Variations among adults in their use of morphemic spelling rules and of word-specific knowledge when spelling
Abstract

The purpose of this research was to examine adults’ knowledge of two of the simplest and most reliable rules in English spelling, concerning the morphological word-ending –s. This spelling is required for regular plural nouns (bricks, bees) and third-person singular present-tense verbs (kicks, sees), but not for similar sounding one-morpheme words (mix, breeze). In Study 1, 205 young adults’ understanding of these rules was tested. These were adults who were recruited for training in skilled and semi-skilled jobs. They were asked in four different choice tasks to choose the appropriate spelling of pseudowords whose endings were determined by their morphological sentence contexts (e.g., Jim wants only one grix). Only 7.4% of individual participants’ choices were significantly above chance in at least three of the four pseudoword categories tested. In Study 2, 72 undergraduate students completed the same tasks, and 83% achieved above-chance performance on at least three categories. These results suggest that many people depend on word-specific knowledge, rather than on spelling rules, when spelling even very simple words. They also throw some doubt on the generality of conclusions about people’s use of morphology in literacy tasks that have been drawn from previous research, which has depended very heavily on testing samples consisting entirely of undergraduate participants.
Most literate adults spell words reasonably well. They usually obey the spelling rules of the script that they learned at school. However, this does not necessarily mean that they use these rules to decide on the spelling of even quite difficult words. There is an alternative possibility, which is that they rely instead on their knowledge of the spelling of a very large number of specific, individual words. This is usually called “word-specific” or “lexical” knowledge.

To take one example, the endings of the English words *magician* and *education* sound the same but are spelled differently, because that sound is spelled as *-ian* at the end of an agentive word (someone who does magic) but as *-ion* at the end of an abstract noun (the business of educating). This is a reliable, and potentially very useful spelling rule (Nunes & Bryant, 2006), to which most adults conform. However, they may spell these words correctly without knowing anything about the rule and simply by remembering these particular spellings, with these words forming part of an acquired pool of memorised spellings (Treiman & Cassar, 1997). Our question therefore is whether people use morphologically based spelling rules (rule knowledge) to spell such words or whether they rely instead on remembering specific spellings for each word (word-specific/lexical knowledge).

In principle, children and adults could rely on a vast bank of word-specific spelling knowledge and might thus get by without having to learn morphemic spelling rules, such as the one for *-ian* and *-ion* endings, or conditional phonological *rules* such as the split-digraph rule in English, which explains the different pronunciations of *rat* and *rate* (Nunes & Bryant, 2009). Thus, a basic question in research on the development of literacy is whether people learn and use these abstract rules or whether they rely instead on word-specific knowledge.
Conventional stage models of spelling development suggest, on the basis of real-word spelling data, that children learn and apply many spelling rules well before the end of primary school, especially rules about inflectional endings: affixes such as -ed and -s, which are added to the base forms of words without changing their grammatical category (Bybee, 1985). Spelling models suggest that simple inflectional endings such as -ed, -ing, and -s and the split-digraph rule are acquired before about the age of ten years by children learning to read and write in English (Ehri, 1986, 1992, 1997; Frith, 1985; Gentry, 1982; Gentry & Gillet, 1993; Marsh, Friedman, Desberg, & Welch, 1980). Both naturalistic (e.g., Read, 1986; Treiman, 1993) and experimental data (e.g., Leong, 2009; Varnhagen, McCallum, & Burstow, 1997) confirm that children improve rapidly in their spelling of inflectional endings across the primary school years.

One way to explore the extent of people’s knowledge of spelling rules is to examine their application of such rules when writing entirely unfamiliar words whose spelling could not possibly be part of their word-specific knowledge. Spelling rules are abstract, and people who know them should be able to apply them to new words as easily as to highly familiar ones. If we told you that “He keeps a /bʌpt/ in his knapsack”, you would almost certainly write the unfamiliar word as bupt: but if the sentence were “Last night we /bʌpt/ until midnight” your spelling would probably be bupped. If you passed this test, we could justly argue that you know the morphemic spelling rule for English regular past tense inflections.

This “acid test” (Nunes & Bryant, 2006) has been adopted in only a handful of studies on spelling rules. Derwing and Baker (1980) and Beers and Beers (1992) both asked primary school children to spell nonsense words with various inflectional endings, and observed steady improvement across the grade levels. Nunes, Bryant,
and Bindman (1997) also used pseudowords in longitudinal research on children’s learning of the past tense inflection -ed, as did Davis and Bryant (2006) in a longitudinal study of children’s knowledge of the conditional split-digraph rule. Both of these longitudinal studies showed some knowledge of the spelling rule in question among the children who took part, but this was far from perfect in either case.

One basic and simple morphological spelling rule that has received only a little experimental attention, is the plural rule: regular plural endings are always spelled as s even though the sound of this ending is sometimes /s/ (as in cats) and sometimes /z/ (as in dogs), and less often as /əz/ (as in dishes). Similarly, third-person singular verbs are always spelled with a final -s inflection, whether they are pronounced /s/ (as in walks), /z/ (as in runs) or /əz/ (as in he dashes). If the sound /z/ is not an inflectional ending, it is not spelled with –s, but instead with se, ze or zz, as in please, freeze, and buzz. There does exist a small number of singular nouns that end in -s, such as politics and rabies. However, these are generally multisyllabic and of Greek or Latin origin. The word stimuli that have been used in the few studies to consider these rules, and in the research to be reported here, have all been monosyllabic and their context has made it clear whether the word was intended as a singular or plural noun. Thus, any possible real-word analogies have been consistent with the pattern discussed above: inflected words spelled with -s (e.g., trees, tricks), or uninflected words not spelled with -s (e.g., breeze, tax), with the exception of lens and some other very low frequency words.

Beers and Beers (1992) included plural endings in their dictated pseudoword spelling study, and found that when spelling /z/ plurals, children in grade 1 correctly used a final -s 93% of the time, increasing to 97% by grades 3-4. Kemp and Bryant (2003) also studied children’s and adults’ knowledge of the plural rule. They found
that children were far more likely to spell the plural inflection -s correctly in words ending in a /z/ sound when the words were highly familiar than when they were pseudowords, even when the sentence context made it clear that the pseudoword was intended as a plural. For example, children were more likely to use -s to spell the final /z/ of real words, as in “That poor little dog has got fleas” than they were to use -s to spell the final /z/ of pseudowords, as in “There are some baby prees in that pond”.

Children in the latter condition often used -ze instead of -s. The children’s greater success in using -s for real than for pseudoword plural nouns is direct evidence that they rely to some extent on word-specific knowledge, since the spelling rule should work as well with unfamiliar as with familiar words.

A group of adults, some of whom had been to university and some of whom had completed their education at the age of 18 years or earlier, also took part in Kemp and Bryant’s (2003) study, and their spelling of the plural inflection in pseudowords was also far from perfect. Those who had attended university spelled plural pseudowords appropriately only 64% of the time, and appropriately avoided using -s for non-plural pseudowords 83% of the time. In contrast, those who had not attended university performed even more poorly, using appropriate spellings 43% and 63% of the time for pseudowords presented as plurals and as non-plurals, respectively.

These apparently pervasive mistakes, even among some well-educated adults, raise the possibility that some people never learn this particular morphemic spelling rule and continue to rely instead on word-specific knowledge, when spelling plural words, throughout their lives. The difference between the two educational groups also suggests that there are definite dangers in restricting the participants in research on this subject to university students, whose use of morphological rules may well be different from that of the majority of the population. Few studies seem to have
examined spelling skills and strategies in non-reading-disabled adults from a non-university background (e.g., Maughan et al., 2009). The participants in most studies of adults’ use of morphology in reading and spelling are university students, (e.g., Baayen, Dijkstra, & Schreuder, 1997; Burt, 2006; Caramazza, Laudanna, & Romani, 1988; Derwing, Smith, & Wiebe, 1995; Diependaele, Dominiek, & Grainger, 2009; Drews, 1996; Rastle, Davis, & New, 2004; Rueckl & Aicher, 2008; Schreuder & Baayen, 1997).

An important conclusion to be drawn from Kemp and Bryant’s (2003) study is that there are strong individual differences among adults in their use of morphological spelling rules in spelling. However, there were too few trials (six) in each condition of that study to determine whether the choices made by individual participants were significantly above chance level. Further, these authors dealt with just one sound, the /z/ ending, and just one inflection, the plural. It seemed important to us to widen the scope of this line of research and so in the two studies that we shall describe, we also looked at people’s knowledge of the spelling of the third-person singular present tense ending, and at the /ks/ ending. When uninflected words end in the sound sequence /ks/, that ending is without exception spelled as x or xe (e.g., box, axe, I fix). However, in inflected words ending in /ks/ (e.g., socks, she picks, he bakes), the two phonemes are represented separately, because the /k/ sound is part of the root and the /s/ represents an inflection. Thus we devised four different spelling tasks: (1) /z/-ending plural and singular nouns (2) /ks/-ending plural and singular nouns (3) /z/-ending third-person singular and other person verbs and (4) /ks/-ending third-person singular and other person verbs.

In each task the participants were given 30 target pseudowords, each embedded in a meaningful sentence. Half the target pseudowords were one-morpheme
and the rest were two-morpheme. The sentence made it clear whether the target pseudoword contained one or two morphemes. The participant had to choose between two spellings for the target pseudoword: one was always the appropriate spelling for a one-morpheme and the other for a two-morpheme word. Since this was a two-choice task, chance level in each task was 15 correct choices (out of 30). The use of a spelling choice task meant that we could include many more items, and thus gain a clearer picture of participants’ spelling rule knowledge, than if we had used a more time-consuming dictation task.

Both males and females participated in this study. There is ample evidence that the prevalence of reading difficulties is greater in males than in females (e.g., Hawke, Olson, Willcut, Wadsworth, & DeFries, 2009; Maughan et al., 2009), and that females are more sensitive than males to the structure of written and spoken language (e.g., Maccoby & Jacklin, 1975). However, we did not anticipate significant sex differences in adults’ application of such apparently simple spelling rules, which the models of spelling development (described earlier) suggest are acquired in primary school.

The aim of the study was to test the hypothesis that adult spellers fall into two distinct groups; those who know and use the rule and those who do not. This led to predictions about the distribution of the participants’ scores within each spelling task, and also about the relation between participants’ success on the different tasks. The hypothesis predicts a bimodal distribution in each task. The members of one group should know the rule, and thus their scores should be well above chance level. In contrast, the members of the other group, not knowing the rule, should make their choices randomly. Thus, the mean score for one subgroup should be significantly above chance, and the mean score for the second subgroup should be close to chance
level. If some people do know and use the relevant rule, in the sample as a whole there should be many more participants whose scores are significantly above chance level than would be expected by chance. More than 5% of the sample should have scores that are significantly above chance ($p < .05$). However, no more than 5% of the sample should have scores that are significantly below chance level.

The hypothesis also produces two predictions about the relation between scores in the different tasks. The spelling rule about both inflections studied (plural -s and third-person singular -s) applies equally to /z/ and /ks/ endings. If an individual knows and uses the rule, his or her use of it should be similar for pseudowords ending in /z/ and in /ks/. Therefore, those who score significantly above chance in the /z/-ending nouns task should tend to have significantly above-chance level scores in the /ks/-ending nouns task as well, and there should be a correlation between their scores on the two tasks. The predictions are different in the case of the participants whose scores are not significantly above chance level in either task. If, as the hypothesis claims, their choices are random, there should be no correlation in their scores between the /z/-ending and the /ks/-ending nouns tasks. We make exactly the same prediction about the scores in the two verb tasks. There should be a strong correlation between the two verb tasks for those whose scores are significantly above chance level in both, but not among those whose scores are significantly above chance in neither task.

Study 1: Adults’ spelling choice for one- and two-morpheme words

Method

Participants

The study was conducted with a group of young adults who had finished their school education and were not at university. All of them had recently joined the
British armed services as new recruits, and were beginning training in a wide variety of skilled and semi-skilled occupations. A total of 205 recruits (159 male, 46 female) took part. Their mean age was 19.9 years, with a range of 16 to 33 years. Information about their academic achievement or their educational level was not available to us. We were, however, able to use their general spelling scores as one of our measures. English was the first language for all but 12 of the sample, and we decided to omit these participants from the analyses only if their literacy skills proved to be significantly below those of the rest of the group.

**Materials**

Before the main task, we administered three background measures: a test of general spelling ability, a real word spelling choice task to check that participants understood the main task requirements, and a pseudoword spelling choice task to determine whether participants could choose the correct pseudoword spelling on the basis of frequent orthographic sequences (as explained in more detail below). The three background measures were:

1. A spelling task, in which we administered the 40 words in the spelling subtest of the Wide Range Achievement Test-3 (WRAT-3, Wilkinson, 1995) to groups of participants. In this test, participants spelled 40 increasingly difficult words to dictation. We could only administer this task as a group test. This meant that we dictated all 40 words, rather than administering the task individually, and stopping at each person’s ceiling, as this test is designed to be given. Since our administration was non-standardized, we used participants’ raw scores, rather than standardized scores.

2. A real word spelling choice task, in which the participants had to choose the correct spelling for a real word from a pair of spellings. The 14
pairs of words were monosyllabic and ended in the sound sequence /ks/, with a mixture of nouns and verbs, of which seven were of one morpheme (e.g., fox, fix) and seven were of two morphemes (e.g., packs, stacks). These real words were presented in sentence contexts, which were read out to the participants, but which they could also read for themselves in a booklet provided to each participant. Two spellings were provided for each target word. One was the correct spelling, while the other contained a phonologically appropriate but incorrectly spelled ending (e.g., The wily old focks/fox is very cunning; He stacks/stax the bales in the barn).

3. A VC/z/ pseudoword spelling choice task, in which we presented a set of 16 sentences, all of which contained a choice between two pseudowords (8 pseuonoun pairs and 8 pseudoverb pairs) ending in a vowel + consonant + /z/ sound, hence the task name VC/z/. This task tested the participants’ ability to choose the spelling that was appropriate for the pseudoword’s morphological status, and for familiar orthographic sequences. These pseudowords conformed to a common orthographic sequence in English. Words that end in a consonant followed by a /z/ sound are virtually always composed of two morphemes (e.g., pads, legs, wins, robs) and therefore require a final -s. The only (non-technical) one-morpheme exceptions are lens, adze, bronze, and cleanse. Previous research (Kemp & Bryant, 2003) suggests that adult spellers are sensitive to these orthographic sequences. This would lead participants to choose the pseudoword spelling truds over trudze and chabs over chabze. In this task the pseudowords were placed in sentences: in half the sentences the pseudoword was presented as a plural noun (e.g., He has three truds/trudze) and in the other half, as a third-person singular verb (e.g., She chabs/chabze
when the rain stops). The status of the pseudowords was counterbalanced, so that each pseudoword appeared half the time as a noun and half as a verb. All the pseudowords in this task were two-morpheme words, and thus the correct choice was always the pseudoword ending in s. We did not present the task on its own because we wanted to avoid the possibility of participants acquiring a bias for words ending in s. Instead we added the sentences in this task to the 120 sentences in the main task (described below) in which 60 correct choices did not end in s.

In the four main tasks, we presented a set of sentences which contained a choice between two pseudowords whose endings were spelled differently, even though these different spellings represented the same sound. In every sentence one of the two spellings was appropriate for the ending of a one-morpheme word (ze or x) and the other was appropriate for the ending of a two-morpheme word (s or cks). The sentences clearly indicated whether the pseudoword was a pseudo-noun or a pseudo-verb, and whether it contained one or two morphemes.

There were four tasks, each of which consisted of 30 trials. They were the:

1) /z/ ending nouns task
2) /z/ ending verbs task
3) /ks/ ending nouns task
4) /ks/ ending verbs task

In half the sentences in each task the correct choice was the pseudoword with a one-morpheme ending, and in the other half it was the pseudoword with the two-morpheme ending. An example of a sentence in which the correct choice was a two-morpheme /z/ ending pseudoverb is He glies/glize his car in the driveway (correct
choice glies) and an example of a one-morpheme /ks/ ending pseudonoun is *Mary has only one yocks/yox* (correct choice yox).

The combination of sentences and pseudowords was systematically varied across the four tasks. Each pseudoword was presented as a one-morpheme noun in one task and a one-morpheme verb in a second task, and as a two-morpheme noun in a third and a two-morpheme verb in a fourth task. The sequence of presentation of the 16 VC/z/ and the 120 /z/ and /ks/ pseudoword pairs, within each task, was randomised to generate four separate 136-item sequences, which were printed in one of four booklets. Individual groups were tested with one of these booklets.

It could be argued that the correct spelling of the pseudowords could be achieved by analogy to real English words (e.g., *yocks* is like *docks*). Many of the pseudowords did look and sound similar to real English words, simply because there are limitations on the number of phonologically legal combinations of consonant (cluster) + vowel + /ks/ or /z/ sounds that can be created. However, the rotation of the pseudowords through sentence conditions meant that any similarity to real words would have been distributed evenly across conditions. Further, in many cases there were numerous examples of analogous English words of both spellings (e.g., *yox* is also like *box*). Thus, even if analogy were used, the study’s counterbalancing and the large number of English words of different spellings means that analogical spelling could not have had a systematic effect on the results.

**Procedure**

The participants were tested in groups of 10 to 34 in a quiet room, in a single session of about 45 minutes, and recorded their responses in an answer booklet. They first completed the general (WRAT-3) spelling test to dictation, and then the choice tasks for real words. In the second of these tasks, they were given the 14 sentences,
which contained the choice of spellings, in written form. The words and sentences were also read out. Finally, participants were given an amalgamated set of 136 sentences which consisted of (a) the 16-sentence VC/z/ pseudoword spelling choice task (b) the 120-sentence main spelling choice /z/ and /ks/ pseudoword spelling choice task. In both the real word and the pseudoword spelling choice tasks, participants saw each sentence printed, including the correct spelling of the target word and its alternative, and were asked to tick the appropriate box each time to indicate “the word that fits most suitably in the sentence”. To ensure that all participants kept pace with the task, the experimenter read aloud each pseudoword first on its own, next in its sentence context, and finally on its own again. An example of a real and a pseudoword item is given below.

\[
\begin{align*}
tix \quad \text{□} & \quad \text{spees □} \\
\text{The church clock} \quad \text{-------- loudly.} \quad \text{When would you like to} \quad \text{------ with me?} \\
ticks \quad \text{□} & \quad \text{speeze □}
\end{align*}
\]

Results and Discussion

Background measures

Table 1 presents the mean scores for the three background measures. The performance of the 12 participants who did not have English as a first language did not differ significantly from that of the rest of the group, for the WRAT, \( F (1, 203) = 3.06, p = .08 \) or the VC/z/ pseudowords, \( F (1, 203) = .266, p = .61 \). The participants with a first language other than English did perform significantly better than those with English as a first language on the experimental real words, \( F (1, 203) = 4.10, p = .04 \), but this difference was numerically small (mean 14.73 vs. 14.42). These 12 participants’ scores were thus included.
The mean number of the 40 WRAT words spelled correctly was around 60%. Women outperformed men in this task and the difference was significant in a one-way analysis of variance, $F (1, 204) = 13.7, p < .001$, partial $\eta^2 = .06$. There was a considerable amount of variance in the scores in this task: they ranged from 7 to 35.

**Table 1 near here**

In the real word spelling choice task, none of the 46 women made any mistakes. Eight of the 159 men made one or more wrong choices: six male participants made one mistake and two made two mistakes.

The participants made more wrong choices in the VC/z/ pseudoword task, but their performance was still quite high. A repeated-measures ANOVA showed no significant effect of sex, $F (1, 203) = .83, p = .37$, or of word type (noun or verb), $F (1, 203) = .50, p = .48$, on the number of correct choices in this task. The relatively small number of mistakes established that the participants understood and were also able to succeed in a pseudoword spelling choice task. The participants presumably made use of orthographic constraints in mainly choosing the two-morpheme (-s) spellings for these pseudowords, both nouns and verbs, although it is also possible that they used the sentence-based morphological cues as well or instead.

To summarise, there was a reasonable amount of variation in participants’ spelling abilities, but they had virtually no difficulty in selecting the correct spelling for the endings of one- and two-morpheme real English words. They did fairly well in a pseudoword spelling choice task in which they could use both morphological and orthographic cues to make their choices. Thus we can be sure that the participants understood the nature of the spelling choice tasks.

_The four main spelling choice tasks_
Table 2 presents the mean number of correct choices in the main spelling task, in which the participants were given 120 choices between two spellings for the endings of one- and two-morpheme pseudonouns and pseudoverbs. Again, the means for participants who did not have English as a first language were virtually identical to those of those who did, $F_s < 0.5$, and so all participants’ scores were included in the analyses.

**Table 2**

Table 2 presents separate scores for the four main categories of pseudowords (nouns and verbs with /z/ and /ks/ end sound sequences). Since they were given 30 choices in each category, the optimum score was 30 in each case and, this being a two-choice task, chance level was 15. The table shows that the spelling choices were surprisingly inaccurate. The overall mean score for each of the four categories was less than 2.5 above chance level. The women performed slightly better than the men in all four categories.

A four-way repeated-measures ANCOVA with the between-subjects variable of sex and the within-subjects variables of word ending (/z/ or /ks/), word type (noun or verb), and number of morphemes in the target word (one or two) was conducted, with WRAT spelling score as the co-variates. We also carried out a by-items ANOVA with the same four main terms: here word ending, word type and number of morphemes were between-items variables and sex became a repeated measure.

There was a significant effect of the co-variates ($F (1, 202) = 26.86, p < .001, \text{partial } \eta^2 = .12$) in the by-subjects analysis, which suggests that spelling ability had a significant relationship with pseudoword spelling choice. There was a significant effect of sex in both analyses, (by-subjects: $F (1, 202) = 56.4, p = .018, \text{partial } \eta^2 = .03$; by-items: $F (1, 229) = 95.74, p < .001, \text{partial } \eta^2 = .295$): women performed better
than men, even after controls for differences in general spelling ability in the first analysis. There was a significant effect of the number of morphemes in both analyses, (by-subjects: $F(1, 202) = 5.38, p = .021$, partial $\eta^2 = .03$; by-items $F(1, 229) = 24.02$, $p < .001$, partial $\eta^2 = .095$), with two-morpheme spellings being correctly identified significantly more often than one-morpheme spellings. Finally, in the by-subjects analysis, but not in the by-items analysis, there was a significant three-way interaction between sex, word type, and number of morphemes (by-subjects $F(1, 202) = 6.30, p = .013$, partial $\eta^2 = .03$; by-items $F(1, 229) = 0.01, p = .906$, partial $\eta^2 = .00$). Since this interaction did not even approach significance in the by-items analysis, we cannot treat it as a reliable or robust result.

*Individual performances*

The group means for correct choices, presented in Table 2, were generally low, but always above chance. One possible reason for this could be that most participants knew and used the rule occasionally, but not all of the time because they found it hard to do so. Another, quite different, possible reason is that there was a bimodal split between a subgroup of participants who used the rule most of the time, and another subgroup who could not use the rule at all and made their choices randomly.

Since these were tasks with 30 trials and each trial was a choice between two possible spellings, chance level in each task was 15 correct choices. There is a 50% chance of being correct on each trial, and so the scores of those participants who chose randomly without using the relevant morphological spelling rules should therefore be at, or around, 15. The scores of participants who used the rule all or most of the time should be well above 15. In fact, on the binomial, scores of 21 or more correct choices are counted as significantly above chance ($p = .045$) in a 30-trial task.
in which chance level in each trial is set at .5. Thus, on the hypothesis of a bimodal
distribution, there should be one subgroup whose scores fall into the 21 or more range
and who therefore were significantly above chance level in the choices that they
made, and another subgroup whose scores for the most part fall below 21 and average
around chance level.

Figure 1 gives the frequency distributions for the correct choices scores in
each of the four tasks, and Table 3 gives the number and percentage of participants
whose scores were significantly above chance level. In each of the four graphs there
was a tail at the positive end of the distribution, made up of people making between
21 and 30 correct choices. There was no such tail at the negative end. The scores of
the remainder, that is, the people who made fewer than 21 correct choices, appear to
form a normal distribution in which the modal score was 16 with the /z/-ending verbs,
17 with the /z/-ending nouns and the /ks/-ending verbs and 18 with the /ks/-ending
nouns. This pattern is consistent with the idea of a bimodal distribution in which one
subgroup knew the relevant rule well and used it most of the time and another
subgroup either did not use it at all or only infrequently. An unexpected aspect of this
bimodal distribution is the relative size of the two subgroups. In each of the four tasks
more people fell into the significantly above-chance range than one would expect by
chance, but Table 3 shows they were always a small minority of the participants:
13.2% and 15.1% of the total sample with the /z/-ending nouns and verbs and 15.1%
and 17.1% with the /ks/-ending nouns and verbs. Thus we can say with some certainty
that these few participants knew and used the relevant morphological rules, while the
rest either did not know them or did not know them at all well.

**Figure 1 and Table 3**
It is reasonably clear that the participants in the higher subgroup in each task knew and used the relevant rule. What about the participants in the lower subgroup? Can we say that their performance choices were entirely random and that, therefore, they did not use the rule at all? In fact, we cannot rule out the possibility of some residual knowledge in the subgroup of participants whose scores were less than 21 correct in these tasks. The mean scores for the subgroup whose scores were not significantly above chance level were slightly above chance level in each of the four tasks. The mean number of correct choices made by these people was just above 16 (16.28, 16.21, 16.14, and 16.13, respectively). One-sample t-tests showed all of these scores to be significantly above the chance level score of 15. We can conclude that a few of the members of these subgroups may have used the relevant rule sporadically but too infrequently to meet the criterion for being significantly above chance, and that most of them never used the rule at all.

We also tested the prediction, made in the Introduction, about correlations. This was that people whose choices are significantly above chance level in both noun tasks (/z/ and /ks/ endings) know the rule about singular and plural noun endings at least to some extent. Therefore, their scores in these two tasks should correlate quite highly, since their performance in both would be determined by the strength of their knowledge of the overarching rule. However, the people whose choices are not significantly above chance on either noun task should be different. Since, according to our hypothesis, they are not using the morphological rule in either task, there is no reason why their scores on the two tasks should correlate with each other. Random choices should not correlate. Exactly the same argument can be made about verb endings: there should be a correlation between the /z/ and the /ks/ tasks among those
who were significantly above chance in both tasks, but no correlation among those whose choices are not significantly above chance level in either task.

These predictions were supported. There was a significant correlation between scores in the two verb tasks ($r = .43$, $p < .01$) among the 17 participants whose scores were significantly above chance level in both tasks, but no significant correlation at all among the 160 participants whose scores were not significantly above chance level in either verb task ($r = -.01$). In the noun tasks, both correlations were significant ($p < .01$). However, the correlation was far stronger among the 16 participants whose scores were significantly above chance level in both noun tasks ($r = .73$) than among the 159 whose scores were not significantly above chance level in either noun task ($r = .28$).

These correlations suggest that the participants whose scores were significantly above chance level in both verb tasks were governed to varying extents by a morphological spelling rule in making their choices with the pseudo-verbs, and that those whose scores were not significantly above chance in either task made their choices randomly. In the noun tasks, the strong correlation among those whose scores were significantly above chance level in both noun tasks is again good evidence that these participants used the relevant rule to varying extents in the two noun tasks. The much smaller correlation among those whose scores were not significantly above chance in either task suggests that the relevant morphological spelling rule did play a part in the choices made by these participants, or at any rate by some of them, though to a relatively small extent.

Finally, we looked at individuals’ success across all four tasks. We made the arbitrary assumption that anyone whose scores were significantly above chance level in at least three of the four main tasks (i.e., more than half of the tasks) must have
substantial and effective knowledge of the role of inflections in determining the spelling of word-endings. Only 15 participants (7.4%) met this criterion. Nine of these 15 participants were female, which supports the suggestion that young women make more use of morphological spelling rules than young men do.

*Inter-item reliability*

Since our hypothesis is that the majority of the participants chose randomly, we also assumed there would be low inter-item-reliability in the four main tasks: if participants are acting randomly, reliability should be low because the correlation between each item and the total score would necessarily be low. In fact, the total inter-item reliability scores (Cronbach’s alpha) were indeed moderate for the four tasks. However, when we looked at reliability separately in those whose scores were significantly above chance in the respective task and in those whose scores did not reach this level, we found that in every task, inter-item reliability was much higher in the scores of the subgroup whose level of correct responses was significantly above chance than in the other subgroup. Cronbach’s alpha scores for those whose scores were significantly above chance in the respective tasks were .74 in the /z/-ending nouns task, .76 in the /z/-ending verbs task, .81 in the /ks/-ending nouns task, and .64 in the /ks/-ending verbs task. The equivalent reliability scores for the participants whose scores were not significantly above chance in the respective tasks were only .24 in the /z/-ending nouns task, .21 in the /z/-ending verbs task, .43 in the /ks/-ending nouns task, and .19 in the /ks/-ending verbs task. Thus, the tasks were reasonably reliable in the case of the participants who knew and followed the relevant rule, but much less so with the participants whose scores were not significantly above chance and were probably making their choices randomly.

Study 2: Undergraduate students’ use of morphological rules
Virtually none of the participants in Study 1 had been to university. This made it rather an unusual research study since the participants in most current research on morphology and on other psycholinguistic topics, as we have remarked, is done with university students. University students spend a great deal of their time reading and writing, and have usually been in frequent contact with books for many years before going to university. Their grasp of spelling rules might therefore be quite unlike that of the rest of the population. In Kemp and Bryant’s (2003) study of adults’ understanding of a morphological spelling rule, those participants who had been to university did much better than those who had not. It is possible, therefore, that we would find a much larger proportion of participants using morphological spelling rules to make their choices among university students than among the participants who took part in Study 1.

Method

Participants

The participants were 72 undergraduate students (35 male, 37 female) with a mean age of 24.8 years, and a range of 19 to 59 years. They were all students at a relatively new British university, which was originally a polytechnic, but achieved university status in 1992. All the participants’ first language was English.

Materials and Procedure

The participants completed the same tasks as in Study 1. They were given these tasks in small groups in a quiet university room.

Results

Background measures

Table 4 presents the mean scores in spelling the 40 WRAT words, and in the real word and the VC/z/ pseudoword spelling choice tasks. On average, the participants
spelled 30.92 of the 40 WRAT words correctly, which was better than the mean score of 24.31 achieved by the participants in Study 1. Women spelled these words significantly better than men, $F(1, 71) = 14.3, p < .001$, partial $\eta^2 = .17$. None of the participants made any mistakes in the real word spelling choice task. They also did well in the VC/z/ pseudoword spelling choice task, in which women outperformed men, $F(1, 70) = 6.66, p = .012$, partial $\eta^2 = .09$.

**Table 4**

The main tasks

Table 6 shows the mean number of correct choices in the four tasks. All the mean scores were 25 or above, which suggests a strong knowledge of the relevant morphological spelling rules among these undergraduates.

The inter-item reliability (Cronbach’s alpha) scores for these tasks were consistently high: .82 in the /z/-ending nouns task, .84 in the /z/-ending verbs task, .88 in the /ks/-ending nouns task, and .83 in the /ks/-ending verbs task. The fact that the reliability scores were much higher in this study than the equivalent scores in Study 1 is probably due to most of participants achieving scores significantly above chance level scores in Study 2 (as we demonstrate below), whereas many of the participants in Study 1 made their choices randomly.

We carried out a 2 x 2 x 2 x 2 by-subjects ANCOVA and a 2 x 2 x 2 x 2 by-items ANOVA in both of which the independent variables were Sex, Word Ending (/z/ or /ks/), Word Type (noun or verb), and Number of Morphemes (one or two): the WRAT spelling score was the co-variate in the by-subjects analysis. Word Ending, Word Type and Number of Morphemes were repeated measures in the by-subjects analysis and between-items measures in the by-items analysis. Sex was a repeated measure in the by-items analysis, and a between-subjects variable in the by-subjects analysis.
There was a significant effect of the covariate in the by-subjects analysis, $F(1, 69) = 7.56$, $p = .008$, partial $\eta^2 = .01$, which indicates that general spelling ability is related to the spelling of morphologically based endings. There was also a highly significant effect of Sex (by-subjects $F(1, 69) = 38.0$, $p < .001$, partial $\eta^2 = .36$, by-items $F(1, 228) = 165.86$, $p < .001$, partial $\eta^2 = .42$) which showed that the women did better than the men. There was a significant interaction between Sex, Word Type, and Number of Morphemes, $F(1, 69) = 6.60$, $p = .012$, partial $\eta^2 = .09$ in the by-subjects analysis, but this fell short of significance in the by-items analysis, $F(1, 228) = 3.01$, $p = .08$, partial $\eta^2 = .01$. Post-hoc tests produced no significant differences that would explain this interaction.

**Table 5**

Individual performance

Table 6 gives the percentage of individual participants whose choices were significantly above chance (i.e., their scores were 21 or more) in all four tasks. In each task, the number of correct choices made by the great majority of the participants was significantly above chance. Figure 2 gives the distribution of the individuals’ scores. The most striking feature of these distributions is that they are virtual mirror images of those that we found in Study 1. In each case there is clear evidence of a relatively large group of participants who knew the relevant spelling rule and whose scores were normally distributed around a score slightly smaller than the optimum. In each task also there was a small tail of individuals whose scores fell below the dividing line of 21.

**Table 6**

The modal score for the whole sample was 28 correct choices (two short of the optimum) in the /z/-ending noun and verb tasks and in the /ks/-ending verb task, and it
was actually 30 (the optimum score) in the /ks/-ending noun task. The obvious ceiling effect in the /ks/-ending noun task led to a skewed distribution of scores of those in the significantly above chance level subgroup, but in the other tasks there are signs of a normal distribution in the 21 or above scores around 28.

As in Study 1, we also looked at the number of participants whose scores were significantly above chance in at least three of the four tasks. Our assumption here is that people whose scores are as consistently good as this, must have a clear idea of the morphological rule for spelling of singular and plural spellings. We found that 82% of the sample met this criterion. This is in stark contrast to the figure of 7.4% of the sample who met the same criterion in Study 1.

Table 6 also shows a remarkable difference in the proportion of women and of men whose scores were significantly above chance. All the women were in the significantly above chance range in two of the tasks, and virtually all the women were in this range in the other two tasks. The proportion of men whose scores were in this range was much lower, although always well above 50%. When we looked at the number of men and women who met the criterion of being significantly above chance level in three out of four of the tasks, we found that all 100% of women but only 65.7% of the men satisfied the criterion.

These differences between the two sexes were a surprise for us. We had expected that further education would damp down the differences between sexes, since men as well as women have to read and write a great deal in their studies at university. We have no ready explanation for this apparently enhanced difference. We were, at least, able to show that it has nothing to do with the type of degree that the students were studying for. This variable had no effect on the number of correct choices that the participants made.
Finally, the number of participants who failed to produce significantly above-chance level scores in both tasks was small: $n = 4$ for the noun tasks, and $n = 7$ for the verb tasks. This made it impossible to test the prediction that the scores for correct choices in the two noun tasks or the two verb tasks would correlate among those whose scores were significantly above chance in both tasks, but not among those whose scores were not significantly above chance in either task.

Discussion

The main aim of these two studies was to look at individual differences in English-speaking adults’ knowledge and use of two basic morphological rules for spelling singular and plural noun endings and present-tense verb endings. We know of no previous research on the possibility that there are sharp differences among literate adults in their awareness of morphological, or of any other, spelling rules.

The results of the two pseudoword spelling choice studies provided strong support for our hypothesis of a bimodal distribution in the knowledge and use of morphological spelling rules. In the first study the distribution of the scores took the shape of two subgroups. In all four tasks, the scores of one subgroup, which represented around 15% of participants, fell significantly above chance. In contrast, the scores of the other subgroup, representing about 85% of participants, were not significantly above chance and appeared to be normally distributed around a modal score that was just above chance level. Our results thus suggest that the great majority of participants may not have learned two of the most basic morphological spelling rules in the language and relied on word-specific memory instead.

This conclusion is in stark contrast to the traditional stage models of spelling development noted earlier, which describe the acquisition of simple inflectional endings as occurring before the end of primary school (e.g., Gentry, 1982). Our
findings also contrast with those of researchers who have found very good spelling of the -s inflection even in children, with both real words (e.g., Leong, 2009) and pseudowords (e.g., Beers & Beers, 1992). However, our findings do align with those of Kemp and Bryant (2003). It seems that spellers’ difficulty with these inflectional endings becomes obvious only when they are faced with pseudowords whose spelling can only be finalised by consideration of their morphological status.

Our conclusion that many adults use word-specific, rather than morphological spelling knowledge was bolstered by the fact that there was a strong correlation between scores in the /z/ and the /ks/ verb tasks among those whose scores were significantly above chance in both verb tasks, but not in those whose scores were not significantly above chance in either verb task. This suggests that the people in the former subgroup were using the same morphological rule about how to spell present-tense endings in both tasks and that those in the second subgroup were not using any rule common to the two verb tasks. A similar difference was found with the scores for the two noun tasks, except that the correlation among those whose scores were not above chance level in either noun task was positive and significant, although much smaller than the correlation among those whose scores were significantly above chance in both noun tasks.

This last finding fits quite well with the pattern of the scores in the less able subgroup in each task. Our prediction was that the mean scores for the less able subgroups would be at chance level, but in fact these means were slightly (and significantly) higher than chance in all four tasks. This result suggests that although not all of the people in these subgroups knew the rule about noun endings, some of the members of the each less able subgroup did occasionally use the morphological spelling rule that was relevant to the task.
The sharp difference in the level and the distribution of the participants’ scores in the two studies is undoubtedly an important result. In Study 1, over 80% of the participants produced scores that were not significantly different from chance. In Study 2, the scores of over 80% of the participants were significantly above chance level. Thus, the majority in Study 2 plainly knew and used the relevant morphological spelling rules. Since the participants in Study 2 were at university and the participants in Study 1 were not, one might conclude that university education enhances people’s knowledge of morphology and spelling. We think that this is not the right explanation.

We collected our data in the years 2004-2006, and in the preceding two decades, when our participants were school-children, teachers in the UK provided very little instruction about the link between morphology and spelling (Nunes & Bryant, 2006). Therefore, most people’s knowledge of these rules was self-taught, and probably depended a great deal on their childhood interest in, and experience of reading and writing, which may be closely related to their later decision to go to university. Hence, most of the participants who were at university (Study 2) would have been in the subgroup of those who know and use the spelling rules and most of those (Study 1) who did not go to university would be in the other subgroup. However, there are other possible reasons for the contrasting results of the two studies. The university students may have performed better than the non-students because they had greater experience of test-taking and intellectual problem-solving, and may also have had higher expectations of themselves in an experimental test situation.

At the very least, the striking contrast in the results of our two samples reinforces the urgent need to widen the scope of psycholinguistic research on adults beyond university students. It seems probable to us that many previous studies of morphology in adults would have produced different results if they had been done with people
whose education stopped when they left school. At the same time we acknowledge that our participants, although more varied than the usual groups, still may not be a completely accurate representative of the community as a whole. Only systematic study of random, rather than conveniently available, samples, will lead eventually to a more accurate view of adult spelling knowledge. Although we have seen a dichotomy in our participants’ performance here, testing even more varied groups might show more of a continuum of rule knowledge and application.

We had not expected any sex differences in the application of a spelling rule that spelling models would suggest is achieved during the primary school years. However, sex differences were found in both studies and were always in favour of the women. Evidence that females are more sensitive than males to the structure of spoken and written language goes back a long way (e.g., Maccoby & Jacklin, 1975), but the differences found in the present study were still a little surprising. The particular difference between the sexes that we have reported suggests that women are better than men at learning morphological spelling rules for themselves in the absence of any systematic teaching about these rules. Perhaps girls have less need than boys for explicit instruction about morphemes and spelling. It is also possible that the sex differences observed were at least partially attributable to other factors. Because we do not have extensive background information on our participants, we cannot rule out the possibility that the females in these studies (who were in the minority in Study 1) may have had more previous experience with written language or written tests, unrelated to their sex.

The spelling of pseudowords is less influenced by word-specific spelling knowledge than the spelling of real words, and thus provides a more rigorous test of spelling rule application. Our tasks required participants to choose the appropriate
spelling from two written pseudowords each time. This relatively quick and simple methodology allowed us to ask participants to work in groups, and to provide data on many more test items than would have been possible than if we had asked them to write down each pseudoword in full to dictation (e.g., Kemp & Bryant, 2003; Leong, 2009) or if we had instead given computer-based morphological priming tasks (e.g., Rueckl & Aicher, 2008). Future research could include dictation tasks to gain further information on the range of spellings that participants might produce, and could employ more difficult real words, as well as pseudowords (e.g., Egan & Pring, 2004), to see how spelling knowledge is applied to familiar but infrequent word spelling. Participants could also be asked directly about their understanding of the spelling knowledge or rule being tested.

In conclusion, we have shown that a large number of literate adults rely on word-specific knowledge to spell singular and plural noun endings and present-tense verb endings. Our evidence suggests that they do not know the apparently simple morphological spelling rules that underlie these spellings; rules that most conventional spelling models and theories suggest are acquired during the primary school years. Most psycholinguistic research, including our own, has drawn conclusions from results gained from university populations. The current findings suggest that future researchers would do well to consider the responses of a much wider range of participants if generalisations about adults’ linguistic knowledge are to be made.
References


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