailed information regarding the methodological and statistical procedures involved at each stage.

The final chapter (Chapter 6) provides a discussion of the results and draws conclusions from the findings in relation to the research on morphology noted in the review of the literature. It examines if the results verify the predictions and if the findings extend beyond the research on which it was initially based. This chapter also considers the educational implications of the research in relation to if explicit teaching of word stem and affix morphemes should be seen as a priority for educators to integrate into current teaching practice.

Chapter 2: Literature Review

A critical review of the literature is the next necessary step for addressing the question of the extent to which implicit and explicit knowledge of morphology contribute to children's spelling in English. The first section examines if children acquire knowledge of morphemes through their experiences with words in oral language, spelling, and reading. The second part investigates if a child's knowledge of morphemes reaches a more explicit level, if this more explicit awareness is associated with their ability to use morphemes effectively when attempting to read and spell. This is followed by a consideration of how children respond to having their knowledge of morphemes enhanced through explicit instruction. The final section presents the research hypotheses and an outline of the three experiments of the current study.

2.1 What knowledge do children have of morphemes?

As Chapter 1 clearly demonstrates that morphology plays a fundamental role in the English orthography, it is worthwhile to consider the extent to which children develop an understanding of morphemes naturally through their everyday encounters with words. This section considers research studies that show if children display an implicit or explicit level of morphological knowledge in both oral (i.e. in speech) and written language (i.e. in spelling and reading). A child's appreciation of morphemes is considered in relation to a range of different aspects of morphology including word stems, inflections, and derivations.

2.1.1 Do children show an understanding of morphemes in oral language?

Berko's (1958) pioneering research on morphology formed one of the primary studies to assess if children display an understanding of morphemes in oral language. She investigated the ability of 4- to 7-year-old children to produce morphemes orally in pseudo-words in their inflected or derived form. For instance, she presented children with a drawing of a bird-like creature called a *wug* and asked them to complete the following sentence: "This is a *wug*. Now there is another one. There are two of them. There are two _____ ." To answer the task correctly, the children were required to make the morphological transformation from the singular form *wug* to saying the inflected plural form *wugs.* She found that 76% of the 4-year-olds and 97% of the older children were able to accurately produce this final /*z*/ sound, and because the word was entirely unfamiliar (i.e. a pseudo-word), it eliminated the possibility that the children were simply relying on word-specific knowledge. Yet, the children struggled to provide the plural ending in some instances. For example, only 14% of the 4- to 5-year-olds and 33% of the 6- to 7-year-olds could accurately produce the plural form *nizzes* from the singular form *nizz.* This shows that the children were able to accurately provide the plural morpheme in some places but not others. Berko (1958) also administered a second task in which children were asked to define familiar compound words that combine two morphemes like *birthday*. She found that for the word *birthday,* for example, only 2% of the children could accurately define it as a day, with not one of them correctly stating that it is a day associated with someone's birth and with most children relating the word to receiving presents or consuming cake. This led Berko (1958) to conclude that the children had some understanding of morphology, at least at an implicit level, as they could accurately produce morphemes in oral language, but that they lacked more explicit knowledge as they

struggled to define familiar compound words and failed to fully understand the morphological rule that all regular plural words end in /*s*/ or /*z*/.

Nunes et al. (2010) also examined a child's understanding of morphology by assessing their knowledge of morphemes in oral language in a group of slightly older children. They asked 9- to 11-year-old children to complete a non-word repetition task that included two types of items: pseudo-words that can be easily analysed into morphemes (e.g. *un-sausag-ish*) and pseudo-words that are not comprised of morphological units taken from the Gathercole assessment of non-word repetition (e.g. *stopograttic*) (see Gathercole, Service, Hitch, and Martin, 1997). The two types of words were matched in the number of syllables so that any differences in the children's answers could not be attributed to word length. In the task, the pseudo-words were read aloud to the children through tape-recordings of a native English speaker and the children were asked to repeat each item after it was presented. Nunes et al. (2010) reported that the children were significantly better at repeating pseudo-words that had a morphological structure than those that did not. This indicates that the children were analysing the pseudo-words into morphemes because syllable length was controlled for so there would have been minimal differences between the two word types if the children relied on syllabic units. Also, it is likely that the children used morphemes as the pseudo-words were entirely unfamiliar so the children could not have merely recalled the words from memory. This demonstrates that 9- to 11-year-old children have some knowledge of the fact that words can be decomposed into morphological units and this understanding was likely to be largely implicit because quick repetition of words in oral language is unlikely to tap into more explicit knowledge (Nunes and Bryant 2006).

2.1.2 Do children show an understanding of morphemes in spelling?

2.1.2.1 In spelling: inflections

Nunes et al. (1997) conducted a longitudinal study to assess a child's understanding of morphological units in spelling. They followed 6- to 8-year-old children across a period of three years to investigate their knowledge of the past-tense inflectional morpheme *-ed*. The children were asked to spell a series of regular past-tense verbs (e.g. *kissed*), irregular past-tense verbs (e.g. *slept*), and non-verbs (e.g. *next*), at three separate time points. The results revealed that at each stage, the children were noticeably better at spelling irregular verbs and non-verbs than the words in the regular past-tense. Close inspection of the children's spellings showed that at the start of the study, the children attempted to spell the past-tense inflection on the basis of phonology as they made many "phonetic" errors such as by writing *kissed* as *kist* or *killed* as *kild* (Nunes and Bryant, 2009). Later on, approximately 7 months later, the children started to use the *-ed* spelling, but often overgeneralised this ending to irregular verbs (e.g. *sleped*) and non-verbs (e.g. *necsed*) rather than appreciating the need to restrict this spelling to the regular past-tense only (Nunes and Bryant, 2006). By the time of the third testing occasion, 13 months later, the children's mean correct spellings of regular verbs still fell well below that of the other two word types at under 80%, but some of the children started to confine the *-ed* ending to the correct places (Nunes and Bryant, 2009). This pattern of spelling indicates that as the children grew older, they started to recognise that *-ed* is a unit in spelling, but that most children failed to make the explicit morphological connection that this ending is used for words in the regular past-tense.

Kemp and Bryant (2003) conducted a similar study that investigated children's knowledge of morphemes in relation to their understanding of the spelling of the plural inflection -*s*. They assessed 5- to 9-year-old children's spelling of plural words that are written with the last letter -*s*, even if the ending is pronounced with a final /*z*/ sound as in *fleas*. Each word was read aloud to the children in a sentence context so that they could clearly see that the word to be spelled was in the plural (e.g. "That naughty boy told *fibs* to his mother"). They found that the children were significantly better at spelling the -*s* affix correctly in words where the /*z*/ sound followed a consonant (e.g. *fibs*) than in words where the /*z*/ ending followed a long vowel (e.g. *fleas*). For example, they spelled the -*s* morpheme accurately 91% of the time in words like *fibs*, but only 73% of the time in words like *fleas*. This effect also held for pseudo-words with the children spelling the plural ending in unfamiliar words like *pleens* (74% correct) significantly more accurately than in pseudo-words like *plees* (37% correct). This difference in spelling could not be explained by an understanding of morphology, but is likely to result from the fact that there is a considerably higher frequency of plural words in English that are spelled with the letter -*s* following a consonant, than words that contain this letter following a long vowel. As this frequency effect extended to pseudo-words, it eliminates the possibility that the children had simply been exposed to the words with a preceding consonant more frequently and had learned each of the spellings by rote. This shows that the inferences that children make about the -*s* ending leads them to adopt the frequency of certain letter patterns in English for spelling, rather than appreciating the morphological rule that all plural words are spelled with -*s*.

2.1.2.2 In spelling: derivations

Carlisle (1988) examined if children display an understanding of morphemes through their spelling of derivations rather than inflections. She investigated if 9- to 13-year-old children appreciate that the spelling of word stem morphemes (e.g. *express*) are often conserved in derived words (e.g. *expression*) in spite of changes in sound (i.e. the stem *express* is conserved in the derivative *expression* even though the *ss* changes in pronunciation from /*s*/ to /*sh*/). She compared the children's spelling of pairs of word stems and derivatives with their ability to produce the same words orally. The word pairs either contained a change in pronunciation between the stem and derived form (e.g. *magic* - *magician*) or did not contain a pronunciation change (e.g. *enjoy* - *enjoyment*). To assess the children's understanding of derivatives, the children were presented with word stems in a sentence context and were asked to generate the derived form (e.g. "Magic. The show was performed by a _____ "). The same procedure followed for measuring the children's knowledge of stems, but they were provided with derived words and asked to produce the related stem. Carlisle (1988) found that the children's performance on the tasks increased with age, but that their spelling ability lagged behind their ability to produce the words orally. She also found that the children across all age groups made significantly more spelling errors in stems and derived forms that contained a pronunciation change than those that did not. This ability to produce morphemes orally implies that the children had some implicit knowledge of stems, but as they experienced difficulty with spelling word pairs that changed in pronunciation, it suggests that they lacked more explicit understanding of the morphological principle that word stem spellings are often conserved across words.

Burton (2014) and Wright (2013) also both independently assessed children's knowledge of word stem morphemes through their spelling of derivations. They asked 7- to 9-year-old children to spell word stems in derivatives that changed in pronunciation between the stem and derived form (e.g. *inject* - *injection*). Each of the derivatives to be spelled was read aloud to the children in the context of sentences and contained one of three possible stem endings: *t*, *ss*, or *c* (e.g. "The boy wanted to show his happiness; his face had a cheerful *expression*"). The results of both studies showed that the children spelled approximately 30% of the stem endings correctly across the derived forms. This demonstrates that a small subset of children started to infer something about the morphological connection between stems and derivatives. However, the vast majority of children did not, and close examination of their misspellings showed that most of the children's spelling errors were due to overgeneralising the stem ending *t* to the incorrect places such as by spelling words like *discussion* as *discution*. The results also revealed that the children had a tendency to use the phonological representation, *sh* (e.g. *discushion*). This shows that the children were relying on phonology, and on the fact that *t* is a more frequent stem ending than *ss* or *c* in derived words in English, to spell the words. In particular, there are more than 2,000 English derivatives that contain the stem ending *t* before -*ion*, whereas there are only 100 that contain *ss* and 79 that contain *c* before -*ian* (MRC Psycholinguistic Database, 1987). The children's bias towards *t* is also likely to be compounded by the fact that the curriculum informs teachers that -*tion* is a morphological unit, which is then incorrectly transferred to the children (e.g. Department for Education, 2013; Department for Education and Employment Spelling Bank, 1999; Department for Education and Skills, 2008). This indicates that many of the children invented their own strategies, such as frequency or phonology, to spell stem endings in derivatives, rather than relying on an understanding of morphology.

Similar research has been conducted in other languages, such as French, to examine children's knowledge of derivational morphemes in spelling (e.g. Sénéchal, 2000; Sénéchal et al. 2006). French, in line with English, requires children to appreciate morphemes because the orthography is comprised of word stems that contain silent letters. For instance, the word stem *regard* contains the silent letter -*d*, but this silent /*d*/ sound is pronounced and written in the derived form of the stem *regarder.* Sénéchal et al. (2006) investigated if 9-year-old French-speaking children use the morphological information in derived forms to assist with their spelling of the silent letter in stems. The children were asked to spell three types of words: morphological word stems with a silent letter (e.g. *regard* - *regarder*); lexical words with a silent letter that is not pronounced in the derivative (e.g. *tabac* - *tabagie*); and phonological words without a silent letter (e.g. *éclair*). The results showed that the phonological words were the easiest for the children to spell, but that they were significantly better at spelling the silent consonant in morphological words (66% correct) than lexical items (44% correct). Sénéchal et al. (2006) also asked the children to describe the strategies that they used to spell the words. They found that 34% of the children reported using a morphological strategy, such as that they thought of a related word, to spell morphological items. The probability of spelling the morphological words correctly was also much higher in children that reported using a morphological strategy than those that did not. This led Sénéchal et al. (2006) to conclude that the 9-year-old children had some explicit understanding of morphology because they were able to report that they used the morphological relations between word stems like *regard* and derivatives like *regarder* to assist their spelling. Yet, the percentage of children that used such a strategy was relatively small (34%), which indicates that most children struggle to make these higher-level explicit morphological connections.

Nunes and Bryant (2006) also assessed children's knowledge of morphemes through their spelling of derivations. Rather than focusing on word stems, they examined 8- to 9-year-old children's understanding of affixes, namely the suffixes of *-ion* and *-ian*. They investigated if children appreciate that even though the two suffixes are both pronounced as /*un*/, the spelling *-ion* is used for abstract nouns and the spelling *-ian* is used for words that refer to a person (see Chapter 1.1). This was tested by asking the children to spell a series of derivatives like *election* and *electrician*. They found that the children spelled approximately 50% of the suffixes correctly and that they were significantly better at spelling derived words ending in *-ion* than *-ian*. They also reported that about one quarter of the children's misspellings were due to overgeneralising the *-ion* ending to the wrong places such as by writing *electrician* as *electricion*. This pattern of spelling indicates that the children were not relying on an understanding of the morphological distinction between *-ion* and *-ian*, but rather they were adopting the noticeably higher frequency of *-ion* suffixes in English to spell the words. In English, there are approximately 2,859 words that end in *-ion* compared with only 963 ending in *-ian* (MRC Psycholinguistic Database, 1987). This shows that the children recognised that *-ion* is a unit in spelling, but that they failed to make the explicit morphological connection that this ending represents abstract nouns.

A child's knowledge of derivations has also been directly compared with their understanding of inflections (e.g. Breadmore and Carroll, 2016; Choi, Tong, Law, and Cain, 2018; Deacon and Bryant, 2005; Dreher, 2015). Deacon and Bryant (2005) and Breadmore and Carroll (2016) both performed studies that investigated if children have a similar level of understanding of these two aspects of morphology. In Deacon and Bryant's (2005) research, 6- to 8-year-old children were asked to spell inflectional morphemes like *-er* at the end of the word *smarter* and derivational morphemes like *-ness* at the end of the word *kindness*.

The children were also asked to spell *-er* and *-ness* at the end of control words like *corner* and *witness* where they did not represent affixes. They reported that the children were significantly better at spelling the inflected items than the control words, but that there was no such positive effect for the derivations. Breadmore and Carroll (2016) conducted a similar study with 7- to 10-year-olds using pseudo-words. The children were asked to spell inflectional morphemes like *-est* at the end of the pseudo-word *gringiest* and derivational morphemes like *-ness* at the end of the pseudo-word *saughtiness*. They found that the children spelled the inflectional morphemes with 80% accuracy, but only accurately spelled 54% of the derivations. These findings clearly show that 6- to 10-year-old children appear to know more about the role of inflections than derivations in spelling, and as this result extended to pseudo-words, it eliminates the possibility that the children had simply encountered the inflected words more frequently and memorised each spelling by rote. In fact, as the children in both studies were asked to intentionally add morphological units to the ends of words, this taps a more explicit level of understanding, which indicates that the children had some explicit knowledge of inflectional morphemes like *-er*, but a lower level of explicit understanding or implicit knowledge of derivational morphemes like *-ness*. This shows, in line with Lorandi and Karmiloff-Smith (2012), that children do not acquire knowledge of morphemes in spelling in an all-or-nothing manner, but that they acquire some aspects more readily than others and to different levels of understanding.

2.1.3 Do children show an understanding of morphemes in reading?

Leong (1989) examined children's knowledge of morphemes in word reading. He assessed if children appreciate that when they read English words, the morphological division in words like *tractor* is between the word stem *tract* and the affix *-or*. This was investigated

by showing 9- to 11-year-old children a series of written words that contained a mixture of upper and lower case letters, which either clearly presented the morpheme boundary between the stem and affix, as in *tractOR*, or did not show the distinction, as in *tracTOR*. The words were presented on a computer screen and the children were asked to press a key to identify whether each word was real or not. He found that the children were significantly faster at identifying words that clearly presented the morpheme boundary (i.e. *tractOR*) through the mixture of upper and lower case letters than those that did not (i.e. *tracTOR*). This shows that the children knew something about morpheme boundaries in word reading, even though Leong (1989) argued that this information was likely to be largely implicit.

Another study that investigated children's knowledge of morphemes in reading was conducted by Singson, Mahony, and Mann (2000). Instead of focusing on a child's understanding of morpheme boundaries, they assessed children's knowledge of morphology through their reading of derivational affixes. They asked 8- to 12-year-old children to read a series of written sentences that each contained a missing derivative. The children were asked to select the appropriate suffixed word out of a set of four (e.g. *impressive* / *impressionable* / *impression* / *impressively*) to complete each sentence (e.g. "She hoped to make a good _____ "). They found that the children's performance on the task increased significantly with age, with the 11- to 12-year-old children selecting the appropriate derivational affix 90% of the time compared with 59% of the time for the 8- to 9-year-olds. This shows that the children had some understanding of derivational morphemes in word reading as they were able to select the appropriate suffixed word in most instances and this knowledge was likely to be largely explicit because suffix choice tasks typically assess more explicit awareness of morphology. Yet, it is important to note that the multiple choice nature of the task suggests that the children could have selected the correct derivatives by chance.

2.1.4 Do children show an understanding of morphemes in priming studies?

Children's knowledge of morphemes has also been investigated through priming. Priming activates a child's implicit knowledge of morphology as it is a non-conscious process that prompts children to generate a certain item or word by having been exposed to a similar item previously (Rosa and Nunes, 2008; Schacter, Dobbins, and Schnyer, 2004). For instance, priming children with a word stem like *harm* could facilitate the related derivative *harmless* (Laudanna, Badecker, and Caramazza, 1989; Nunes and Bryant, 2009). If such a faciliatory effect arises, it shows that children have some implicit understanding of morphology as they can decompose words into morphological units (Cain, 2010) and provides evidence for the fact that words are stored in the mental lexicon of the brain in a morphologically segmented form (e.g. Caramazza, Laudanna, and Romani, 1988; Laudanna et al. 1989; Taft, 1979, 1991; Taft and Forster, 1975).

Rosa and Nunes (2008) investigated morphological priming in a study of 6- to 9-year-old Portuguese children. The Portuguese orthography requires children to appreciate morphemes because it contains a similar stem conservation principle to English. For instance, the spelling of the word stem *tambor* is conserved in the derived word *tamborilar* even though there is a shift in stress and the *o* vowel changes in pronunciation from /*o*/ to /*w*/. This led Rosa and Nunes (2008) to examine if priming Portuguese-speaking children with word stems is an effective way of improving their spelling of this vowel sound in derived forms. They asked the children to spell a series of word (e.g. *tamborilar*) and pseudo-word (e.g. *candorilar*) derivatives that were presented in the context of sentences. The children were randomly assigned to one of three priming conditions: an oral-plus-written group that heard written sentences containing a stem prime (e.g. *tambor*); an oral-

only group that heard sentences containing a prime without seeing the written form; and a control group that heard sentences that did not contain a prime. They found that the oral-plus-written group were significantly better at conserving the vowel spelling in derived forms than the oral-only and control conditions, and that this effect was only evident in the 8- to 9-year-old children. This shows that 8- to 9-year-olds have implicit knowledge of morphology because they can use a stem prime to enhance their spelling of words with a morphological structure, which indicates that words are represented in the mental lexicon in a morphologically decomposed form. The findings reveal that this priming effect also held for pseudo-words, which shows that the children could not have been relying on word-specific knowledge to spell the words. This means that the children had a level of morphological knowledge that enabled them to isolate the stem (e.g. *candor*) from the word (e.g. *candorilar*) by stripping off the affix (e.g. -*ilar*). This enabled them to realise that the stem prime and the stem in the derived form were spelled the same. This shows that children have some implicit knowledge of morphology, which can be activated through priming in a way that is useful for spelling.

Wright (2013) replicated Rosa and Nunes' (2008) study to examine a child's knowledge of morphemes through priming in English. She primed 7- to 9-year-old children with word (e.g. *magic*) and pseudo-word stems (e.g. *lagic*) to assess if this enhanced their ability to conserve stem spellings in morphologically related derivatives that contain a pronunciation change (e.g. *magician*; *lagician*). She assigned the children to one of three priming groups: an oral-plus-written condition that heard written sentences that contained a stem prime (e.g. *magic*); an oral-only group that heard sentences containing a prime without the written form; and a control condition that heard a synonym of each stem instead (e.g. *tricks*). The results revealed, in line with Rosa and Nunes (2008), that priming children with word stems

significantly enhanced their ability to preserve stem spellings in derivatives in comparison to the control group, and that the children made the most noticeable improvements if they received a combination of oral and written primes. This shows that the priming effect reported in Portuguese extends to English as the children could use a stem prime to enhance their spelling. This provides further evidence to indicate that words are represented in the brain in terms of their constituent morphemes. As this finding was evident across stimuli that included pseudo-words, it implies that seeing the stem visually (e.g. *lagic*) and hearing the derivative orally (e.g. *lagician*) enabled the children to use affix stripping to recognise the similarity between the two stems. Therefore, it is possible to conclude that children have some implicit understanding of morphology than can be facilitated through priming.

Priming studies have also assessed children's knowledge of morphemes in word reading (e.g. Casalis, Dusautoir, Colé, and Ducrot, 2009; Clahsen and Fleischhauer, 2014; Quémart, Casalis, and Duncan, 2012). For instance, Clahsen and Fleischhauer (2014) investigated if priming 7- to 10-year-old German-speaking children with a regular past-tense inflected word like *gelandet* facilitates their reading of a morphologically related stem like *lande*. The children were not only primed with morphologically related words, they also received primes that were unrelated to the stem (e.g. *schildern*). They reported that the children across all ages were significantly faster at reading the stem if they were primed with a related inflected word than if they were primed with an unrelated word. This demonstrates that children can use a morphological prime to improve their word reading, which indicates, in accordance with Rosa and Nunes (2008) and Wright (2013), that children have some implicit knowledge of morphemes and that words are stored in the mental lexicon in a morphologically segmented form. Also, as the children were primed with an affixed word

rather than a stem, it provides additional evidence to indicate that children can strip off affixes in order to isolate morphological units.

Burton (2014) performed a further priming study that expanded upon the previous research to investigate if children benefit from having their attention explicitly directed towards morphemes. She assessed if explicitly directing 7- to 9-year-old children's attention to word stems is an effective way of aiding their spelling of stems in English derivatives. She randomly assigned the children to one of three experimental conditions: an explicit group that had their attention explicitly directed towards stem primes; an implicit group that were exposed to stems but did not have their attention drawn to them; and a control group that did not receive any word stem exposure. The three groups of children were asked to spell a set of derivatives that were presented in a series of oral and written sentences. The children in the explicit and implicit conditions received stem primes to help them to spell each derived word (e.g. the prime *confess* for the word *confession*), whereas the control group were presented with a synonym of each stem in place of the prime (e.g. *admit*). The explicit group also had their attention drawn towards the stems as they were told that these clue words would help them when attempting to spell each derived form. Burton (2014) found that the explicit group were significantly better at conserving the spelling of stems in derivatives than the children in the implicit and control conditions. This shows that 7- to 9-year-old children have some understanding of morphology, and that attending to stem primes, at a more explicit level, enables children to use this knowledge in a way that noticeably improves their spelling. This suggests that words are analysed in the brain in terms of morphological units and that a child's ability to access this knowledge could be further enhanced if they explicitly attend to morphemes.

2.2 Does morphological awareness predict a child's ability to use morphemes effectively in reading and spelling?

It is clear from the research reviewed in Chapter 2.1 that children acquire some knowledge of morphemes through the inferences they make in their everyday encounters with words and that this knowledge can span from implicit to more explicit levels of understanding (i.e. Karmiloff-Smith, 1992), the latter of which is often termed morphological awareness. It has been argued that a child's awareness of morphology, at a more explicit level, is connected to their ability to use morphemes effectively in reading and spelling (Cain, 2010; Carlisle, 1995). A plethora of studies have been conducted to investigate the relations between morphological awareness and children's literacy, and this research spans a number of different languages, in addition to English (e.g. see Bryant, Nunes, and Aidinis, 1999 for Greek; Freitas, Mota, and Deacon, 2018 for Portuguese; Rispens, McBride-Chang, and Reitsma, 2008 for Dutch; Sénéchal, 2000 for French; and Tong, McBride-Chang, Shu, and Wong, 2009 for Chinese). This section focuses on the core of this research, with a particular emphasis on studies conducted in the English orthography.

The extent to which a child's awareness of morphology, at an explicit level, is associated with their accurate use of morphemes in English spelling was investigated in Nunes et al.'s (1997) longitudinal study of the past-tense (see Chapter 2.1.2.1). The 6- to 8-year-old children were not only asked to spell *-ed* in regular past-tense verbs, they also completed a series of assessments at the start of the study that measured their morphological awareness. For instance, the children were presented with a sentence analogy task in which they heard a set of sentences and were asked to produce the missing sentence by changing the tense of the verb (e.g. Tom helps Mary : Tom helped Mary :: Tom sees Mary : _____). The children were also presented with a word analogy task that followed the same structure, but

contained words rather than sentences (e.g. *teacher* : *taught* :: *writer* : _____). The results showed that the children's performance on the morphological awareness tasks was a significant predictor of their correct use of *-ed* in spelling 7 and 20 months later. This effect held even after controlling for age, IQ, and the children's use of phonology in spelling. This shows that the children were significantly more likely to spell the *-ed* morpheme correctly if they had some explicit awareness of morphology. This indicates that a child's morphological awareness predicts their ability to use morphemes effectively in spelling.

Sénéchal (2000) also conducted a similar study in French to assess if the connections between morphological awareness and spelling extend to the French orthography. This formed an earlier version of the paper conducted by Sénéchal et al. (2006) and assessed the children's spelling of word stems with a silent consonant (e.g. *regard*) in a group of slightly younger 7- to 9-year-old children (see Chapter 2.1.2.2). She assessed the children's morphological awareness by using the same word analogy task as in Nunes et al.'s (1997) study, but revised the test to include sets of French words (e.g. *danse* : *danser* :: *saut* : _____). She found that the children's explicit awareness of morphemes was a significant predictor of their spelling of word stems with a silent consonant, even after the effects of age, phoneme awareness, and reading experience had been taken into account. She also examined if the children's awareness of morphology was a significant predictor of their spelling of words with a phonological structure (e.g. *éclair*) and found that this did not have a significant influence. This shows that the contribution of morphological awareness to a child's spelling was specific to words with a morphological structure, which indicates that there is a specific relation between a child's explicit understanding of morphemes and their correct use of morphology for spelling in French.

Nunes et al. (2006) performed a further longitudinal study to investigate if the relationship between morphological awareness and spelling is reciprocal. Rather than assessing if a child's explicit understanding of morphology predicts their ability to use morphemes in spelling, they investigated if a child's experiences with spelling morphemes in words predicts their morphological awareness. They examined 7- to 9-year-old children's spelling of two morphological units at the start of the study; their spelling of regular past-tense verbs with *-ed* and their conservation of stem spellings across words. The *-ed* measure followed the same format as in Nunes et al.'s (1997) study (see Chapter 2.1.2.1) and the stem conservation test asked the children to spell stem and derivative pairs that contained a change in pronunciation. For instance, the children were asked to spell the word stem *know* and the derivative *knowledge*. To eliminate the possibility that the children's correct spelling of stems could result from word-specific knowledge, Nunes et al. (2006) also repeated the test with pseudo-words that contained a silent letter. The pseudo-words were names of dinosaurs like *ironosaurus* that contained a real word stem like *iron*. Each dinosaur name was presented alongside a drawing that clearly showed the connection between the stem and derived form. In both the word and pseudo-word tasks, the children were asked to spell the word stem of the pair on one day and the derivative on a second day.

The children's morphological awareness was then assessed 13 months later using a pseudo-word definitions task. This involved asking the children to define pseudo-words that combined real morphemes and had a clear meaning even though they were unfamiliar. For example, the children were asked to define the pseudo-word *chickener*, which is likely to refer to someone who keeps chickens. They found that the children's correct use of *-ed* in spelling and their correct spelling of pseudo-word stems at the start of the study were significant predictors of their ability to define pseudo-words 13 months later, even after

controlling for age and IQ. They also found that the children's correct spelling of word stems just missed significance (p = .07). Therefore, these findings show that the children had a tendency to perform well on the morphological awareness task at a later stage if they used morphemes correctly in spelling at the start of the study. This demonstrates that if children have some explicit awareness of morphology, that this does only not only predict their ability to use morphemes in spelling, it is also predicted by their experiences with spelling morphemes in words. Consequently, there appears to be a two-way relationship between morphological awareness and children's spelling.

Nagy et al. (2006) conducted a study to investigate if morphological awareness contributes to a child's word reading and reading comprehension in a similar way to spelling. They argued that reading comprehension is closely connected to a child's understanding of morphology because morphemes are meaningful units that assist with the comprehension of individual words (see also Kieffer and Lesaux, 2008). They assessed 9- to 15-year-old children's ability to read words with a morphological structure that contained prefixes (e.g. *mis-*, *un-*, *dis-*), suffixes (e.g. *-ed*, *-s*, *-er*), or unfamiliar stems (e.g. *betongue*). They also tested the children's reading comprehension by asking them to complete a series of multiple-choice questions after silently reading passages. The children's awareness of morphology was measured using the same suffix choice task as in Singson et al. (2000), which asked the children to choose the appropriate suffixed word to complete a sentence out of a list of four (e.g. "Did you hear the _____ ?" *directs* / *directions* / *directing* / *directed*) (see Chapter 2.1.3). Nagy et al. (2006) also created two similar sub-tests using pseudo-words to eliminate the possibility that the children were choosing familiar sounding words by chance. For instance, the children were asked to choose the correct sentence for a pseudo-word that was combined of real morphemes like *dogless*. They were presented with the following

sentences: “When he got a new puppy, he was no longer *dogless*” and “He was in the *dogless*,” to assess if the children could identify that the suffixed word in the first sentence made more sense. Nagy et al. (2006) found, using structural equation modelling, that morphological awareness made a significant unique contribution to both the children’s word reading and reading comprehension, even after controlling for their phonological skills. This shows that if children have some explicit knowledge of morphology, that this does not only predict their spelling, it also predicts their effective use of morphemes in reading and their reading comprehension.

Tong et al. (2011) performed a further study that investigated the relations between morphological awareness and children’s reading comprehension. They examined if 10-year-old children with specific reading comprehension impairments (i.e. “poor comprehenders”) (see Cain and Oakhill, 2007; Nation, 2005) experience difficulty with morphological awareness tasks in comparison to children with average reading comprehension. The children were categorised using a regression technique and a comprehension measure that assessed their ability to provide the missing word after reading a series of passages (see Tong et al. 2011 for a full description). The children’s awareness of morphology was assessed using a word analogy test similar to Nunes et al. (1997) (e.g. *paint* : *painter* :: *bake* : _____) and a sentence completion task that involved selecting the appropriate word to complete a series of sentences (e.g. “She was an excellent hockey _____ (*player*, *playful*)”). The children also received a phonological awareness test to serve as a control measure, which involved deleting phonemes from a set of items that were presented orally (e.g. “Say *snail*. Now say *snail* without the /*n*/”). The results revealed that the children with average reading comprehension significantly outperformed the poor comprehenders on the word analogy task, but that there was no such significant difference for the sentence

completion test. The findings also revealed that there was not a significant difference between the two groups in terms of phonological awareness. This shows that children with reading comprehension difficulties have a specific deficit in morphological awareness, despite having adequate phonological skills. This indicates that there is a specific association between a child's explicit awareness of morphology and their ability to comprehend words in reading.

2.3 What happens if children are taught about morphemes?

It is evident from Chapter 2.2 that a child's awareness of morphology, at a more explicit level, is closely related to their ability to use morphemes in reading and spelling. This indicates that children may benefit from having their morphological understanding enhanced through some form of direct instruction to make their knowledge more explicit. This is feasible because intervention research with phonology has shown that explicitly teaching children about the sounds of words noticeably enhances their effective use of phonology in reading and spelling (e.g. Bradley and Bryant, 1983; Ehri, Nunes, Stahl, and Willows, 2001a; Ehri et al. 2001b; Nunes et al. 2003). Thus, it is possible that teaching children about morphemes could lead to similar improvements. In fact, a wealth of intervention studies have been conducted that have examined the advantage of explicitly teaching children about morphology. For instance, meta-analyses by Bowers et al. (2010), Carlisle (2010), and Reed (2008) have investigated the effect of morphological instruction in relation to both children's word reading and spelling.

A pioneering intervention study that investigated teaching of morphemes was conducted by Nunes et al. (2003). They directly compared explicit teaching of morphological and

phonological rules on 7- to 8-year-old children's reading and spelling. The children that received morphological teaching were presented with training games in which they were taught about aspects of morphology, such as the meaning behind the spellings of affixes like *-ed* and *-er*, whereas the children that received phonological training were taught about aspects of phonology, such as the difference in vowel pronunciation between words like *hat* and *fate*. The effect of such training was assessed in relation to the children's reading and spelling of words that followed morphological principles like *mishandle* and *stopped*. Nunes et al. (2003) found that the children that received morphological teaching significantly outperformed both the phonological training group and a control group that did not receive any form of instruction. This indicates that teaching children about morphology significantly improved their reading and spelling of words with a morphological structure in a way that phonological or no instruction did not. This shows that in order to noticeably enhance a child's reading and spelling, they may need to be explicitly taught principles about morphology. It is also important to note that the benefits of morphological teaching were even more substantial for the children's spelling than for reading, which may explain why intervention research typically targets spelling when teaching children about morphemes. Therefore, the vast majority of studies reviewed in this section will focus on the effectiveness of teaching morphemes for children's spelling.

Hurry et al. (2005) assessed the effect of explicit morphological instruction on children's spelling in 7- to 11-year-olds. They examined if children benefit from receiving training in inflectional and derivational morphemes, such as *-ed*, *-er*, and *-ion*, through a morphological intervention that was delivered on a whole-class basis by their school class teacher. Prior to the intervention, the teachers received a 10-session morphological training course, which informed them of the role of morphology in the English orthography and outlined strategies

for teaching children particular morphological spelling principles. Both before and after the intervention, the children were asked to spell a series of words and pseudo-words with a morphological structure and their performance on the task was compared with that of an untaught control group. Hurry et al. (2005) found that there were minimal differences in spelling between the two groups at the start of the study, but that after the teaching, the children that received explicit instruction performed significantly better at spelling morphological units than the controls. This demonstrates that morphological teaching is not only beneficial for spelling, but that training school teachers with morphological knowledge is an effective way of transferring this information to the children, which in turn, leads to noticeable improvements in their spelling.

Devonshire and Fluck (2010) also examined the benefit of explicit instruction of morphemes for spelling in 5- to 11-year-olds. Prior to administering the morphological intervention, the children were asked to spell a list of words with a morphological structure (e.g. *dogs* and *objection*) and to explain the strategies that they used to spell them. The two most common spelling strategies that the children reported were sounding-out or recalling entire words from memory. Only 39% of the children noted using morphological strategies for spelling (e.g. "I know you have to add -*s* to make a plural") (Devonshire and Fluck, 2010, p. 363) and this was most evident in the 7- to 9-year-old children. The children then received a morphological intervention in which they were explicitly taught that words are formed of morphological units and the meaning behind particular affixes. For example, they were taught that the -*ian* suffix is used for person words and that the -*ed* spelling is used for words in the past-tense. They were then asked to spell the same list of morphemic words for a second time. Devonshire and Fluck (2010) reported that the children that received morphological training significantly outperformed a group of controls the second time of

spelling the words. They also found that the intervention was effective for all age groups, but that the 7- to 9-year-old children made the most noticeable spelling improvements. This indicates that even though some of the children had an awareness of morphemes prior to the teaching, that this knowledge was noticeably enhanced through direct morphological instruction, and was of most benefit for children in their third or fourth year of schooling.

Casalis, Pacton, Lefevre, and Fayol (2018) performed an intervention study that investigated morphological teaching in the French orthography. They assessed the effect of direct instruction of morphological units on 8-year-old French-speaking children's spelling of derivatives. They randomly assigned the children to either a morphological training group or a control condition. The intervention group were taught about morphemic units in spelling, such as the fact that the word *lenteur* contains the two morphemes *lent* and *-eur*, whereas the control condition did not receive any morphological instruction. The children were then asked to spell French derivatives with a morphological structure like *mangeur* and *blancheur*. They found that the morphological training group were significantly better at accurately spelling the derived words than the control condition. These findings indicate that the advantage of explicit teaching is not restricted to the English orthography, it also has positive outcomes for a child's spelling in French.

Nunes and Bryant (2006) also assessed the effect of explicitly teaching children about morphemes for spelling. They focused on teaching 8- to 9-year-old children the morphological distinction between the derivational affixes of *-ion* and *-ian* (see Chapter 1.1 and 2.1.2.2). The children either received explicit instruction of the distinction between abstract nouns and person words, implicit instruction that increased exposure to *-ion* and *-ian* suffixes without any explicit teaching, a mixture of both explicit and implicit instruction,

or training on an unrelated topic as the control. They then asked the children to spell a series of derived words and pseudo-words ending in *-ion* and *-ian* like *injection* and *electrician*. They found that the children who received implicit instruction were significantly better at spelling both words and pseudo-words with *-ion* and *-ian* endings than the control condition, which shows that repeated exposure to affixes does lead to some improvements in children's spelling. Yet, the two groups of children that received explicit suffix teaching achieved even more significant improvements, which implies that overt teaching of a particular morphological principle enhances a child's knowledge of morphemes in a way that is even more valuable for spelling. This advantage of explicit teaching also held over 2 months later, which shows that the positive outcomes of morphological instruction for spelling were retained over time. This indicates that explicit instruction of affixes increases a child's understanding of derivational morphemes in a way that noticeably aids their spelling.

However, in spite of the success of teaching affixes in morphological intervention research, there is a dearth of studies in English that explicitly teach children about the first part of a word with a morphological structure, namely word stems. Teaching word stems could be beneficial for spelling because research has clearly shown that children experience a particular difficulty with the morphological connection that stem spellings are conserved across different words (see Burton, 2014; Carlisle, 1988; and Wright, 2013; Chapter 2.1.2.2). This lack of focus on teaching stems may result from the fact that stem teaching is a more difficult process to that of teaching affixes because affix-based principles involve teaching the meaning behind a fixed affix spelling (e.g. *-ed*), whereas stem-based principles involve teaching more generally that looking for a word stem (e.g. *discuss*) could help children to spell a related word (e.g. *discussion*) that might be difficult (see Chapter 1.4.1). This implies

that it would be useful for research to examine if children benefit from being explicitly taught the morphological principle for stems.

Although intervention research for teaching stems in English is limited, Kemper et al. (2012) performed a study that investigated the effect of explicit stem teaching on children's spelling in Dutch. The Dutch orthography, in a similar way to English, follows a "principle of uniformity," which upholds that morphemes are often spelled in the same way across different words in spite of changes in sound (Kemper et al. 2012). For instance, the spelling of a word stem like *hond* is often conserved in plural words like *honden* irrespective of the fact that the final *d* is pronounced as /*t*/ in the stem form. Kemper et al. (2012) investigated the effect of explicitly teaching this morphological principle on 6- to 8-year-old Dutch-speaking children's spelling. The children either received explicit stem instruction, implicit instruction that increased exposure to pairs of stems and plural words in the absence of explicit teaching, or no stem teaching in the control condition. The children were then asked to spell a series of word stems (e.g. *paard*) that had a related plural form (e.g. *paarden*) in which the stem spelling was conserved. They found that explicit teaching significantly improved the children's spelling of word stems in comparison to the implicit and control conditions. This provides some of the primary evidence to show that explicit morphological instruction does noticeably increase a child's understanding of word stem spellings, which means it is possible to hypothesise that explicit stem teaching could improve a child's spelling in English. This indicates that the next step in research is to directly assess if the benefit of explicit stem teaching reported in Dutch is generalisable to the English orthography by conducting a similar experiment using English words.

2.3.1 Do children need explicit teaching of morphemes to acquire explicit knowledge?

It is important to note that through explicit teaching of one aspect of morphology, children are inevitably exposed to both the stem and affix parts of a word. For instance, Nunes and Bryant (2006) presented children with whole derivatives (e.g. *musician* and *injection*) in their instruction of *-ion* and *-ian* suffixes so that the children could fully appreciate the difference between words that refer to a person and those that are abstract nouns. In much the same way, Kemper et al. (2012) exposed the Dutch-speaking children to entire plural forms in the training (e.g. *honden* and *vrienden*) so that they could appreciate how to conserve stem spellings across words. This implies that if children are, for example, taught the morphological distinction between the affixes of *-ion* and *-ian*, that they are exposed to whole words with a morphological structure like *election* in the teaching. This may enable them to strip the affix (e.g. *-ion*) from the word to recognise something explicitly about the morphological unit that is left behind, namely the stem (e.g. *elect*). This means that it could be hypothesised that through explicit teaching of one morphological unit, that children may acquire explicit understanding of the spelling of the taught word part, and also attain explicit knowledge of another, related aspect (e.g. word stems) that does not receive instruction. This is likely because research has shown that children acquire some knowledge of morphemes through repeated exposure to words with a morphological structure (e.g. Nunes and Bryant, 2006).

Alternatively, a second possibility is that explicit teaching of each particular morphological unit is necessary for children to acquire explicit knowledge of the two word parts. In this view, focusing explicit instruction on one morpheme (e.g. word stems) could detract attention from the other (e.g. affixes) and lead to limited explicit understanding of the

untaught skill. This is feasible because research has shown that if children are primed with a word stem and orally presented with whole derived forms, that they strip the affix (e.g. *-ion*) from the stem (e.g. *elect*) to focus on the primed word part (e.g. Rosa and Nunes, 2008; Wright, 2013; see Chapter 2.1.4). This implies that research studies should assess the extent to which explicit teaching of one morphological principle leads children to acquire explicit knowledge of other, associated rules.

2.3.2 Do children benefit from being explicitly taught about word stem and affix morphemes together?

It may be that children make the most noticeable improvements in spelling if they are explicitly taught about both word stems and affixes, in conjunction with one another. Although this it yet to be directly tested in research, Nunes et al. (2006) assessed if understanding both the stem and affix parts of a word enhances a child's spelling (see Chapter 2.2). They examined 7- to 9-year-old children's ability to conserve stem spellings in derivatives like *magician* and their ability to spell affixes at the end of regular past-tense verbs like *opened*. They found that the children's correct use of a word stem across derived forms and their correct use of the *-ed* morpheme across regular past-tense verbs was significantly correlated with one another. This implies that the children were noticeably more likely to spell a stem correctly across words if they also accurately applied affix spellings like the past-tense *-ed*. This suggests that children spell word stems and morphological endings correctly more often if they have knowledge of the meaning behind both of these morphological units.

As children appear to benefit from understanding both the stem and affix parts of a word, it could be hypothesised that explicit teaching of stems and affixes could significantly improve

children's spelling of words with a morphological structure. The question that now remains is how to explicitly teach children the meaning behind these two morphological units. It may be that children benefit from receiving simultaneous instruction of word stems and affixes at the same time or sequential instruction of the two morphemes in a particular sequence.

Simultaneous instruction of word stems and affixes could be beneficial for spelling as this type of teaching would visually present the two morphological rules at the same time so children could use visual processing to synthesise their knowledge of these two word parts together. Visually presenting these two morphological units at the same time is likely to be beneficial for spelling as it has been argued that visual processing plays a key role in children's spelling accuracy (Plaza and Cohen, 2006). Plaza and Cohen (2006) investigated the contribution of visual processing to 6-year-old children's spelling in French. The children were asked to visually identify target letters in an array of distractor items and their ability to visually process these letters was assessed in relation to their performance on a spelling task. Some of the French words that the children were asked to spell had a morphological structure, whilst others had a phonological structure. They reported that the children's ability to visually process letters significantly predicted their performance on the spelling task. This suggests that visual processing can enhance a child's spelling performance, which indicates that children may benefit from receiving simultaneous instruction of stems and affixes together.

Although simultaneous instruction could be beneficial for spelling, combined teaching could be too overwhelming for children because it has been argued that humans have a limited cognitive load in that they can only process a finite number of elements in working memory at any given time (Miller, 1956; Sweller, 1994). Pollock, Chandler, and Sweller (2002)

directly compared the effect of teaching participants all of the information about a particular topic at once with teaching isolated elements of information in a series of procedural steps. The participants were asked to provide self-report ratings of the mental effort that they felt was required in the training and they were also asked to complete a practical task to assess the knowledge they acquired. Pollock et al. (2002) found that the participants who were taught isolated elements of information performed significantly better on the practical task than participants who received all of the information at once. The self-report ratings also showed that the isolated elements group found their training significantly less demanding. This implies that being taught a few elements of information at any one time is beneficial for knowledge acquisition, and even though this research was not conducted with children, it suggests that teaching too much information at once could have a similar negative effect on their working memory.

Teaching children isolated elements of information in a step-by-step sequence has been directly examined in a study by Nunes and Bryant (2009). They sequentially taught 7- to 8-year-old children two related phonological spelling rules. The children were taught the *a-e* split digraph rule, which states that a word like *hate* sounds different to that of *hat* because the final *-e* changes the preceding vowel sound, followed by the *o-e* split digraph principle, which states that a similar change in vowel pronunciation arises between words like *hope* and *hop*. The children's spelling of *a* and *a-e* word (e.g. *cap* and *cape*) and pseudo-word pairs (e.g. *nad* and *nade*) was then assessed. They reported that sequential instruction of these two rules significantly improved the children's spelling of *a* and *a-e* words over and above that of a control condition that only received instruction of the first rule. This shows that sequential instruction of two related principles noticeably improves a child's understanding of phonology in a way that significantly improves their spelling. This

indicates that children could, in a similar way, benefit from being sequentially taught about two related aspects of morphology. This indicates that research should directly compare the effect of sequential instruction of stems and affixes with simultaneous teaching to see which approach effectively enhances a child's spelling.

If children are sequentially taught about morphemes, they may benefit from receiving instruction about word stems prior to instruction about affixes. Tyler and Nagy (1989) directly compared 9- to 15-year-old children's knowledge of word stems and affixes in their study. They asked the children to identify the meaning of stems in word pairs that did not contain a pronunciation change (e.g. *mild* - *mildness*) and to select the appropriate suffixed word to complete a series of sentences using a similar suffix choice task to Singson et al. (2000) (see Chapter 2.1.3). They found that the children struggled with both tasks, but that the youngest children (i.e. the 9- to 10-year-olds) experienced even more difficulty with the suffix-based test than the test relating to stems. This implies that children start to develop a basic understanding of word stems at an earlier stage than affixes. As children begin to process stems first, it is likely that sequential instruction of stems and affixes should be taught in this sequence.

2.4 Conclusions

It is clear from the wealth of research reviewed in this chapter that children acquire some knowledge of morphemes through their experiences with words in oral language, spelling, and reading, and that as a child's awareness of morphemes becomes more explicit, that this is associated with their ability to use morphemes effectively when attempting to read and spell. The intervention studies reported in this chapter also indicate that enhancing a child's

knowledge of morphemes to a more explicit level through instruction is of notable benefit for spelling. In fact, the research demonstrates that morphological teaching appears to be of a particular advantage for 7- to 9-year-old children.

It is also evident from this chapter that affixes have received greater attention in research than word stems and so the first experiment of the current study focuses on stems. This research extends the earlier literature to assess the differential effectiveness of implicit versus explicit teaching of the morphological principle for stem conservation on a child's spelling of stems in English. A child's everyday understanding of word stems is compared with explicit instruction, that directly teaches children the morphological rule for stems; and implicit instruction, that increases a child's exposure to word stems in the absence of explicit teaching. This tests the hypothesis that explicit teaching would lead to more significant improvements in children's spelling of stems in derivatives than implicit instruction, and that implicit stem teaching would lead to greater enhancements than no instruction.

It is also apparent from the review that studies are yet to be conducted that examine if explicit teaching of one morphological unit (e.g. word stems) improves a child's spelling of that specific aspect of a derivative, and also enables children to attain explicit knowledge of a related aspect (e.g. affixes) that does not receive instruction. The effect of explicit stem teaching is compared with explicit teaching of the morphological distinction between the affixes of *-ion* and *-ian* and no morphological teaching on a child's spelling of these two word parts in derivatives. This tests the hypothesis that explicit teaching of one aspect of morphology would significantly improve a child's spelling of that particular part of a derived word, with some explicit understanding of the spelling of the other, untaught aspect.

There is also a distinct lack of research in the literature that investigates the benefit of explicitly teaching children morphological principles about both word stems and affixes together. The third experiment attempts to address this deficit and compares simultaneous teaching of word stems and affixes, with sequential teaching of the two rules, one after the other, and no morphological instruction in relation to a child's spelling of both word stems and affixes in derivatives. This tests the hypothesis that explicitly teaching children the two rules, either simultaneously or in sequence, would significantly improve their spelling of the two word parts in derivatives to a greater extent than no morphological instruction.

To summarise, the research reviewed in this chapter provides a clear framework from which to test the hypotheses of the current study. The next step, which will be addressed in the following chapters, is to describe the three experiments that assess if morphological teaching is an effective way of enhancing a child's knowledge of morphemes for spelling.

Chapter 3: Methodology and Results for Experiment 1 – Implicit and explicit teaching of word stem morphemes for spelling

3.1 Background

3.1.1 Word stem morphemes

It is clear from Chapters 1 and 2 that spelling in a morphophonemic orthography, such as English, requires an understanding of both phonology and morphology (Jaffré, 1997; Venezky, 1967, 1970). Morphology is important for spelling because in many English words morphology overrides the spelling that would be predicted on the basis of the word's sounds (see Chapter 1.1; Venezky, 1999). For instance, the spelling of word stem morphemes like *magic* are often conserved in derived words like *magician* even though the vowel sound changes and the letter *c* changes in pronunciation from /*k*/ to /*sh*/. The purpose of the current experiment is to examine the extent to which children acquire knowledge of this morphological principle for stem conservation through their regular encounters with words and if they would benefit from having their understanding enhanced for spelling through some form of direct instruction.

3.1.2 Children's knowledge of word stems

Carlisle (1988) investigated a child's knowledge of word stem morphemes for spelling through their everyday encounters with words (see Chapter 2.1.2.2). She compared 9- to 13-year-old children's ability to spell and produce orally pairs of word stems and derivatives (e.g. *magic* - *magician* and *enjoy* - *enjoyment*) that contain the same stem spelling across

both forms even when there is a change in pronunciation. She found that the children's spelling performance lagged behind their ability to generate the words orally. She also reported that the children experienced more difficulty with spelling word pairs that contained a pronunciation change than those that did not. This shows that children often struggle to appreciate the morphological rule for stem conservation in a way that is useful for spelling.

Sénéchal et al. (2006) performed a similar study in the French orthography. They asked 9-year-old French-speaking children to spell word stems like *regard* that are spelled the same in derived words like *regarder* even though the silent letter *d* is only pronounced in the derived form. The children were also asked to report the strategies that they used to spell the words. Sénéchal et al. (2006) found that 34% of the children reported using a morphological strategy, such as that they used a related word, to accurately spell the silent letter *d* at the end of the stem spellings. This shows that only a small proportion of the children could use their knowledge of stems to assist their spelling, which indicates, in accordance with Carlisle's (1988) study, that a child's understanding of word stem morphemes is limited for accurate spelling, and that there may be an advantage of improving their knowledge through morphological teaching.

Burton (2014) and Wright (2013) also both examined a child's understanding of word stems for spelling. They independently assessed 7- to 9-year-old children's spelling of word stems in derivatives (e.g. *inject* in *injection*) and found that they were biased towards writing all stem endings with *t* even if they should be spelled with the letters *ss* (e.g. *discuss*) or *c* (e.g. *magic*). This implies that the children were relying on the high frequency of *t* stem endings in English (MRC Psycholinguistic Database, 1987), rather than the morphological rule for

stems, to spell the derived words. This provides further evidence to indicate that it may be beneficial to enhance a child's understanding of stems through direct instruction of the morphological principle for stem conservation.

3.1.3 Teaching children about word stems for spelling

It is possible that children benefit from having their knowledge of word stem morphemes improved through direct teaching. For instance, it may be worthwhile for children to receive explicit instruction of the morphological rule for stems, or implicit stem teaching, which exposes children to word stems in the absence of explicit teaching of the rule. Yet, there is a distinct lack of morphological intervention studies in English that overtly teach children about stems for spelling. Instead, the vast majority of this research has focused on teaching children morphological principles about affixes.

Nunes and Bryant (2006) compared explicit versus implicit teaching of affixes in their study (see Chapter 2.3). They focused on teaching children the morphological distinction between the affixes of *-ion* and *-ian*. The children received training games that either implicitly exposed them to derivatives with *-ion* and *-ian* endings or exposed them to these materials in conjunction with explicit teaching of the morphological rule. They found that explicit teaching significantly aided the children's spelling of affixes in derivatives over and above that of implicit instruction, and that implicit teaching led to more significant spelling improvements than a control group that did not receive any morphological instruction. This shows that children benefit from having their understanding of morphemes enhanced through explicit teaching.

Whilst research on teaching stems in the English orthography is limited, Kemper et al. (2012) directly investigated the effect of explicit stem instruction on 6- to 8-year-old children's spelling in Dutch. They compared implicit versus explicit instruction of the principle that the spelling of a word stem like *hond* is conserved in plural words like *honden* even though the final *d* is pronounced as /*t*/ in the stem form. They reported that explicit teaching significantly improved the children's stem spelling in comparison to those that received implicit instruction and a group of control children. This shows that children benefit from receiving explicit instruction of stems in Dutch, which implies that it is necessary to assess if this advantage of stem instruction arises in the English orthography.

3.1.4 Experiment 1

The aim of the first experiment of the current study was to investigate the differential effectiveness of implicit versus explicit teaching of the morphological spelling rule for the conservation of stems in English. The effect of explicit stem teaching was compared with implicit and no stem teaching in a similar way to previous research (e.g. Kemper et al. 2012; Nunes and Bryant, 2006) to determine if children benefit from having their understanding of stems enhanced for spelling. Seven to 9-year-old children were assessed because previous morphological intervention research has reported positive effects for teaching morphemes in this age group (e.g. Devonshire and Fluck, 2010; Kemper et al. 2012; Nunes and Bryant, 2006; Nunes et al. 2003). It was hypothesised that explicit teaching would lead to more significant improvements in children's spelling of stems in derivatives than implicit teaching, and that implicit instruction would lead to more significant enhancements than no stem teaching.

3.2 Method

3.2.1 Participants

Participants were 90 children in Years 3 (age range = 90-101 months; *M* = 95 months; *SD* = 3.56 months) and 4 (age range = 102-113 months; *M* = 107 months; *SD* = 3.57 months) from three state-supported primary schools in Hampshire and Oxfordshire. There were 43 girls and 47 boys in the sample and the study was conducted towards the middle of the school year between March and July. A larger pool of children was recruited than necessary, which enabled 30 children to be randomly selected from each school to participate. The inclusion of children from three schools spanning two counties led to a sample that was ethnically diverse and included a range of socioeconomic backgrounds. All of the children that participated spoke English fluently and this included those who spoke English as a second language (*n* = 11) or had recognised learning difficulties (*n* = 9).

The children were initially recruited by approaching the Head Teachers of ten state-supported primary schools. The schools were contacted by sending a letter to each Head Teacher to describe the purpose of the research and the benefit of the study for the children's spelling (see Appendix A). Once access to three schools had been granted, information letters and "opt-out" consent forms were sent to the parents or guardians of the children (see Appendix B). After consent had been acquired, each child's verbal assent was also attained to ensure that they were happy to participate (BERA, 2018; BPS, 2014).

3.2.2 Design

An experimental research design was employed with random assignment at the child level within the same class. Children were assigned to one of three groups: an explicit stem intervention group (n = 30), an implicit stem intervention group (n = 30), or an unseen control group (n = 30). All three groups were asked to complete a pre-test measure to assess their spelling of stems in derivatives prior to the teaching. The pre-test examined if there were any differences in spelling between the conditions at the start of the study and was delivered to all three groups within the same testing session. After the pre-test, the explicit and implicit groups received a morphological intervention, whereas the unseen control condition did not receive any form of activity. All of the children were given a post-test assessment after the intervention had been completed, which contained the same spelling test as the pre-test measure. This was then subsequently repeated after a two-week delay to assess if any knowledge acquired from the intervention was likely to be stored in their long-term memory.

The three groups of children were provided with a short morphological intervention at the end for ethical reasons that was delivered in a whole class session. This provided an opportunity for all of the children, irrespective of experimental condition, to benefit from the study and acquire an understanding of morphology that could assist their spelling. The same experimenter administered the materials throughout and the pre- and post-tests were delivered in whole group sessions, which noticeably reduced the possibility of bias in the administration.

3.2.3 Measures

3.2.3.1 Pre-test and post-test assessments

The pre-test and post-test were a spelling test that was completed individually by each child and administered on a whole-class basis in each primary school by the researcher; a native speaker of English. The test was developed for this experiment on the basis of Nunes and Bryant's (2006) well-established spelling activity for assessing morphology and involved presenting children with a series of 24 written sentences that contained a missing word or pseudo-word that the children were asked to spell. Each of the sentences was read aloud to the children, including the missing word, and this word was repeated both before and after the sentence so that the children could clearly hear the target word. For example, the children heard the sentence "The man who plays the piano is a *musician*" and they were asked to write down the spelling of the word *musician* in the gap in the sentence on their answer sheet. The list of sentences is presented in Appendix C and example answer sheets are provided in Figures 3.1 and 3.2.

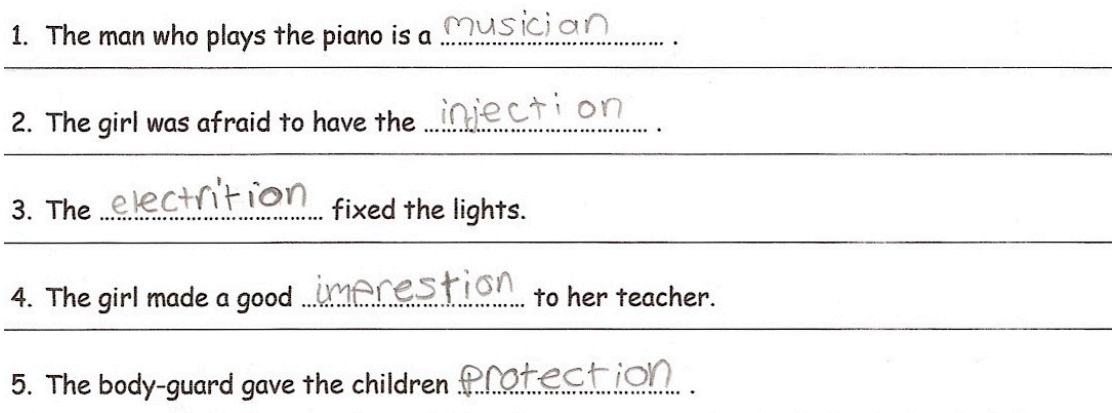


Figure 3.1. Example of the first part of an answer sheet for the pre-test and post-test for words.

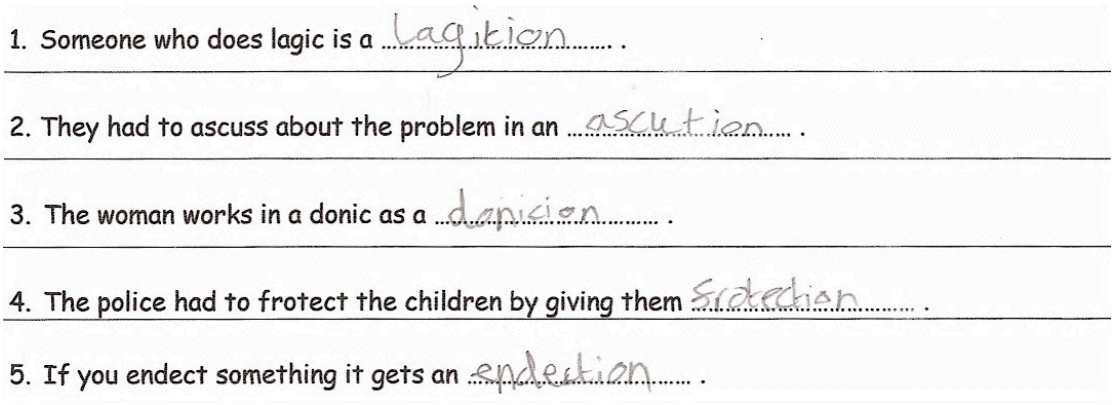


Figure 3.2. Example of the first part of an answer sheet for the pre-test and post-test for pseudo-words.

In the task, all of the word and pseudo-word derivatives were comprised of a word stem plus *-ion* or *-ian* suffix. The researcher designed the test in such a way that the word stems contained a variety of each of the stem endings of *t*, *ss*, and *c* and the spelling of each of these endings was preserved in the derivatives in spite of changes in sound. The inclusion of a variety of stem endings accounted for any bias towards particular spellings because research has indicated that children's spelling is influenced by the frequency of certain letter patterns in English (e.g. Burton, 2014; Kemp and Bryant, 2003; Wright, 2013) (see Chapter 2).

Pseudo-word derivatives (e.g. *lagician*) were also included in the task and the children were provided with a related pseudo-word stem (e.g. *lagic*) in each sentence because they would have had no way of knowing the stem spelling if they only heard the derived form. Pseudo-words provide evidence for knowledge of morphology because if, after teaching, children correctly spell word stems in pseudo-words that they have never encountered in print before, it suggests that they know something about morphology because they could not have previously acquired word-specific knowledge of these spellings by rote. If children struggle to spell stems in pseudo-word derivatives at pre-test or in the unseen control group, it

indicates that they have limited knowledge of the principle for stems and implies that they may benefit from receiving some form of morphological instruction.

The children's answers in the pre-test and post-test were marked as correct on the basis of their spelling of the stem ending in each word or pseudo-word derivative. The stem ending was assessed in the scoring as this is the part of the stem that is conserved even when phonology predicts that the ending should be spelled as *sh*. Any other parts of the word or pseudo-word were not considered as it did not matter whether the children spelled the whole word stem correctly or applied the correct suffix of *-ion* or *-ian*. For example, the children received a mark for writing *injection* as *ingecton* because they successfully preserved the stem ending *t* in the derivative.

3.2.3.2 Morphological interventions

In between the pre-test and post-tests, the children in the implicit and explicit stem groups were seen on a one-to-one basis by the researcher for a morphological intervention that was divided into two parts: a teaching session and a training game. As the unseen control group did not receive any form of morphological instruction, they are not noted in this section.

3.2.3.2.1 Teaching session

In the teaching session, the children in the implicit and explicit intervention groups were presented with a series of slides on a computer that were developed by the researcher using Microsoft Power Point. The slides displayed a set of word stems (e.g. *magic*) and each child was asked how they thought related derivatives (e.g. *magician*) should be spelled. They were

then asked to try to spell the derivatives on the answer sheet provided. The children were shown the correct spellings and only the explicit stem group was encouraged to say if they saw any similarity between words like *magic* and *magician*. At this point, the explicit group were also taught that an easy way to spell words like *magician* is to think about if that word is related in meaning to another smaller one like *magic*, which is contained within it. They were taught that these smaller words are word stems whose spelling remains the same when a suffix (e.g. -*ian*) is added in spite of changes in sound. The children were also taught that when stems end in -*e*, -*y*, or -*s*, the last letter must be removed before adding the -*ian* ending (see Ganske, 2008; Nunes and Bryant, 2009). The implicit stem group did not receive this explicit teaching. Instead, the children were exposed to the same slides about the derivatives, but were not asked to explain anything about the words and were not directly taught the morphological rule for stems. Figure 3.3 presents an example of the Power Point slides that were presented in the explicit and implicit morphological teaching sessions.

		
Explicit stem intervention group 1. The children were presented with the word *magic* on a Power Point slide and asked how they thought the related word *magician* should be spelled. They were asked to try to spell this word on the answer sheet provided.	2. The children were presented with the correct spelling of the word *magician* and asked to explain if they saw any similarity between the two words *magic* and *magician*.	3. They were then taught that an easy way to spell *magician* is to think about if that word is related in meaning to another smaller one like *magic* that is contained within it. They were told that these smaller words are stems whose spelling remains the same when a suffix, such as the *-ian* ending, is added in spite of changes in sound.
Implicit stem intervention group 1. The children were presented with the word *magic* on a Power Point slide and asked how they thought the related word *magician* should be spelled. They were asked to try to spell this word on the answer sheet provided.	2. The children were presented with the correct spelling of the word *magician*, but were not asked to explain anything about the two words *magic* and *magician*.	3. They were not taught the morphological principle for stem conservation.

Figure 3.3. Example of the Power Point slides for one of the word stem and derivative pairs administered in the explicit and implicit teaching sessions.

3.2.3.2.2 Training game

The children in both the implicit and explicit stem groups were then presented with a computer-based spelling game that was designed and developed by the researcher of the

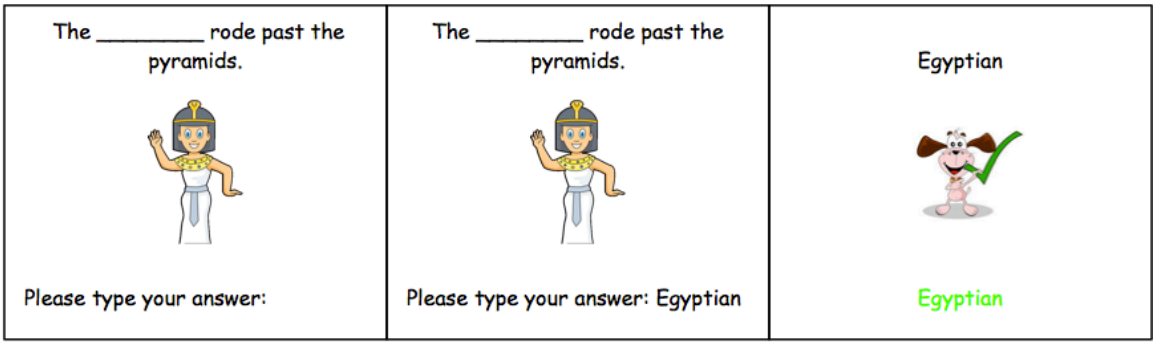
current study using Matlab programming software (see Appendix D). The two taught groups received exactly the same procedure so that the only difference between the conditions was the teaching session before the game.

The game followed a similar format to the pre-test and post-test; it involved the visual and oral presentation of 30 sentences, each of which contained a missing derivative that the children were asked to spell (see Appendix E). The sentences were administered in a series of trials and the children were asked to type the spelling of each derived word using a child-friendly keyboard, which had clear, bright, and easily identifiable letters. They were asked to type the words because using a computer is engaging and research has shown that 6- to 11-year-old children are equally accurate at producing individual alphabetic letters by keyboard as by pen (Berninger, Abbott, Augsburger, and Garcia, 2009). This level of accuracy was acquired across a sample of 459 children that were not screened for learning difficulties so this could arguably be reflective of typical patterns in the primary school classroom. The children's spellings were marked as correct on the basis of their stem ending spelling in each derivative in the same way as at pre- and post-test (see Chapter 3.2.3.1). At the end of each trial, the children were presented with the correct spelling of each derivative and received feedback on their response before proceeding to the next sentence. None of the words used in the pre-test and post-test were included in the training game.

The number of stem endings that each child spelled correctly in the game was assessed in relation to a criterion, which was interpreted as assessing if the children could be considered to have learned the morphological principle for stems. The criterion was used as a stopping rule, used to reduce the chance that children who had acquired an understanding of the morphological principle would experience inattention or fatigue effects if they had to

continue to answer the items. A relatively stringent criterion was set to minimise the likelihood that the children were spelling each word correctly by chance without using the rule. The binomial distribution was considered at the probability value of 0.33, considering that the children received trials on three stem endings, *t*, *ss*, and *c*. The criterion was stringent because they might not have stopped using the phonological representation, *sh*. With this criterion, the cumulative probability of children spelling 15 words correctly in 30 trials by chance was 0.04. If a child reached 15 correct spellings, the game interrupted and they received no further trials. If the children failed to reach the criterion, the game was repeated for a second time. Figure 3.4 presents two example trials from the Matlab spelling game.

a) A correctly answered trial:



b) An incorrectly answered trial:

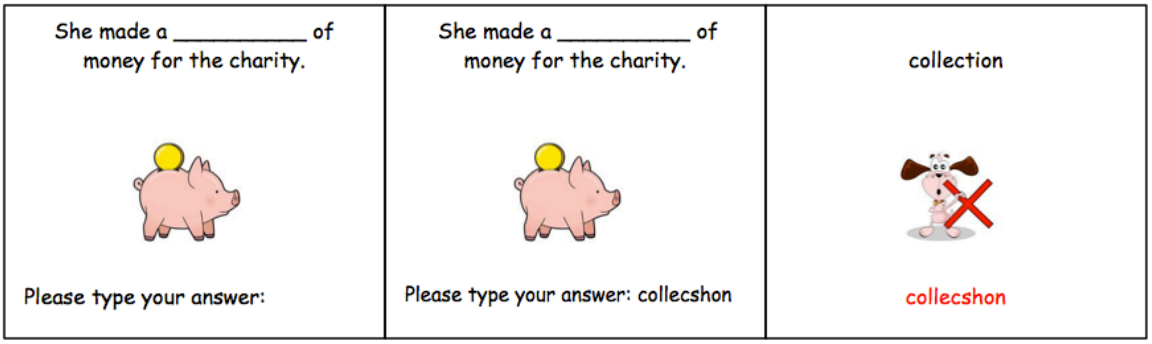


Figure 3.4. Example of two trials from the Matlab training game.

3.3 Results

3.3.1 Criterion results

All of the children that received explicit teaching reached the criterion for stems. Ninety percent of the explicit group successfully reached the criterion during the first presentation of the game, whereas only 37% of the implicit stem condition reached this criterion in the first presentation. The explicit stem group took an average of 20 trials to reach criterion, whereas the implicit group only did so after completing most of the trials (i.e. 28). The children that failed to reach the criterion were asked to repeat the game for a second and final time; all of the children in the explicit condition successfully reached it on their second attempt compared with only two children from the implicit group.

3.3.2 Intervention results

It was hypothesised that explicitly teaching children the morphological principle for stem conservation would lead to more significant improvements in their spelling of stem endings in derivatives than implicit teaching, and that implicit teaching would lead to greater spelling enhancements than no teaching. The children's mean spelling scores across the three groups were examined and are presented in Table 3.1. The table shows that the mean number of correct stem ending spellings in word and pseudo-word derivatives was noticeably higher in the explicit stem group than the implicit or control conditions, and this effect was evident at both immediate and delayed post-test. There was a slight increase in spelling in the implicit stem group at both post-tests in comparison to the controls, but this increase was noticeably lower than that of the explicit group.

Table 3.1

Mean (SD) number of correct stem ending spellings in word and pseudo-word derivatives by group.

Group	N	Words			Pseudo-words		
		Pre-test	Immediate Post-test	Delayed Post-test	Pre-test	Immediate Post-test	Delayed Post-test
Explicit Stem	30	3.40 (3.20)	7.50 (2.21)	6.87 (2.87)	3.17 (3.17)	7.40 (3.75)	6.70 (3.73)
Implicit Stem	30	3.30 (2.77)	4.87 (2.69)	4.50 (3.09)	3.10 (2.83)	4.53 (3.48)	4.47 (3.74)
Unseen Control	30	3.43 (2.70)	3.10 (2.55)	3.13 (2.56)	3.20 (2.71)	2.77 (2.47)	2.97 (2.76)

3.3.2.1 Pre-test scores

A comparison of stem ending spelling scores at pre-test revealed that there was not a significant difference in spelling across the three groups at the start of the study for both words, $F(2, 87) = 0.02$, $p = .983$, $\eta_p^2 = .00$, and pseudo-words, $F(2, 87) = 0.01$, $p = .991$, $\eta_p^2 = .00$. This indicates that random assignment produced groups that were largely equivalent in terms of morphological knowledge at the start of the study.

3.3.2.2 Intervention effects for word and pseudo-word stem ending spelling

To test the prediction that the children's word and pseudo-word stem ending spellings in derivatives would differ significantly between the three experimental groups across the three time points, two 3 (group) x 3 (testing occasion) mixed analyses of variance (ANOVA) were carried out, with intervention group (explicit stem, implicit stem, unseen control) as the between-subjects factor, and test at different times (pre-test, immediate post-test, delayed post-test) as the within-subjects factor. Mauchly's test indicated that the assumption of sphericity had been violated for words, ($\chi^2(2) = 13.76$, $p < .05$), but not pseudo-words, so it

was necessary to correct the degrees of freedom for words using the Greenhouse-Geisser correction. The analysis revealed that there was a significant main effect of time on the children's word stem ending spelling, $F(1.74, 151.58) = 35.06$, $p < .001$, $\eta_p^2 = .29$, and on their pseudo-word spelling, $F(2, 174) = 23.24$, $p < .001$, $\eta_p^2 = .21$. This indicates that the children's stem spelling differed between some of the time points that the test was administered. There was also a significant time x intervention group interaction effect for word, $F(3.49, 151.58) = 18.79$, $p < .001$, $\eta_p^2 = .30$, and pseudo-word stems, $F(4, 174) = 13.11$, $p < .001$, $\eta_p^2 = .23$. This shows that the children's spelling accuracy at some of the time points differed depending on the type of teaching that they received.

Planned contrasts for the time variable were examined even though the comparisons did not take the intervention groups into account. The contrasts revealed that the children's word and pseudo-word stem ending spellings differed significantly between pre-test and immediate post-test ($p < .001$), and between pre-test and delayed post-test ($p < .001$). This shows that the children's spelling performance improved post-teaching. There was not a significant difference in word ($p = .079$) or pseudo-word ($p = .460$) stem ending spelling between the two post-tests. This shows that there was not a significant decay in spelling performance after the teaching stopped and that there was no further improvement without teaching.

Means for the children's stem ending spellings in derivatives at the three time points are presented graphically for words and pseudo-words in Figures 3.5 and 3.6. The figures clearly show that the mean number of correct stem ending spellings for words and pseudo-words was largely equivalent across the three groups at pre-test. At the two post-tests, the mean

number of correct spellings was highest for the children in the explicit group, then the children in the implicit condition, and lastly the children in the unseen control group.

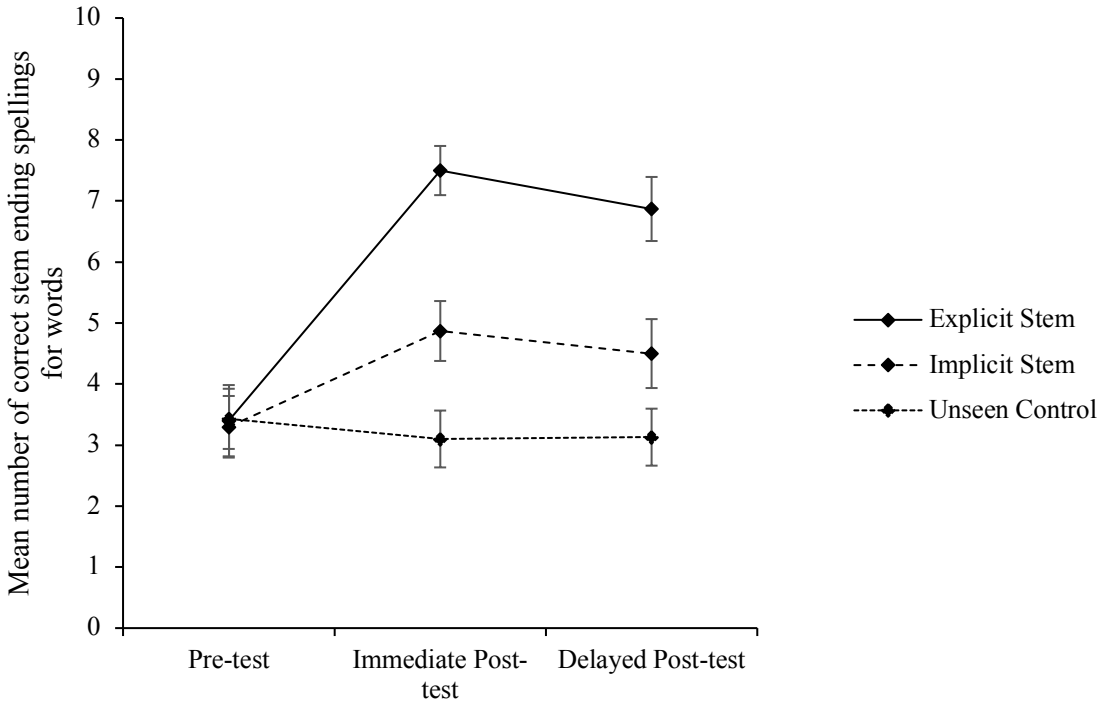


Figure 3.5. Means for the children's word stem ending spellings in derivatives for each intervention group at pre-test, immediate post-test, and delayed post-test. Error bars represent standard errors of the means.

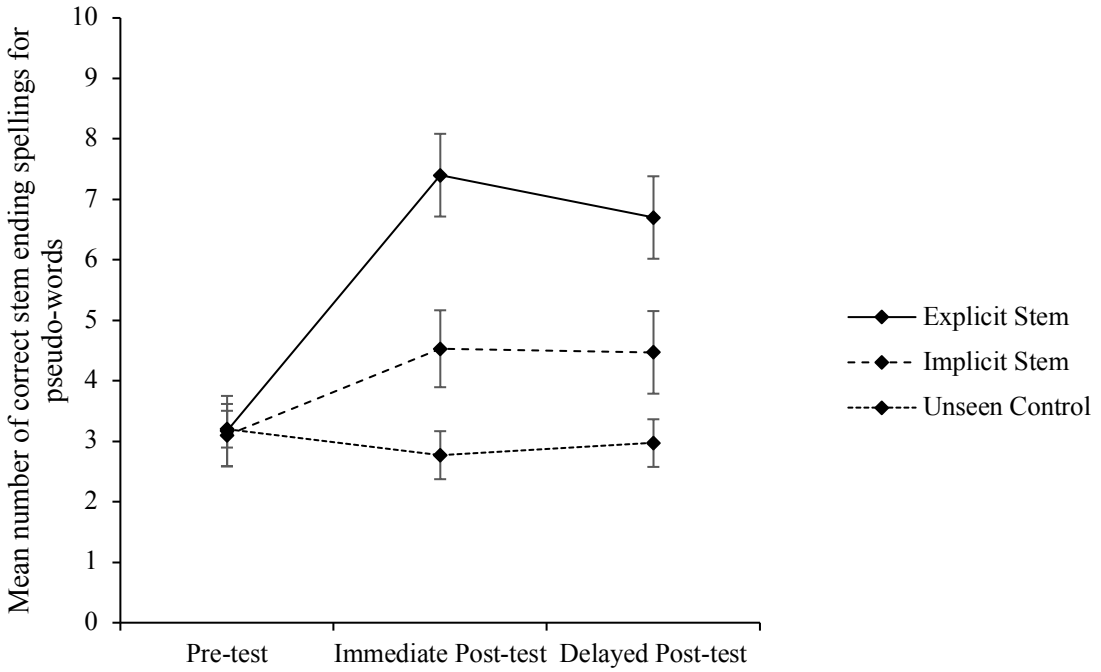


Figure 3.6. Means and standard errors for the children's stem ending spellings in pseudo-word derivatives for each experimental condition at the three testing occasions.

Post-hoc tests performed using the Bonferroni adjustment revealed that there was a significant difference between the explicit and implicit stem intervention groups in terms of word stem ending spelling at both immediate ($p < .001$, $d = 1.07$) and delayed post-test ($p < .05$, $d = 0.80$), and in terms of pseudo-word spelling at these two testing occasions ($p < .05$, $d = 0.79$ and $d = 0.60$). This was also apparent between the explicit and unseen control groups, which differed significantly in terms of word ($p < .001$, $d = 1.85$ and $d = 1.38$) and pseudo-word ($p < .001$, $d = 1.49$ and $d = 1.15$) stem ending spelling at both time points. Although there was a significant difference between the stem spellings of the implicit and unseen control groups at immediate post-test for words ($p < .05$, $d = 0.68$), this effect was not maintained by the time of the delayed post-test ($p = .200$). There was not a significant difference between the pseudo-word stem ending spellings of the implicit and control conditions at either post-test ($p = .120$ and $p = .285$).

These findings provide support for the prediction that explicitly teaching children about word stems significantly improves their spelling of stem endings in derivatives in comparison to implicit or no stem teaching. This beneficial effect did not only enhance the children's spelling in the short-term, but rather it was maintained over time. The children that received implicit or no stem teaching struggled to conserve the spelling of stem endings in derivatives due to a lack of morphemic instruction. Although the implicit group had some benefit over the controls for the spelling of words, this effect was not maintained over time, or for pseudo-words, which indicates that increasing children's exposure to stems is unlikely to noticeably improve their spelling outcomes. The advantage of explicit teaching also held for pseudo-words, which suggests that is it likely that the explicit stem group acquired an understanding of the morphological principle for stems as they accurately applied this rule to words that they could not have previously memorised by rote.

3.3.3 Change in stem ending spellings over time

It was also worthwhile to examine the frequency of word and pseudo-word spellings that the children in the three intervention groups wrote with the stem ending *t* at pre-test in comparison to the two post-tests. This was beneficial because previous research has shown that in the absence of morphological instruction children are noticeably biased by the higher frequency of *t* stem endings in English and often write all stem endings with *t* even if they should be written with the letters *ss* or *c* (see Chapter 2.1.2.2; Burton, 2014; Wright, 2013). It was predicted that the children in the explicit stem group would be biased towards the *t* spelling at pre-test and that this would decline considerably after instruction at post-test. It was also expected that the implicit stem group would experience a slight decline in use of *t*

over time, but that the unseen control condition would be biased towards *t* at all three time points.

Figure 3.7 shows, in line with the prediction, that at pre-test, the explicit stem group were biased towards writing all word and pseudo-word stem endings with *t* irrespective of whether they should be written with *ss* or *c*. For instance, the children wrote the *t* spelling 49% of the time in stems ending in *t*, but also 37% of the time in stems ending in *ss* and in 47% of stems ending in *c*. This shows that children often overgeneralise the *t* spelling to the incorrect places such as by writing *musician* as *musition.* This indicates that in the absence of explicit teaching, children often rely on the higher frequency of *t* stem endings in English, rather than the morphological principle for stem conservation, to spell stems in derived words.

The children's bias towards *t* declined considerably by the time of the two post-tests and they were more likely to apply the *t* ending to the correct instances. At immediate post-test, the children in the explicit stem group only used the *t* spelling in 13% of stems ending in *ss* and in 32% of stems ending in *c*, whereas they correctly used the *t* ending in 92% of stems that should be spelled with *t* (see Figure 3.7). This implies that explicitly teaching children about word stems reduced their bias towards using frequency and increased their use of morphology for the spelling of stems.

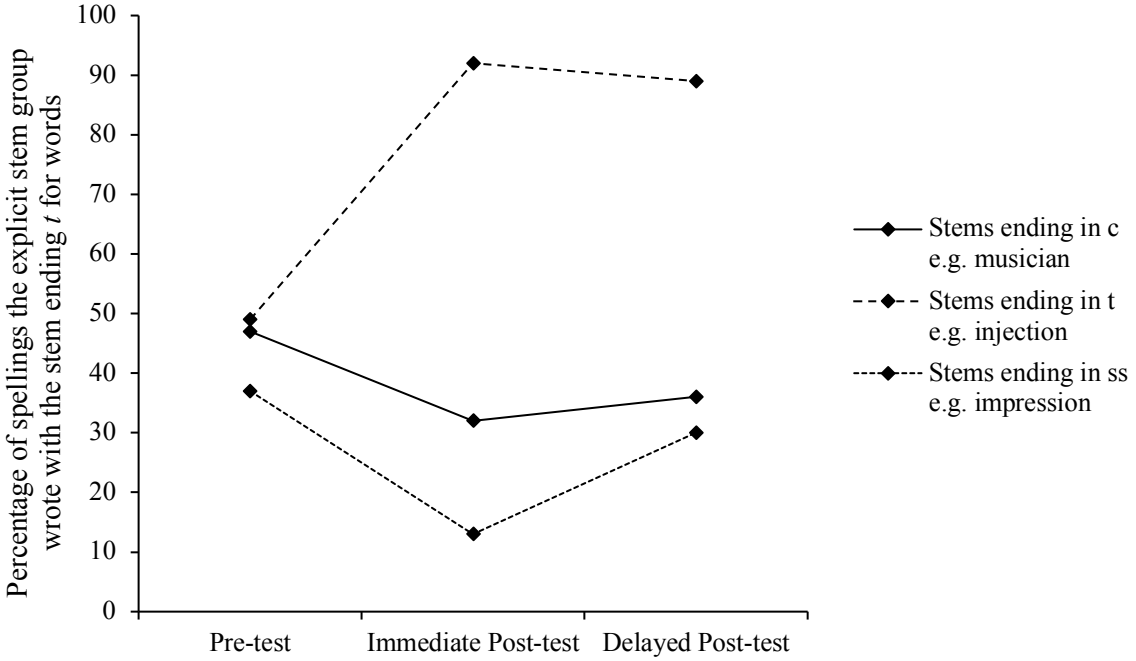


Figure 3.7. Percentage of derived words the explicit stem group spelled with the stem ending *t* at pre-test, immediate post-test, and delayed post-test.[1]

Figure 3.8 shows that the implicit stem group displayed a similar pattern of *t* spellings to the explicit condition; they were biased towards *t* for all three stem endings at pre-test, but this bias declined post-teaching. Yet, the reduction in use of *t* for the implicit group was smaller than that of the explicit condition, with an even lesser decline by the time of the delayed post-test. This implies that children start to recognise something about morphemes through implicit teaching, but that mere exposure to words with a morphological structure is largely insufficient for children to grasp the morphological rule for stems.

[1] Note: The derived word *librarian* was not included in Figures 3.7, 3.8, and 3.9 because this stem ending is not spelled with one of the endings of *t*, *ss*, or *c*. This word was included in the pre-test and post-test to see if the children understood the *y* drop rule for stems ending in *y*.

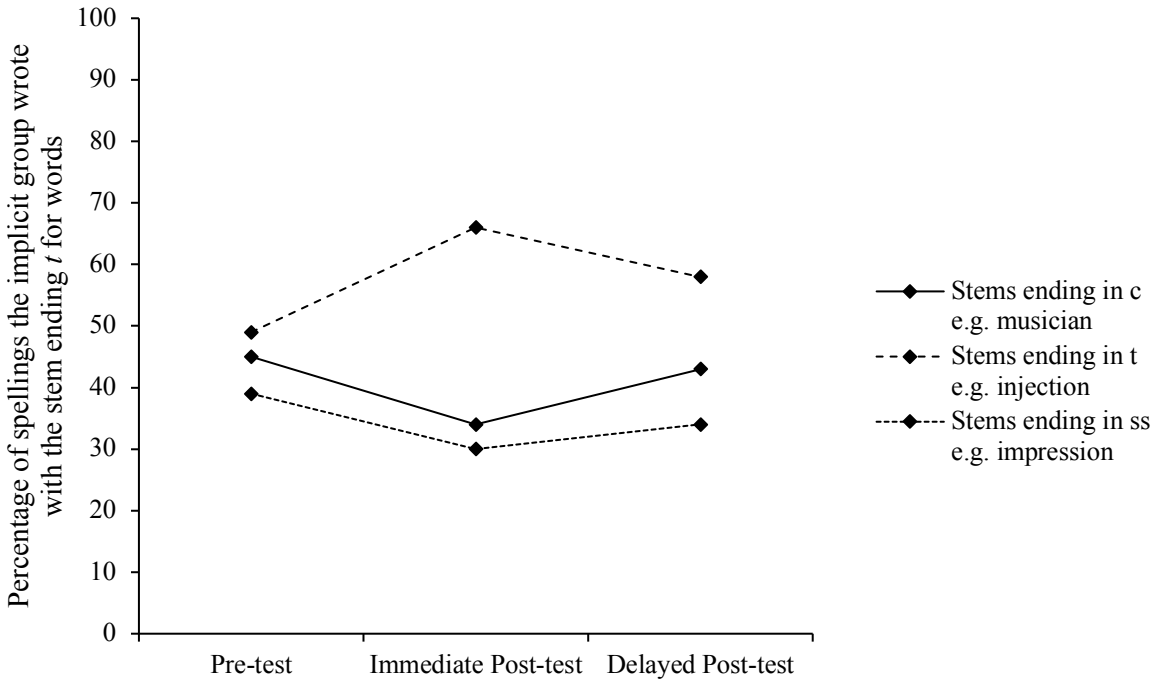


Figure 3.8. Percentage of derivatives the implicit stem group wrote with the stem ending *t* at the three time points.

Figure 3.9 displays the frequency of *t* spellings for the unseen control condition. The graph shows that the children were biased towards using *t* at all three testing occasions and that this effect remained relatively consistent over time. For instance, the children spelled stems ending in *ss* with the *t* spelling 39% of the time at pre-test, 37% of the time at immediate post-test, and 40% of the time at delayed post-test. This shows that the children's spellings were not influenced by encountering the same spelling test on multiple occasions. Graphs for the children's frequency of *t* stem ending spellings for pseudo-words are presented for each intervention group in Appendix G and they display a similar pattern to that reported for words.

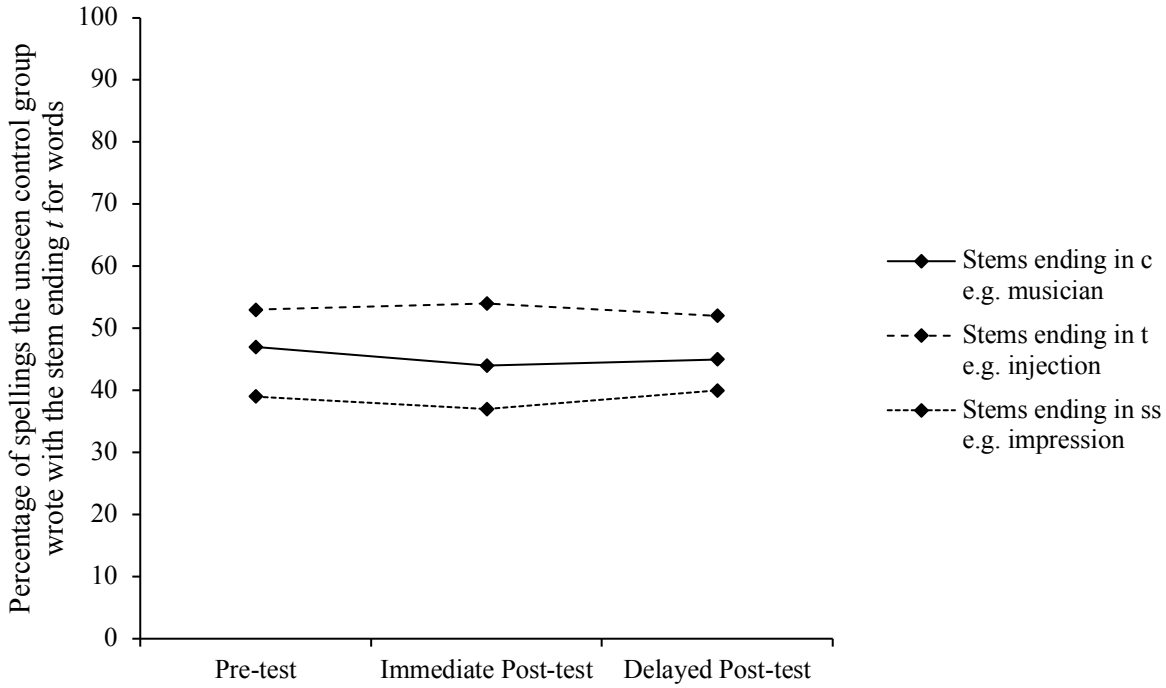


Figure 3.9. Percentage of derived words the unseen control group wrote with the stem ending *t* at pre-test and the two post-tests.

Close inspection of the children's answer sheets also revealed that prior to morphological teaching, the children did not only misspell the derivatives by using the stem ending *t*, they also had a tendency to make several phonetic errors by using the phonological representation of the word's spelling, *sh*. The letter sequence, *sh*, was not included in the frequency graphs because there are no derived words in English that contain this stem ending. In fact, *sh* only arises in 22 English words in total (MRC Psycholinguistic Database, 1987). This implies that the children did not only rely on frequency, they also used phonology, in place of morphology, for the spelling of stem endings in derivatives. An example of the children's phonetic misspellings at pre-test is presented in Figure 3.10.

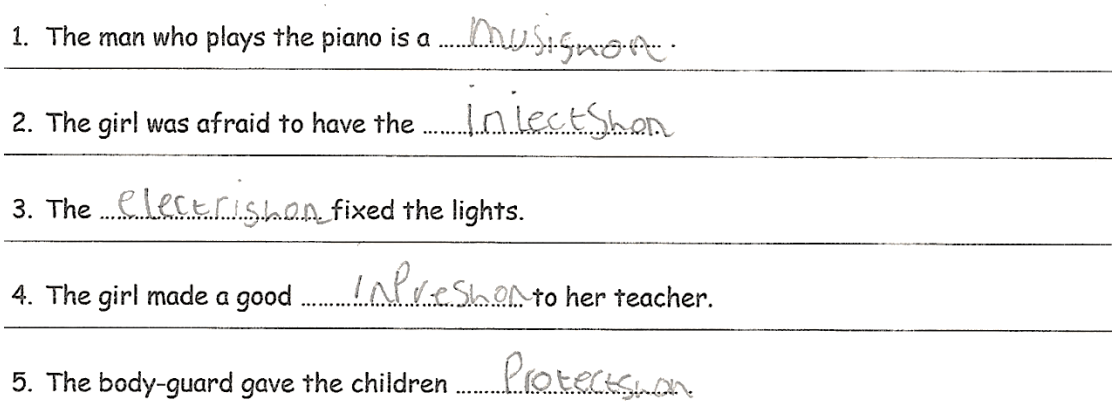


Figure 3.10. Example of the children's use of the phonological representation, *sh*, at pre-test.

3.4 Discussion

The aim of the current experiment was to extend previous research to assess the differential effectiveness of implicit versus explicit instruction of the morphological principle for stem conservation on a child's spelling of stems in derived words in English. The findings show, in line with the hypothesis, that explicitly teaching children about word stems led to more significant improvements in their spelling of stems in derivatives than implicit or no stem teaching. This suggests that children benefit from having their understanding of stems, as reported by Burton (2014), Carlisle (1988), and Wright (2013), enhanced through explicit instruction. This falls in line with previous morphological intervention research by Kemper et al. (2012) and Nunes and Bryant (2006), which shows that explicit instruction is an effective way of improving children's understanding of morphology. The results of the current experiment actually extend beyond this earlier research by showing that the positive effect of explicit stem teaching reported in Dutch is also observed in English. This shows that the advantage of stem teaching is not only applicable to one niche area, but rather has the potential to be appropriate for a number of languages.

It is also important to acknowledge that whilst explicit teaching was by far the most effective approach, the children who received implicit instruction were significantly better at spelling real word derivatives than those in the unseen control condition. This suggests, in line with the prediction, that increasing children's exposure to word stems, in the absence of explicit teaching, did lead to some improvements in children's spelling. Yet, this advantage of implicit teaching was only evident when the children spelled words immediately after instruction and was not sustained after the two-week delay or for pseudo-words. In contrast, explicit teaching led to significant improvements that were maintained after a delay and across the two word types, which suggests that the knowledge acquired from explicit instruction was more likely to enter the children's long-term memory. This supports the conclusion made by Kemper et al. (2012) and Nunes and Bryant (2006) that explicit teaching of morphemes is more beneficial for spelling than implicit instruction.

As explicit teaching of stems led to significant improvements in a child's stem spelling, the results of the current experiment also indicate that children have the capacity to analyse words into morphological units. This provides evidence to suggest, in line with Taft's (1979; 1991) theory (see Chapter 1.2.2; Chapter 2.1.4), that words are represented in the brain not only as whole units, but also in a morphologically segmented form. As this result also extended to pseudo-words (e.g. *lagician*), it shows that the children were using affix stripping to concentrate on the stem because they could not have been relying on word-specific knowledge to reach the correct stem spelling.

The findings also show that prior to morphological teaching, the children were biased towards writing all stem endings in derivatives with *t*, even if they should be spelled with the letters *ss* or *c*, and that this bias noticeably declined after explicit stem instruction. This

implies, in line with research by Burton (2014) and Wright (2013), that children often rely on the frequency of certain letter patterns in English, rather than morphology, to spell word stems in derivatives. As this bias towards frequency declined post-teaching, it provides further evidence to suggest that children benefit from being explicitly taught about word stem morphemes for spelling.

The benefit of explicit stem teaching suggests that future research should examine whether the same positive results are replicable in the real-life context of the school classroom. This involves applying the explicit stem teaching in this study to a large group setting. This is achievable by presenting the Power Point slides and training game to a whole class using a projector. In the administration of the game, the children could write down their spellings on an answer sheet and take it in turns to write their answer for each trial on the board. This process not only involves training teachers to explicitly teach children the morphological rule for stems, it also requires overall morphological training to restructure the way teachers currently view the English orthography so that they appreciate that it incorporates morphemes as well as phonemes. Previous research has shown that it only takes 10 sessions across one school term to transform teachers' understanding of morphemes (Hurry et al. 2005), which is a relatively short time period considering the long-term benefits such training could have on the children's spelling. Therefore, this experiment has important educational implications and highlights the crucial need to explore whether such an advantage of explicit stem teaching can be effectively transformed into school policy and teaching practice.

Chapter 4: Methodology and Results for Experiment 2 – Explicit teaching of one aspect of morphology may lead to explicit knowledge of another

4.1 Background

4.1.1 Explicit teaching of word stems

The previous experiment clearly shows that explicitly teaching children the principle for stem conservation in English significantly enhances their spelling of that particular part of a derived word (see Chapter 3; Kemper et al., 2012). The purpose of the second experiment of the current study is to extend this research to investigate, for what appears to be the first time, if explicit teaching of one aspect of morphology (e.g. word stems) enables children to acquire explicit understanding of this taught word part, and explicit knowledge of another, related aspect (e.g. affixes) to improve their spelling of a second morphological unit that does not receive attention. The present experiment does not only focus on teaching stems, it also directly compares the effect of explicit stem teaching with explicit teaching of a particular affix-based principle, namely the distinction between the suffixes of *-ion* and *-ian*.

4.1.2 Explicit teaching of affixes

Morphological intervention research has investigated if explicit teaching of affixes improves a child's spelling (see Chapter 2.3). For instance, Devonshire and Fluck (2010) explicitly taught 5- to 11-year-old children morphological rules about affixes in their study. The children were taught the morphological principle that the suffix *-ian* makes a word become a person noun and the rule that *-ed* means that a word is in the past-tense. They found that

explicit teaching significantly enhanced the children's spelling of the two suffixes in comparison to a control condition that did not receive any form of instruction. This indicates that affix teaching noticeably improves a child's spelling of that specific part of a word.

Similar research was conducted by Nunes and Bryant (2006) to examine if explicitly teaching 8- to 9-year-old children the morphological distinction between the affixes of *-ion* and *-ian* aids their spelling. The children were taught that the endings of derivatives like *musician* and *discussion* sound exactly the same, but that the spelling *-ian* is used for words that refer to a person, whereas the ending *-ion* is used for words that are not about people (see Chapter 1.1). They reported that explicit instruction significantly improved the children's spelling of suffixes in derivatives in comparison to a group of control children. This clearly shows that explicitly teaching children morphological principles about affixes aids a child's affix spelling in much the same way as explicit stem teaching enhances a child's spelling of stems.

4.1.3. Explicit teaching of one morphological principle may lead to explicit knowledge of other, related rules

It is possible that children could acquire some explicit understanding of another, related aspect of morphology through explicit instruction of just one morphological unit. This is likely because explicit teaching of one morpheme exposes children to both the stem and affix parts of a word. For instance, Nunes and Bryant (2006) presented children with whole derivatives (e.g. *musician* and *discussion*) in their affix training and Kemper et al. (2012) exposed the Dutch-speaking children to entire plural forms in their teaching of stems (e.g. *honden* and *vrienden*). This implies that through explicit teaching of one aspect of morphology, such as affixes, that children could acquire explicit understanding of the

spelling of this taught word part, and also strip the affix (e.g. -*ian*) from the derivative (e.g. *magician*) to notice something explicitly about the untaught word stem (e.g. *magic*), which is left behind. This is feasible because research has shown that mere exposure to words with a morphological structure improves a child's spelling to some extent (Nunes and Bryant, 2006; see Chapter 2.3).

Another possibility is that explicit teaching of each morphological unit is required for children to attain explicit knowledge of both word parts. This implies that explicit teaching of one aspect of morphology (e.g. word stems) may restrict a child's attention to the other, and lead to minimal explicit understanding of the untaught morpheme (e.g. affixes). This is likely because Rosa and Nunes (2008) and Wright (2013) found that priming children with word stems (e.g. *tambor*) and orally exposing them to whole derivatives (e.g. *tamborilar*) enabled them to isolate the stem from the word by stripping off the affix (e.g. -*ilar*) (see Chapter 2.1.4). Therefore, it is worthwhile to assess the extent to which explicit teaching of one morphological principle leads to explicit knowledge of other, associated rules.

4.1.4 Experiment 2

The aim of this experiment was to examine if explicit teaching of one aspect of morphology (e.g. word stems) enables children to acquire explicit understanding of another, related aspect (e.g. affixes) that does not receive instruction. The effect of explicit stem teaching was compared with explicit teaching of a particular affix-based principle (i.e. the distinction between the suffixes of -*ion* and -*ian*) and no morphological teaching on a child's spelling of both word stems and affixes in derivatives. As in Experiment 1, 7- to 9-year-old children were included in line with earlier morphological intervention research (e.g. Devonshire and

Fluck, 2010; Kemper et al. 2012; Nunes and Bryant, 2006; Nunes et al. 2003). It was hypothesised that explicit teaching of one morphological unit would lead to significant improvements in a child's spelling of that particular part of a derived word, in comparison to no morphological teaching, with some explicit understanding of the spelling of the other, untaught aspect.

4.2 Method

4.2.1 Participants

Participants were 90 children in Years 3 (age range = 85-96 months; *M* = 90 months; *SD* = 3.41 months) and 4 (age range = 97-108 months; *M* = 102 months; *SD* = 3.59) from the same three state-supported primary schools as Experiment 1. As a large pool of participants was recruited at the start of the study, this was sufficient to serve the second experiment so the description of schools, the recruitment process, and the nature of the participants was the same as that described in Chapter 3.2.1. The children who participated in Experiment 2 were different from those included in the first experiment even though they were from the same schools. There were 46 girls and 44 boys in the sample and the experiment was conducted at the start of the school year between October and February, in comparison to the first experiment, which was conducted between March and July. All of the participants were fluent in English and this included those who spoke English as an additional language (*n* = 12) or had specific learning difficulties (*n* = 7).

4.2.2 Design

An experimental design was employed with randomisation at the child level. Children were assigned to one of three intervention groups: a stem teaching group (n = 30), a suffix teaching group (n = 30), or an unseen control group (n = 30). All three conditions received the same pre-test and post-test measure that was employed in the first experiment, which was administered at the same three time points: prior to the teaching (pre-test), after the intervention (immediate post-test), and following a two-week delay (delayed post-test) (see Chapter 3.2.2). In between the pre- and post-tests, the stem teaching and suffix teaching groups received a morphological intervention, but the children in the control condition did not receive any activity. All three groups were provided with a morphological teaching session at the end of the experiment so that all of the children benefited from their participation. The design risks were low because the same researcher administered the testing materials throughout and the pre- and post-tests were delivered in a whole class session.

4.2.3 Measures

4.2.3.1 Pre-test and post-test assessments

The pre-test and post-test consisted of the same spelling test and administration procedure as Experiment 1; the children were asked to spell a word or pseudo-word derivative in a series of 24 written sentences that were read aloud by the researcher (see Chapter 3.2.3.1). For example, the children heard the sentence "The girl was afraid to have the *injection*" and

they were asked to spell the word *injection* on their answer sheet. The list of sentences that were administered is noted in Appendix C.

In the task, the derivatives that the children were asked to spell contained an equal proportion of the suffix endings of *-ion* and *-ian* and a variety of each the stem endings of *t*, *ss*, and *c*. A range of stem endings and affixes were included to minimise any bias towards particular spellings, such as the stem ending *t* or the suffix *-ion*, as research has shown that a child's spelling is often influenced by letter patterns that are more frequent in English (e.g. Burton, 2014; Nunes and Bryant, 2006; Wright, 2013).

The children's answers in the pre- and post-test were scored as correct on the basis of two criteria: their spelling of stem endings in derivatives and their spelling of affixes. The stem ending spelling was assessed in the scoring because this is the part of the stem that is preserved in spite of changes in phonology. For instance, the children received a point for spelling *electrician* as *eletricion* as they effectively conserved the stem ending *c* in the derivative (see Chapter 3.2.3.1). For affix spellings, the whole suffix of *-ion* or *-ian* was assessed in the scoring because phonology predicts that the two endings should both be written as *un*. The children received a mark for writing *musician* as *musitian* because the suffix *-ian* was correctly spelled in the derivative. Any other parts of the derived word or pseudo-word were not considered in the scoring.

4.2.3.2 Morphological interventions

After the pre-test, the children in the stem teaching and suffix teaching groups were seen individually by the researcher for a morphological intervention, which was separated into

two parts: a teaching session and a training game. The unseen control condition did not receive a morphological intervention and are not included in this section.

4.2.3.2.1 Teaching session

The stem teaching group received the same teaching session that was administered to the explicit stem group in the first experiment (see Chapter 3.2.3.2.1), whereas the suffix teaching group received a similar procedure, but they were explicitly taught the morphological distinction between the affixes of -*ion* and -*ian*. In the suffix teaching session, the children were presented with a series of Power Point slides developed by the researcher that displayed a set of word stems (e.g. *Egypt* and *attract*) and each child was asked how they thought related derivatives (e.g. *Egyptian* and *attraction*) should be spelled. They were then asked to try to spell the derivatives on an answer sheet provided. The children were shown the correct spellings and encouraged to say if they could explain any difference between the endings of words like *Egyptian* and *attraction*. At this point, the children in the suffix teaching group were explicitly taught that words like *Egyptian* are spelled with -*ian* because they refer to a person, whereas words like *attraction* are spelled with -*ion* because they are not about people. Figure 4.1 presents an example of the Power Point slides that were presented in the suffix teaching session.

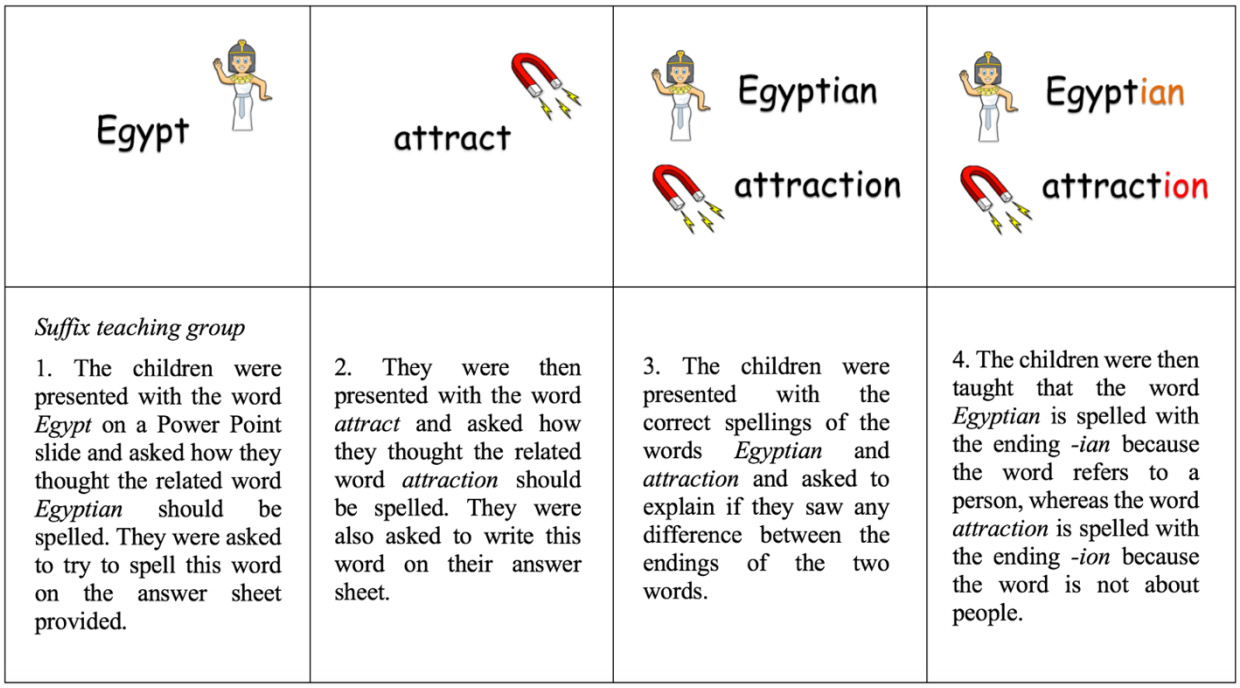


Figure 4.1. Example of the Power Point slides for one of the *-ion* and *-ian* derivative pairs that were used in the suffix teaching session.

4.2.3.2.2 Training game

The children in both the stem and suffix teaching groups then received a computerised spelling game that was developed by the researcher using Matlab (see Appendix D). The game followed the same format to that of Experiment 1; the children were visually and orally presented with 30 sentences each containing a missing derivative that they were asked to spell using a child-friendly keyboard (see Chapter 3.2.3.2.2; Appendix E). The two conditions received the same administration procedure so that the difference between the groups was the teaching session before the game.

The number of stem endings that the children in the stem teaching group spelled correctly in the training game was assessed in relation to the stem-based criterion presented in Experiment 1 (see Chapter 3.2.3.2.2), whereas the number of affix spellings that the suffix

teaching group spelled correctly was measured in relation to a different criterion that assessed if the children could be considered to have learned the morphological distinction between the suffixes of -*ion* and -*ian*. The binomial distribution was considered at the probability value of 0.5, considering that the children received trials on two affixes: -*ion* and -*ian*. The criterion was relatively stringent to eliminate the chance that the children were only spelling one type of suffix correctly. With this criterion, the cumulative probability of children spelling 20 words correctly in 30 trials by chance was 0.05. If a child reached 20 correct spellings, the game interrupted and they received no further trials. If the children failed to reach the criterion, the game was repeated for a second time.

4.3 Results

4.3.1 Criterion results

All of the children in the stem teaching and suffix teaching groups reached their respective criteria. Eighty-six percent of the children that received stem teaching reached the criterion for stems and 93% of the children that received suffix teaching reached the affix-based criterion the first time of receiving the game. Those who failed to reach criterion were asked to repeat the game for a second time and all of the children successfully reached it by their second attempt.

4.3.2 Intervention results

It was hypothesised that explicitly teaching children one aspect of morphology would significantly improve their spelling of that specific aspect of a derived word, with some

explicit understanding of another, untaught aspect (e.g. affixes). Tables 4.1 and 4.2 report the mean spelling scores for stems and affixes across the three intervention groups for words and pseudo-words. Table 4.1 shows that the mean number of correct stem ending spellings in word and pseudo-word derivatives was markedly higher for children in the stem teaching group than those in the suffix teaching or control conditions, and that this effect was apparent at both immediate and delayed post-test. Table 4.2 displays a similar pattern for the children's spelling of affixes, with the suffix teaching condition achieving remarkably higher mean suffix spelling scores than the stem teaching and unseen control groups.

Table 4.1

Mean (SD) number of correct stem ending spellings in word and pseudo-word derivatives by group.

		Words			Pseudo-words		
Group	N	Pre-test	Immediate Post-test	Delayed Post-test	Pre-test	Immediate Post-test	Delayed Post-test
Stem Teaching	30	3.40 (2.53)	7.73 (2.27)	6.90 (2.85)	3.30 (3.13)	7.47 (2.65)	6.83 (3.29)
Suffix Teaching	30	3.27 (2.42)	4.23 (2.76)	4.07 (3.02)	3.23 (2.74)	4.20 (3.47)	4.03 (3.83)
Unseen Control	30	3.43 (3.05)	3.20 (2.68)	3.13 (2.66)	3.30 (3.06)	3.00 (2.48)	2.77 (2.57)

Table 4.2

Mean (SD) number of correct suffix spellings in word and pseudo-word derivatives by group.

		Words			Pseudo-words		
Group	N	Pre-test	Immediate Post-test	Delayed Post-test	Pre-test	Immediate Post-test	Delayed Post-test
Stem Teaching	30	4.27 (3.60)	5.93 (2.88)	5.63 (2.74)	4.00 (3.35)	5.57 (2.91)	5.23 (2.92)
Suffix Teaching	30	4.20 (3.00)	8.57 (3.17)	7.97 (3.34)	4.07 (2.80)	8.10 (3.47)	7.67 (3.67)
Unseen Control	30	4.17 (3.31)	4.13 (2.87)	4.03 (2.93)	4.03 (3.38)	3.93 (3.00)	3.90 (3.32)

4.3.2.1 Pre-test scores

A comparison of stem ending spelling scores at pre-test revealed that there was not a significant difference in stem ending spelling between the three groups at the start of the study for both words, $F(2, 87) = 0.03$, $p = .968$, $\eta_p^2 = .00$, and pseudo-words, $F(2, 87) = 0.01$, $p = .995$, $\eta_p^2 = .00$. A similar effect was found for the children's suffix spelling at pre-test, which revealed that there was not a significant difference between the three groups for words, $F(2, 87) = 0.01$, $p = .993$, $\eta_p^2 = .00$, or pseudo-words, $F(2, 87) = 0.00$, $p = .997$, $\eta_p^2 = .00$. This indicates that random assignment produced groups that were matched in terms of morphological knowledge at the beginning of the experiment.

4.3.2.2 Intervention effects for word and pseudo-word stem ending spelling

To test the prediction that the children's word and pseudo-word stem ending spellings in derivatives would differ significantly between the three intervention groups across the testing occasions, two 3 (group) x 3 (testing occasion) mixed ANOVAs were carried out, with intervention group (stem teaching, suffix teaching, unseen control) as the between-subjects variable, and time (pre-test, immediate post-test, delayed post-test) as the within-subjects variable. As Mauchly's test revealed that the assumption of sphericity had been violated for pseudo-words, ($\chi^2(2) = 11.48$, $p < .05$), but not for words, the degrees of freedom were corrected for pseudo-words using the Greenhouse-Geisser correction. The analyses revealed that there was a significant main effect of time on the children's word stem ending spelling, $F(2, 174) = 36.88$, $p < .001$, $\eta_p^2 = .30$, and on their pseudo-word spelling, $F(1.78, 154.68) = 17.36$, $p < .001$, $\eta_p^2 = .17$. This indicates that the children's stem spelling differed between some of the testing occasions. There was also a significant time x intervention

group interaction effect for words, $F(4, 174) = 24.82$, $p < .001$, $\eta_p^2 = .36$, and pseudo-words, $F(3.56, 154.68) = 12.95$, $p < .001$, $\eta_p^2 = .23$, which shows that the children's stem ending spellings differed between the intervention groups at some of the time points.

Planned contrasts for the time variable were examined even though the comparisons did not include the effects of the different intervention groups. The contrasts showed that the children's word and pseudo-word stem ending spellings differed significantly between pre-test and immediate post-test ($p < .001$), and between pre-test and delayed post-test ($p < .001$). The difference in spelling between the two post-tests was not significant for words ($p = .062$) or pseudo-words ($p = .141$). These findings show that the children's spelling performance improved at post-test and that there was not a noticeable decline in spelling after teaching.

Graphs to show the means for the children's spelling of stem endings in derivatives across the three time points are presented for both words and pseudo-words in Figures 4.2 and 4.3. The graphs show that there were minimal differences between the three groups in terms of stem ending spelling for both words and pseudo-words at pre-test. By the time of the two post-tests, the mean number of correct spellings was highest for children in the stem teaching group, then the children in the suffix teaching condition, and lastly the children in the control group.

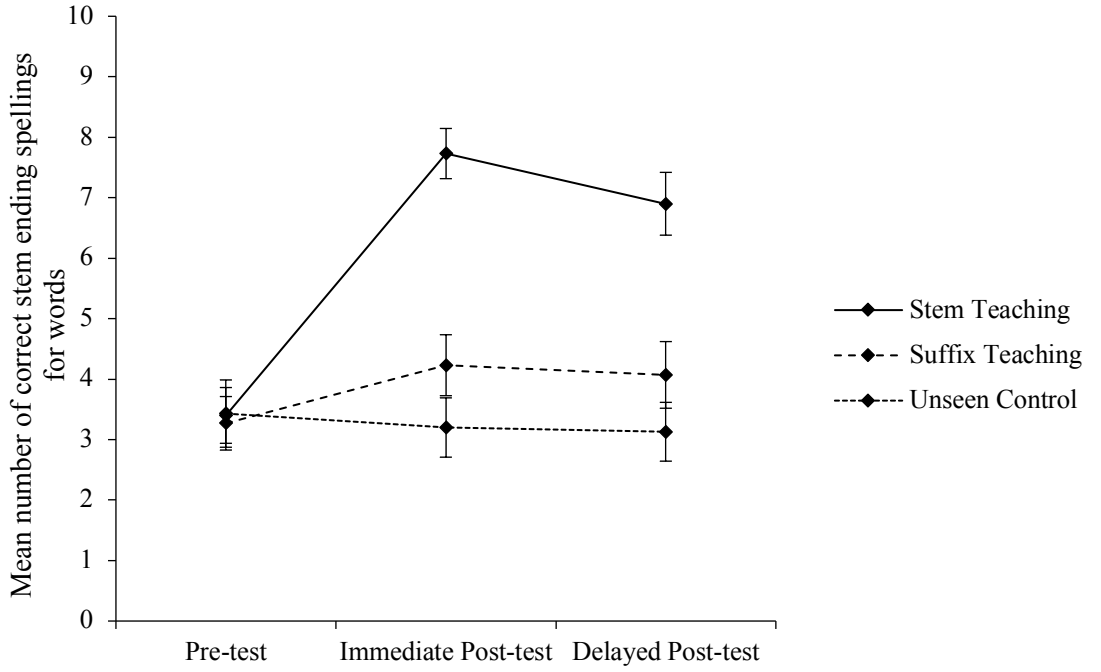


Figure 4.2. Means for the children's word stem ending spellings in derivatives for each experimental condition at the three testing occasions. Error bars represent standard errors of the means.

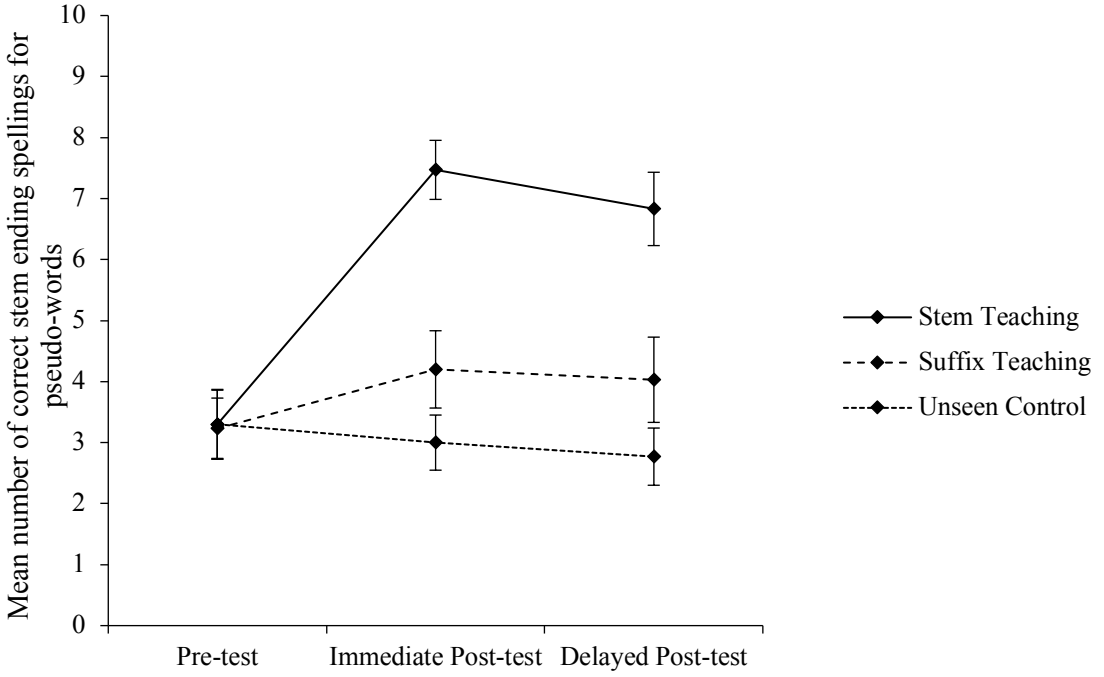


Figure 4.3. Means and standard errors for the children's pseudo-word stem ending spellings in derivatives for the three intervention groups at pre-test, immediate post-test, and delayed post-test.

Post-hoc tests conducted using the Bonferroni correction showed that there was a significant difference between the stem teaching and unseen control groups in terms of word stem ending spelling at both immediate ($p < .001$, $d = 1.83$) and delayed post-test ($p < .001$, $d = 1.37$), and for pseudo-words at these two time points ($p < .001$, $d = 1.74$ and $d = 1.39$). This was also evident for the stem teaching and suffix teaching conditions, which differed significantly in terms of word ($p < .001$, $d = 1.39$ and $p < .05$, $d = 0.96$) and pseudo-word stem spelling ($p < .001$, $d = 1.07$ and $p < .05$, $d = 0.79$) at these two testing occasions. There was not a significant difference in word stem ending spelling between the suffix teaching and control groups at either immediate ($p = .374$) or delayed post-test ($p = .622$), and this lack of significance also held for pseudo-words ($p = .337$ and $p = .412$).

These results support the prediction that explicitly teaching children the morphological principle for stems would significantly improve their spelling of that particular aspect of a derived word in comparison to no morphological teaching. This benefit did not only enhance the children's spelling in the short-term, but rather it was maintained after a delay. This positive outcome also held for pseudo-words, which suggests that the children learned the morphological rule for stem conservation as they successfully applied this principle to words that they could not have memorised word-specifically. As the suffix teaching and unseen control conditions did not differ significantly in terms of stem spelling, it indicates that the two groups struggled to conserve the spelling of stems in derivatives due to a lack of stem-based instruction. This shows that explicit teaching of affixes led to limited explicit understanding of stems and that explicit stem instruction may be necessary to noticeably improve a child's stem spelling.

4.3.2.3 Intervention effects for word and pseudo-word suffix spelling

To test the prediction that the children's spelling of suffixes in word and pseudo-word derivatives would differ significantly between the experimental groups across the three time points, a further two 3 (group) x 3 (testing occasion) mixed ANOVAs were conducted with intervention group (stem teaching, suffix teaching, unseen control) as the between-subjects factor, and test at different times (pre-test, immediate post-test, delayed post-test) as the within-subjects factor. Mauchly's test showed that sphericity had been violated for both words ($\chi^2(2) = 24.96$, $p < .001$) and pseudo-words, ($\chi^2(2) = 23.43$, $p < .001$), so it was necessary to use Greenhouse-Geisser to correct the degrees of freedom. The analyses revealed that there was a significant main effect of time on the children's suffix spelling for words, $F(1.60, 138.99) = 34.79$, $p < .001$, $\eta_p^2 = .29$, and pseudo-words, $F(1.62, 140.49) = 40.22$, $p < .001$, $\eta_p^2 = .32$, which shows that the children's spelling of affixes differed between some of the time points. The analyses also showed that there was a significant time x intervention group interaction effect for suffixes in both word, $F(3.20, 138.99) = 14.91$, $p < .001$, $\eta_p^2 = .26$, and pseudo-word derivatives, $F(3.23, 140.49) = 18.07$, $p < .001$, $\eta_p^2 = .29$. This indicates that the children's spelling accuracy differed between the testing occasions depending on the level of instruction that they received.

Planned comparisons for the time variable revealed that the children's word and pseudo-word suffix spellings differed significantly between pre-test and immediate post-test ($p < .001$), and between pre-test and delayed post-test ($p < .001$). This indicates that the children's affix spellings improved post-teaching. There was not a significant difference in the children's spellings between the two post-tests for words ($p = .071$) or pseudo-words (p

= .101). This shows that there was not a noticeable decline in suffix spelling after the teaching had ceased.

Means for the children's spelling of suffixes in word and pseudo-word derivatives at the three testing occasions are displayed graphically in Figures 4.4 and 4.5. The figures clearly show that the mean number of correct affix spellings was largely equivalent across the three intervention groups at pre-test. By the time of the two post-tests, the suffix teaching group achieved noticeably higher mean spelling scores than both the stem teaching and unseen control conditions, respectively.

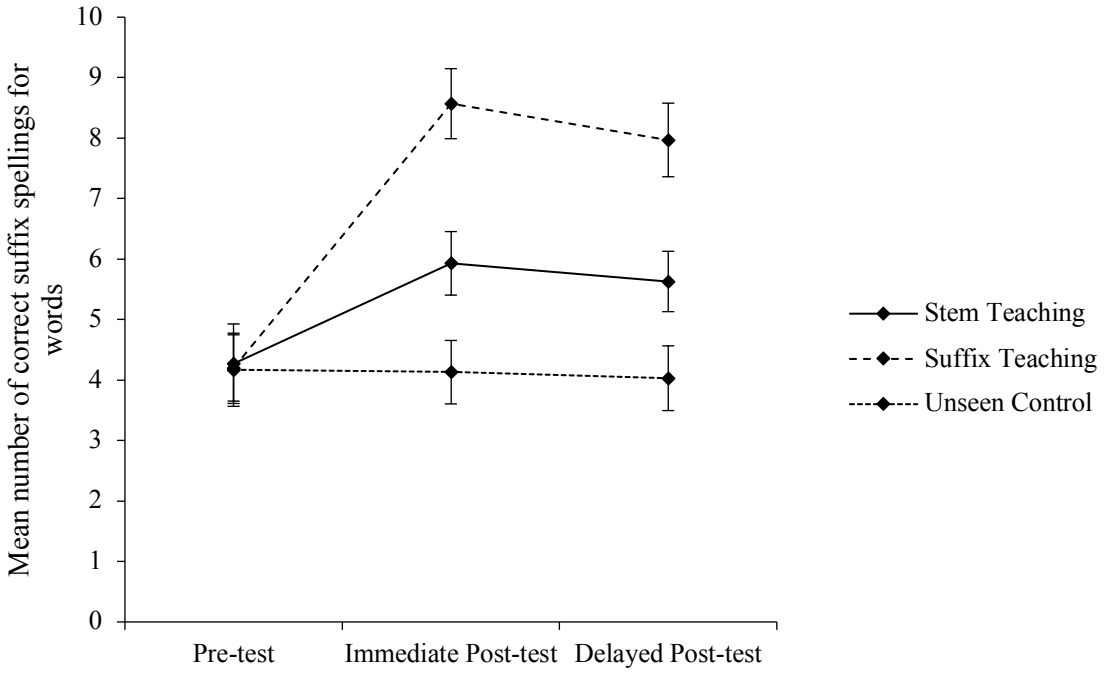


Figure 4.4. Means for the children's suffix spelling in word derivatives for each intervention group at pre-test, immediate post-test, and delayed post-test. Error bars denote standard errors of the means.

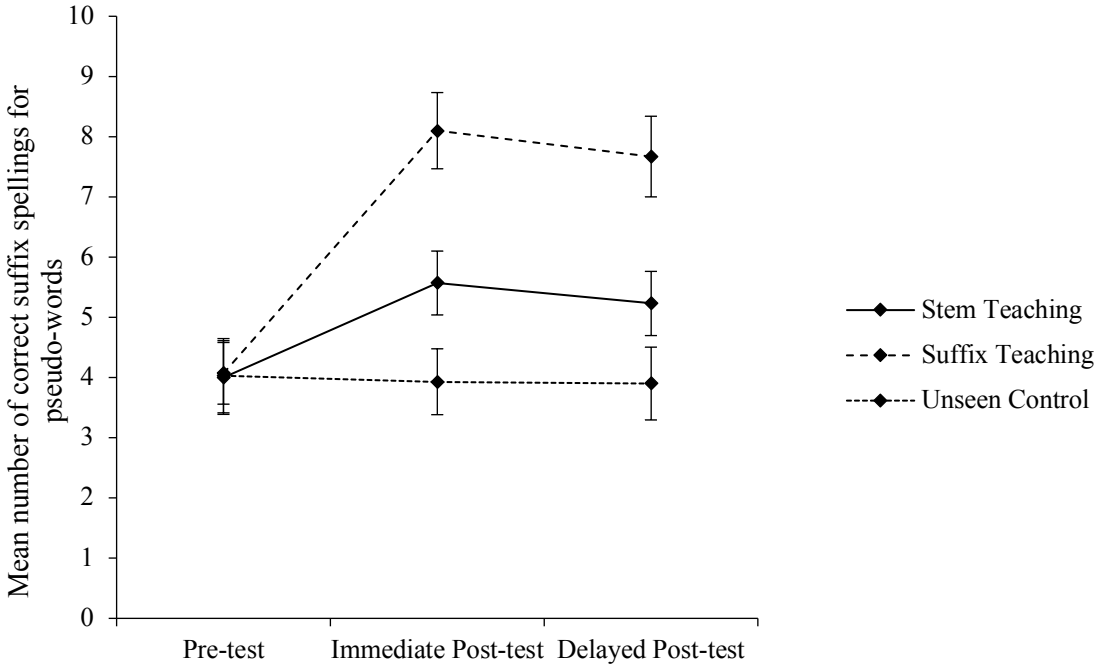


Figure 4.5. Means and standard errors for the children's suffix spellings in pseudo-word derivatives for each experimental condition at the three time points.

Post-hoc tests revealed that there was a significant difference between the suffix teaching and unseen control conditions in terms of suffix spelling at both post-tests for words ($p < .001$, $d = 1.47$ and $d = 1.25$) and pseudo-words ($p < .001$, $d = 1.29$ and $d = 1.08$). There was also a significant difference between the suffix teaching and stem teaching groups for both word ($p < .05$, $d = 0.87$ and $d = 0.77$) and pseudo-word ($p < .05$, $d = 0.79$ and $d = 0.74$) affix spelling at these two time points. The suffix spellings of the stem teaching and unseen control groups did not differ significantly for words at either immediate ($p = .064$) or delayed post-test ($p = .128$), or for pseudo-words at these two testing occasions ($p = .140$ and $p = .369$).

These findings provide support for the prediction that explicitly teaching children a particular affix-based principle (i.e. the morphological distinction between the suffixes of -*ion* and -*ian*) would significantly improve their spelling of that part of a derived word over

and above that of no morphological teaching. This positive effect was sustained after a two-week delay and also held for pseudo-words, which indicates that suffix teaching could have long-term benefits for spelling and that the children learned the morphological distinction between the two affixes as they effectively applied these morphological units to words that they could not have previously memorised by rote. As the stem teaching and unseen control groups did not differ significantly in terms of suffix spelling, it suggests that they experienced difficulty with this task due to a lack of affix-based instruction. This shows that that explicit stem teaching leads to limited explicit knowledge of affixes and that explicit affix teaching may be necessary to noticeably improve a child's spelling.

4.3.2.4 Summary of the intervention effects for Experiment 2

Table 4.3 summarises the intervention effects that are reported across the ANOVAs in this experiment. The table shows that the stem teaching group differed significantly from both the suffix teaching and unseen control conditions in terms of stem ending spelling for words and pseudo-words at the two time points, but that there was not a significant difference in stem spelling between the suffix teaching and control conditions. This shows that stem teaching led to more significant improvements in a child's spelling of stems in derivatives than the other two conditions. This indicates that explicit teaching of suffixes led to limited explicit understanding of stems.

For affix spelling, the table shows that the suffix teaching group differed significantly from the stem teaching and unseen control conditions for word and pseudo-word spelling at both post-tests, but that there was not a significant difference in suffix spelling between the stem teaching and control conditions. This indicates that suffix teaching improves a child's

spelling of affixes in derivatives to a greater extent than the other two groups, which shows that explicit stem teaching led to limited explicit knowledge of suffixes.

Table 4.3.

Summary of the post-hoc comparisons between the stem teaching, suffix teaching, and unseen control groups in Experiment 2.

	Children's correct spelling					
	Stem endings in derivatives			Suffixes in derivatives		
	Stem teaching vs. suffix teaching	Stem teaching vs. unseen controls	Suffix teaching vs. unseen controls	Suffix teaching vs. stem teaching	Suffix teaching vs. unseen controls	Stem teaching vs. controls
Reached 95% significance	X	X		X	X	
Failed to reach 95% significance			X			X

Note. This pattern of results applies to both words and pseudo-words and the two post-tests.

4.3.3 Change in stem ending spellings over time

It was also beneficial to examine the frequency of word and pseudo-word stem ending spellings that the children in the three experimental conditions wrote with the *t* spelling at pre-test in relation to the two post-tests (see Chapter 3.3.3). This was investigated because previous research has shown that children are often biased towards writing *t* for all three stem ending spellings (i.e. *t*, *ss*, and *c*) due to the higher frequency of *t* endings in English (see Chapter 2.1.2.2; Burton, 2014; Wright, 2013). It was predicted that the children in the stem and suffix teaching conditions would be biased towards writing *t* at pre-test and that this would decline post-teaching. It was also expected that the unseen control condition would be biased towards *t* at all three testing occasions.

Figure 4.6 shows, in accordance with the expectation, that at pre-test, the children in the stem teaching group were biased towards writing all word and pseudo-word stem endings with *t* even if they should be written as *ss* or *c*. For example, the children wrote the *t* stem ending 54% of the time in stems that should be written as *t*, but also 39% of the time in stems ending in *ss*, and 44% of the time in stems ending in *c* (see Figure 4.6). This demonstrates that the children often incorrectly applied the *t* spelling to wrong places such as by writing *electrician* as *electrition*. This pattern of spelling parallels with that reported in the first experiment (see Chapter 3.3.3), and shows that in the absence of stem teaching, children often use frequency for stem spelling rather than appreciating the need to use morphology.

This bias towards *t* reduced considerably at post-test and the children were much less likely to apply the *t* stem ending to the incorrect instances. At immediate post-test, the children only used the *t* spelling 9% of the time in stems ending in *ss* and 31% of the time in stems ending in *c*, whereas they accurately applied the *t* spelling 91% of the time (see Figure 4.6). This clearly shows that explicit stem teaching increases a child's use of morphology, in place of frequency, for the spelling of stems.

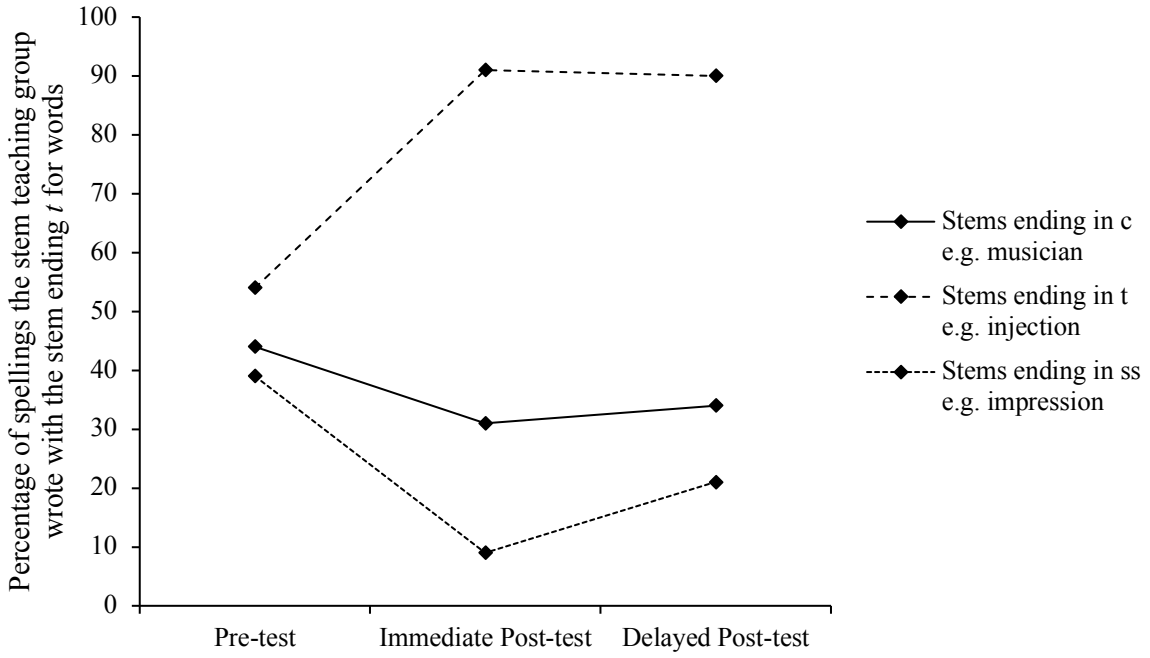


Figure 4.6. Percentage of derivatives the stem teaching group spelled with the *t* stem ending at the three testing occasions. [2]

Figure 4.7 presents the frequency of *t* spellings for the suffix teaching condition. The graph displays a similar pattern to the stem teaching group; the children were biased towards writing all three stem endings with *t* at pre-test, but this bias declined post-teaching with the children using *t* more often in the right instances. Yet, the decline in bias towards *t* was considerably smaller than that of the stem teaching condition. This implies that mere exposure to morphological units through explicit suffix teaching led to limited explicit understanding of stems, but may have enabled the children to acquire some knowledge, at an implicit level.

[2] Note: The derivative *librarian* was not included in the frequency data for Figures 4.6, 4.7, and 4.8 as this word does not contain one of the following three stem endings: *t*, *ss*, or *c*. The children received this derived word in the pre- and post-test assessment to test their understanding of the *y* drop rule for stems that end in the last letter *y*.

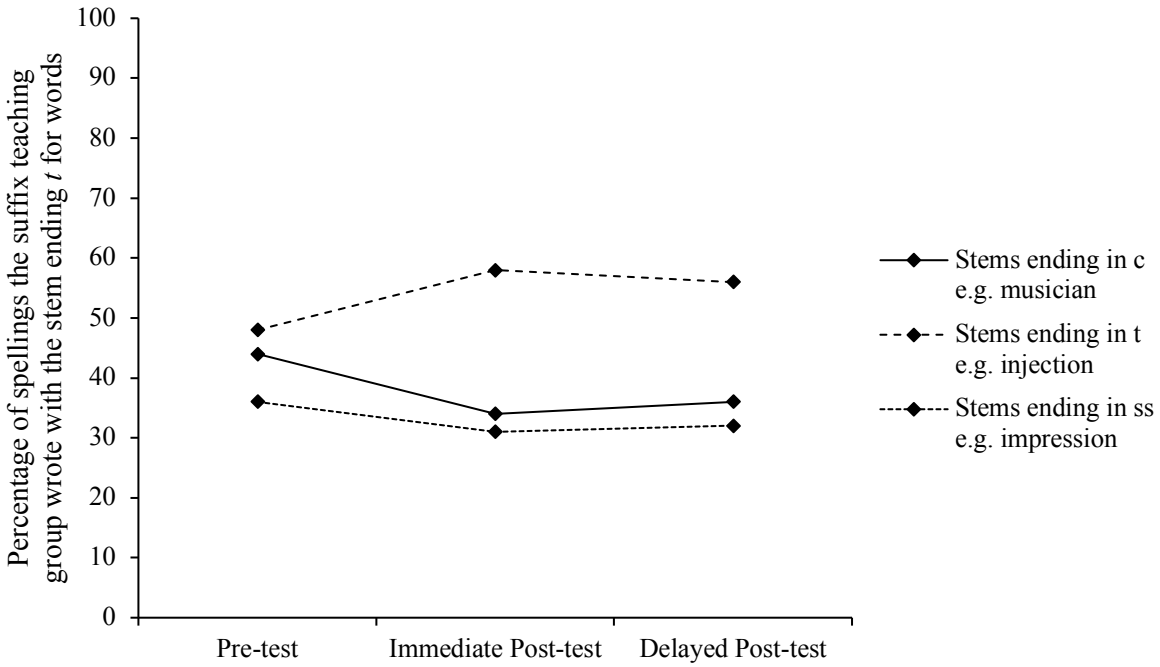


Figure 4.7. Percentage of derived words the suffix teaching group wrote with the *t* spelling at pre-test, immediate post-test, and delayed post-test.

Figure 4.8 shows that the children in the unseen control group were biased towards the *t* spelling for all three stem endings and that this remained relatively stable over time. For example, the children wrote stems ending in *c* with the *t* spelling 41% of the time at pre-test, 44% of the time at immediate post-test, and 42% of the time at delayed post-test. This indicates that the children's spellings did not improve naturally over the course of the experiment and that children often use frequency to spell stems in derivatives in the absence of explicit teaching.

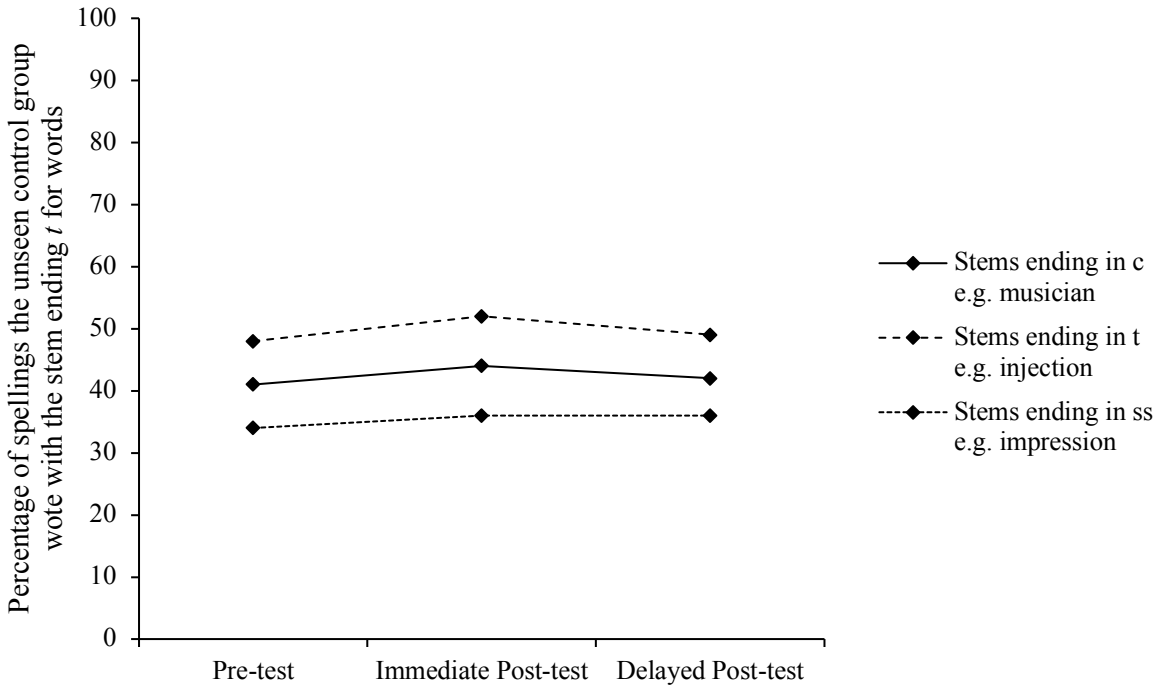


Figure 4.8. Percentage of derivatives the unseen control condition spelled with the *t* stem ending spelling at pre-test and the two post-tests.

The children's frequency of *t* spellings for pseudo-words largely paralleled with that reported for words and the graphs for each of the intervention groups are presented in Appendix G. It is also worth noting, in line with Experiment 1, that even though many of the children's spelling errors were due to using the stem ending *t*, they also had a tendency to employ the phonological representation, *sh* (see Chapter 3.3.3; Figure 3.10). This shows that children often rely on phonology, as well as frequency, to spell stem endings in derivatives.

4.3.4 Change in suffix spellings over time

The frequency of different word and pseudo-word suffix spellings that the children wrote at pre-test in comparison to the two post-tests was also examined. This was assessed because research has shown that in the absence of morphological teaching, children are noticeably

biased by the higher frequency of *-ion* suffixes in English and have a tendency to write all affix spellings with *-ion* even if they should be spelled with *-ian* (see Chapter 2.1.2.2; Nunes and Bryant, 2006). It was expected that the children in the suffix and stem teaching groups would be biased towards writing the *-ion* spelling at pre-test and that this bias would reduce after instruction at post-test. It was also predicted that the unseen control condition would be biased towards writing *-ion* at all three time points.

Figure 4.9 shows, in line with the prediction, that at pre-test, the children in the suffix teaching group had a tendency to write all affixes with *-ion* even if they should be spelled with *-ian*. For example, the children wrote the *-ion* suffix in 55% of words that should be spelled with *-ion* and in 50% of words that should be spelled with *-ian* (see Figure 4.9). This clearly shows that the children overgeneralised the *-ion* spelling to the incorrect instances by writing a word like *musician* as *musicion*. This implies that prior to explicit suffix teaching, children often rely on the high frequency of *-ion* suffixes in English to spell affixes in derived words.

The children's bias towards the *-ion* spelling reduced considerably by the time of the two post-tests and they were much more likely to use *-ion* in the right places. Figure 4.9 shows that the children only used the *-ion* spelling 30% of the time in suffixes ending in *-ian* and accurately applied the ending 85% of the time. This indicates that explicit suffix teaching noticeably decreased the children's bias towards using frequency and increased their use of morphology for spelling affixes.

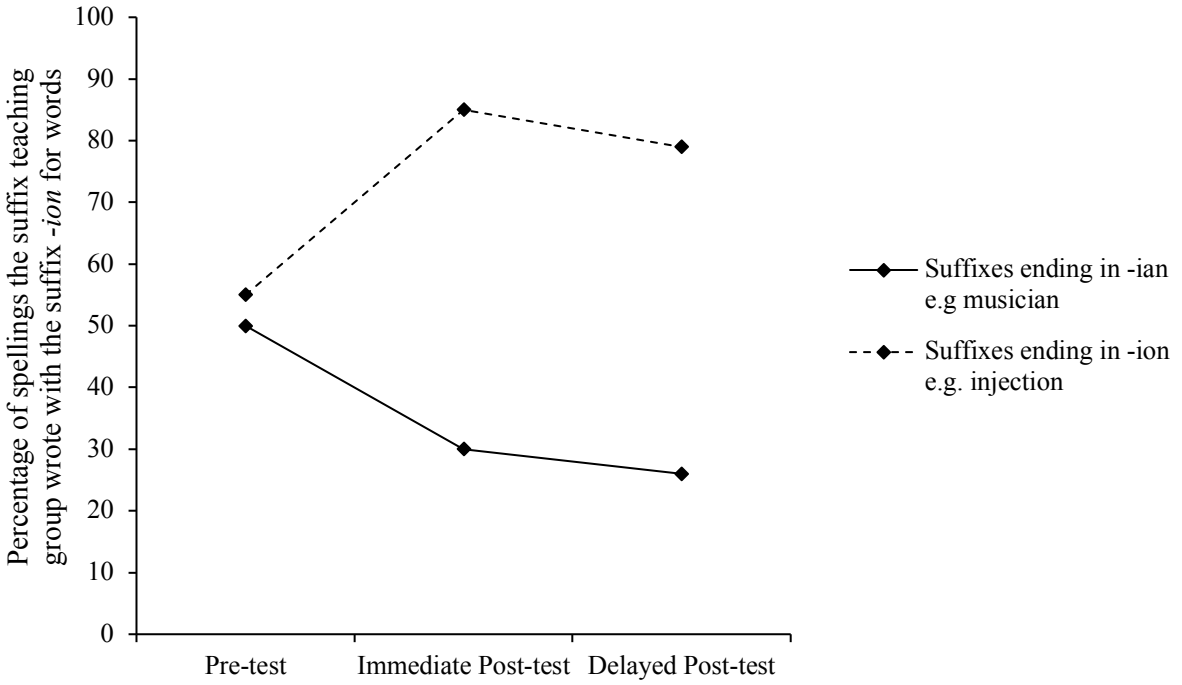


Figure 4.9. Percentage of derivatives the suffix teaching group wrote with the suffix *-ion* at pre-test, immediate post-test, and delayed post-test.

Figure 4.10 shows that the stem teaching group presented a similar pattern of *-ion* spellings to the suffix teaching condition; the children used *-ion* for both suffix spellings at pre-test, but this bias reduced at post-test. However, the decline in use of *-ion* in place of *-ian* was noticeably smaller than that of the suffix teaching group. For instance, the children still used *-ion* in 45% of suffixes that should be spelled with *-ian* by the time of the delayed post-test. This indicates that the children were more likely to acquire implicit rather than explicit knowledge of affixes through explicit stem teaching.

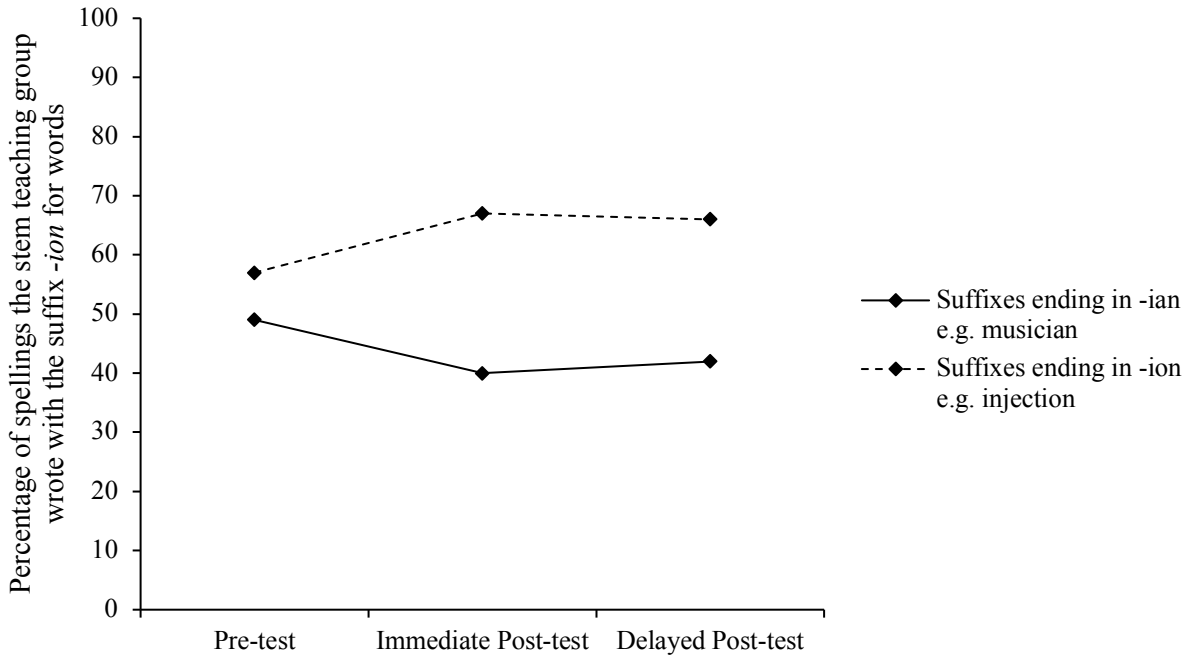


Figure 4.10. Percentage of derived words the stem teaching condition wrote with the suffix *-ion* at pre-test and the two post-tests.

Figure 4.11 presents the frequency of *-ion* suffix spellings for the unseen control group. The graph shows that the children's use of *-ion* in both the correct and incorrect instances remained relatively consistent over time. For example, the children accurately used the *-ion* ending 52% of the time at pre-test, 56% of the time at immediate post-test, and 54% of the time at delayed post-test. This shows that repeating the spelling test three times did not lead to a natural improvement in performance. This indicates that children often use frequency, rather than morphology, for the spelling of affixes. Graphs for the children's pseudo-word suffix spellings are presented in Appendix G and show that the children's bias towards *-ion* followed a similar pattern.

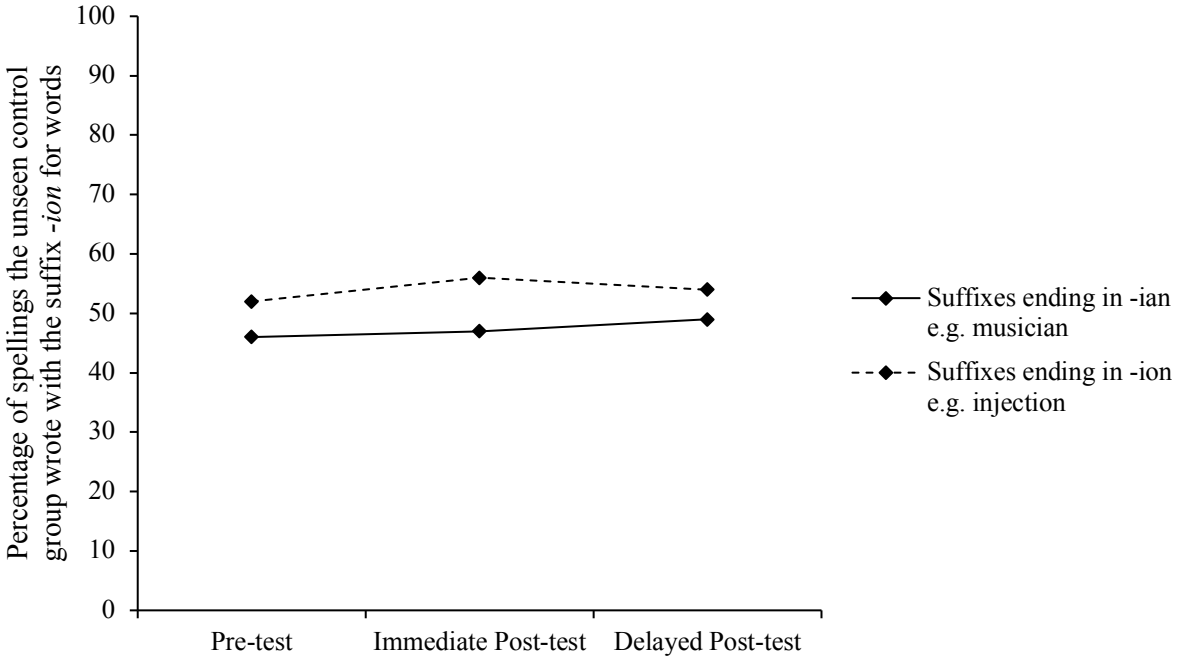


Figure 4.11. Percentage of derivatives the unseen control group wrote with the suffix *-ion* at the three testing occasions.

4.4 Discussion

The aim of this experiment was to examine if explicit teaching of one aspect of morphology (e.g. word stems) enhances a child's spelling of that particular aspect of a derived word, with some explicit understanding of another, related aspect (e.g. affixes) that does not receive explicit attention. The results show, in line with the first part of the prediction, that stem teaching significantly improved a child's spelling of stems in derivatives in comparison to no morphological teaching. This supports research by Kemper et al. (2012) and the first experiment of the current study by showing that explicit teaching of stems noticeably aids a child's spelling of that specific aspect of a derived word. The findings also reveal that suffix teaching significantly improved a child's spelling of suffixes. This shows, in accordance with Devonshire and Fluck (2010) and Nunes and Bryant (2006), that explicit teaching of a particular affix-based principle noticeably enhances a child's spelling.

The results of Experiment 2 also show, arguably for the first time, that explicit teaching of stems leads to limited explicit understanding of affixes, and that explicit teaching of affixes leads to limited explicit knowledge of stems. This shows that children struggle to acquire explicit knowledge of the spelling of another, related aspect of morphology through explicit instruction of one morphological unit. This indicates, in accordance with previous research (see Rosa and Nunes, 2008; Wright, 2013) that focusing a child's attention on one aspect of morphology (e.g. word stems) detracts attention from the other (e.g. affixes) such that they use affix stripping to concentrate on the taught word part. This implies that children analyse words into morphological units for spelling, which provides support for Taft's (1979; 1991) (see Chapter 1.2.2; Chapter 2.1.4) theory that words are represented in the brain in terms of their constituent morphemes. This outcome indicates that children have a tendency to focus on the morphological unit that has received explicit attention.

The findings also reveal, in line with Experiment 1, that the children were biased towards frequency for spelling word stem and affix morphemes and that this bias reduced considerably after morphological teaching. The results showed that explicit stem teaching noticeably reduced a child's bias towards writing stem endings with *t*, even if they should be spelled with *ss* or *c* (i.e. Burton, 2014; Wright, 2013), due to the higher frequency of *t* stem endings in English. The findings also revealed, in line with earlier research by Nunes and Bryant (2006), that without teaching, the children used -*ion* for the spelling of suffixes in derivatives, even if they should be written as -*ian*, and that this bias declined after explicit suffix instruction at post-test. This implies that explicit teaching noticeably reduced a child's bias towards frequency for the spelling of morphological units.

However, it is important to note that there was a slight reduction in bias towards *t* and *-ion* for the children that received explicit instruction of a related morphological rule. This implies that the children acquired some understanding of the untaught word part, at least an implicit level, but lacked more explicit awareness of this morphological unit in a way that was useful for spelling. This finding is particularly interesting as it indicates that children are perhaps more likely to acquire implicit rather than explicit knowledge of a related aspect of morphology through explicit instruction of one morphological rule. This implies that explicit teaching of each morphological unit may be necessary to lead to the most noticeable improvements in children's spelling.

As explicit instruction of word stems and affixes appears be valuable for spelling, future research should examine if children benefit from being explicitly taught about both of these morphological units in conjunction with one another. If children receive instruction about both word stems and affixes, it has the potential to noticeably improve their spelling of words with a morphological structure. Yet, it is important to note that teaching the two rules at the same time may be too overwhelming for children so they may need to be taught the two principles separately and in a particular sequence. In fact, children may need to appreciate that affixes are attached to a core word stem before they can fully comprehend the rules that apply when they attempt to add specific morphological suffixes (Tyler and Nagy, 1989). This implies that the next logical step, which will be investigated in the following experiment, is to examine the effect of combined instruction of stems and affixes on children's spelling of these two word parts in derivatives.

Chapter 5: Methodology and Results for Experiment 3 – Explicit teaching of word stem and affix morphemes together

5.1 Background

5.1.1 Explicit teaching of word stems and affixes

As the previous experiment shows that explicitly teaching children about either word stems or affixes improves their spelling of that particular aspect of a derived word, with limited explicit understanding of other, related aspects, the purpose of Experiment 3 is to combine morphological instruction of these two word parts together. Although this is yet to be directly examined in morphological intervention studies, there is some evidence in research to show that there are significant correlations between a child's correct spelling of a stem across words and their correct spelling of morphological endings like the past-tense *-ed* (Nunes et al. 2006) (see Chapter 2.3.2). This implies that children are more likely to spell the stem and affix parts of a word correctly if they appreciate the meaning behind both of these morphological units.

5.1.2 Simultaneous or sequential instruction of word stems and affixes

The question that now remains is if children should be taught about these two morphological units simultaneously (i.e. at the same time) or sequentially (i.e. one after the other). Simultaneous teaching of the rule for stem conservation in the same teaching session as a particular affix-based principle (e.g. the distinction between the suffixes of *-ion* and *-ian*) could enable children to effectively synthesise the meanings of these two word parts together to enhance their spelling. This is feasible because simultaneous instruction would visually

present the two morphological principles at the same time and within the same words and it has been claimed that visual processing plays a key role in children's spelling accuracy (Plaza and Cohen, 2006).

Although simultaneous teaching could be worthwhile, it may be too overwhelming for children as it has been proposed that humans have a limited cognitive load and can only process a few elements of information in working memory at any one time (Miller, 1956; Sweller, 1994). Research with adults provides evidence to support this view and shows that presenting all of the information about a particular topic at once often overwhelms working memory, whereas presenting isolated elements of information, one after the other, enables this knowledge to be acquired more effectively (Pollock et al. 2002) (see Chapter 2.3.2). Even though this research was not directly performed with children, it is possible that teaching too much information at once could hamper their working memory.

Teaching isolated elements of information one after the other was investigated in a study by Nunes and Bryant (2009). They taught 7- to 8-year-old children the *a-e* split digraph rule (i.e. that *hate* and *hat* are pronounced differently because the *-e* changes the vowel sound) followed by the *o-e* split digraph principle (i.e. that *hope* and *hop* contain the same vowel sound change). They found that sequential instruction of these two related phonological rules significantly enhanced the children's spelling when compared to a control group that were only taught the first rule. This implies that similar benefits in spelling could arise from sequentially teaching children two related aspects of morphology.

If children are taught about both word stem and affix morphemes in sequence, it is likely that they could benefit from receiving instruction of the rule for stem conservation prior to

instruction of a particular affix-based principle (i.e. the distinction between *-ion* and *-ian*). This is feasible because previous research has shown that children start to process word stems at an earlier stage than affixes (Tyler and Nagy, 1989; see Chapter 2.3.2). Thus, the current experiment examines sequential instruction of morphemes in this sequence.

5.1.3 Experiment 3

The aim of the third experiment was to investigate the differential effectiveness of simultaneous versus sequential instruction of word stems and affixes on children's spelling. The effect of simultaneous teaching was compared with sequential instruction and no morphological teaching on a child's spelling of word stems and affixes, namely the suffixes of *-ion* and *-ian*, in derivatives. As in the previous two experiments, the children were 7- to 9-year-olds in accordance with earlier morphological intervention research (e.g. Devonshire and Fluck, 2010; Kemper et al. 2012; Nunes and Bryant, 2006; Nunes et al. 2003). It was hypothesised that explicitly teaching children about both word stems and affixes, either simultaneously or in sequence, would significantly improve their spelling of these two word parts in derivatives to a greater extent than no morphological teaching.

5.2 Method

5.2.1 Participants

Participants were 90 children in Years 3 (age range = 89-100 months; M = 93 months; SD = 3.38 months) and 4 (age range = 101-112 months; M = 105 months; SD = 3.37 months) from the same three state-supported primary schools that were recruited at the start of the study.

This meant that the nature of the participants and the recruitment process paralleled with Chapter 3.2.1. The children who participated in Experiment 3 were different from those included the first two experiments. There were 48 boys and 42 girls in the sample and the experiment was conducted between February and June, whereas Experiment 2 was performed from October to February, and Experiment 1 was conducted between March and July. The sample included children with recognised learning difficulties (n = 8) and those that spoke English as an additional language (n = 10), but all of the children were fluent English speakers.

5.2.2 Design

An experimental research design was employed with random assignment at the individual level within the same class. Children were assigned to one of three intervention groups: a stem + suffix simultaneous group (n = 30), a stem + suffix sequential group (n = 30), or an unseen control group (n = 30). The three groups were asked to complete the same pre- and post-test measure as in the previous experiments at the start of the study (pre-test), after a morphological intervention (immediate post-test), and after a two-week delay (delayed post-test) (see Chapter 3.2.2). The two taught groups received a morphological teaching session in between the pre-test and post-test, but the unseen control group did not receive any activity. For ethical reasons, all of the children, irrespective of condition, were provided with a short morphological intervention at the end of the experiment to allow all of the participants to benefit from their involvement. As the same researcher delivered the teaching materials throughout and the spelling measure was administered on a whole class basis, the design risks of the experiment were low.

5.2.3 Measures

5.2.3.1 Pre-test and post-test assessments

The pre-test and post-test consisted of the same spelling measure as Experiment 1 and followed the same administration procedure; the children were asked to spell 24 word or pseudo-word derivatives in a sentence context that was read aloud by the researcher (see Chapter 3.2.3.1). To minimise the chance of bias in the children's spellings, the test contained an equal number of derivatives ending in *-ion* and *-ian* and a range of different stem ending spellings (e.g. *t*, *ss*, and *c*). Each of the sentences is presented in Appendix C.

The children's spellings were scored as correct on the basis of their spelling of stem endings in derivatives and their spelling of affixes, in line with Experiment 2 (see Chapter 4.2.3.1). Stem ending spellings were employed because this is the part of the stem that is conserved even when phonology predicts a different spelling (i.e. *sh*). For instance, the children received a mark for their stem spelling if they correctly spelled the letters *ss* in the word *impression*. Suffix spellings were also included in the scoring because phonology suggests that *-ion* and *-ian* should both be spelled as *un*. For example, the children received a score for suffix spelling if they correctly wrote *-ian* in the word *politician*. Any other parts of the derivatives were not included in the scoring.

5.2.3.2 Morphological interventions

In between the pre-test and post-tests, the children in the simultaneous and sequential conditions received a morphological intervention that was delivered on a one-to-one basis

by the researcher and contained two parts: a teaching session and a training game. As the unseen control condition did not receive any morphological teaching, they are not reported in this section.

5.2.3.2.1 Teaching session

The children in the stem + suffix sequential group received two teaching sessions one after the other: the explicit stem instruction described in Experiment 1 (see Chapter 3.2.3.2.1) followed by the suffix teaching outlined in Experiment 2 (see Chapter 4.2.3.2.1). The principle for stem conservation was taught prior to the -*ion* versus -*ian* distinction because research suggests that children begin to process word stems prior to affixes (Tyler and Nagy, 1989).

The children in the simultaneous condition received a teaching session that integrated stem and suffix instruction together. They were taught the morphological rule for stems at the same time and within the same words as they were taught the distinction between the suffixes of -*ion* and -*ian*. In the teaching session, the children were presented with a series of Power Point slides developed by the researcher that displayed a set of word stems (e.g. *magic* and *discuss*) and each child was asked how they thought related derivatives (e.g. *magician* and *discussion*) should be spelled. They were then asked to try spell the words on the answer sheet provided. The children were shown the correct spellings and encouraged to say if they could explain any difference between the spelling of words like *magician* and *discussion*. At this point, the children were explicitly taught that an easy way to spell the words is to think about if they are related in meaning to another smaller one like *magic* or *discuss* that is contained within it. They were taught that these smaller words are word stems

whose spelling remains the same when a suffix (e.g. *-ion* or *-ian*) is added in spite of changes in pronunciation. They were told that when stems end in *-e*, *-y*, or *-s*, they must remove this last letter before adding the *-ion* or *-ian* ending (see Ganske, 2008; Nunes and Bryant, 2009). The children were also explicitly taught that words like *magician* are spelled with *-ian* because they refer to a person, whereas words like *discussion* are spelled with *-ion* because they are not about people. Figure 5.1 presents an example of the Power Point slides that were employed in the simultaneous teaching session.

			
Stem + suffix simultaneous group 1. The children were presented with the word *magic* on a Power Point slide and asked how they thought the related word *magician* should be spelled. They were asked to try to spell this word on the answer sheet provided.	2. They were then presented with the word *discuss* and asked how they thought the related word *discussion* should be spelled. They were also asked to write this word on their answer sheet.	3. The children were presented with the correct spellings of the words *magician* and *discussion* and asked to explain if they saw any similarities between the spellings of the two words.	4. They were taught that an easy way to spell *magician* and *discussion* is to think about if these words are related in meaning to another smaller one like *magic* or *discuss* that is contained within it. They were told that these smaller words are stems whose spelling remains the same when a suffix, such as the *-ion* or *-ian* ending, is added in spite of changes in sound. The children were also taught that the word *magician* is spelled with the ending *-ian* because the word refers to a person, whereas the word *discussion* is spelled with the ending *-ion* because the word is not about people.

Figure 5.1. Example of the Power Point slides for one of the derivative pairs that was used in the simultaneous teaching.

5.2.3.2.2 Training game

The children in the simultaneous and sequential conditions were then presented with a computerised Matlab spelling game that was designed by the researcher and followed the same procedure to that of Experiments 1 and 2 (see Appendix D); the children were asked to type the spellings of up to 30 derivatives in a series of sentences that were visually and orally presented (see Chapter 3.2.3.2.2; Chapter 4.2.3.2.2; Appendix E). This meant that the only difference between the two groups was the teaching session prior to the game.

The children's spellings were measured in relation to two criteria that assessed if they could be considered to have learned both the principle for stems and the morphological distinction between the suffixes of *-ion* and *-ian*. Their spelling of stems was assessed in relation to the stem-based criterion noted in Experiment 1 (see Chapter 3.2.3.2.2) and the children's suffix spellings were measured in relation to the criterion for affixes described in Experiment 2 (see Chapter 4.2.3.2.2). If a child reached both the stem criterion (i.e. 15 correct stem ending spellings out of 30 trials) and the suffix criterion (i.e. 20 correct suffix spellings out of 30 trials), the game stopped and they received no further trials. If they failed to reach the two criteria, the game was presented for a second time.

5.3 Results

5.3.1 Criterion results

All of the children that received a combination of stem and suffix instruction reached both the criterion for stems and the criterion for affixes. Ninety-three percent of the children that

received simultaneous teaching and 97% of the children that received sequential instruction reached these criteria the first time of receiving the game. The children who failed on their first attempt successfully reached the two criteria when they repeated the game for a second time.

5.3.2 Intervention results

It was hypothesised that explicitly teaching children about both word stems and affixes, either simultaneously or in sequence, would significantly improve their spelling of these two word parts in derivatives to a greater extent than no morphological teaching. The children's mean spelling scores for stems and *-ion* and *-ian* suffixes were examined and are presented in Tables 5.1 and 5.2. Table 5.1 shows that the mean number of correct stem ending spellings in word and pseudo-word derivatives was noticeably higher in the two taught groups than in the unseen control condition, and that this effect was apparent at both post-tests. Table 5.2 indicates that the same spelling pattern was achieved for suffixes, with the two combined teaching groups achieving much higher mean spelling scores than the control condition.

Table 5.1

Mean (SD) number of correct stem ending spellings in word and pseudo-word derivatives by group.

		Words			Pseudo-words		
Group	N	Pre-test	Immediate Post-test	Delayed Post-test	Pre-test	Immediate Post-test	Delayed Post-test
Stem + Suffix Simultaneous	30	3.43 (2.62)	8.47 (2.47)	7.83 (3.59)	3.20 (2.75)	8.17 (3.10)	7.50 (3.72)
Stem + Suffix Sequential	30	3.47 (2.71)	9.77 (2.16)	9.27 (2.33)	3.33 (2.75)	9.70 (2.32)	9.13 (2.40)
Unseen Control	30	3.43 (2.89)	3.17 (2.57)	3.30 (2.65)	3.27 (2.55)	2.90 (2.76)	3.00 (2.63)

Table 5.2

Mean (SD) number of correct suffix spellings in word and pseudo-word derivatives by group.

Group	N	Words			Pseudo-words		
		Pre-test	Immediate Post-test	Delayed Post-test	Pre-test	Immediate Post-test	Delayed Post-test
Stem + Suffix Simultaneous	30	4.30 (2.98)	8.87 (2.40)	8.43 (3.12)	4.10 (3.09)	8.57 (2.60)	8.07 (3.21)
Stem + Suffix Sequential	30	4.20 (3.22)	9.97 (1.73)	9.77 (1.94)	4.13 (2.83)	9.73 (1.82)	9.30 (2.05)
Unseen Control	30	4.30 (3.31)	4.07 (3.18)	4.00 (3.05)	4.07 (3.29)	4.03 (3.15)	3.77 (3.18)

5.3.2.1 Pre-test scores

A comparison of the children's stem ending spelling scores at pre-test revealed that there was not a significant difference between the three intervention groups at the start of the study for words, $F(2, 87) = 0.00$, $p = .999$, $\eta_p^2 = .00$, or pseudo-words, $F(2, 87) = 0.02$, $p = .982$, $\eta_p^2 = .00$. A similar comparison was made for affixes at pre-test, which showed that the word, $F(2, 87) = 0.01$, $p = .990$, $\eta_p^2 = .00$, and pseudo-word, $F(2, 87) = 0.00$, $p = .996$, $\eta_p^2 = .00$, suffix spellings of the three groups did not differ significantly. This suggests that random assignment produced groups that did not differ in terms of morphological knowledge at the start of the experiment.

5.3.2.2 Intervention effects for word and pseudo-word stem ending spelling

To test the prediction that the children's word and pseudo-word stem ending spellings in derivatives would differ significantly between the experimental conditions across the three time points, two 3 (group) x 3 (testing occasion) mixed analyses of variance (ANOVA) were conducted, with intervention group (stem + suffix simultaneous, stem + suffix sequential,

unseen control) as the between-subjects factor, and test at different times (pre-test, immediate post-test, delayed post-test) as the within-subjects factor. Mauchly's test revealed that sphericity was violated for word stem spelling ($\chi^2(2) = 14.14$, $p < .05$), but not for pseudo-word stems, so the degrees of freedom were corrected for words using the Greenhouse-Geisser correction. The analyses showed that there was a significant main effect of time on the children's stem ending spelling, $F(1.74, 151.09) = 153.70$, $p < .001$, $\eta_p^2 = .64$, and on their pseudo-word spelling, $F(2, 174) = 108.09$, $p < .001$, $\eta_p^2 = .55$. This shows that the children's spellings differed between some of the time points that the test was administered. The analyses also revealed that there was a significant time x intervention group interaction effect for word, $F(3.47, 151.09 = 44.97$, $p < .001$, $\eta_p^2 = .51$, and pseudo-word stems, $F(4, 174) = 33.85$, $p < .001$, $\eta_p^2 = .44$, which indicates that the children's stem ending spelling differed between the groups at some of the testing occasions.

Planned contrasts were performed for the time variable even though the comparisons did not take the experimental conditions into account. The contrasts revealed that the children's word and pseudo-word stem ending spellings differed significantly between pre-test and immediate post-test ($p < .001$) and between pre-test and delayed post-test ($p < .001$). This shows that the children's spelling performance improved after teaching. There was not a significant difference in the children's word and pseudo-word stem spellings between immediate and delayed post-test ($p = .071$ and $p = .116$). This indicates that the children's spelling performance did not significantly improve or decline post-teaching.

Graphs to show the means for the children's word and pseudo-word stem ending spellings in derivatives at the three testing occasions are displayed in Figures 5.2 and 5.3. The figures reveal that the mean number of correct stem ending spellings was largely equivalent across

the three groups at pre-test, but that at post-test, the two combined teaching groups achieved noticeably higher mean spelling scores.

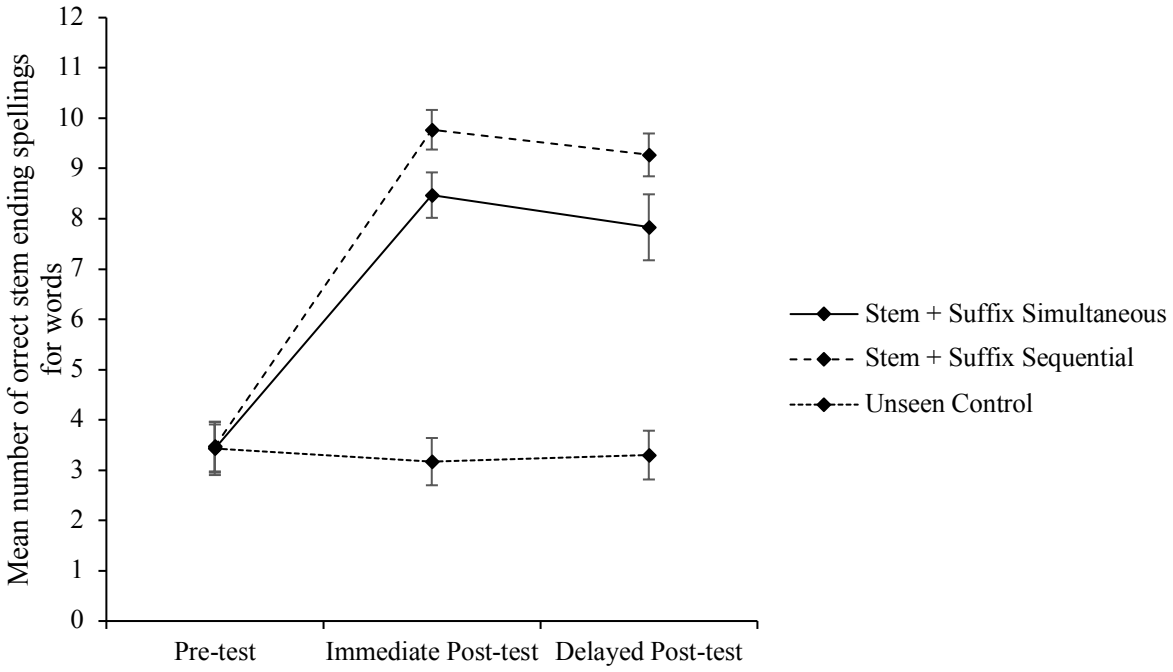


Figure 5.2. Means for the children's stem ending spellings for words across the intervention groups at pre-test, immediate post-test, and delayed post-test. Error bars represent standard errors of the means.

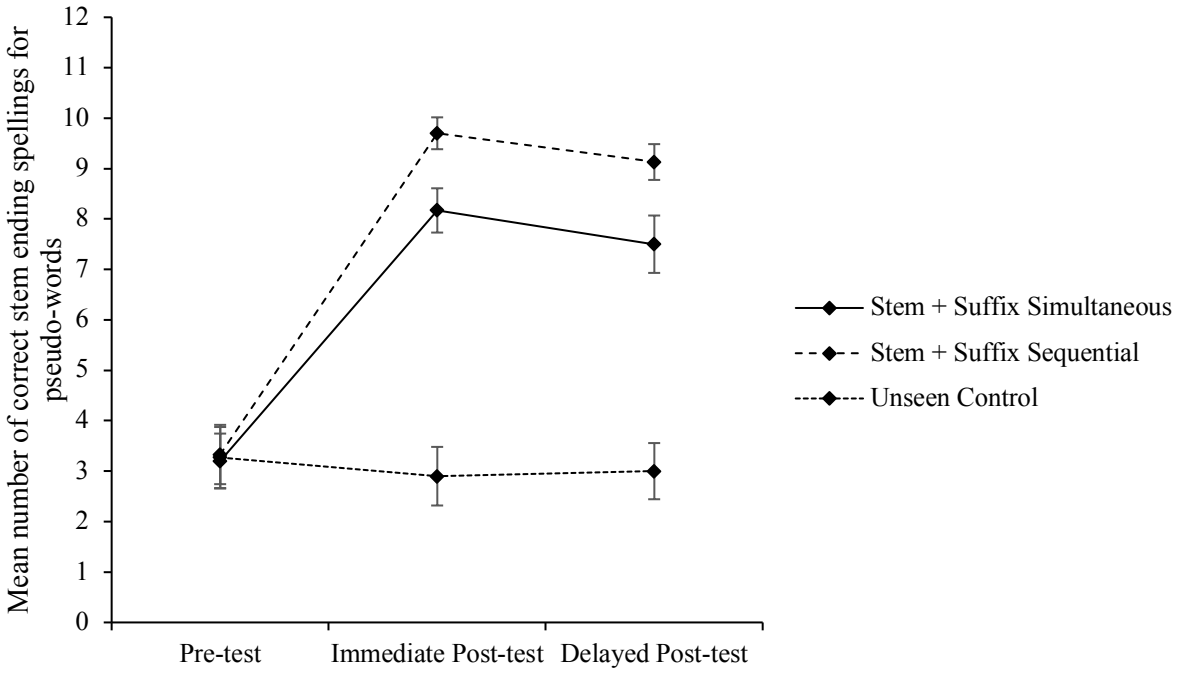


Figure 5.3. Means and standard errors for the children's stem spelling in pseudo-word derivatives for the three experimental conditions at the three time points.

Post-hoc tests performed using the Bonferroni adjustment showed that there was a significant difference between the simultaneous and unseen control conditions in terms of word stem ending spelling at both immediate ($p < .001$, $d = 2.10$) and delayed post-test ($p < .001$, $d = 1.45$) and in terms of pseudo-word stem spelling at these two time points ($p < .001$, $d = 1.80$ and $d = 1.42$). There was also a significant difference between the sequential and control groups in terms of stem spelling for words ($p < .001$, $d = 2.78$ and $d = 2.40$) and pseudo-words ($p < .001$, $d = 2.68$ and $d = 2.43$) at these two testing occasions. There was not a significant difference between the simultaneous and sequential instruction groups in terms of word ($p = .119$ and $p = .179$) or pseudo-word stem ending spelling ($p = .100$ and $p = .109$) at either post-test.

These findings support the prediction that combined teaching, either simultaneous or in sequence, would significantly improve a child's spelling of stem endings in derivatives in

comparison to no morphological teaching. This beneficial effect of combined instruction did not only enhance the children's stem spelling in the short-term, but rather it was sustained after a delay. As the result held for pseudo-words, it shows that the children acquired an appreciation of the morphological rule for stems as they applied this knowledge to words that were entirely unfamiliar. The fact that the two taught groups did not differ significantly indicates that combined instruction is worthwhile for spelling irrespective of whether the materials are presented at the same time or in a particular sequence.

5.3.2.3 Intervention effects for word and pseudo-word suffix spelling

To test the prediction that the children's suffix spellings in word and pseudo-word derivatives would differ significantly between the intervention groups at the three testing occasions, a further two 3 (group) x 3 (testing occasion) mixed ANOVAs were conducted, with intervention group (stem + suffix simultaneous, stem + suffix sequential, unseen control) as the between-subjects variable, and time (pre-test, immediate post-test, delayed post-test) as the within-subjects variable. Mauchly's test indicated that the assumption of sphericity had been violated for word, ($\chi^2(2) = 9.36$, $p < .05$), and pseudo-word suffix spelling, ($\chi^2(2) = 8.35$, $p < .05$), so it was necessary to use Greenhouse-Geisser to correct the degrees of freedom. The analyses revealed that there was a significant main effect of time on the children's affix spelling for words, $F(1.81, 157.74) = 94.71$, $p < .001$, $\eta_p^2 = .52$, and pseudo-words, $F(1.83, 159.26) = 103.80$, $p < .001$, $\eta_p^2 = .54$. This implies the children's spelling accuracy differed between the testing occasions. The analyses also showed that there was a significant time x intervention group interaction effect for word, $F(3.63, 157.74) = 28.98$, $p < .001$, $\eta_p^2 = .40$, and pseudo-word suffixes, $F(3.66, 159.26) = 29.64$, $p < .001$,

η_p^2 = .41, which shows that the children's spelling performance at the different time points varied depending on the intervention that they received.

Contrasts for the time variable revealed that the children's word and pseudo-word affix spellings differed significantly between pre-test and immediate post-test ($p < .001$) and between pre-test and delayed post-test ($p < .001$). This shows that there was a noticeable improvement in spelling post-teaching. There was not a significant difference in word or pseudo-word suffix spellings between the two post-tests ($p = .310$ and $p = .064$). This indicates that there was not a noticeable decline in the children's spelling performance after the teaching.

Means for the children's affix spelling in word and pseudo-word derivatives across the three time points are presented graphically in Figures 5.4 and 5.5. The graphs show that there were minimal differences between the three conditions in terms of suffix spelling at pre-test. By the time of the two post-tests, the two combined teaching groups achieved noticeably higher mean affix spelling scores than the unseen control condition.

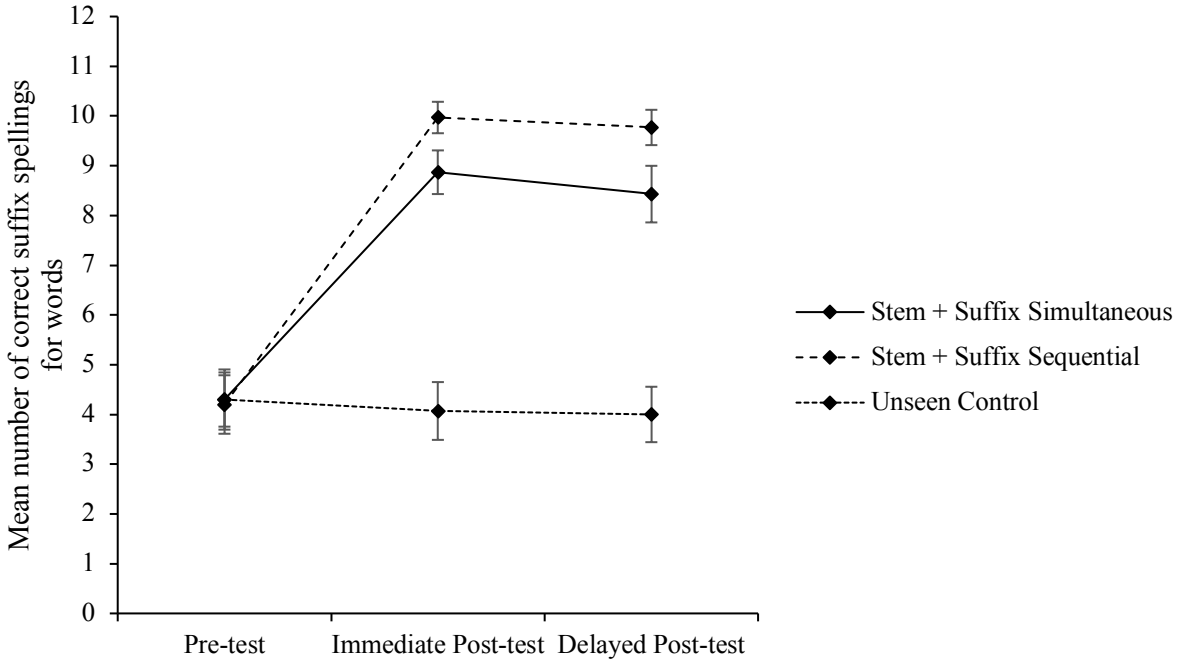


Figure 5.4. Means for the children's suffix spellings in word derivatives for each intervention group at the three testing occasions. Error bars denote standard errors of the means.

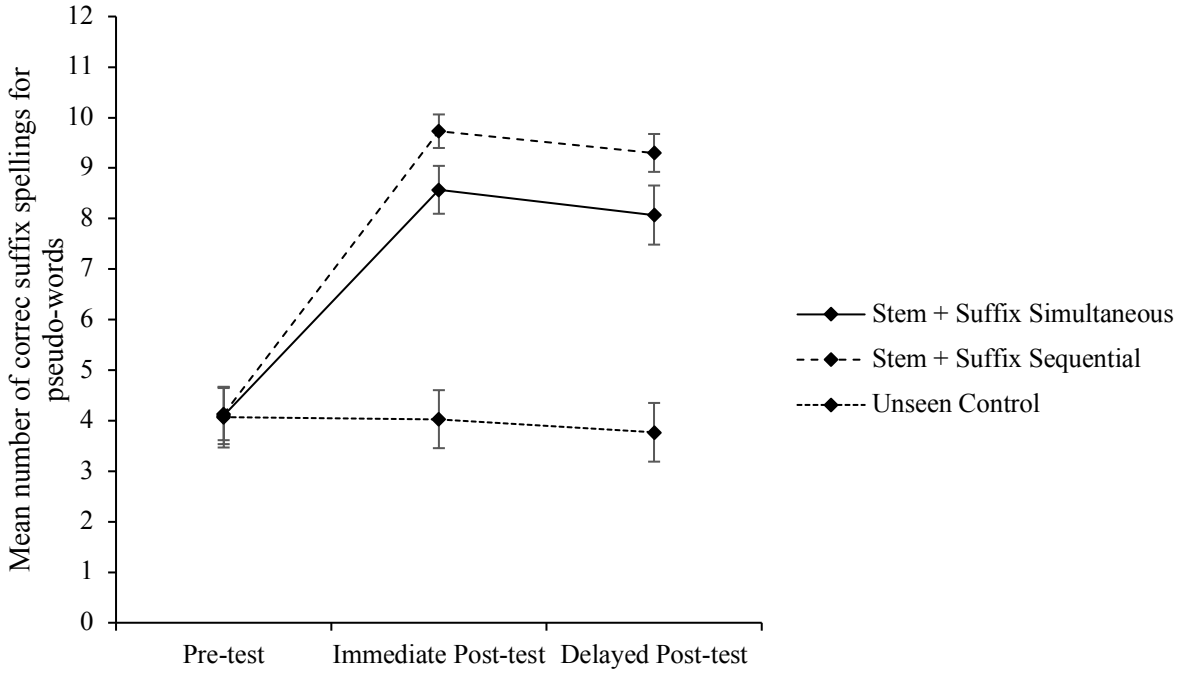


Figure 5.5. Means and standard errors for the children's spelling of suffixes in pseudo-word derivatives for each of the experimental conditions at pre-test and the two post-tests.

Post-hoc tests revealed that there was a significant difference between the simultaneous and unseen control conditions in terms of suffix spellings for words at immediate ($p < .001$, $d = 1.72$) and delayed post-test ($p < .001$, $d = 1.43$), and in terms of pseudo-word affix spelling at these two testing occasions ($p < .001$, $d = 1.59$ and $d = 1.34$). This was also apparent between the sequential and unseen control groups, which differed significantly in terms of word ($p < .001$, $d = 2.40$ and $d = 2.31$) and pseudo-word suffix spelling ($p < .001$, $d = 2.30$ and $d = 2.11$) at the two time points. The simultaneous and sequential teaching conditions did not differ significantly in terms of word ($p = .280$ and $p = .193$) or pseudo-word suffix spelling ($p = .250$ and $p = 297$) at either immediate or delayed post-test.

The results for affixes largely parallel with those reported for stems and provide support for the expectation that simultaneous or sequential instruction would noticeably improve a child's suffix spelling to a greater extent than no teaching. As this finding extends to pseudo-words, it indicates that the children that received combined instruction acquired an understanding of the distinction between the affixes of *-ion* and *-ian* as they correctly applied these morphological units to words that they could not have previously memorised word-specifically. As the simultaneous and sequential instruction groups did not differ significantly, it suggests that whilst teaching a combination of rules about word stems and affixes is beneficial, the method of presentation employed during teaching does not appear to have a noticeable influence.

5.3.2.4 Effect size comparisons between the stem and suffix teaching from Experiment 2 and the combined teaching from Experiment 3

It was also beneficial to assess if the two types of combined instruction (i.e. simultaneous or sequential) led to greater improvements in children's spelling of these two word parts in derivatives than stem or suffix teaching in isolation. This was examined by performing a series of effect size comparisons between the stem and suffix teaching groups from Experiment 2 and the two combined instruction conditions from Experiment 3. The comparisons were conducted using an approach developed by Rosenthal and Rubin (1982) and each effect size was calculated on the basis of the effect of each taught group in relation to the unseen control condition. It was expected that there would be a slight benefit of combined teaching on the children's stem and suffix spelling over and above that of isolated instruction. This was predicted as research has shown that a child's correct spelling of stems and affixes across words is significantly correlated with one another (Nunes et al. 2006).

5.3.2.4.1 Effect size comparisons for stem ending spelling

Effect size comparisons using the χ^2 distribution revealed that the effect of sequential instruction at both immediate (d = 2.78) and delayed post-test (d = 2.40) on the children's word stem ending spelling differed significantly from the effect of stem teaching (d = 1.83 and d = 1.37) at these two time points ($p < .05$). The effect of stem teaching was then compared with the effect of simultaneous instruction (d = 2.10 and d = 1.45), but these comparisons were not found to be significant at either post-test (p = .546 and p = .845). The comparisons were then repeated for pseudo-words. Using the χ^2 distribution, the effect of sequential instruction at immediate (d = 2.68) and delayed post-test (d = 2.43) on the children's pseudo-word stem ending spelling differed significantly from the effect of stem

teaching (d = 1.74 and d = 1.39) at these two testing occasions ($p < .05$). The comparisons between simultaneous instruction (d = 1.80 and d = 1.42) and stem teaching for pseudo-word stems were not found to be significant at either post-test (p = .890 and p = .942).

These findings suggest that there was a slight benefit of sequential instruction for the children's stem ending spelling over stem teaching in isolation, but that this effect was not apparent for simultaneous instruction. This implies that even though there was not a significant difference in stem spelling between the sequential and simultaneous conditions in the post-hoc analyses, that further effect size comparisons reveal that there may be some degree of significant difference. This suggests that children may benefit from receiving sequential instruction of stems and affixes over and above that of simultaneous teaching or teaching of stems in isolation.

5.3.2.4.2 Effect size comparisons for suffix spelling

Comparisons using the χ^2 distribution showed that the effect of sequential instruction at both immediate (d = 2.40) and delayed post-test (d = 2.31) on the children's word affix spellings differed significantly from the effect of suffix teaching (d = 1.47 and d = 1.25) at these two testing occasions ($p < .05$). The effect of suffix teaching was then compared with the effect of simultaneous teaching (d = 1.72 and d = 1.43), but these comparisons were not found to differ significantly at either post-test (p = .553 and p = .657). The comparisons were then conducted for pseudo-word affixes. The results revealed that the effect of sequential instruction at immediate (d = 2.30) and delayed post-test (d = 2.11) on the children's pseudo-word affix spelling differed significantly from the effect of suffix teaching (d = 1.29 and d = 1.08) at the two time points ($p < .05$). The comparisons between simultaneous instruction

(d = 1.59 and d = 1.34) and suffix teaching for pseudo-word affixes were not significant at either time point (p = .466 and p = .514). These results suggest, in accordance with the findings acquired for stems, that there is some advantage of sequential instruction for the children's suffix spelling over that of simultaneous teaching or teaching of affixes in isolation.

5.3.2.5 Summary of the intervention effects and effect size comparisons for Experiment 3

Table 5.3 provides a summary of the intervention effects from the ANOVAs reported in this experiment. The table shows that both the simultaneous and sequential instruction groups differed significantly from the unseen control condition in terms of stem and affix spelling for words and pseudo-words at the two post-tests, but that there was not a significant difference in spelling between the two taught groups. This shows that combined instruction of stems and affixes leads to noticeable improvements in children's spelling of these two word parts in derivatives, irrespective of the presentation of the materials during teaching.

Table 5.3.

Summary of the post-hoc comparisons for stem and suffix spelling between the simultaneous, sequential, and unseen control conditions in Experiment 3.

	Children's correct spelling					
	Stem endings in derivatives			Suffixes in derivatives		
	Simultaneous teaching vs. sequential teaching	Sequential teaching vs. unseen controls	Simultaneous teaching vs. unseen controls	Simultaneous teaching vs. sequential teaching	Sequential teaching vs. unseen controls	Simultaneous teaching vs. unseen controls
Reached 95% significance		X	X		X	X
Failed to reach 95% significance	X			X		

Note. This pattern of results applies to both words and pseudo-words and to both post-tests.

Table 5.4 summarises the effect size comparisons that were conducted to assess if the isolated stem or suffix teaching from Experiment 2 differed significantly from the two types of combined instruction from Experiment 3. The comparisons revealed that the effect of sequential instruction led to more significant improvements in the children's stem and affix spelling than stem or suffix teaching in isolation, but that simultaneous instruction did not lead to such significant differences. This suggests that sequential instruction may lead to greater spelling improvements than simultaneous teaching or teaching of one part in isolation.

Table 5.4.

Summary of the effect size comparisons between the stem and suffix teaching from Experiment 2 and the two types of combined instruction from Experiment 3.

	Children's correct spelling			
	Stem endings in derivatives		Suffixes in derivatives	
	Stem teaching vs. simultaneous teaching	Stem teaching vs. sequential teaching	Suffix teaching vs. simultaneous teaching	Suffix teaching vs. sequential teaching
Reached 95% significance		X		X
Failed to reach 95% significance	X		X	

Note. This pattern of results applies to both words and pseudo-words and to both post-tests.

5.3.3 Change in stem ending spellings over time

It was also worthwhile to assess if the children's word and pseudo-word stem ending spellings were influenced by frequency in a similar way to Experiments 1 and 2 (see Chapter 3.3.3; 4.3.3). This was examined because research has shown that a child's spelling is often influenced by the high frequency of *t* stem endings in English (see Chapter 2.1.2.2; Burton, 2014; Wright, 2013). It was expected that the children in the sequential and simultaneous teaching conditions would have a tendency to write *t* for all stem endings at pre-test and that this bias would decline after teaching. It was also predicted that the unseen control group would display a bias towards *t* at all three time points.

Figures 5.6 and 5.7 show that the spelling pattern for the sequential and simultaneous conditions largely paralleled with one another. The two graphs indicate, in line with the expectation, that at pre-test, the children had a tendency to spell all stem endings with *t* regardless of whether they should be written as *ss* or *c*. For instance, Figure 5.6 shows that

for the sequential teaching group, the children wrote the *t* stem ending 57% of the time in stems ending in *t*, 39% of the time in stems ending in *ss*, and 45% of the time in stems ending in *c*. This indicates that children often use the *t* spelling in the incorrect instances such as by using *t* in place of *ss* in the word *impression* (i.e. *impretion*). This shows that without teaching, children often rely on the higher frequency of *t* stem endings in English to spell morphemes in derived words.

The children's bias towards *t* in the two combined instruction conditions markedly declined after teaching and the children were more likely to apply the *t* ending to the right instances. For example, at immediate post-test, the sequential instruction group wrote *t* in 90% of stems that should be spelled with *t*, and only 16% of stems ending in *c*, and 10% of stems ending in *ss* (see Figure 5.6). This shows that teaching children about word stems and affixes, either simultaneously or in sequence, reduced the children's bias towards frequency for the spelling of stems.

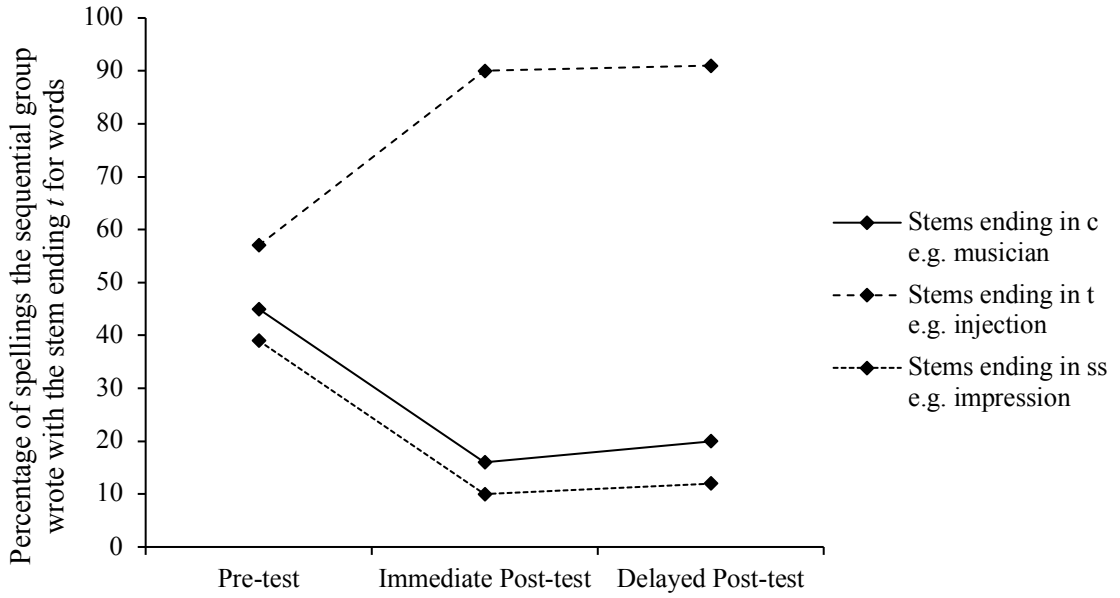


Figure 5.6. Percentage of derivatives the sequential condition spelled with the *t* stem ending at the three testing occasions.[3]

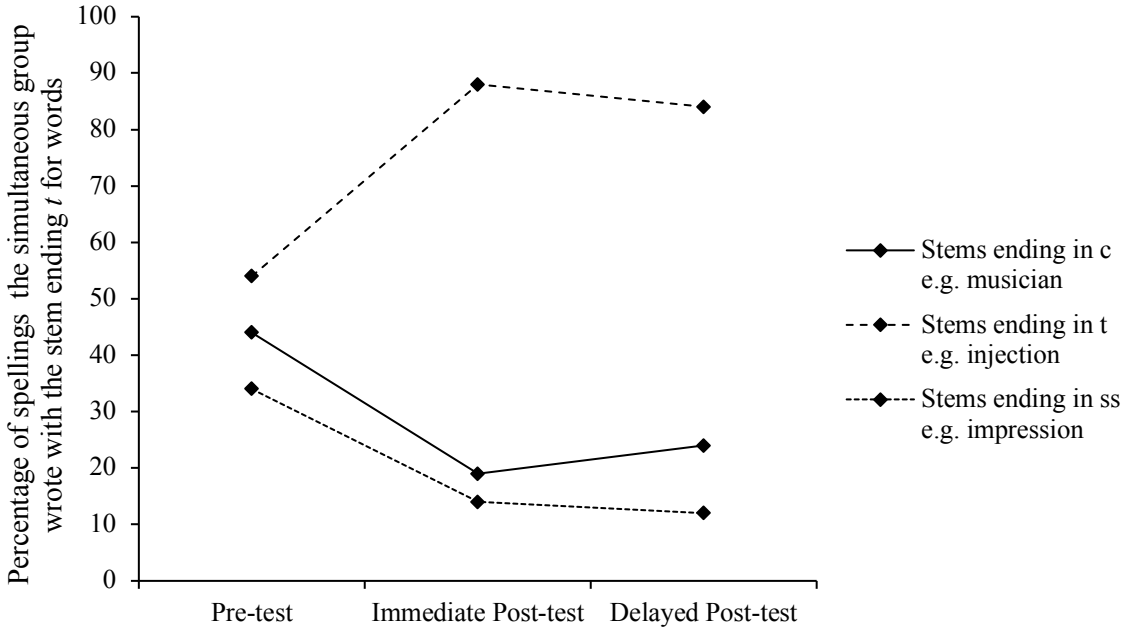


Figure 5.7. Percentage of derived words the simultaneous group spelled with the *t* ending at pre-test, immediate post-test, and delayed post-test.

[3] Note: The children's spellings of the derivative *librarian* were not included in Figures 5.6, 5.7, and 5.8 because the stem ending is not spelled with *t*, *ss*, or *c*. This word was presented in the pre-test and post-test to assess if children appreciate the *y* drop rule for stems ending in *y*.

Figure 5.8 displays the frequency of *t* spellings for the unseen control condition. The graph shows that the children were biased towards *t* at all three time points and that their use of *t* remained largely consistent over time. This implies that the children's spelling did not fluctuate with repeated exposure to the same test and that explicit teaching may be necessary to alleviate their reliance on frequency. The children's pseudo-word spellings for the three experimental conditions are presented in Appendix G and display the same frequency bias as for words. As in Experiments 1 and 2, the children's spellings were also influenced by phonology as they often spelled stem endings in derivatives with *sh* (see Chapter 3.3.3; Figure 3.10).

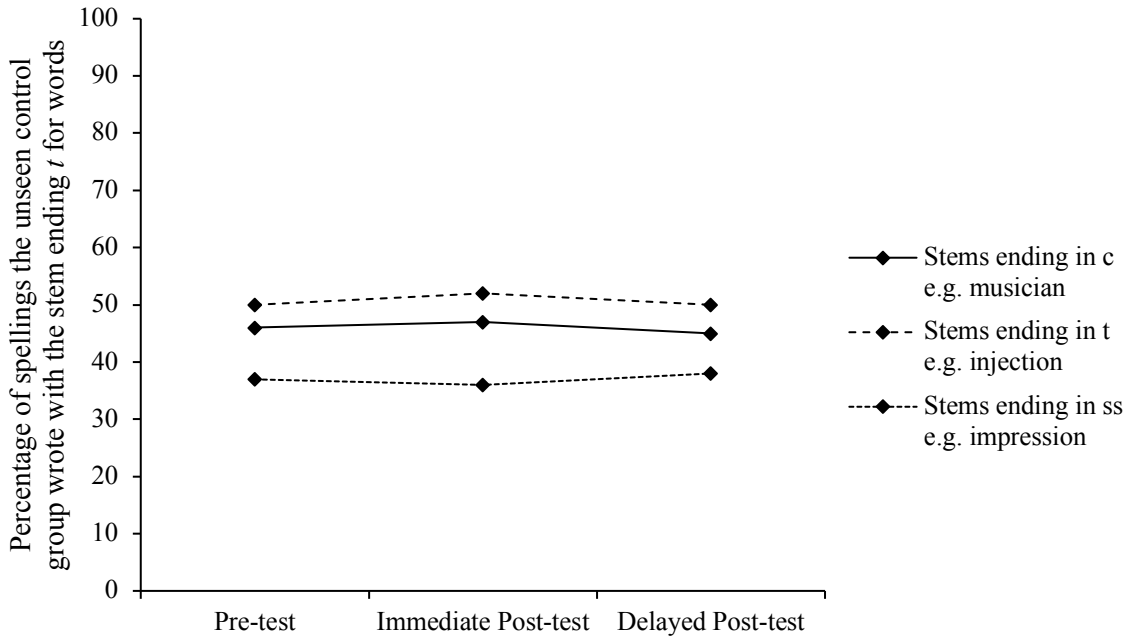


Figure 5.8. Percentage of derivatives that the unseen control condition wrote with the stem ending *t* at the three time points.

5.3.4 Change in suffix spellings over time

The frequency of different suffix spellings that the children wrote at the three time points for words and pseudo-words was also assessed (see Chapter 4.3.4). It was expected that the

children that received combined instruction would have a tendency to write all suffix spellings with *-ion* at pre-test due to the high frequency of this suffix in English (see Nunes and Bryant, 2006) and that this bias would decline post-teaching. It was also predicted that the unseen control group would be biased towards the *-ion* ending at all three testing occasions.

Figures 5.9 and 5.10 reveal that the children in the sequential and simultaneous instruction groups were biased towards writing all suffixes with *-ion* at pre-test even if they should be written as *-ian*. For instance, the children in the sequential condition wrote the *-ion* affix in 48% of words that should be written with *-ian* and in 56% of words that should be spelled with *-ion* (see Figure 5.9). This means that the children often applied the *-ion* spelling to the incorrect places such as by writing the derivative *electrician* as *electrishion*.

This bias towards *-ion* declined considerably at post-test and the children were more likely to apply the correct affix spelling in the majority of instances. Figure 5.9 displays that at immediate post-test the children in the sequential group only incorrectly applied the *-ion* spelling 17% of the time in suffixes ending in *-ian*, whereas they accurately applied *-ion* 91% of the time. This indicates that teaching children a combination of rules about both stems and suffixes reduces their use of frequency for spelling.

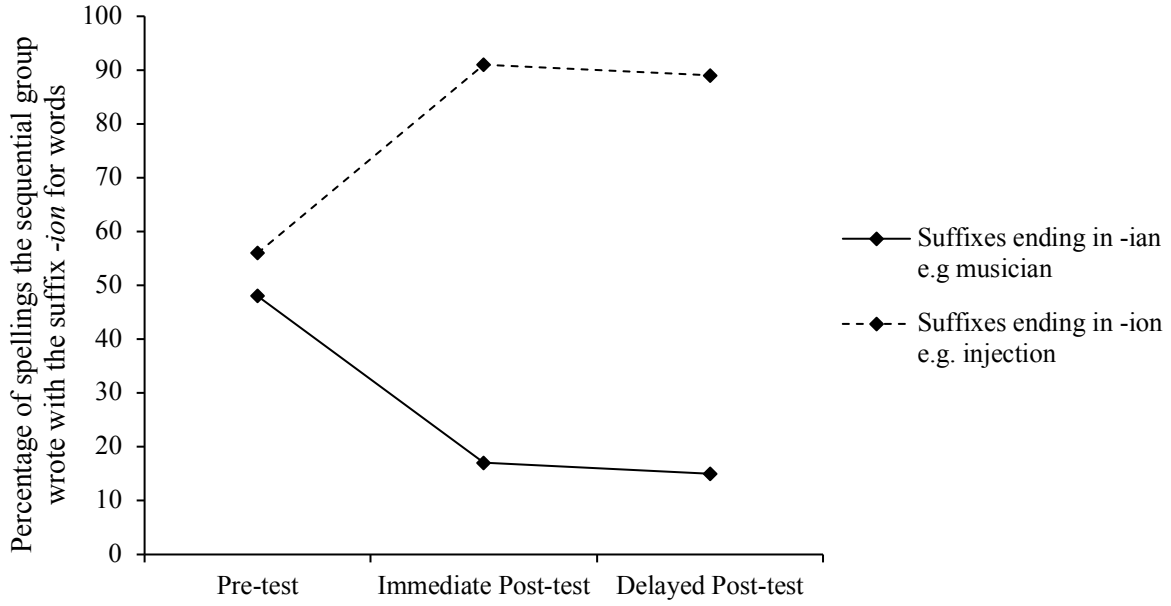


Figure 5.9. Percentage of derived words the sequential group spelled with the suffix *-ion* at pre-test, immediate post-test, and delayed post-test.

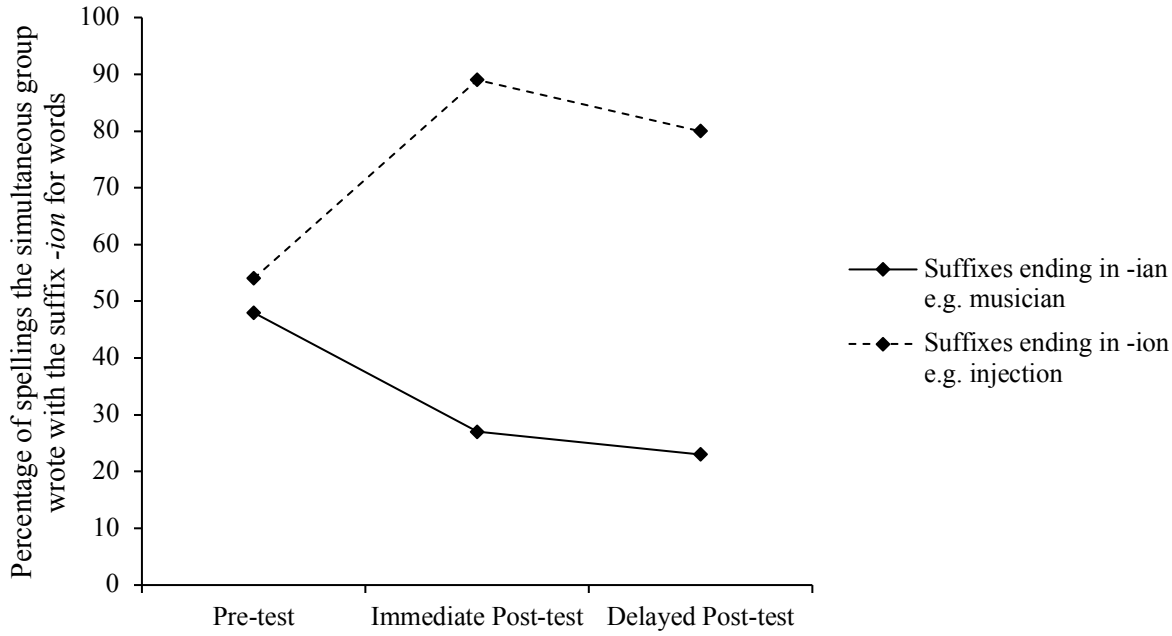


Figure 5.10. Percentage of derivatives the simultaneous condition spelled with the suffix *-ion* at the three time points.

Figure 5.11 displays the frequency of *-ion* spellings for the unseen control condition. The graph shows that the children were biased towards writing *-ion* in place of *-ian* and that this effect was sustained across the testing occasions. For instance, the children used *-ion* in the incorrect places 46% of the time at pre-test, 49% of the time at immediate post-test, and 47% of the time at delayed post-test. This shows that the children's ability to apply *-ion* to the correct instances was not influenced by receiving the same test multiple times. It also implies that in the absence of explicit teaching children often struggle to appreciate the morphological distinction between the affixes of *-ion* and *-ian*. The graphs for the children's *-ion* spellings for pseudo-words are presented in Appendix G.

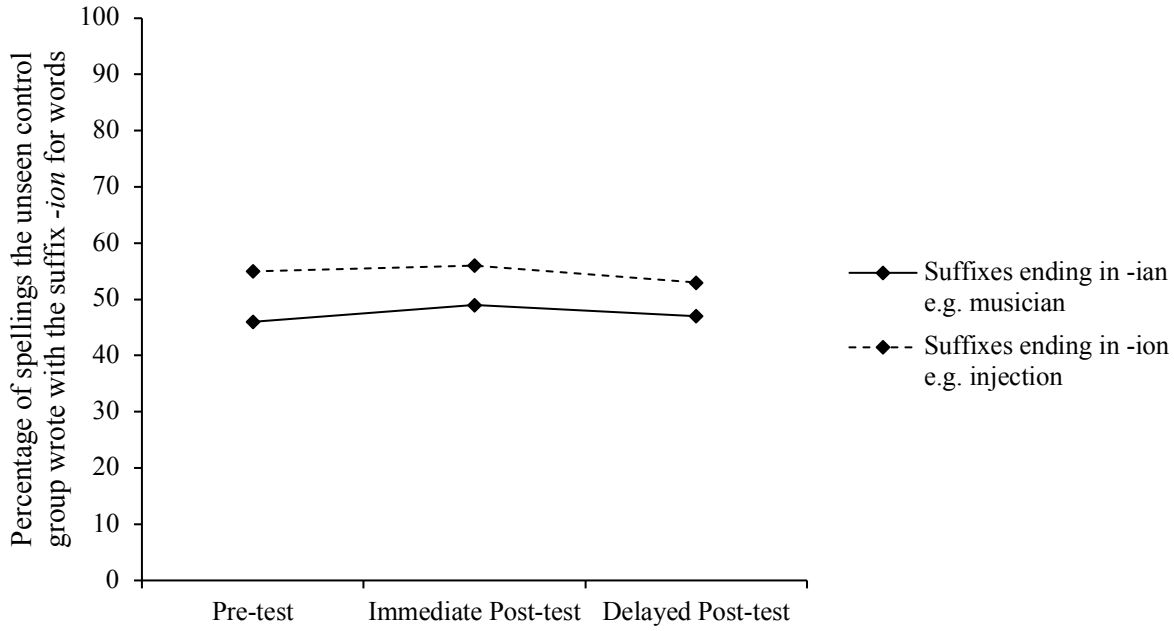


Figure 5.11. Percentage of derived words the unseen control group spelled with the suffix *-ion* at the three testing occasions.

5.4 Discussion

The aim of this experiment was to investigate if explicitly teaching children about both word stems and affixes would significantly improve their spelling of these two word parts in

derivatives to a greater extent than no morphological instruction. The results revealed, in line with the hypothesis, that explicitly teaching children the morphological rule for stem conservation and the distinction between the affixes of *-ion* and *-ian* significantly enhanced both their spelling of stem endings in derivatives and their spelling of affixes. This outcome provides support for research by Nunes et al. (2006) as it indicates that children are likely to spell word stems and morphological endings correctly if they appreciate the meaning behind both of these morphological units. The findings also extend beyond this earlier research because Nunes et al. (2006) reported correlations between a child's correct spelling of stems and affixes, whereas the present experiment provides causal evidence to show that teaching children the meaning behind these two units directly improves their spelling.

The findings also reveal that the simultaneous and sequential instruction groups did not differ significantly in terms of the children's stem and affix spelling. This contradicts the conclusion made by Pollock et al. (2002), that simultaneous instruction of too much information at once could be overwhelming for working memory, and suggests, in line with Plaza and Cohen (2006), that presenting the two rules at the same time is valuable for children's spelling. This outcome also upholds previous research by Nunes and Bryant (2009) as the results indicate that children benefit from being sequentially taught two related morphological spelling rules. This demonstrates that teaching children about both word stems and affixes is beneficial for spelling the two word parts, irrespective of the method of presentation that is employed during the teaching.

It is important to note that effect size comparisons between the stem and suffix teaching groups from Experiment 2 and the two combined instruction conditions from Experiment 3 showed that there was some advantage of sequential instruction over teaching of one rule in

isolation. This pattern of spelling could be explained by the fact that teaching children two related rules in sequence enables them to attain an understanding of the two principles more quickly. This is possible because Nunes and Bryant (2009) reported that if children are sequentially taught two related spelling rules, they acquire knowledge of the principles more quickly and efficiently than if they only receive instruction of the first rule. However, there was not a significant difference in spelling between the simultaneous group and the two isolated teaching conditions in the same way as for the children that received sequential instruction. This shows that there may be a slight benefit of teaching children about stems and affixes sequentially over and above that of simultaneous instruction.

The results also show that in the absence of morphological teaching, children have a tendency to rely on frequency, rather than morphology, for the spelling of stems and affixes in derivatives. For instance, the children were biased towards writing derivatives with the stem ending *t* and had a tendency to write *-ion* in place of *-ian* due to the higher frequency of these spelling patterns in English (see Chapter 2.1.2.2; Burton, 2014; Nunes and Bryant, 2006; Wright, 2013). This bias towards frequency declined after the children received sequential or simultaneous instruction. This shows that teaching children a combination of rules about both word stems and affixes reduces a child's reliance on frequency for the spelling of these two morphological units.

The results of this experiment also have important implications for instruction of morphemes in the school classroom. The present research shows, for what seems to be the first time, that children benefit from being taught morphological principles about both stems and affixes for spelling. This implies that there is a crucial need to increase the presence of stem and affix morphemes in everyday teaching practice so that they receive more attention in the

curriculum, and form a fundamental part of the way in which spelling is taught in primary schools across England.

Chapter 6: Discussions and Conclusions

The final chapter provides a discussion of the results of the current study and draws conclusions in relation to the research on morphology reported in the review of the literature. The first section examines the theoretical implications of the study and if the results of the three experiments extend beyond the earlier literature to broaden and strengthen an understanding of the relative contributions of implicit and explicit knowledge to a child's spelling in English. The second part considers if the testing and teaching materials designed for the present series of experiments contribute methodologically to research on morphology by revealing innovative ways of teaching children about morphemes for spelling. This is followed by a description of any limitations of the study and suggestions for future research. The concluding section considers if the findings have important educational implications for the way in which children are taught about morphemes in the school classroom.

6.1 Contributions of the current study

It is worthwhile to consider the theoretical contributions of the current study and if the findings of the three experiments support each of the research hypotheses and reinforce the literature on morphology and spelling presented in Chapter 2. This section provides an overarching framework from which to consider the results of the research in relation to theory and then examines each experiment in turn to assess if the results do not only parallel with the earlier literature, but also extend beyond it to reveal something more about the relationship between morphology and children's spelling.

6.1.1 Theoretical Contributions

The findings of the current study are informative for theoretical understanding of the different levels at which children attain morphological information, namely implicit and explicit knowledge (i.e. Karmiloff-Smith, 1986; 1992; Lorandi and Karmiloff-Smith, 2012; see Chapter 1.3). As the present series of experiments show that explicit teaching of morphemes noticeably enhances 7- to 9-year-old children's spelling of morphological units in derivatives, this indicates that children acquire an explicit understanding of morphemes for spelling through direct instruction. As a child's understanding of morphemes for spelling is enhanced to a higher level through explicit teaching, this implies that the knowledge of morphemes that children acquire through their everyday encounters with words lies at an implicit or lower level of explicit understanding. This indicates, in accordance with Karmiloff-Smith's (1986; 1992) theoretical model, that morphological understanding is initially represented in the developing lexicon at a more implicit level, but that as children acquire morphological information, this knowledge becomes "redescribed" to a higher level of understanding. Also, as the current research reveals that explicit teaching of one morphological unit (e.g. word stems) enhances a child's spelling of that word part, with limited explicit understanding of the spelling of another, related morpheme (e.g. affixes), the present study also upholds Karmiloff-Smith's (1986; 1992) assumption that a child's acquisition of morphological knowledge arises for each aspect of morphology at different times (see Chapter 1.3).

The results of the present research do not only provide experimental evidence to support this theoretical framework, they also broaden understanding of the type of morphological knowledge that is required for children to use morphemes most effectively in spelling. The

findings of the current study show that an explicit level of morphological understanding that is acquired through explicit teaching leads to more significant enhancements in a child's spelling of both word stems and affixes in derivatives than the knowledge of morphemes that children attain through their regular experiences with words or through implicit exposure to morphological units. This demonstrates that the present study extends upon Karmiloff-Smith's (1986; 1992) model to show that the type of knowledge that is of most benefit for children's spelling is explicit, and that morphological teaching may be necessary for children to reach this level of understanding.

6.1.2 Contributions of Experiment 1

The first hypothesis: explicit stem teaching would lead to more significant improvements in children's spelling of stems in derivatives than implicit instruction, and implicit stem teaching would lead to more significant enhancements than no stem instruction.

As noted in the review of the literature (see Chapter 2), the vast majority of morphological intervention studies have focused almost exclusively on teaching affixes for spelling, with limited emphasis on teaching children about word stems (see meta-analyses by Bower et al. 2010; Carlisle, 2010; Reed, 2008). Although there is some evidence for the benefit of stem teaching for spelling reported in Dutch (e.g. Kemper et al. 2012), there is a distinct lack of similar studies conducted in the English orthography. The findings of the first experiment attempt to address this deficit in the literature as they demonstrate, arguably for the first time, that teaching 7- to 9-year-old children the principle for stem conservation in English significantly improves their spelling of word stems in derivatives (e.g. *music* in *musician*). This finding upholds previous research by Kemper et al. (2012), and actually surpasses it,

to show that the advantage of stem instruction found in Dutch is observed in English. This indicates that the positive effect of stem teaching is not only applicable to one language, but rather has the potential to be beneficial for a number of different orthographies in which an understanding of morphology is necessary for accurate spelling.

The results of the first experiment do not only further the literature by showing that children benefit from being taught about word stems in English, they also reveal that explicit teaching is a more effective method than implicit instruction or no stem teaching. This supports Carlisle's (1988) research, which shows that children struggle to accurately spell stems in derivatives in the absence of explicit instruction, and contradicts the conclusion made by Sénéchal et al. (2006) that children acquire explicit awareness of the principle for stems naturally through their everyday encounters with words (see Chapter 2.1.2.2). Although explicit teaching was the most effective approach, there was a slight advantage of implicit stem instruction over and above that of no stem teaching. This shows, in accordance with Nunes and Bryant (2006), that increasing the children's exposure to morphological units did lead to some improvements in spelling. Yet, this beneficial effect of implicit stem teaching was only apparent immediately after instruction, and did not extend to pseudo-words or after a two-week delay. In contrast, explicit stem instruction led to benefits in spelling that were maintained after a delay and extended to pseudo-words. This implies that explicit teaching led to a level of morphological knowledge that could enter the children's long-term memory and could be applied to unfamiliar pseudo-words that they could not have previously memorised by rote.

The findings of Experiment 1 also contribute to Karmiloff-Smith's (1986; 1992) implicit versus explicit distinction of children's morphological knowledge. As the results show that

explicit stem teaching noticeably improves a child's spelling of word stems in derivatives, this indicates that children acquire an explicit understanding of word stem morphemes for spelling through explicit instruction. As explicit teaching enhanced a child's stem spelling to a greater extent than implicit or no stem instruction, this demonstrates that in the absence of explicit teaching a child's understanding of stems lies at an implicit or lower-level of explicit information. This upholds Karmiloff-Smith's (1986; 1992) theory that there are different levels at which children acquire morphological knowledge, and extends beyond it to show that explicit knowledge is of most benefit for children's spelling of stems.

The findings also have implications for Taft's (1979; 1991) theory that words are stored in the mental lexicon of the brain in a morphologically segmented form. As the first experiment shows that explicit stem teaching improves a child's spelling of stems in derivatives, it implies that children have the capacity to segment words into morphological units for spelling. This provides evidence to indicate that children have a decomposed representation of words with a morphological structure in their lexicon. Also, as this finding held for pseudo-words, it shows that the children were using affix stripping to concentrate on the stem because they could not have been relying on word-specific knowledge to reach the correct stem spelling.

It is also clear from the research presented in Chapter 2 that in the absence of explicit teaching, children have a tendency to rely on frequency or phonology, rather than morphology, to spell words with a morphological structure (e.g. Burton, 2014; Kemp and Bryant, 2003; Nunes and Bryant, 2006; Wright, 2013). The results of the first experiment provide support for this earlier research as they indicate that prior to instruction at pre-test, the children often employed the phonological representation *sh* (e.g. *electrishion*) to spell

stem endings in derivatives and that they also had a tendency to write derivatives with the stem ending *t*, even if they should be spelled as *ss* or *c*, due to the high frequency of *t* spellings in English (MRC Psycholinguistic Database, 1987). This means that 7- to 9-year-old children often overgeneralise the *t* spelling to the incorrect places such as by writing a word like *musician* as *musition*. This predisposition towards *t* is not only likely to be influenced by frequency, it is also compounded by the fact that educational policy documents (e.g. Department for Education, 2013; Department for Education and Employment Spelling Bank, 1999; Department for Education and Skills, 2008) propose to teach children in a way that presents *-tion* as an affix, even though the morphological division is between the stem ending *t* and the suffix *-ion*. However, it is important to note that previous research has been limited by the failure to examine if the children's bias towards *t* could be alleviated through explicit stem teaching. The results of the first experiment of the current study attempt to overcome this shortfall of the earlier literature as they show that the children's bias towards *t* reduced considerably after explicit teaching at post-test and that they were noticeably more likely to apply the *t* stem ending to the correct places. This clearly shows that explicit instruction reduced the children's bias towards frequency for the spelling of stems.

Consequently, the findings of the first experiment provide support for the hypothesis that explicit stem teaching would lead to more significant improvements in spelling than implicit instruction, and that implicit stem teaching would lead to greater benefits than no stem instruction. This outcome widens current understanding of morphology by demonstrating that enhancing a child's knowledge of word stems to an explicit level does have positive consequences for their spelling of stems in English derivatives.

6.1.3 Contributions of Experiment 2

The second hypothesis: explicit teaching of one aspect of morphology would significantly improve a child's spelling of that particular aspect of a derived word, in comparison to no morphological teaching, with some explicit understanding of the spelling of another, untaught aspect.

Previous morphological intervention studies have shown that explicit teaching of affixes significantly improves a child's affix spelling (e.g. Devonshire and Fluck, 2010; Nunes and Bryant, 2006; Nunes et al. 2003) and that explicit teaching of word stems significantly improves a child's spelling of stems (see Chapter 3; Kemper et al. 2012). The second experiment of the current study provides further evidence to support this research as explicit teaching of one aspect of morphology significantly enhanced a child's spelling of that particular part of a derived word in comparison to no morphological instruction. Experiment 2 also forms one of the initial studies to show that explicit teaching of one morphological rule (e.g. word stems) leads to limited explicit understanding of the spelling of another, related aspect that does not receive attention (e.g. affixes). This pattern of spelling could not be explained by a reliance on word-specific knowledge because, if so, it is likely that the children would spell both the word stem and the affix to an equal level of proficiency. This outcome provides support for research by Rosa and Nunes (2008) and Wright (2013) as it indicates that if children are asked to focus on one morphological unit, such as word stems, that this detracts attention from the other such that they strip the affix (e.g. *-ian*) from the derivative (e.g. *magician*) and focus on the taught word part, namely the stem (e.g. *magic*). This implies that 7- to 9-year-old children can segment words into their constituent morphemes for spelling and use affix stripping to focus on the word part that has received

direct instruction. This provides additional support for Taft (1979; 1991) and Taft and Forster's (1975) theory that words are stored in the mental lexicon of the brain not only as whole words, but also in a morphologically decomposed form. This finding shows that morphological instruction is largely specific; it enhances a child's spelling of the word part that receives explicit attention.

The outcomes of Experiment 2 also have implications for the theoretical assumption that children acquire knowledge of each aspect of morphology at different stages (i.e. Karmiloff-Smith, 1986; 1992; Lorandi and Karmiloff-Smith, 2012). As explicit teaching of one aspect of morphology (e.g. word stems) improves a child's spelling of that word part, with minimal explicit understanding of the spelling of another, related morpheme (e.g. affixes), this indicates that children can have explicit representations of the principle for stem conservation at the same time as a lower level of morphological knowledge of the affixes of *-ion* and *-ian*. This supports Karmiloff-Smith's (1986; 1992) assumption that a child's acquisition of morphological knowledge arises for each morphological unit at different times.

The results of the second experiment also show, in accordance with the literature presented in Chapter 2 (i.e. Burton, 2014; Nunes and Bryant, 2006; Wright, 2013), that children have a tendency to rely on frequency for the spelling of word stem and affix morphemes prior to explicit instruction. The findings also further the earlier literature to reveal, in line with Experiment 1, that this bias towards frequency declined post-teaching. In particular, the results show that explicit stem teaching noticeably reduced the children's overreliance on *t* and that explicit suffix teaching markedly declined a child's bias towards *-ion*. This indicates that explicit teaching of a particular aspect of morphology lessens a child's reliance on

frequency for the spelling of morphological units. However, it is important to acknowledge that there was a slight decline in bias towards *t* and *-ion* for the children that received explicit teaching of a related aspect of morphology. This indicates that the children attained some implicit understanding of the untaught morphological unit, but lacked more explicit knowledge of this word part in a way that noticeably enhanced their spelling. This suggests that children may acquire implicit rather than explicit knowledge of a related aspect of morphology through explicit teaching of one morphological unit. This provides support for Karmiloff-Smith's (1986; 1992) theory that children can acquire implicit or explicit knowledge of morphemes and implies that children may benefit from receiving explicit instruction of each word part for spelling.

As a result, the findings of the second experiment support the first part of the hypothesis that explicit teaching of one aspect of morphology would significantly improve a child's spelling of that particular part of a derived word in comparison to no morphological instruction. Yet, the results do not indicate that explicit teaching of one morphological unit leads children to acquire explicit understanding of the other, untaught aspect. This indicates that children fail to acquire an understanding of morphemes that is useful for spelling through their repeated encounters with words and that explicit instruction of each morphological rule may be necessary to noticeably enhance a child's spelling.

6.1.4 Contributions of Experiment 3

The third hypothesis: explicitly teaching children about both word stems and affixes, either simultaneously or in sequence, would significantly improve their spelling of these two word parts in derivatives to a greater extent than no morphological teaching.

The research on morphology presented in the review of the literature shows that a child's correct spelling of a stem across words and their correct spelling of morphological endings is significantly correlated with one another (Nunes et al. 2006). This indicates that children are more likely to spell word stems and affixes correctly if they appreciate the meaning behind both morphological units. The third experiment of the current study expands upon this earlier work and forms one of the initial studies to investigate and show that explicit teaching of word stems and affixes within the same teaching session significantly aids 7- to 9-year-old children's spelling of both of these word parts in derivatives. This outcome extends beyond Nunes et al.'s (2006) research, as they only reported correlations between a child's stem and affix spelling, and shows that there may, in fact, be a causal relationship between a child's understanding of these two morphological units and their spelling of these two word parts in derived forms. This is feasible because the only difference between the combined instruction conditions and the unseen control group was the intervention (see Field, 2017) so it is possible to conclude that teaching these two morphological rules together could cause the effect of improved spelling. This finding provides some of the primary evidence to show that children could benefit from being taught about both stems and affixes, in conjunction with one another.

The results of the third experiment also further the literature as they show that there was not a significant difference between the two types of combined instruction for the children's spelling. This supports Plaza and Cohen's (2006) finding that visual processing is associated with children's spelling accuracy, as it shows that visually presenting stems and affixes at the same time and within the same words enables children to synthesise the meanings of the two word parts together to improve their spelling. In contrast, the findings oppose Pollock et al.'s (2002) assumption that simultaneous instruction of too much material at once

hampers working memory (Miller, 1956; Sweller, 1994). This finding also reinforces and extends upon Nunes and Bryant's (2009) research as it shows that teaching two related morphological spelling rules in sequence is of benefit for children's spelling, in a similar way to sequential instruction of phonology. As this is one of the initial studies to combine instruction of stems and affixes together, it shows that teaching children these two rules is valuable for a child's spelling, irrespective of whether the materials are presented simultaneously or sequentially.

It is also worthwhile to note that effect size comparisons between the stem and suffix teaching groups from Experiment 2 and the two types of combined instruction from Experiment 3 revealed that there was a slight benefit of sequential teaching over and above that of teaching one rule in isolation. This could be explained by Nunes and Bryant's (2009) research as they reported that teaching two related spelling rules in sequence enabled children to acquire knowledge of the principles more quickly and effectively than if they only received instruction of the first rule. However, there was not a significant difference between the simultaneous condition and the two isolated teaching groups in the same way as for the sequential condition. This indicates that there may be a slight advantage of teaching two related spelling rules in sequence over that of simultaneous instruction.

The outcomes of Experiment 3 also have implications for Karmiloff-Smith's (1986; 1992) theory as they demonstrate that explicitly teaching children about both word stems and affixes, either simultaneously or sequentially, noticeably aids a child's spelling of each word part, which indicates that children acquire explicit knowledge of the two morphological units in the lexicon through explicit instruction. The results also show that an explicit level of morphological understanding that is acquired through teaching enhances a child's spelling

accuracy for each word part to a greater extent than no morphological instruction. This expands theoretical understanding as the findings indicate that explicit knowledge is necessary for children to use morphemes most effectively in spelling.

The findings of the third experiment also show, in accordance with Experiments 1 and 2, that children often employ frequency for the spelling of morphological units in derivatives. This falls in line with previous research (see Chapter 2.1.2.2; Burton, 2014; Nunes and Bryant, 2006; Wright, 2013), and actually moves beyond it, to show that the children's bias towards frequency declined considerably for both word parts after the children received combined instruction. This demonstrates that combining teaching of word stems and affixes together alleviates a child's dependence on frequency for the spelling of both morphological units.

As a consequence, the results of the third experiment support the hypothesis that explicitly teaching children about both word stems and affixes, either simultaneously or in sequence, would significantly improve a child's spelling of these two word parts in derivatives in comparison to no morphological instruction. Yet, it is important to note, that there was a slight advantage of sequential teaching over simultaneous instruction and teaching of stems or affixes in isolation. This broadens understanding of morphology in the literature as it does not only suggest that children benefit from having their knowledge of morphemes enhanced through explicit teaching, it also indicates that it could be worthwhile for children to receive instruction of related morphological principles together.

6.2 Methodological contributions

It is also beneficial to consider if the testing and teaching materials that were developed for the three experiments of the current study were effective and if they contribute methodologically to research on morphology by providing an insight into an arguably different way of teaching children about morphemes for spelling.

The first experiment clearly shows that the stem-based intervention that was created and designed for the present study noticeably enhanced a child's spelling of stems in derived words in English. As this was one of the primary studies to investigate stem teaching in the English orthography, the current research does not only reveal that children benefit from being taught the principle for stem conservation, it also provides a clear methodological framework and procedure from which to teach children this morphological rule. The present research also provides some of the initial evidence to show the positive effect of teaching children morphological principles about both word stem and affix morphemes together. Thus, the current study also provides a clear procedure for combining instruction of morphological units.

It is also evident that the present research forms one of the first morphological intervention studies to employ innovative coding materials to specifically develop and create a training game for children to acquire an understanding of morphology. The three experiments show that the game was an effective way of aiding the children's appreciation of the rules that they were taught in the teaching session. This reinforces research by Nunes and Bryant (2006), which employed computerised games to enhance children's spelling, but actually moves beyond it, as the coding was designed in such a way that the children could actively

type their answers to each trial on the computer rather than writing their answers by hand. This focus on using a computer is beneficial because technological advancements have led literacy games and apps to form a focal part of a child's learning experience on a day-to-day basis. This indicates that the teaching materials developed for the current research are relevant and appropriate for literacy instruction in school.

The spelling task that was employed across the three experiments of the present study was also likely to be an effective way of measuring a child's understanding of morphology. This type of task was originally developed by Nunes and Bryant (2006) and was modified and adapted for the current research so that the children received a variety of derivatives that contained each of the stem endings of *t*, *ss*, and *c*, and each of the suffixes of -*ion* and -*ian*. This modification controlled for any bias towards frequency, because if, for example, all of the derivatives contained the stem ending *t*, the children could reach the correct spelling by relying on the high frequency of *t* stem endings in English (MRC Psycholinguistic Database, 1987), rather than an understanding of morphology. The spelling measure also included pseudo-words to eliminate the possibility that the children were simply relying on word-specific knowledge for spelling. This indicates that the task was a useful way of assessing a child's knowledge of morphology because the test controlled for frequency and memorisation of each word by rote.

Therefore, the three experiments of the present study contribute in a number of ways to enhancing and increasing the range of materials that are available for testing and teaching children about morphology. The intervention sessions and training games were an effective way of teaching children about morphemes for spelling and the spelling task was a successful way of assessing a child's understanding of morphology.

6.3 Limitations of the study

It is not only important to examine the results of the study in relation to the appropriate literature and the methodological contributions, it is also worthwhile to acknowledge possible limitations. For instance, it is beneficial to consider if the intervention in the current study reflects typical teaching routines as the materials were delivered on a one-to-one basis by the researcher rather than the familiar classroom teacher. As there is increasing awareness of special educational needs and one-to-one support with teaching assistants, the presence of the researcher need not be so different to the experiences that children encounter in school on a regular basis. It is also important to note that the sample in the present study included 270 children from three different primary schools spanning two counties, which implies that the findings have the potential to be generalisable to the primary school environment.

It is also valuable to consider if the one-to-one instruction in the present study could be effectively applied to the large group setting of the school classroom. It is feasible that the computerised teaching sessions and training game could be presented to a whole class using a projector and that the children could take it in turns to write their answers for each trial on the board or on their answer sheet (see Chapter 3.4). It is also possible, in line with research by Hurry et al. (2005), that school teachers could be trained so that they start to appreciate that morphemes form a fundamental role for spelling in the English orthography in addition to phonemes. This would equip teachers with the necessary morphological knowledge to teach children, which they could disseminate effectively in class. This implies that the one-to-one teaching materials that were developed for the current research could be successfully transformed so that they are applicable to the classroom context.

A further consideration is that the present study only explicitly taught children the meaning behind one pair of affixes, even though there are a number of different affix morphemes in English. This implies that children may benefit from receiving interventions that teach the meaning behind word stems followed by instruction of a different affix-based principle. Yet, it is clear from research by Nunes and Bryant (2006) that children experience a particular difficulty with spelling this pair of morphological endings (i.e. -*ion* and -*ian*), which implies that extending understanding of how to teach this morphological distinction could be valuable for children's spelling. It is also important to note that focusing instruction on the affixes of -*ion* and -*ian* throughout the current study meant that it was possible to perform effect size comparisons between the isolated teaching in Experiment 2 and the combined instruction in Experiment 3. As this morphological distinction does not receive direct attention in the curriculum, it is likely that furthering an understanding of how children approach these two affixes is an effective way of contributing to the literature on morphology and spelling.

It is also important to note that the children who received explicit teaching were not asked to explain the strategies that they used to spell the words. This implies that it is difficult to decipher if the children were using a morphological strategy for spelling, and even though word-specific knowledge was eliminated through the inclusion of pseudo-words, the pseudo-word sentences included a stem prime (e.g. the prime *lagic* for the derivative *lagician*), which means that the children could have reached the correct stem spelling through priming, which is an implicit, non-conscious process that is unlikely to involve explicit knowledge of morphological rules. Yet, it is important to note that this method of assessing the children's understanding of morphology has been employed widely in the literature (i.e. Nunes and Bryant, 2006), and as there was a discrepancy between the

spellings of the taught groups and the control conditions, it is likely that teaching enhanced the children's understanding of morphology in a way that noticeably improved their spelling.

6.4 Suggestions for future research

The ideas raised in the previous section, rather than limiting the study, naturally pave the way for future directions in research. For instance, additional studies could be conducted that examine if children respond more effectively to morphological interventions that are delivered by the regular classroom teacher rather than by the researcher. This could be a valuable way to bridge the gap between research and everyday teaching practice because if teachers start to recognise the benefit of morphemes for a child's spelling, this could provide the necessary impetus for increasing the presence of morphemes in the National Curriculum and for resolving some of the inadequacies of the current guidelines with respect to morphology. Future studies could also investigate if the positive effects acquired from one-to-one teaching could be replicated in a whole class setting. This would assess if the teaching materials and training game are suitable for the primary classroom and if children attain similar advantages from receiving morphological teaching in a group context as they do from individualised instruction.

Future research could also examine the effectiveness of explicitly teaching children about word stems followed by instruction of a different affix-based principle. For instance, further studies could be conducted that teach children the principle for stem conservation in conjunction with the rule that all regular past-tense verbs are spelled with *-ed*. Although there is not a pronunciation change in the stem of inflected words like *kissed* in the same way as for derivatives like *magician*, it is likely that children still need to appreciate that *kiss*

is a stem that is conserved across words so that they can recognise where the morpheme boundary lies and effectively add the morphological ending (i.e. *-ed*). Earlier research by Nunes et al. (1997) provides evidence to support this view as they reported that children have a tendency to misspell past-tense verbs like *kissed* by writing *kist*, which indicates that children often fail to conserve stem spellings across inflected forms as well as struggling to apply the past-tense morpheme *-ed*. This implies that it would be worthwhile to perform additional experiments that investigate if children benefit from being explicitly taught about stems alongside other morphological rules.

It could also be beneficial to perform a further study that compares the two types of combined instruction and stem or suffix teaching in isolation within the same experiment. This would extend the effect size comparisons between the experiments of the current study to assess, more directly, and within a more controlled environment, if there is a significant difference in stem and affix spelling between sequential instruction and simultaneous teaching or teaching of one rule in isolation. Such an investigation would bolster and strengthen the findings of the present research and provide an even clearer understanding of how to combine instruction of morphological principles together for children's spelling.

A further study could also be conducted that extends the present research to include an additional outcome measure to assess a child's knowledge of each morphological rule more directly. This could involve asking the children to explain the strategies that they used to spell the words in the spelling task both before and after explicit teaching, in a similar way to previous research (i.e. Devonshire and Fluck, 2010; Sénéchal et al. 2006). This additional task could determine if the improvement in the children's spellings after teaching was due to changes in their knowledge of morphology. For instance, if a child who received explicit

teaching was able to explain that they used the -*ian* spelling because the word *musician* refers to a person, but that they were unable to provide this explanation at pre-test, this shows that their morphological understanding of the affixes of -*ion* and -*ian* was enhanced to a more explicit level through instruction. This outcome measure could further advance theoretical understanding of the type of morphological knowledge that is of most benefit for children's spelling.

6.5 Educational implications

The results of the present study do not only open the door for future research, they also provide an invaluable insight into how to teach children about morphemes in the school classroom. For example, the findings of the current research clearly show that children benefit from receiving explicit instruction of morphemes, and more specifically, that explicit teaching of the morphological principle for stem conservation followed by a particular affix-based rule (i.e. the distinction between the suffixes of -*ion* and -*ian*) noticeably aids a child's spelling. This indicates that the current curriculum guidelines are limited with respect to morphology and that the documentation should be modified to incorporate additional morphological principles (see Chapter 1.5). For instance, the guidelines for key stages one and two should be extended to acknowledge the role of word stems and to include the rule that the spelling of a stem is often conserved in derived words in spite of changes in sound. The documentation should also be amended to ensure that -*tion* and -*cian* are not treated as morphological units, but rather so that it is clear that the affixes are, in fact, -*ion* and -*ian*. The guidelines should also teach these two suffixes in direct relation to their meaning so that children can appreciate that the spelling -*ion* is used for abstract nouns and that the ending -*ian* is used for words that refer to a person (Nunes and Bryant, 2006). If children are taught

specific morphological principles in this way, it is possible that they could generate a number of correct spellings from just being taught a small set of rules. For instance, if children are taught about the affixes of *-ion* and *-ian*, they have the potential to accurately spell the endings of over 3,000 English words that contain these endings. This implies that modifying the National Curriculum to encompass further morphological rules could noticeably enhance a child's understanding of morphology for spelling.

The current study does not only show that the curriculum should incorporate additional morphological principles, it also indicates that educational policy documents should be restructured so that they place a stronger emphasis on the role of morphemes for children's spelling. For example, it is clear that the term morpheme is yet to be defined in the 2013 documentation (see Department for Education, 2013), which means that children, and education practitioners alike, could fail to appreciate that morphemes are units of meaning that determine the spelling of many English words, in addition to phonemes. It is likely that extending the curriculum to include a definition of morphemes could be an effective way of increasing understanding of morphology. It is also important to note that if morphemes are placed at the forefront of literacy instruction, alongside phonemes, that this is not only likely to be beneficial for children's spelling, it also has the potential for more far-reaching effects, such as leading to significant enhancements in a child's word reading and reading comprehension. This is likely because Nagy et al. (2006) and Tong et al. (2011) clearly showed that a child's awareness of morphology is closely associated with their ability to read and comprehend individual English words (see Chapter 2.2). This implies that incorporating a greater understanding of morphemes into the guidelines for everyday teaching practice could enrich the knowledge that educators have of morphology, which could, in turn, noticeably enhance a child's reading and spelling.

6.6 Conclusions

To summarise, it is clear that the present study increases understanding of how implicit and explicit knowledge of morphology contribute to children's spelling in English. The current research provides some of the primary evidence to show that 7- to 9-year-old children benefit from having their understanding of word stem and affix morphemes enhanced to an explicit level through explicit instruction, and that this leads to greater spelling improvements than no morphological teaching or repeated exposure to morphological units; either through implicit teaching (see Experiment 1) or through explicit instruction of another, related morphological rule (see Experiment 2). This clearly shows that the knowledge of morphology that children acquire as a consequence of explicit teaching is of notable benefit for spelling.

The present research does not only reveal that it is worthwhile to explicitly teach children about morphemes, it also forms one of the initial studies to show that explicit instruction of two related morphological principles, in conjunction with one another, has positive outcomes for a child's spelling (see Experiment 3). Also, the research clearly shows that explicit instruction is an effective way of reducing a child's reliance on frequency for the spelling of morphological units. Consequently, the outcomes of the present investigation have important implications for the way in which children are taught about morphemes in school, and provide a clear strategy for how to revise the National Curriculum in England to place a stronger emphasis on the importance of morphology for children's spelling.

References

Berko, J. (1958). The child's learning of English morphology. *Word,* 14, 150-177.

Berninger, V. W., Abbott, R. D., Augsburger, A. and Garcia, N. (2009). Comparison of pen and keyboard transcription modes in children with and without learning disabilities. *Learning Disability Quarterly,* 32(3), 123-141.

Bowers, P. N. and Kirby, J. R. (2010). Effects of morphological instruction on vocabulary acquisition. *Reading and Writing,* 23, 515-537.

Bowers, P. N., Kirby, J. R., and Deacon, S. H. (2010). The effects of morphological instruction on literacy skills: a systematic review of the literature. *Review of Educational Research,* 809(2), 144-179.

Bradley, L. and Bryant, P. E. (1983). Categorizing sounds and learning to read—a causal connection. *Letters to Nature,* 301, 419-421.

Breadmore, H. L. and Carroll, J. M. (2016). Morphological spelling in spite of phonological deficits: evidence from children with dyslexia and otitis media. *Applied Psycholinguistics,* 37, 1439-1460.

British Educational Research Association (2018). *Ethical Guidelines for Educational Research,* 4th ed. London: BERA.

British Psychological Society (2014). *Code of Human Research Ethics,* 2nd ed. Leicester: BPS.

Bryant, P., Nunes, T. and Aidinis, A. (1999). Different morphemes, same spelling problems: cross-linguistic developmental studies. In M. Harris and G. Hatano (eds.). *Learning to read and write: a cross-linguistic perspective*. Cambridge: Cambridge University Press, pp. 112-133.

Burton, L. (2014). Do we need magic to spell magician? The importance of word stems for children's spelling. University of Oxford, Oxford.

Butterworth, B. (1983). Lexical representation. In B. Butterworth (eds.). *Language Production.* London: Academic Press, pp. 257-294.

Cain, K. (2010). *Reading Development and Difficulties.* Oxford: BPS Blackwell.

Cain, K. and Oakhill, J. (2007). Reading comprehension difficulties: correlates, causes, and consequences. In K. Cain and J. Oakhill (eds.). *Children's comprehension problems in oral and written language: a cognitive perspective*. New York: Guilford Press, pp. 41-75.

Caramazza, A., Laudanna, A. and Romani, C. (1988). Lexical access and inflectional morphology. *Cognition,* 28, 297-332.

Carlisle, J. F. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics,* 9, 247-266.

Carlisle, J. F. (1995). Morphological awareness and early reading achievement. In L. B. Feldman (eds.). *Morphological aspects of language processing*. New Jersey: Lawrence Erlbaum, pp. 189-210.

Carlisle, J. F. (2010). Effects of instruction in morphological awareness on literacy achievement: an integrative review. *Reading Research Quarterly,* 45, 464-487.

Casalis, S., Dusautoir, M., Colé, P. and Ducrot, S. (2009). Morphological effects in children word reading: A priming study in fourth graders. *British Journal of Developmental Psychology,* 27, 761-766.

Casalis, S., Pacton, S., Lefevre, F. and Fayol, M. (2018). Morphological training in spelling: Immediate and long-term effects of an interventional study in French third graders. *Learning and Instruction,* 53, 89-98.

Choi, W., Tong, X., Law, K. S. and Cain, K. (2018). Within- and cross-language contributions of morphological awareness to word reading development in Chinese-English bilingual children. *Reading and Writing,* 31, 1787-1820.

Clahsen, H. and Fleischhauer, E. (2014). Morphological priming in child German. *Journal of Child Language,* 41, 1305-1333.

Deacon, S. H. and Bryant, P. (2005). What young children do and do not know about the spelling of inflections and derivations. *Developmental Science,* 8(6), 583-594.

Department for Education (2013). National Curriculum: Primary Curriculum. [Online]. Available from: https://www.gov.uk/government/publications/national-curriculum-in-england-primary-curriculum. [Accessed 12 November 2015].

Department for Education and Employment (1999). *Spelling bank: Lists of words and activities for the KS2 spelling objectives.* London: Department for Education and Employment.

Department for Education and Skills (2008). Primary Framework for literacy and mathematics. [Online]. Available from: http://www.educationengland.org.uk/documents/pdfs/2006-primary-national-strategy.pdf. [Accessed 12 November 2015].

Devonshire, V. and Fluck, M. (2010). Spelling development: Fine-tuning strategy-use and capitalising on the connections between words. *Learning and Instruction,* 20, 361-371.

Dreher, K. (2015). Spelling "madnus": Finding meaning in children's morphological spelling patterns. University of Oxford, Oxford.

Ehri, L. C. (1986). Sources and difficulty in learning to spell and read. In M. L. Wolraich and D. Routh. (eds.). *Advances in Developmental and Behavioural Practice.* Connecticut: JAI Press, pp. 121-195.

Ehri, L. C., Nunes, S. R., Stahl, S. A. and Willows, D. M. (2001a). Systematic phonics instruction helps students learn to read: evidence from the National Reading Panel's meta-analysis. *Review of Educational Research,* 71, 393-447.

Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z. and Shanahan, T. (2001b). Phonemic awareness instruction helps children learn to read: evidence from the National Reading Panel's meta-analysis. *Reading Research Quarterly,* 36, 250-287.

Field, A. (2017). *Discovering Statistics Using IBM SPSS Statistics*, 5th ed. London: Sage.

Freitas, P. V. Jr., Mota, M. M. P. E. and Deacon, S. H. (2018). Morphological awareness, word reading, and reading comprehension in Portuguese. *Applied Psycholinguistics,* 39, 507-525.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, M. Coltheart, and J. Marshall. (eds.). *Surface Dyslexia.* London: Lawrence Erlbaum, pp. 301-330.

Ganske, K. (2008). *Mindful of Words: Spelling and Vocabulary Explorations 4-8.* New York: The Guildford Press.

Gathercole, S. E., Service, E., Hitch, G. J. and Martin, A. J. (1997). Phonological short-term memory and new word learning in children. *Developmental Psychology,* 33, 966-979.

Gentry, J. R. (1978). Early spelling strategies. *The Elementary School Journal,* 79(2), 88-92.

Goulden, R., Nation, P. and Read, J. (1990). How large can a receptive vocabulary be? *Applied Linguistics,* 11, 341-363.

Hart, J. (1569). *An Orthographie conteyning the due order and reason, howe to write or paint thimage of mannes voice, most like to the life or nature.* London: William Seres.

Hurry, J., Nunes, T., Bryant, P., Pretzlik, U., Parker, M., Curno, T. and Midgley, L. (2005). Transforming research on morphology into teacher practice. *Research Papers in Education,* 20(2), 187-206.

Jaffré, J. P. (1997). From writing to orthography: the functions and limits of the notion of system. In C. A. Perfetti, L. Rieben and M. Fayol. (eds.). *Learning to Spell: Research Theory and Practice Across Languages.* New Jersey: Lawrence Erlbaum, pp. 3-20.

Jensen, A. R. (1962). Spelling errors and the serial-position effect. *Journal of Educational Psychology*, 53, 105-109.

Karmiloff-Smith, A. (1986). From meta-processes to conscious access: evidence from children's metalinguistic and repair data. *Cognition*, 23, 95-147.

Karmiloff-Smith, A. (1992). *Beyond Modularity: A Developmental Perspective on Cognitive Science.* London: MIT Press.

Kemp, N. (2006). Children's spelling of base, inflected, and derived words: Links with morphological awareness. *Reading and Writing,* 19, 737-765.

Kemp, N. and Bryant, P. (2003). Do beez buzz? Rule-based and frequency-based knowledge in learning to spell plural -s. *Child Development,* 74(1), 63-74.

Kemp, N., Mitchell, P. and Bryant, P. (2017). Simple morphological spelling rules are not always used: Individual differences in children and adults. *Applied Linguistics*, 38, 1071-1094.

Kemper, M. J., Verhoeven, L. and Bosman, A. M. T. (2012). Implicit and explicit instruction of spelling rules. *Learning and Individual Differences,* 22, 639-649.

Kieffer, M. J. and Lesaux, N. K. (2008). The role of derivational morphology in the reading comprehension of Spanish-speaking English language learners. *Reading and Writing,* 21, 783-804.

Kirby, J. R., Deacon, S. H., Bowers, P. N., Izenberg, L., Wade-Woolley, L. and Parrila, R. (2012). Children's morphological awareness and reading ability. *Reading Writing,* 25, 389-410.

Laudanna, A., Badecker, W. and Caramazza, A. (1989). Priming homographic stems. *Journal of Memory and Language,* 28, 531-546.

Laws, J. and Ryder, C. (2014). Getting the measure of derivational morphology in adult speech: a corpus analysis using morphoquantics. *Language Studies Working Papers: University of Reading,* 6, 3-17.

Leong, C. K. (1989). The effects of morphological structure on reading proficiency - a developmental study. *Reading and Writing,* 4, 327-364.

Lobeck, A. and Denham, K. (2014). Navigating English Grammar: A Guide to Analysing Real Language. Chichester: Wiley-Blackwell.

Lorandi, A. and Karmiloff-Smith, A. (2012). From sensitivity to awareness: morphological knowledge and the representational redescription model. *Letras de Hoje,* 47(1), 6-16.

Marsh, G., Friedman, M. P., Welch, V. and Desberg, P. (1980). The development of strategies in spelling. In U. Frith (eds.). *Cognitive Processes in Spelling.* London: Academic Press, pp. 339-353.

Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *The Psychological Review,* 63(2), 81-97.

Mitchell, P., Kemp, N. and Bryant, P. (2011). Variations among adults in their use of morphemic spelling rules and word-specific knowledge when spelling. *Reading Research Quarterly*, 46(2), 119-133.

Nagy, W., Berninger, V. W. and Abbott, R. D. (2006). Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. *Journal of Educational Psychology,* 98(1), 134-147.

Nation, K. (2005). Children's reading comprehension difficulties. In M. J. Snowling and C. Hulme (Eds.). *The science of reading: a handbook.* Oxford: Blackwell, pp. 248-265.

Nunes, T. and Bryant, P. (2004). Morphology and Spelling. In T. Nunes and P. Bryant (eds.). *Handbook of Children's Literacy.* London: Kluwer Academic Publishers, pp. 91-118.

Nunes, T. and Bryant, P. (2006). *Improving Literacy by Teaching Morphemes.* London: Routledge.

Nunes, T. and Bryant, P. (2009). *Children's Reading and Spelling: Beyond the First Steps.* Oxford: Wiley-Blackwell.

Nunes, T., Bryant, P. and Bindman, M. (1997). Morphological spelling strategies: developmental stages and processes. *Developmental Psychology,* 33(4), 637-649.

Nunes, T., Bryant, P. and Bindman, M. (2006). The effects of learning to spell on children's awareness of morphology. *Reading and Writing,* 19, 767-787.

Nunes, T., Bryant, P. and Evans, D. (2010). Morphological knowledge and learning new words. *Revista Portuguesa de Pedagogia & Psychologica,* Special joint volume, 67-74.

Nunes, T., Bryant, P. and Olsson, J. (2003). Learning morphological and phonological spelling rules: an intervention study. *Scientific Studies of Reading,* 7(3), 289-307.

Nunes, T., Bryant, P. and Snaith, R. (2000). Children learn an untaught rule of spelling. *Nature,* 403, 157-158.

Nunes, T. and Hatano, G. (2004). Morphology, reading and spelling: Looking across languages. In T. Nunes and P. Bryant (eds.). *Handbook of Children's Literacy.* London: Kluwer Academic Publishers, pp. 651-672.

Patrick, M. A. (2010). Box not bocks, socks not sox: How children learn morphological spelling rules. University of Oxford, Oxford.

Peters, M. L. (1967). *Spelling: caught or taught?* London: Routledge and Kegan Paul.

Plaza, M. and Cohen, H. (2006). The contribution of phonological awareness and visual attention in early reading and spelling. *Dyslexia,* 13, 67-76.

Pollock, E., Chandler, P. and Sweller, J. (2002). Assimilating complex information. *Learning and Instruction,* 12, 61-86.

Quémart, P., Casalis, S. and Duncan, L. (2012). Exploring the role of bases and suffixes when reading familiar and unfamiliar words: evidence from French young readers. *Scientific Studies of Reading,* 16(5), 424-442.

Reed. D. K. (2008). A synthesis of morphology interventions and effects on reading outcomes for students in grades K–12. *Learning Disabilities Research and Practice,* 23(1), 36-49.

Rispens, J. E., McBride-Chang, C. and Reitsma, P. (2008). Morphological awareness and early advanced word recognition and spelling in Dutch. *Reading and Writing,* 21, 587-607.

Rosa, J. M. and Nunes, T. (2008). Morphological priming effects on children's spelling. *Reading and Writing,* 21, 763-781.

Rosenthal, R. and Rubin, D. B. (1982). Comparing effect sizes of independent studies. *Psychological Bulletin,* 92 (2), 500-504.

Schacter, D. L., Dobbins, I. G. and Schnyder, D. M. (2004). Specificity of priming: a cognitive neuroscience perspective. *Nature Reviews Neuroscience,* 5, 853-862.

Sénéchal, M. (2000). Morphological effects in children's spelling of French words. *Canadian Journal of Experimental Psychology,* 54(2), 76-85.

Sénéchal, M., Basque, M. T. and Leclaire. T. (2006). Morphological knowledge as revealed in children's spelling accuracy and reports of spelling strategies. *Journal of Experimental Child Psychology,* 95, 231-254.

Singson, M., Mahony, D. and Mann, V. (2000). The relation between reading ability and morphological skills: evidence from derivational suffixes. *Reading and writing,* 12, 219-252.

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction,* 4, 295-312.

Taft, M. (1979). Recognition of affixed words and the word frequency effect. *Memory and Cognition,* 7, 263-272.

Taft, M. (1991). *Reading and the Mental Lexicon.* Hove: Lawrence Erlbaum.

Taft, M. and Forster, K. I. (1975). Lexical storage and retrieval of prefixed words. *Journal of Verbal Learning and Verbal Behavior,* 14, 638-647.

Tong, X., Deacon, S. H., Cain, K., Kirby, J. R. and Parrila, R. (2011). Morphological awareness: a key to understanding poor reading comprehension in English. *Journal of Educational Psychology,* 103(3), 523-534.

Tong, X., McBride-Chang, C., Shu, H. and Wong, A. M. (2009). Morphological awareness, orthographic knowledge, and spelling errors: keys to understanding early Chinese literacy acquisition. *Scientific Studies of Reading,* 13(5), 426-452.

Tyler, A. and Nagy, W. (1989). The acquisition of English derivational morphology. *Journal of Memory and Language,* 28, 649-667.

Venezky, R. L. (1967). English orthography: its graphical structure and its relation to sound. *Reading Research Quarterly,* 2(3), 75-105.

Venezky, R. L. (1970). *The Structure of English Orthography.* The Hague: Mouton.

Venezky, R. L. (1999). *The American Way of Spelling: The Structure and Origins of American English Orthography.* New York: The Guildford Press.

Wilson, M. (1987). *MRC Psycholinguistic Database.* [Online]. Available from: http://websites.psychology.uwa.edu.au/school/MRCDatabase/mrc2.html. [Accessed on 22 November 2014].

Wright, C. (2013). What is the effect of morphological priming with word stems on children's spelling of derivatives? University of Oxford, Oxford.

Appendix A: Letter to Head Teachers

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: +44(0)1865 274024 Fax: +44(0)1865 274027
general.enquiries@education.ox.ac.uk www.education.ox.ac.uk

Director Professor Jo-Anne Baird

Dear [Head Teacher Name],

I am currently studying for my doctorate at the University of Oxford and have spent the past four years focusing on children's literacy development. My research investigates how children learn to spell words that are not spelled the way they sound. For example, the word 'magician' leads to many spelling errors because the sound that is normally spelled with SH is spelled with C in magician. The reason for this spelling is that the word stem 'magic' is preserved in the derived word 'magician' even though its pronunciation changes. Another difficulty with this spelling is that the ending of the word is spelled with '-ian' even though it sounds the same as the ending '-ion' in the word 'discussion'. This is because the '-ian' ending is used to refer to a person, whilst '-ion' is used to refer to abstract nouns. I am writing to invite your school to participate in my current research, which aims to find out whether increasing children's awareness of stems and suffixes can enhance their ability to spell.

I would like to work with children from Years 3 and 4 during the early part of the forthcoming term. With your approval, I would separate each class into three subgroups for comparison purposes. These groups would participate in tasks that vary in the degree to which they teach children about stems or suffixes before they spell derived words. All of the children would take part in two 10-minute spelling activities designed to be enjoyable, which would be presented to each subgroup as a whole. Each of the teaching sessions would last no longer than 25 minutes and would explain to the children how they can use stems and suffixes to spell derived words. A comparison group initially receives no teaching but will be given the opportunity to learn about the spellings at the end of the study.

I appreciate that my presence in school could cause some disruption to your daily routines and I would make every effort to plan my research around the needs of the individual classroom teachers. I attach a copy of the letter that I would like to send to parents beforehand in order to obtain their consent for their child's participation. This study has been reviewed and approved by the University of Oxford's Central University Research Ethics Committee and I have a valid DBS certificate for working with children in schools. Finally, I would be very interested in sharing my findings with you and a summary could be made available to parents upon request.

I do hope that your school will consider participating in this study and I would be delighted to talk to you about this in more detail. I will contact you in about [7 days] to find out whether you would like your school to participate. If you would like more information before deciding, I am happy to answer questions then or you can email me at [email of researcher].

Thank you very much for taking the time to read this letter.

Yours sincerely,

[Name of Researcher]

Appendix B: Letter to Parents/Guardians and Consent Forms

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: +44(0)1865 274024 Fax: +44(0)1865 274027
general.enquiries@education.ox.ac.uk www.education.ox.ac.uk

Director Professor Jo-Anne Baird

Dear Parent/Guardian,

I am currently studying for my doctorate at the University of Oxford and would like to invite your child to take part in my research on improving children's spelling. Your child's school has kindly agreed to participate in this study during the early part of the forthcoming term. I very much hope that you would like your child to take part, but before you decide, it is important that you understand why the study is being done and what it will involve.

What is the research trying to find out?

My study investigates new ideas about how children learn and whether increasing children's awareness of some aspects of English enhances their ability to spell.

What will happen if my child takes part?

If you choose for your child to take part in this study, your child will participate in three group-administered spelling activities and a one-to-one teaching session carried out in school on one occasion. Before beginning the activity, I will ask the children if they are happy to participate and they will be able to withdraw at any time. In the teaching session, I will teach them ways in which they can improve their own spelling of derived words by thinking of how the words are formed.

Your child's year group will be divided into three subgroups that will receive slightly different teaching sessions. They will be assigned to these groups by lotto. The variation in the teaching will help clarify how different ways of teaching spelling rules affect how well children spell. Your child will take part in three spelling tasks and a beneficial teaching session of no longer than 25 minutes, which will be both interesting and enjoyable.

What happens to the results of the study?

The results of this study will form part of my doctoral thesis, which aims to establish how children learn to spell and how this learning process can be enhanced. If you choose for your child to take part, your contribution will form an invaluable part of this process. At the end of the study, an overall summary of the findings will be given to your school and can be made available to you upon request. No information about any child's individual results will be given to anyone. The study only analyses the outcomes of different ways of teaching the children.

This research has been reviewed and approved by the University of Oxford's Central University Research Ethics Committee and I have a valid DBS certificate for working with children in schools.

Thank you very much for taking the time to read this letter.

[Name of Researcher]

What should I do next?

I do hope that you would like your child to take part in this study and if you would like to discuss the research in more detail, or have any further questions, please do not hesitate to contact me by email at [email of researcher]. If for any reason you do not wish for your child to participate in this research, please fill in the opt-out form below and return it to your school office by [DATE].

- -

Opt-Out Form

If you **DO NOT** wish for your child to participate in the research, 'The spelling of a word does not always parallel with the way it sounds: the importance of teaching children morphological spelling rules,' please fill out the form below and return it to your school office by [DATE]. If I do not receive an opt-out form from you, your child may be invited to take part in the study, which is described in the accompanying information sheet.

I hereby do DO NOT give permission for my child to take part in the above study:

Name of Child:……**Date of Birth:**……..

Name of School:……

Name of Parent/Guardian:……

Signature:……**Date:**……

Appendix C: Pre-test and Post-test Assessment

Real word sentences

1. Musician. The man who plays the piano is a *musician*. Musician.
2. Injection. The girl was afraid to have the *injection.* Injection.
3. Electrician. The *electrician* fixed the lights. Electrician.
4. Impression. The girl made a good *impression* to her teacher. Impression.
5. Protection. The body-guard gave the children *protection*. Protection.
6. Librarian. The *librarian* checked out the books. Librarian.
7. Clinician. She works in a hospital as a *clinician*. Clinician.
8. Expression. The boy had a cheerful *expression*. Expression.
9. Politician. He won the vote to be the next *politician*. Politician.
10. Education. The woman had a good *education.* Education.
11. Statistician. The *statistician* solved a maths problem. Statistician.
12. Possession. The man took *possession* of a boat. Possession.

Pseudo-word sentences

1. Lagician. Someone who does lagic is a *lagician*. Lagician.
2. Ascussion. They had to ascuss the problem in an *ascussion*. Ascussion.
3. Donician. The woman works in a donic as a *donician*. Donician.
4. Frotection. The police had to frotect the children by giving them *frotection*. Frotection.
5. Endection. If you endect something it gets an *endection*. Endection.
6. Trusician. My sister is good at trusic because she is a *trusician*. Trusician.
7. Trocession. If you often trocess you develop a *trocession*. Trocession.
8. Koptician. The man works in a koptic as a *koptician*. Koptician.
9. Latistician. An expert at working out latistic problems is a *latistician.* Latistician.
10. Delection. She had to delect her favourite sweets from the *delection*. Delection.
11. Oxpression. To *oxpress* happiness you show a positive *oxpression.* Oxpression.
12. Golitician. He is studying golitic to become a *golitician.* Golitician.

Appendix D: Designing the Matlab Spelling Game

The training game for the children's spelling was designed by the researcher of the current study using Matlab programming software. The researcher initially received formal training in how to produce computer code using Matlab and then applied this knowledge to produce a unique set of coding for a spelling game that could be played by young children. This was achieved by using Psychtoolbox, which produces games that are similar in format to that of E-Prime.

The code was developed in such a way that when the spelling game began, the researcher typed the children's experimental condition and their year group into the programme. This information was then automatically written to an output file that was saved on the researcher's computer. The spelling game then opened and, when the children were ready, the trials of the game began. The game contained 30 trials that were similar in format to the pre-test and post-test assessment noted in Experiment 1 (see Chapter 3.2.3.1).

Each trial presented a written sentence that contained a missing derivative that the children were asked to type using a child-friendly keyboard. The computer read each sentence aloud to the children through audio recordings of the researcher's voice. Each sentence was read, including the missing word, and this word was repeated both before and after the sentence so that the children were fully aware of the target word. For instance, the children were visually presented with the sentence "The _____ rode past the pyramids" and the computer said: "*Egyptian*. The *Egyptian* rode past the pyramids. *Egyptian*." An appropriate image was added to the coding of each trial to make the trials interesting and attractive for the children (see Figure D.1).

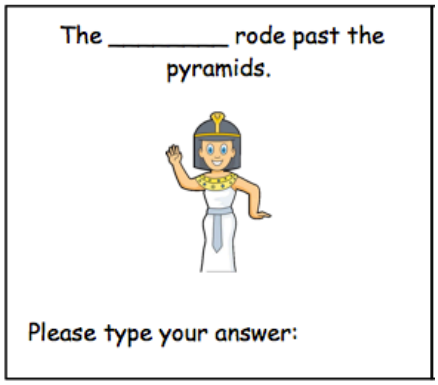


Figure D.1. The first part of a trial from the computerised Matlab spelling game.

At the end of each trial, the children were presented with a feedback slide, which showed the correct spelling and an image of a tick or cross depending on whether the child's typed spelling was correct or not (see Figure D.2). A list of the correct stem and affix spellings for each derivative was included in the coding so that the programme could measure the children's correct responses. This meant that the code could calculate if the children had reached the criterion number of correct spellings within each game. Once the children reached the criterion (e.g. 15 correct out of 30 trials for stem ending spellings) the game interrupted and they received no further trials.



Figure D.2. The feedback part of a trial from the Matlab training game.

The children's performance on the game was automatically written to an output file on the researcher's computer. This file provided information about the criterion. For example, if a child reached the criterion in the spelling game for stems, the file stated: "Participant reached criterion of (15 trials correct) in 30 trials." At the end of the experiment, the following appeared on the computer screen "Well done for taking part! Great spelling!"

Appendix E: Materials for the Matlab Spelling Game

1. Magician. The *magician* performed the tricks. Magician.
2. Discussion. The children had a *discussion* about the problem. Discussion.
3. Infection. The boy was worried that the cut would get an *infection*. Infection.
4. Election. There was an *election* of a candidate for a post. Election.
5. Collection. She made a *collection* of money for the charity. Collection.
6. Logician. She is a *logician* who completes word puzzles. Logician.
7. Optician. The *optician* gave the woman an eye test. Optician.
8. Procession. The guards walked to the palace in *procession*. Procession.
9. Confession. The robber made a *confession* that he stole the jewels. Confession.
10. Brazilian. The *Brazilian* player scored a goal. Brazilian.
11. Selection. She chose a *selection* of her favourite sweets. Selection.
12. Egyptian. The *Egyptian* rode past the pyramids. Egyptian.
13. Progression. The girl made a positive *progression* with her school work. Progression.
14. Obsession. He had an *obsession* with his work. Obsession.
15. Mathematician. The man is a *mathematician* who plays number games. Mathematician.
16. Confusion. There was some *confusion* about the exam. Confusion.
17. Attraction. The magnet had a strong *attraction* to the metal. Attraction.
18. Arithmetician. The *arithmetician* was good at adding and subtracting. Arithmetician.
19. Italian. The *Italian* cooked the pasta. Italian.
20. Christian. The *Christian* went to church every Sunday. Christian.
21. Subtraction. The girl struggled with *subtraction* in her maths lesson. Subtraction.
22. Hungarian. The *Hungarian* woman wore a bright skirt. Hungarian.
23. Comedian. The *comedian* made the children laugh. Comedian.
24. Historian. The *historian* studied the war. Historian.
25. Arabian. The *Arabian* was on a camel in the desert. Arabian.
26. Physician. The *physician* checked the man was healthy. Physician.
27. Amazonian. The *Amazonian* lived in the rainforest. Amazonian.
28. Compression. He used *compression* to crush the grapes to make juice. Compression.
29. Operation. The surgeon performed an *operation.* Operation.
30. Perfection. The lady baked the cake to *perfection*. Perfection.

Appendix F: Pilot Study

To assess the administration procedure for the pre-test, morphological teaching sessions, and post-test, a pilot study was conducted prior to the main investigation. This provided an opportunity for the researcher to evaluate the testing materials and teaching procedure of the three experiments.

Method

A total of 24 children were recruited for the pilot study with twelve children from Year 3 and twelve children from Year 4. All of the children received the pre-test spelling task (see Chapter 3.2.3.1) prior to a morphological intervention, which assessed their spelling of stems and affixes in derivatives. The children were randomly assigned to experimental condition so that two children from each year group received teaching in one of the following conditions: explicit stem teaching, implicit stem teaching, suffix teaching, stem + suffix simultaneous instruction, stem + suffix sequential teaching, or no morphological instruction. After the teaching, the same spelling test was repeated a few days after the intervention and this assessment was also repeated after a two-week delay.

Outcomes

The results revealed that the spelling test, teaching sessions, and training game were appropriate for the main investigation. The pilot of the Matlab training game revealed that the children found the stimuli enjoyable and engaging. It also allowed the researcher to become fully acquainted with the materials to ensure that they could be administered in a relatively consistent manner.

Modifications

One main alteration to the methodology arose as a consequence of the pilot study. It was originally considered that the children in the simultaneous and sequential teaching groups would receive two separate Matlab training games: one that assessed the children's spelling of stems and a second that assessed the children's spelling of affixes. It was concluded that two training games, plus any repetition of the game if they failed to reach criterion on the first presentation, would lead the children to experience inattention or fatigue effects. This

led the researcher to integrate the stem and affix assessments within one Matlab training game.

Appendix G: Frequency Graphs

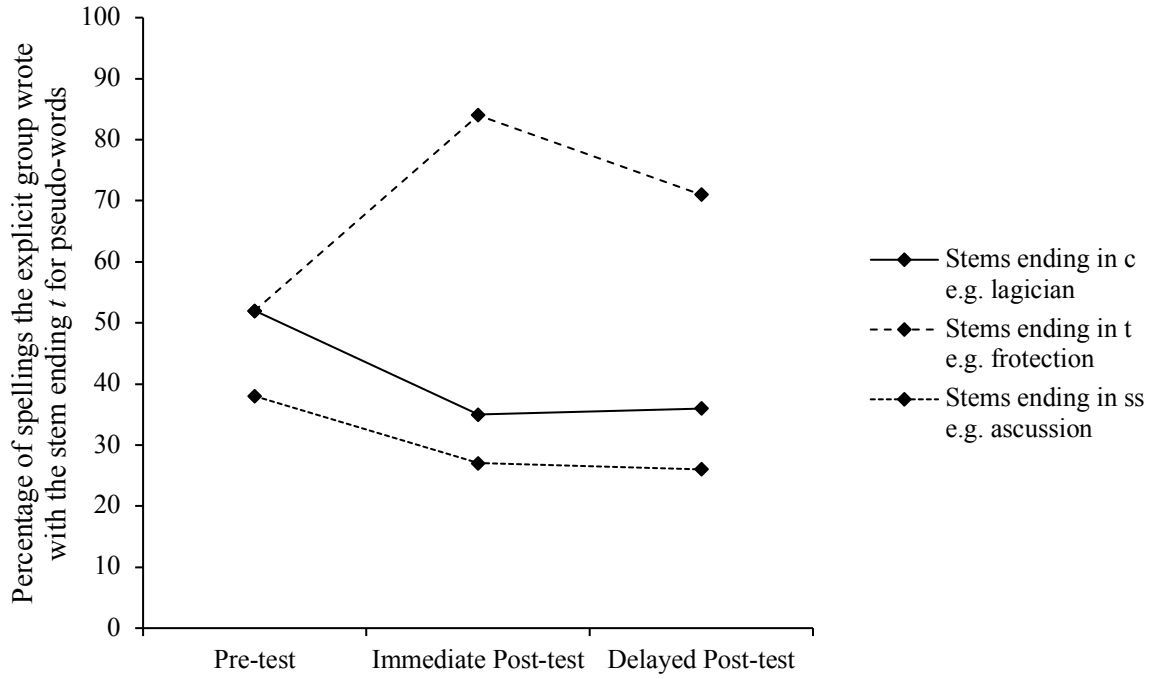


Figure G.1. Percentage of pseudo-word derivatives the explicit stem group in Experiment 1 spelled with the stem ending *t* at the three time points.

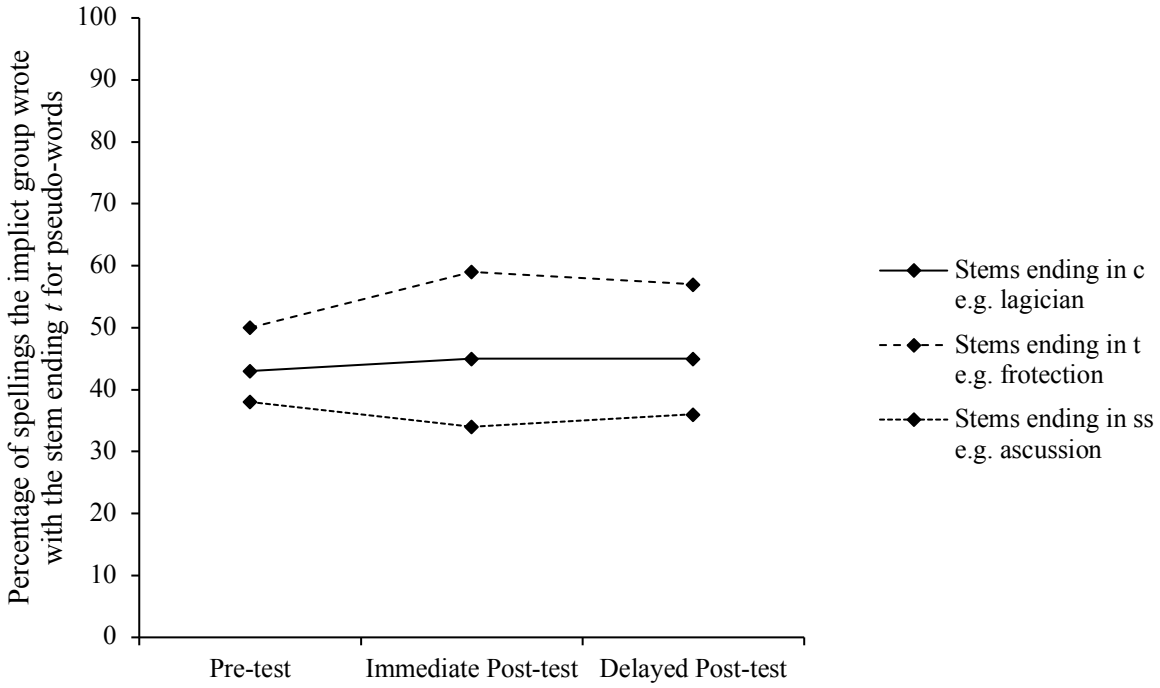


Figure G.2. Percentage of pseudo-words the implicit stem group in Experiment 1 wrote with the *t* spelling at pre-test, immediate post-test, and delayed post-test.

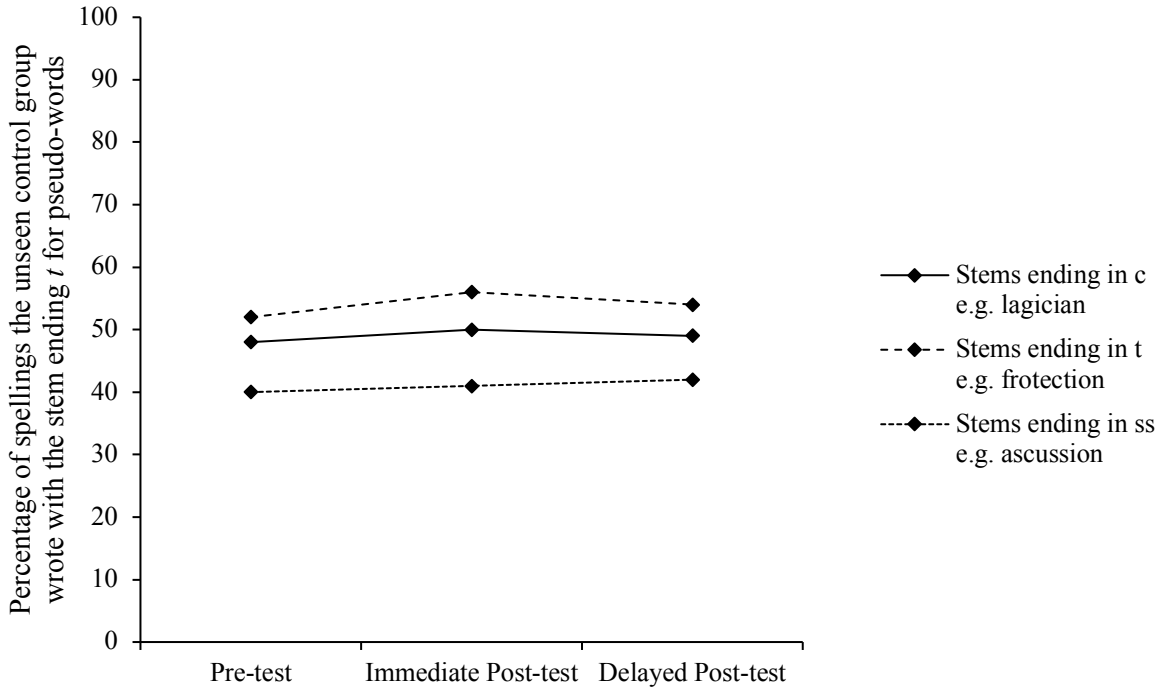


Figure G.3. Percentage of pseudo-word derivatives the unseen control condition in Experiment 1 spelled with the *t* stem ending at the three testing occasions.

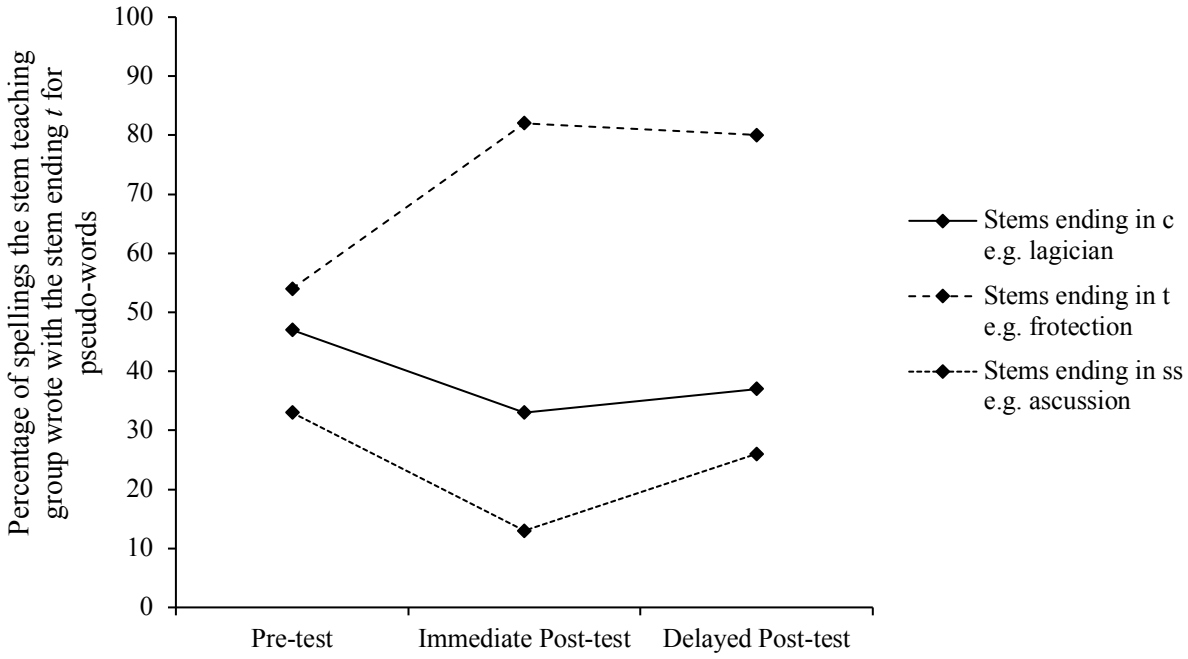


Figure G.4. Percentage of pseudo-word derivatives the stem teaching group in Experiment 2 wrote with the stem ending *t* at pre-test, immediate post-test, and delayed post-test.

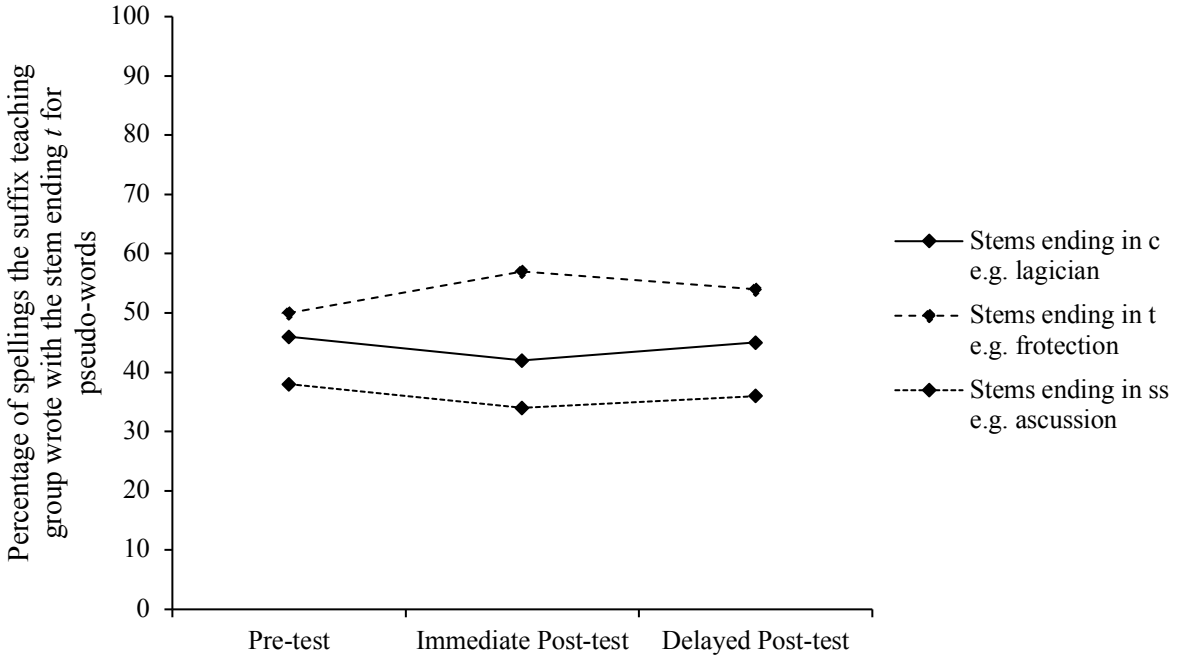


Figure G.5. Percentage of pseudo-words derivatives the suffix teaching group in Experiment 2 wrote with the *t* spelling at the three testing occasions.

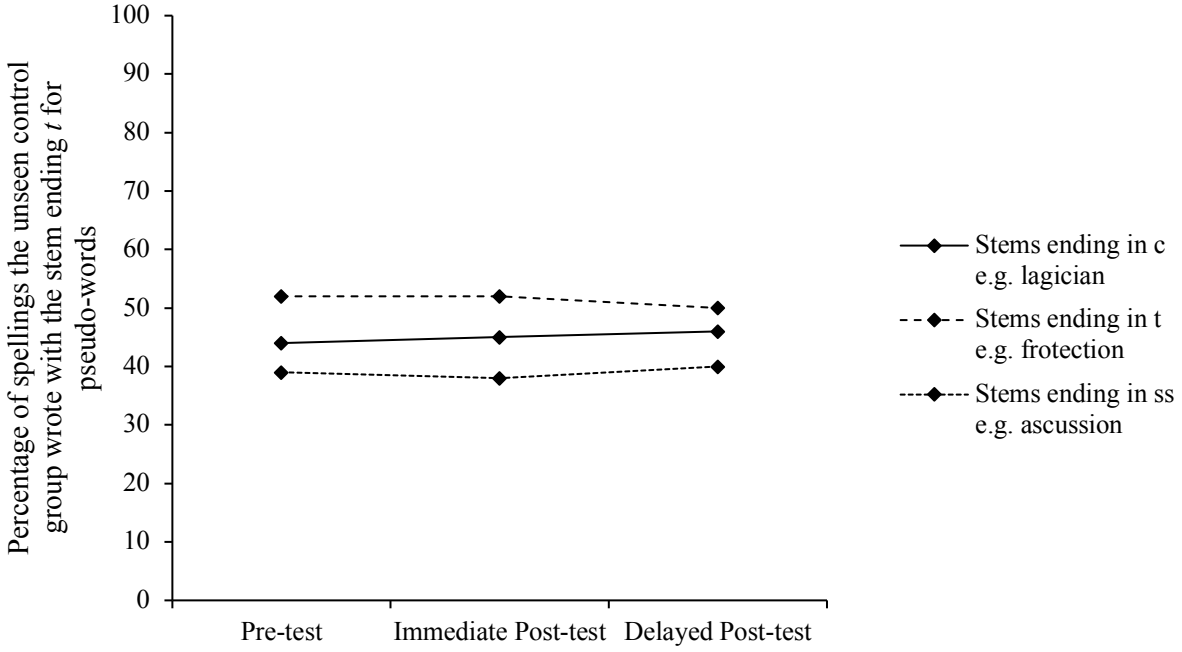


Figure G.6. Percentage of pseudo-words the unseen control group in Experiment 2 spelled with the *t* stem ending at pre-test and the two post-tests.

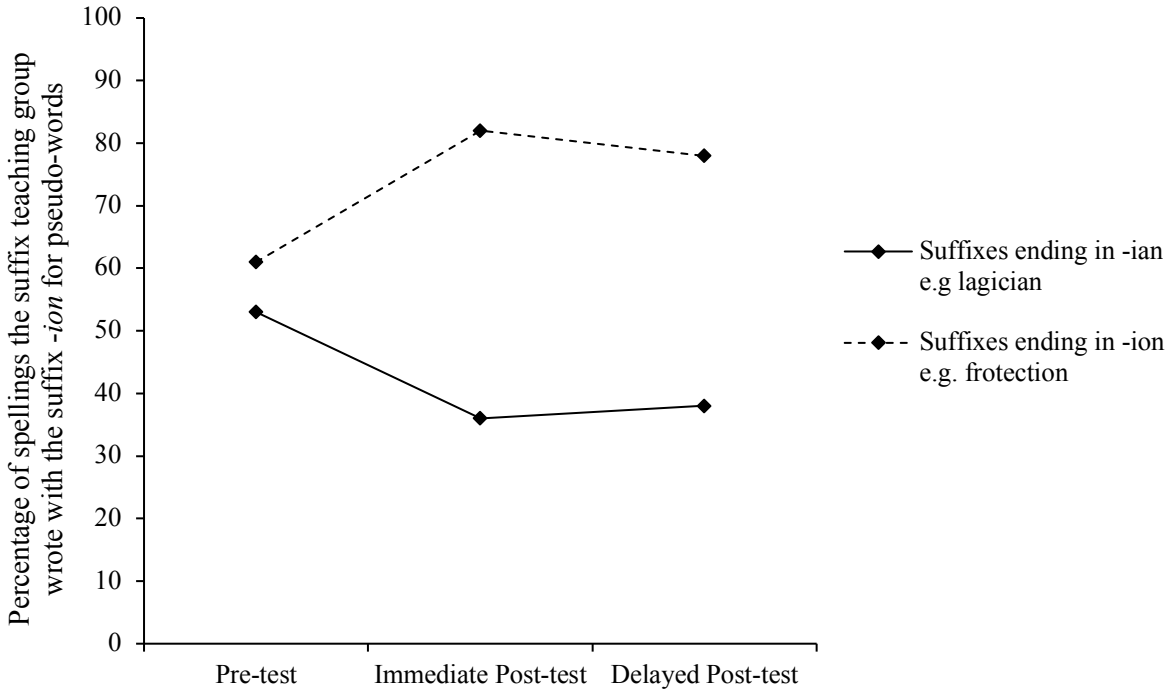


Figure G.7. Percentage of pseudo-word derivatives the suffix teaching group in Experiment 2 wrote with the suffix -*ion* at pre-test, immediate post-test, and delayed post-test.

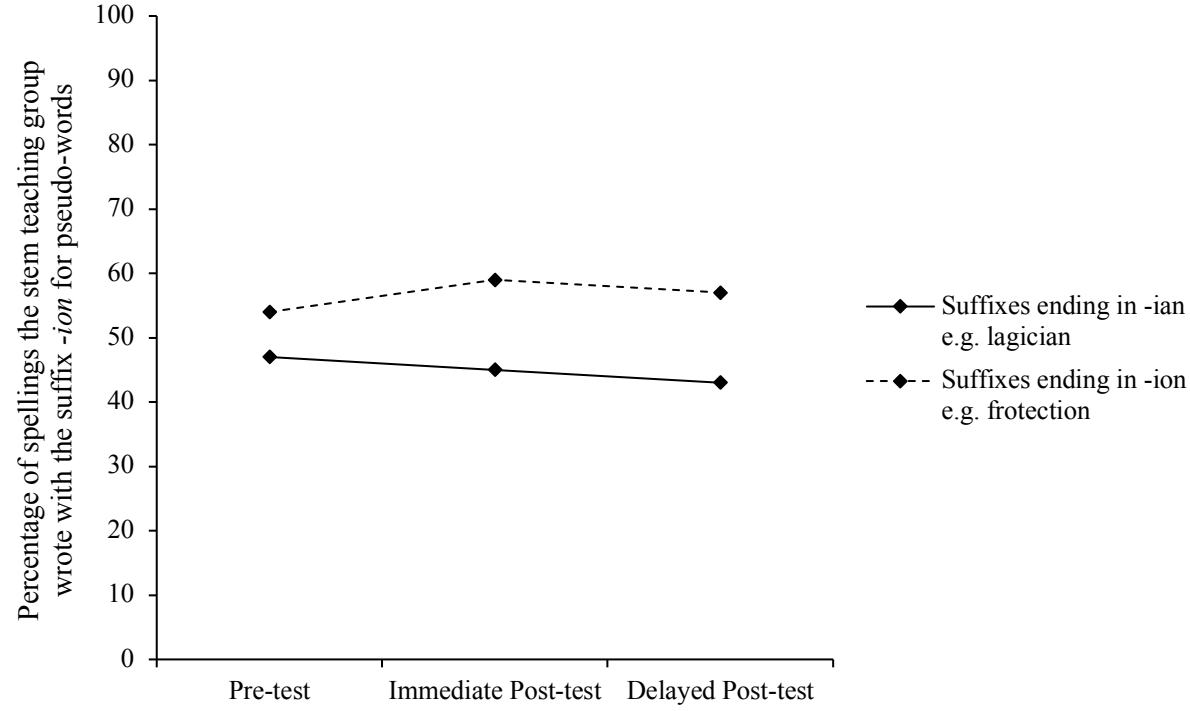


Figure G.8. Percentage of pseudo-words the stem teaching condition in Experiment 2 spelled with the suffix -*ion* at the three time points.

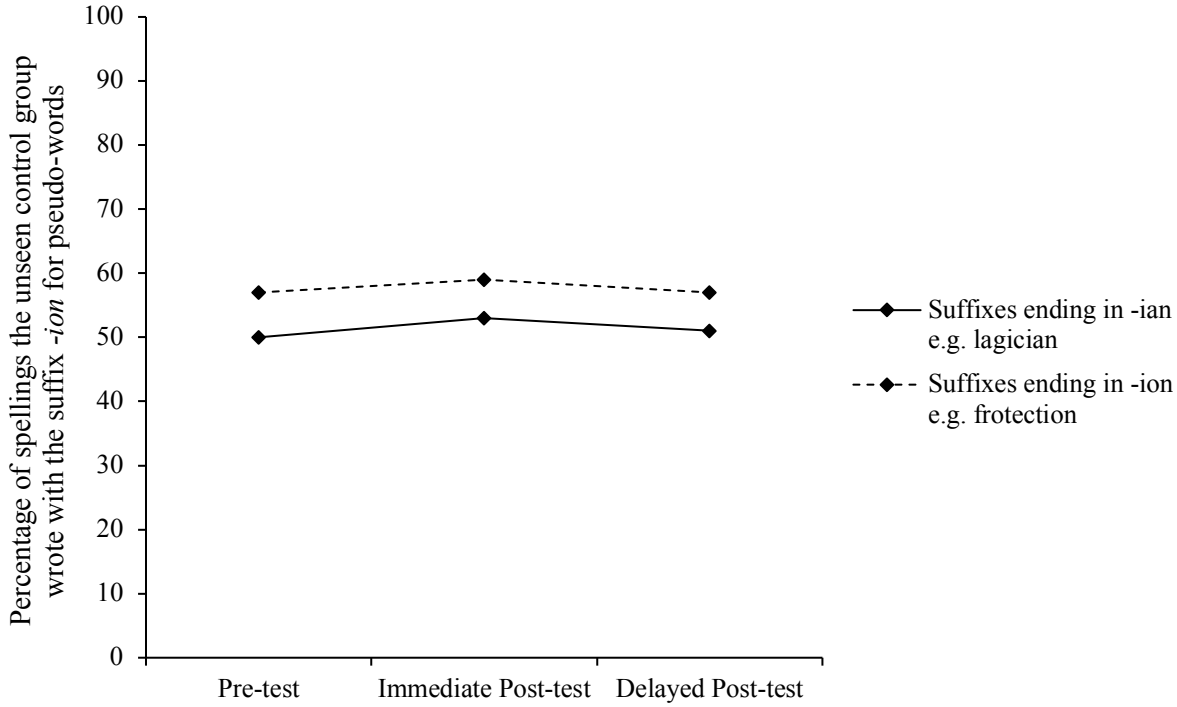


Figure G.9. Percentage of pseudo-words the unseen control group in Experiment 2 wrote with the suffix *-ion* at the three testing occasions.

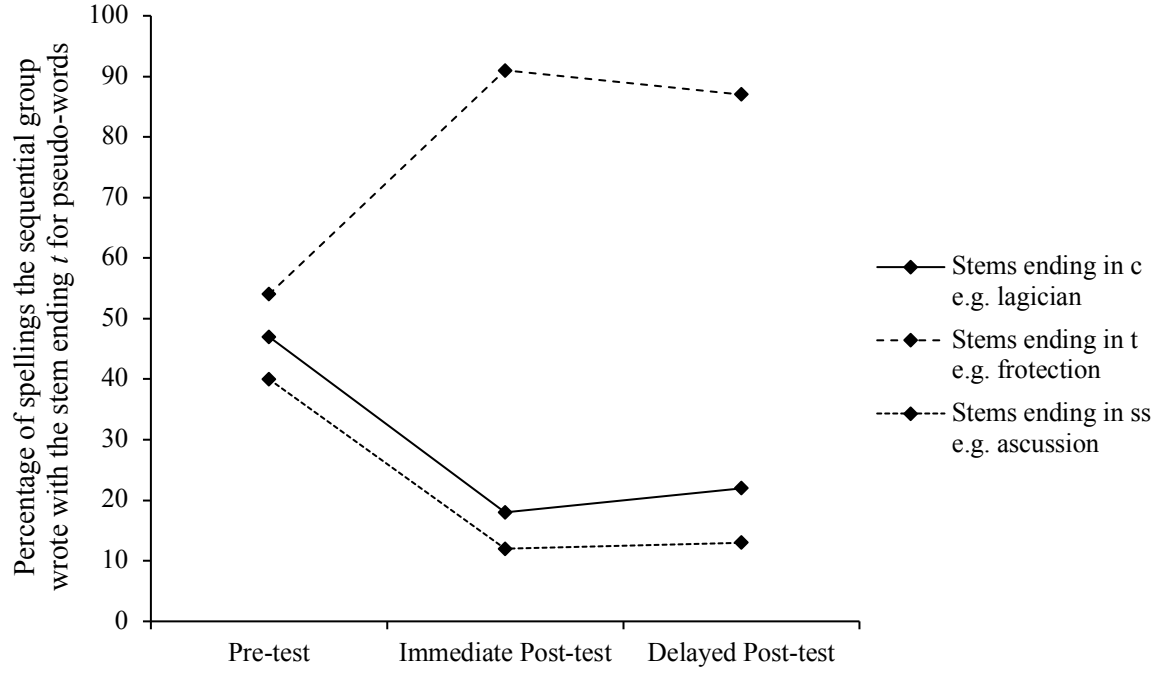


Figure G.10. Percentage of pseudo-word derivatives the sequential teaching condition in Experiment 3 wrote with the *t* stem ending at pre-test and the two post-tests.

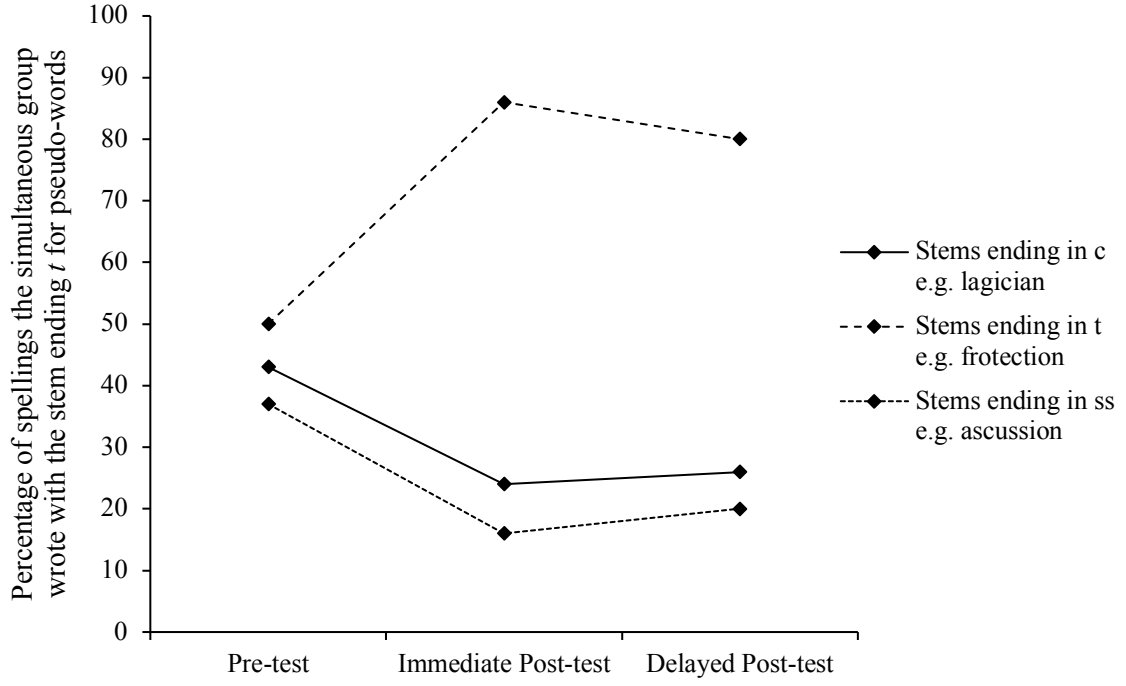


Figure G.11. Percentage of pseudo-words the simultaneous teaching condition in Experiment 3 wrote with the *t* spelling at pre-test, immediate post-test, and delayed post-test.

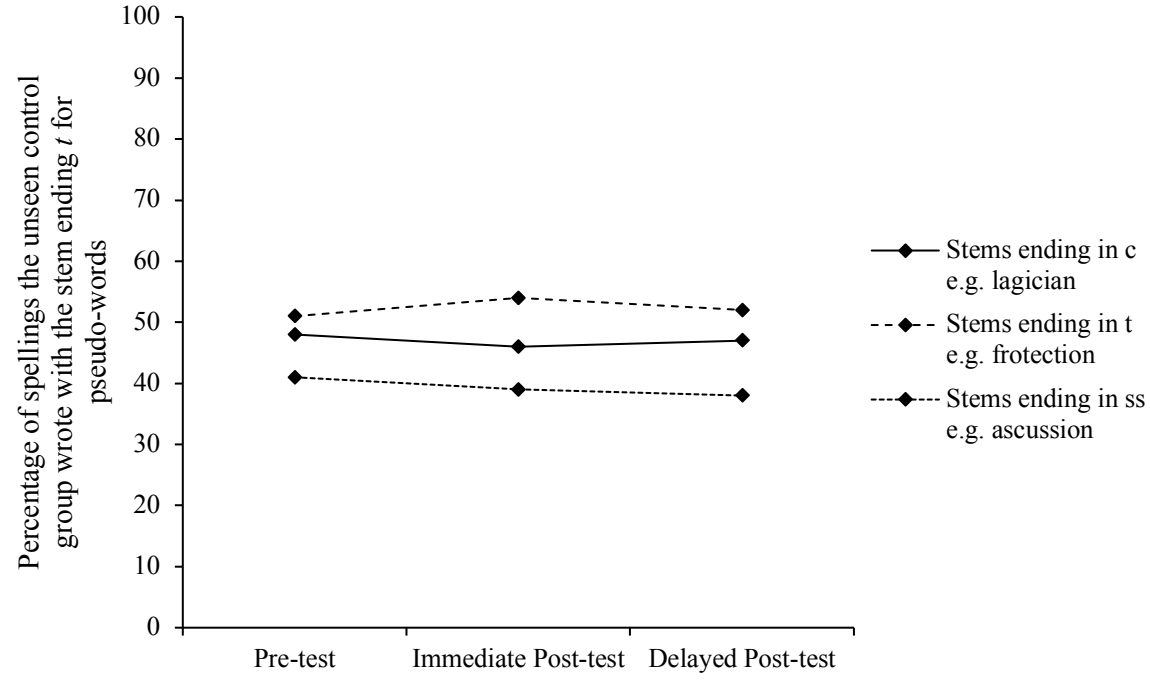


Figure G.12. Percentage of pseudo-words the unseen control condition in Experiment 3 wrote with the *t* spelling at the three testing occasions.

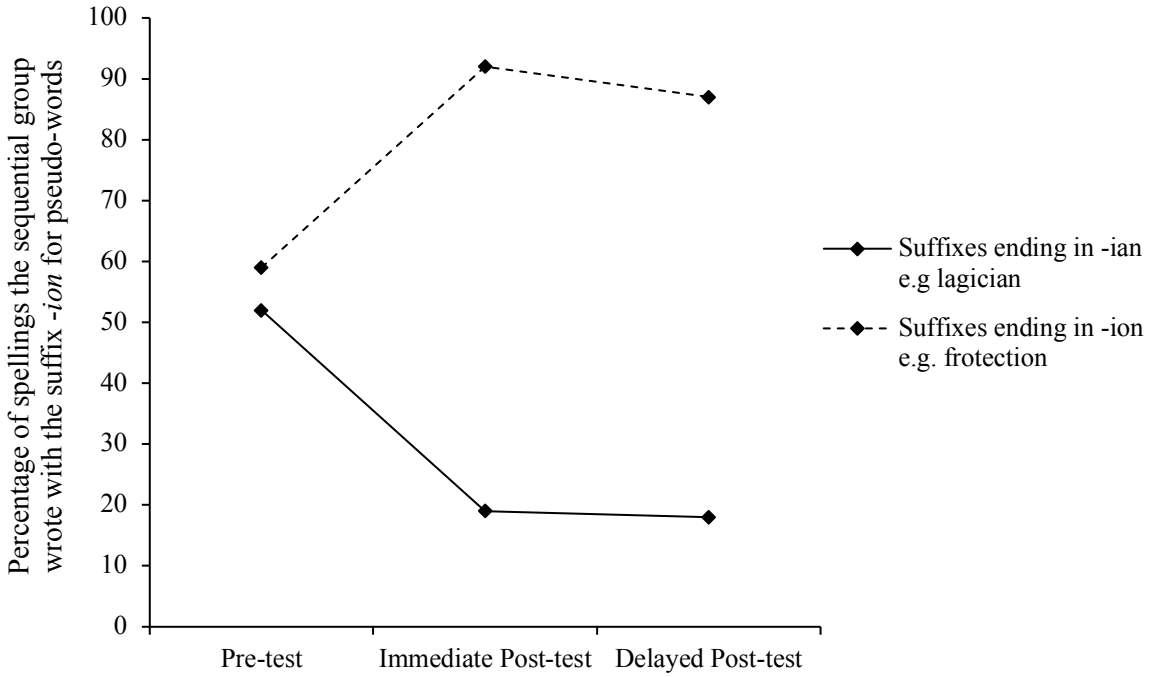


Figure G.13. Percentage of pseudo-word derivatives the sequential condition in Experiment 3 wrote with the suffix *-ion* at pre-test, immediate post-test, and delayed post-test.

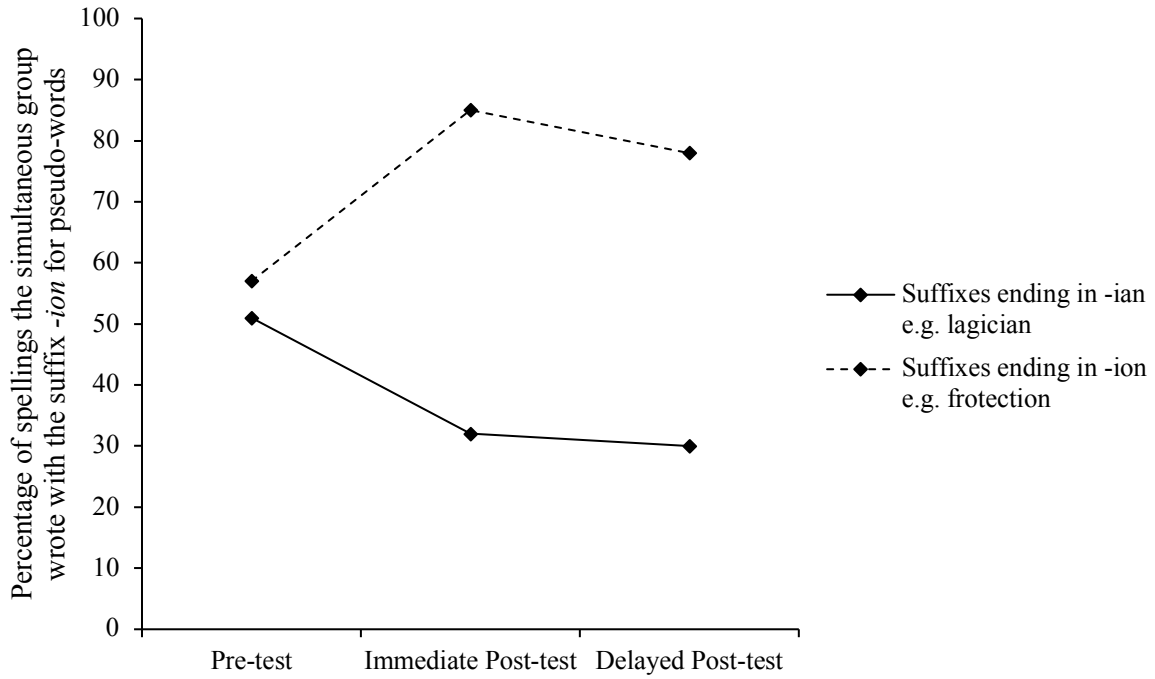


Figure G.14. Percentage of pseudo-word derivatives the simultaneous group in Experiment 3 wrote with the suffix *-ion* at the three time points.

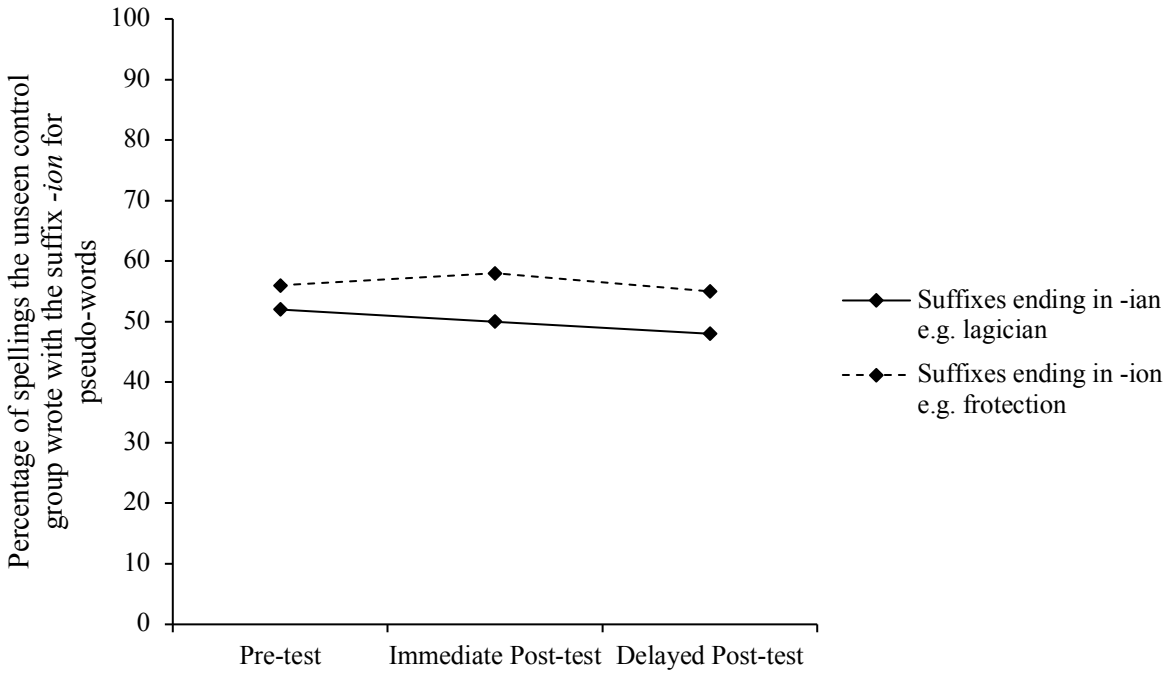


Figure G.15. Percentage of pseudo-words the unseen control group in Experiment 3 wrote with the suffix *-ion* at the three testing occasions.

Appendix H: CUREC Form

University of Oxford
CENTRAL UNIVERSITY RESEARCH ETHICS COMMITTEE (CUREC)
CUREC/1A Checklist for the Social Sciences and Humanities

The University of Oxford places a high value on the knowledge, expertise, and integrity of its members and their ability to conduct research to high standards of scholarship and ethics. The research ethics clearance procedures have been established to ensure that the University is meeting its obligations as a responsible institution. They start from the presumption that all members of the University will take their responsibilities and obligations seriously and will ensure that their research on human subjects is conducted according to the established principles and good practice in their fields and in accordance, where appropriate, with legal requirements. Since the requirements of research ethics review will vary from field to field and from project to project, the University accepts that different guidelines and procedures will be appropriate. Please check the CUREC website to ensure that you have the correct form for your project.

This form does not cover research governance, satisfactory methodology, compliance with the requirements of publishers when administering their tests or questionnaires, or the health and safety of employees and students. As principal investigator, it is your responsibility to ensure that requirements in these areas are met. Please carry out a risk assessment of the project, in consultation with all researchers involved, using the checklist and CUREC's other documentation.

The use of an asterisk in this form indicates a phrase defined in the glossary. The glossary and further information on the University's research ethics procedures are available from the CUREC website:

www.admin.ox.ac.uk/curec

This form is designed largely for research that falls within the Divisions of Social Sciences and Humanities and which does not involve a high level of risk to the subjects. Elite interviews, field work and oral history are included in the CUREC process. Please take a moment to read through it and if you have any questions or doubts as to whether it is the appropriate form, please review Section A or consult the CUREC website.

Note on anonymised data and audit: you do not need to obtain ethical approval for your study if:

- you are using previously collected **anonymised data** about people which neither you nor anyone else involved in your study can trace back to the individuals who provided them (e.g. census data, administrative data, secondary analysis). Please refer to the definition of *personal data in the glossary and FAQ A4 for further guidance; or
- you are conducting research on behalf of or at the request of a service provider that matches the definition of *audit in the glossary.

If your research is audit or uses prior-anonymised data, please check this box: ☐

You do not need to seek ethical approval from CUREC, and you do not need to complete any more of this form. However, please check with your department's requirements, as some departments require you to lodge this form with them.

Office use only: IDREC Ref. No. _____

Date of confirmation that checklist accepted on behalf of IDREC: // //

SECTION A	Yes	No
1) Are you using research methodologies commonly used in biomedical or behavioural laboratory sciences?		✓
2) Is there a significant risk that the research will induce anxiety, stress or other harmful psychological states in participants that might persist beyond the duration of any test or interview in which they are participating?		✓
3) Will the research involve human participants recruited by means of their status as present or past NHS patients or their relatives or carers?		✓
4) Does the research involve *human participants aged 16 and over who do not have *capacity to consent for themselves? See the Mental Capacity Act 2005		✓
5) Is the study to be funded by the US National Institutes of Health or another US federal funding agency?		✓

If you answered 'yes', please **stop** work on this checklist and

- **for questions 1 and 2**, complete CUREC/1 instead (available from www.admin.ox.ac.uk/curec);
- **for questions 3 and 4**, submit your proposal to the appropriate NHS ethics committee (see www.nres.nhs.uk and www.admin.ox.ac.uk/researchsupport/=ctrg for further information);
- **for question 5**, or **if you answered 'yes' to questions 1, 2 or 4 and your research will take place outside the EU and is a biomedical study**, submit your proposal to OXTREC, which uses separate documentation. **Applications to OXTREC using this form will not be accepted.** If your research is not a biomedical study and does not have US funding, but will take place outside the EU, you may use this form to submit your application for approval to the Social Sciences and Humanities IDREC.

If you have answered 'no' to all questions in Section A, please complete Sections B-E. This form and any supporting materials should be typewritten.

SECTION B

****Principal investigator/ supervisor/student researcher (title and name):***	[Name of researcher]
Name of supervisor (STUDENT RESEARCH PROJECTS ONLY):	Professor Terezinha Nunes
Degree programme, e.g. DPhil, MPhil, MSc (STUDENT RESEARCH PROJECTS ONLY):	DPhil in Education
Department or institute:	Department of Education
Address for correspondence (if different):	Department of Education, University of Oxford, 15 Norham Gardens, Oxford, OX2 6PY
Email and phone contact:	[Email and phone contact of researcher]
Title of research project:	The spelling of a word does not always parallel with the way it sounds: the importance of teaching children morphological spelling rules.

Title and brief lay description of *research (about 150 words), plus description (about 200 words) of the nature of participants (including the criteria for inclusion/exclusion & method of recruitment, how professional guidelines are being applied (if applicable) and use to which the results/data will be put.

Please describe how you will obtain informed consent, citing and attaching, where applicable, documentation produced in support of your application such as generic recruitment and advertisement material, participant information sheet(s), consent form(s) and defriefing document(s).

Title: The spelling of a word does not always parallel with the way it sounds: the importance of teaching children morphological spelling rules.

Description of research: This research aims to explain how children learn to spell words. Research already suggests that children often experience difficulty when attempting to spell words that do not represent their sounds. For example, in the word 'magician' children typically fail to realise that the spelling of the word stem 'magic' is preserved even though its pronunciation changes. Another difficulty with this spelling is that the ending of the word is spelled with '-ian' even though it sounds the same as the ending '-ion' in the word 'discussion'. The reason for this spelling is that the '-ian' affix is used to refer to a person, whilst the '-ion' suffix is used to refer to abstract nouns. The aim of this study is to investigate whether explicitly teaching rules about stems and affixes is an effective way of improving children's spelling.

Participants: Letters that provide information about the purpose of the research will be sent to the Head Teachers of three primary schools in Hampshire to obtain consent for their participation (see Appendix A). Once access has been granted, information letters about the research project will be sent to the parents or guardians of the children (see Appendix B). The children recruited for this study will be 7- to 9-year-olds that will be too young to provide informed consent. Therefore, in order to comply with the ethical guidelines of CUREC Protocol 25, the parents or guardians will be asked to complete an 'opt-out' consent form if they do not wish for their child to take part. In view of the content of this project, which involves playing spelling games and does not involve sensitive content, an opt-out procedure can be applied, following Protocol 25. If the parents or guardians allow their child to participate, the researcher will informally ask the children if they are happy to take part before administering a spelling activity.

Methodology: The research will consist of a series of three experiments that will investigate the effect of teaching children morphological rules about word stems and affixes on their spelling of derived words. Different participants will be recruited for each experiment, thus identification of participants does not need to be preserved from one experiment to the other. The first experiment will investigate the effect of teaching children about word stems, the second experiment will compare the effect of teaching about word stems with the teaching of affixes, and the final experiment will combine teaching about stems and affixes together. In each experiment, participants from Years 3 and 4 will be separated into subgroups so that the different types of teaching can be compared. Each experiment will consist of a sequence of three parts: a pre-test, an intervention period, and a post-test. All of the children will take part in a spelling activity at pre- and post-test, which will be presented to the class as a whole. This will involve presenting the children with 24 oral and written sentences in which they will be asked to try to spell a missing derived word or pseudo-word (see Appendix C). In the intervention period, the children will receive a teaching session using an enjoyable spelling game on Matlab programming software (see Appendix D and E).

Use of results: The results of this study will form the basis of a doctoral thesis at the University of Oxford, which aims to establish how young children learn to spell and how this learning process can be enhanced. If parents are interested, a summary of the results will be provided for them upon request. Any results or personal information collected about each child will be kept strictly confidential and will not be used for any purpose other than inclusion in the research report. Results will be presented only for groups; no individual results will be published. All information will be anonymous and kept in a password protected computer until no longer required after publication. This research will comply with the University of Oxford's Central University Research Ethics Committee and the researcher is already in possession of a valid DBS certificate.

List actual or probable location(s) where project will be conducted, if known:	Three primary schools in Hampshire
If your research involves overseas travel or fieldwork, have you completed and returned a travel risk assessment form? (Bear in mind that this may be necessary to ensure that the travel or fieldwork is covered by the University's travel insurance – see http://www.admin.ox.ac.uk/finance/insurance/travel/.)	N/A
Anticipated duration of project:	4 years
Anticipated start date:	01 / 10 / 2014
Anticipated end date:	01 / 12 / 2018
Name and status (e.g. 3rd year undergraduate; post-doctoral research assistant) of others taking part in the project:	N/A
Please indicate what training on research ethics the researchers involved with this study have received, e.g. the title of the online or in-person course, and date completed (online training available at www.admin.ox.ac.uk/researchsupport/integrity/human/):	Research Ethics Seminar by David Mills 20.11.14. Discussion with my supervisor Professor Terezinha Nunes.

SECTION C

Methods to be used in the study (**tick** as many as apply: this information will help the committee understand the nature of your research and may be used for audit).

	Please tick
Interview	
Questionnaire	
Analysis of existing records	
Participant performs verbal/paper and pencil/computer based task	✓
Measurement/recording of motor behaviour	
Audio recording of participant	
Video recording or photography of participant	
Physiological recording from participant	
Participant observation	
Covert observation	
Systematic observation	

Observation of specific organisational practices	
Other (please specify)	

SECTION D

Have you read one or more of the following professional guidelines and do you undertake to use the principles listed there as a guide for your own work? Please note that this is not intended to be an exhaustive list. Links to the guidelines listed below are included on the CUREC website.

	Please tick
British Society of Criminology: Code of Ethics for Researchers in the Field of Criminology [www.britsoccrim.org/codeofethics.htm]	
British Educational Research Association Ethical Guidelines for Educational Research [www.bera.ac.uk/guidelines]	✓
Academy of Management's Code of Ethics [www.aomonline.org/aom.asp?ID=&page_ID=242]	
Association of American Geographers Statement on Professional Ethics [www.aag.org/cs/resolutions/ethics]	
Oral History Society of the UK Ethical Guidelines [http://www.oralhistory.org.uk/index.php]	
American Political Science Association (APSA) Guide to Professional Ethics in Political Science (Section H) [www.apsanet.org/content_9350.cfm]	
Political Studies Association Guide to Good Professional Conduct [www.psa.ac.uk/psa]	
British Psychological Society Code of Ethics and Conduct [www.bps.org.uk/what-we-do/ethics-standards/ethics-standards]	✓
Ethics Guidelines of the Association of Social Anthropologists of the UK and Commonwealth [www.theasa.org/ethics/guidelines.shtml]	
Social Research Association: Ethical Guidelines [http://the-sra.org.uk/sra_resources/research-ethics/ethics-guidelines/]	
Statement of Principles of Ethical Research Practice from the Socio-Legal Studies Association [www.slsa.ac.uk/content/view/247/270/]	
Statement of Ethical Practice for the British Sociological Association [www.britsoc.co.uk/about/equality/statement-of-ethical-practice.aspx]	
Other professional guidelines (please specify): Ethical Codes of the Economic and Social Research Council (ESRC)	✓

SECTION E

Please put a tick in the yes/no column as appropriate to indicate your response.

	Yes	**No**
1) Will you obtain informed consent according to good practice in your discipline before participation?	✓	
2) Will you ensure that *personal data collected directly from participants or via a *third party is held and processed in accordance with the provisions of the Data Protection Act?	**Yes** ✓	**No**

	Yes	No
3) Does the research involve as participants *people whose ability to give free and informed consent is in question? ***Note: participants aged under 16 are generally considered to require consent of a parent or guardian (only answer 'no' to this question if you can cite one of the protocols listed under 'children'). For participants aged 16-17, consult FAQ C13.*** ***Protocol number(s):*** Protocol 25.		✓
4) As a consequence of taking part in the research, will participants be at serious risk of rendering themselves liable to criminal prosecution (e.g. by providing information on drug abuse or child abuse)?		✓
5) Does the research involve the *deception of participants, as part of the investigation/experiment?		✓

If any of your answers above are in a shaded box, please indicate whether those aspects of your project are fully covered by the following.

	Yes	No
6) Research protocol(s) which has/ve received IDREC/CUREC approval? ***If yes, please give protocol number(s):*** Protocol 25.	✓	
7) Professional guidelines that you will be following, as noted under Section D? British Educational Research Association Ethical Guidelines for Educational Research and the Ethical Codes of the Economic and Social Research Council (ESRC).	✓	

If any of your answers in Section E are in a shaded box and are not covered by a protocol or by professional guidelines, please complete CUREC/2, available to download from the CUREC website. Then submit both this form (you need not complete section F) and the CUREC/2 to the Social Sciences and Humanities IDREC.

If all your answers in Section E are in the unshaded boxes or your answers in shaded boxes are covered by a protocol or professional guidelines, complete Section F and submit this form and any accompanying documents to the Social Sciences and Humanities IDREC or to the relevant officer/committee at departmental level (see notes and address below).

FINAL CHECK

Please check each of the following before submitting the checklist. **If the appropriate supporting documentation is not included with your application, you will then be asked to provide this separately. This may well delay the ethical review process, and thus the start of your research.**

Have you completed Sections A-E? ☑

Have you defined all technical terms and abbreviations used? ☑

If you have produced any documentation in support of your application (which might include questionnaires, participant information, consent forms/form or note of procedure for recording oral consent, advertisements and surveys), have you attached a copy of these? ☑

Are all pages (including appendices and attachments) numbered? ☑

SECTION F

You can submit this checklist by email and/or as a signed hard copy; if it is being sent by email only, the checklist, and any email from the head of department or nominee separately endorsing its submission, must be sent from a University of Oxford email address (i.e. as a minimum, the checklist and supporting documents must be submitted by the head of department or nominee indicating his/her approval from a University of Oxford email account).

Complete this section only if you do not need to submit form CUREC/2.

I understand my responsibilities as principal researcher/supervisor/student researcher as outlined in the CUREC glossary and guidance on the CUREC website.

I declare that the answers above accurately describe my research as presently designed and that I will submit a new checklist should the design of my research change in a way which would alter any of the above responses so as to require completion of CUREC/2 (involving full scrutiny by an IDREC). I will inform the relevant IDREC if I cease to be the principal researcher on this project and supply the name and contact details of my successor if appropriate.
Signed by principal researcher/supervisor/student researcher: Lauren Burton
Date: 02/03/15
Print name (block capitals) LAUREN BURTON
Signed by supervisor:…Terezinha Nunes…(for student projects)
Date:…19/05/2015…
Print name (block capitals)…TEREZINHA NUNES……..…

I understand the questions and answers that have been entered above describing the research, and I will ensure that my practice in this research complies with these answers, subject to any modifications made by the principal researcher properly authorised by the CUREC system.

Signed by associate/other researcher: ……..
Print name (block capitals)……
Date ……

I have read the research project application named above. On the basis of the information available to me, I:
(i) consider the principal researcher/supervisor/student researcher to be aware of her/his ethical responsibilities in regard to this research;

(ii) consider that any ethical issues raised have been satisfactorily resolved or are covered by relevant professional guidelines and/or CUREC approved protocols, and that it is appropriate for the research to proceed without further formal ethical scrutiny at this stage (noting the principal researcher's obligation to report should the design of the research change in a way which would alter any of the above responses so as to require completion of a CUREC/2 full application);

(iii) am satisfied that the proposed project has been/will be subject to appropriate *peer review and is likely to contribute something useful to existing knowledge and/or to the education and training of the researcher(s) and that it is in the *public interest.

(iv) [FOR DEPARTMENTS/FACULTIES WITH A DEPARTMENTAL RESEARCH ETHICS COMMITTEE (DREC) OR EQUIVALENT BODY - PLEASE DELETE IF NOT APPLICABLE] confirm that this checklist (and associated research outline) has been reviewed by the Department's Research Ethics Committee (DREC)/equivalent body, and attach the associated report from that body.

Signed:……..
(Head of department or nominee e.g Chair of DREC, Director of Graduate Studies for postgraduate student projects)
Print name (block capitals)……
Date:……

If your research involves participants recruited by means of their status as current or former NHS staff, or the research will, in whole or in part, be carried out on NHS premises, use NHS facilities or assess NHS facilities or services, please see FAQ B3 (www.admin.ox.ac.uk/curec/faqs/).

Please check with your department about its procedures for the approval of CUREC forms. If your department indicates that the checklist should be submitted directly to the IDREC, please send it, together with any supporting documentation, to the following address(es), keeping a copy for yourself:

Secretary of the Medical Sciences IDREC Email: ethics@medsci.ox.ac.uk
Research Services
University of Oxford
Wellington Square
Oxford, OX1 2JD

Secretary of the Social Sciences and Humanities IDREC Email: ethics@socsci.ox.ac.uk
Research Services
University of Oxford
Wellington Square
Oxford, OX1 2JD

IDRECs and/or CUREC will review a sample of completed checklists and may ask for further details of any project.

Appendix I: CUREC Approval Letter

Dear Lauren,

CUREC APPROVAL: The spelling of a word does not always parallel with the way it sounds: the importance of teaching children morphological spelling

On behalf of the Departmental Research Ethics Committee I am pleased to offer approval of your research project.

Good luck with this interesting study.

All good wishes

Liam

Dr Liam Francis Gearon
Associate Professor
Department of Education
And Senior Research Fellow
Harris Manchester College
University of Oxford

Conjoint Professor, School of Humanities and Social Science, Newcastle University, Australia

Appendix J: Risk Assessment Form Approval

Dear Lauren

Your form has been approved. Please note that you are not insured as you will be staying in Oxford and also at your home address in Hampshire.
Best wishes.

Jackie

Jackie Bridges – Higher Degrees Administrative Assistant
University of Oxford | Department of Education
15 Norham Gardens, Oxford OX2 6PY
Tel: 01865 274187
Email: jackie.bridges@education.ox.ac.uk
Web: www.education.ox.ac.uk