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Integrated Morphological Awareness Intervention as a Tool for Improving Literacy

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Although good phonological awareness skills are essential for learning to read and write effectively (e.g., Stahl & Murray, 1994; Torgesen, Wagner, & Rashotte, 1994), recent findings suggest that by 10 years of age, knowledge about the structure of words is a better predictor of decoding ability than is phonological awareness (Mann & Singson, 2003). Thus, as children encounter longer, more complex words, morphological awareness becomes critical for developing good literacy skills (Carlisle, 2003). The goal of this study was to evaluate the effectiveness of an intervention program that aimed to improve reading and spelling in children with specific spelling difficulties by teaching them to coordinate morphological awareness with other types of linguistic awareness. These other types of linguistic awareness include phonological awareness, orthographic awareness, syntactic awareness, and semantic awareness.

Morphological awareness involves the ability to analyze words into their component morphemes. For example, the word *unimportantly* is made up of two prefixes, the base word *port,* and two suffixes. Morphological awareness also involves the ability to recognize families of words and their shared meanings. For example, the words *spectacular, bespectacled,* and *inspection* all share the base word *spect,* and they all have something to do with seeing. Families of words can also be related through sharing a common suffix, as with the agentive *-er* suffix, which is found in words such as *teacher, painter, fighter,* and *drinker*.

ABSTRACT: **Purpose:** This study evaluated the effects of an intervention program aimed to improve reading and spelling ability through instruction in morphological awareness together with other forms of linguistic awareness, including knowledge of phonology, orthography, syntax, and semantics.
Method: Sixteen children aged between 8;07 (years;months) and 11;01 who demonstrated specific spelling difficulties were randomly assigned to either an experimental or a control group. Participants received an average of 19.4 sessions of intervention that focused on increasing awareness of the morphological structure of words, with particular attention to the orthographic rules that apply when suffixes are added to the base word.
Results: Participants in the experimental group made significantly greater gains in reading and spelling accuracy than those in the control group on both experimental and standardized measures of reading and spelling. The results also show that participants were able to generalize to new words what they had learned in the intervention sessions.
Conclusion: Practitioners should consider the likely benefits of literacy intervention that focuses on developing morphological awareness in conjunction with other types of linguistic awareness.

KEY WORDS: literacy intervention, morphological awareness, linguistic awareness, spelling, reading

Being able to identify the morpheme boundaries in a word can help with both decoding that word and understanding what that word means. For example, compare the words *uniformed* and *uninformed*. Both begin with the same three graphemes. However, knowing that the first morpheme boundary falls after the *i* in *uniformed* and after the *n* in *uninformed* helps to pronounce these words correctly. Furthermore, understanding the morphological relationships between words can help to spell the words correctly. For example, knowing how to spell the word *photograph,* which is the base word for *photography,* makes *photography* much easier to spell. The reduced vowels in the first and third syllables of *photography* make it difficult to recover the quality of these vowels. In addition, the phoneme /f/ in this word is spelled with the digraph *ph*. Therefore, a child using a phonemic spelling strategy is likely to spell *photography* as *fitografe*.

Morphological awareness is only one of a number of linguistic skills that must be mastered in order to read and spell effectively. In addition to morphological awareness, a number of other linguistic skills contribute to the acquisition of literacy, including phonological awareness, orthographic awareness, syntactic awareness, and semantic awareness. The following paragraphs describe each of these different types of linguistic awareness.

Phonological awareness involves the ability to think about, reflect on, and manipulate the sound structures of a language, and it is vital to the acquisition of early literacy skills. However, because the relationship between phonology and morphology is often not transparent, having good phonological awareness skills is not enough for children to become proficient at reading and spelling. For example, when learning the past tense, children must come to realize that three different phonological forms (e.g., [t] as in *hopped,* [d] as in *robbed,* and [d] as in *batted*) can be used to represent the same morpheme.

Orthographic awareness involves the ability to translate spoken language into its written form. For example, as children begin to encounter the past tense morpheme in written text, they come to understand that the written form of this morpheme is invariant despite the variability of its phonology. An essential component of orthographic awareness is knowledge of the orthographic modifications that must be made to a base word when it is concatenated with a suffix. Being able to discriminate short and long vowel sounds provides the basis for mastering many of these orthographic patterns. For example, when the *-ing* suffix is added to a base word containing a short vowel, the final consonant of the base is doubled (e.g., *hopping*). When the *-ing* suffix is added to a base word containing a long vowel where the long vowel is represented by a split digraph, then the final *-e* of the base is deleted (e.g., *hoping*). Understanding these orthographic patterns is essential for the reader/listener to accurately read and spell morphologically complex words.

Syntactic awareness interacts with morphological awareness to help the reader/listener understand the meaning of words they have not encountered before. A good grasp of basic syntactic categories and how different word classes interact with various affixes makes it possible for the reader/listener to learn new words. For example, knowing that the *-y* suffix can be concatenated with a noun to form an adjective can help the reader/listener determine that in the sentence, *The crackers were very mushy*, the word *mushy* is describing the crackers and it is related in meaning to the nominal base word *mush*.

As the above discussion has shown, morphological awareness does not exist in a vacuum and requires the integration of various forms of linguistic knowledge. When morphological, phonological, orthographic, and syntactic awareness are used in concert, this leads to improved understanding of the meaning of words, or *semantic awareness*. The coordination of these different aspects of linguistic awareness allows the expression and comprehension of ideas, which is the purpose of reading and writing. Systematic instruction in the development of linguistic awareness has the potential to provide a valuable method for improving literacy skills.

Intervention Studies That Integrate Morphological Awareness With Other Forms of Linguistic Awareness

A number of recent studies have shown that intervention programs focusing on the integration of morphological awareness with other forms of linguistic awareness can help improve the literacy skills of both typically developing children and children with reading disabilities. Berninger and colleagues (Berninger et al., 2003) have shown that morphological awareness intervention can result in improved reading performance for fourth, fifth, and sixth graders (ages 10;6–12;5 [years;months]) with persistent reading difficulties. The intervention tasks in their study included combining affixes and base words, generating new words for each morpheme in a given word, identifying base words and affixes, recognizing semantic relationships between morphologically complex words, and sorting words by affix. By the end of the study, participants showed improved rate and accuracy of phonological decoding, as well as slower rate but improved accuracy of decoding morphologically complex words. The authors concluded that morphological processing requires attention to phonology, orthography, and meaning, even though these skills were not directly targeted in the intervention.

As well as improving reading skills in children with reading disabilities, integrated morphological awareness intervention has been successful in improving spelling skills in typically developing children. For example, Butyniec-Thomas and Woloshyn (1997) explicitly taught third-grade students a variety of spelling strategies that included segmenting words into syllables, identifying orthographic changes to the base word when a suffix is added, and developing mental images of the target words. Children who were taught these strategies in the context of a story outperformed children who received spelling instruction where the training words were presented in list form. Both of these groups outperformed children in a third group who were exposed to the target words in a story but who received no explicit spelling instruction. Similar group differences were found for 17 words that were not included in any of the intervention sessions, showing that this approach to spelling instruction resulted in generalization to new words.

In addition, Apel, Masterson, and Hart (2004) reported on the results of a study where typically developing third- and fourth-grade students were given intervention that integrated morphological awareness, phonological awareness, orthographic awareness, and mental graphemic representations. After intervention, the spelling skills of these children had significantly improved relative to those of children who received the traditional school spelling curriculum. However, it is not clear from the results whether or not improvements in spelling included improved accuracy in the spelling of morphologically complex words.

To date, there has been very little research investigating the effectiveness of integrated morphological awareness intervention on

the development of literacy skills in children with specific spelling difficulties. However, a recent case study (Apel & Masterson, 2001) suggests that intervention focusing on multiple linguistic factors is a promising method for improving literacy for children with impairments in both reading and spelling. Based on the results of the studies reviewed here, we have reason to believe that an intervention program focusing on morphological awareness integrated with other forms of linguistic awareness will be effective for children with specific spelling difficulties.

Aims of the Current Study

The current study was designed to assess the effectiveness of an integrated morphological awareness intervention program in improving the literacy skills of children with specific spelling difficulties. The following research questions were addressed:

- Will accuracy on experimental reading and spelling probes improve as a result of the intervention program?
- Will reading and spelling accuracy generalize to words that were not taught during the intervention program?
- Will accuracy on standardized tests of reading and spelling improve as a result of the intervention program?

METHOD

Participants

Sixteen children took part in the study (11 boys, 5 girls). Participants were randomly assigned to either an experimental group ($n = 8$) who received intervention immediately or to a control group ($n = 8$) who did not receive intervention until after the experimental group had completed the intervention program. Participants were aged between 8;07 and 11;01 at the beginning of the study. The first language of all participants was standard New Zealand English, and they were all of Caucasian descent. The parents of all participants provided informed consent consistent with the human subjects' review board at the institution where this research was conducted.

Participants attended two schools in high socioeconomic areas (as determined by the Ministry of Education school rating) in the city of Christchurch, New Zealand. Teachers at these two schools were asked to put forward the names of children who they considered to be poor spellers of normal intelligence. Twenty-three children were identified by their classroom teachers as fitting this description, and these children were administered standardized tests of spelling (Test of Written Spelling—Fourth Edition, TWS–4; Larsen, Hammill, & Moats, 1999) and nonverbal intelligence (Test of Nonverbal Intelligence—Third Edition, TONI–3; Brown, Sherbenou, & Johnsen, 1997). Children who obtained a standard score of 85 or below on the TWS–4 and a score of 85 or above on the TONI–3 were included in the study.

Scores on a number of additional preintervention measures were collected from participants. A standardized measure of language was administered using the Clinical Evaluation of Language Fundamentals—Fourth Edition—Australian Standardized Edition (CELF–4 Australian; Semel, Wiig, & Secord, 2006). For those participants who were under the age of 9 years at the beginning of the study, the core language score was calculated using the following subtests: Concepts and Following Directions, Word Structure, Recalling Sentences, and Formulated Sentences. For participants aged 9 years or older at the beginning of the study, the core language score was calculated by replacing the Word Structure subtest with the Word Classes 2—Total subtest. All participants received a core language score that was greater than 1 *SD* below the mean, except for 2 children in the control group who received standard scores of 79 and 84.

A standardized measure of reading was administered using the Basic Skills Cluster of the Woodcock Reading Mastery Tests—Revised (WRMT–R; Woodcock, 1987), which consists of the Word Identification and Word Attack subtests. Participants' raw scores on these tests were converted to standard scores based on age. All participants received a standard score on the Basic Skills Cluster that was greater than 1 *SD* below the mean, except for 1 child in the experimental group who received a standard score of 82.

A criterion-referenced test of phonological awareness was administered using the CELF–4 Australian. If a child equals or exceeds the criterion score set for his or her age, this indicates adequate phonological awareness skills. All participants in the study met the criterion set for their age on this test.

A hearing screening that included pure-tone audiometry and otoscopy was administered. Three of the 16 participants failed the screening because of mild hearing loss in one or both ears. Two of the children who failed the hearing screening were in the experimental group, and 1 child was in the control group. These children were retained in the study as their hearing loss was only mild, and we had no reason to believe that it would impact on the findings of the study. The 3 children who failed the hearing screening were referred for medical or audiological follow-up as appropriate.

Preintervention Between-Groups Comparisons

Before intervention commenced, equivalency of the two groups (experimental, control) was examined across the following variables: chronological age, nonverbal intelligence, core language, phonological awareness, standardized tests of reading and spelling, and an experimental reading and spelling probe (see the Appendix for a complete list of the items in the experimental probe). Participants' raw scores served as the dependent variable for the phonological awareness subtest of the CELF–4 as this is a criterion-referenced test, as well as for the reading and spelling probes. Participants' standard scores served as the dependent variable for all other tests. A comparison of the group means and standard deviations for all preintervention tests is presented in Table 1. An analysis of variance (ANOVA) showed no preexisting group differences for any of the variables tested: chronological age, $F(1, 14) = 0.86$, $p = .37$, $f = 0.24$; nonverbal intelligence, $F(1, 14) = 3.12$, $p = .1$, $f = 0.42$; core language, $F(1, 14) < 0.001$, $p = 1$, $f = 0.0$; phonological awareness, $F(1, 14) = 3.14$, $p = .1$, $f = 0.42$; standardized test of basic reading skills; $F(1, 14) = 0.98$, $p = .34$, $f = 0.26$; standardized test of spelling, $F(1, 14) = 0.005$, $p = .95$, $f = 0.02$; experimental reading probe $F(1,14) = 2.36$, $p = .15$, $f = 0.37$; and experimental spelling probe $F(1, 14) = 0.04$, $p = .85$, $f = 0.05$.

General Procedure

This study compared the effects of integrated morphological awareness intervention on two groups of children (experimental and control) using repeated measures at three points in time. Before intervention (Time 1), all participants were tested on the criterion-referenced

Table 1. Means, standard deviations, and minimum and maximum scores for preintervention assessments by group.

	*Experimental group (*n = *8)*				*Control group (*n = *8)*			
	Mean	SD	*Min*	*Max*	*Mean*	SD	*Min*	*Max*
Chronological age	113.8	11.8	103	133	109.4	6.3	103	121
Nonverbal intelligence	95.8	8.2	89	111	106.4	14.9	89	135
Core language	100.4	5.9	89	109	100.4	13.2	79	117
Phonological awareness	73.9	3.8	68	79	70.3	4.3	65	79
Standardized reading	92.9	5.4	82	100	97.5	12.1	89	126
Standardized spelling	77.9	3.5	73	84	77.8	3.9	72	85
Reading probe	42.6	5.4	32	50	46.6	5.0	39	53
Spelling probe	11.4	5.8	3	20	12.0	7.4	4	25

and standardized tests discussed above, as well as on an experimental probe consisting of 60 items. Participants were asked to first spell the items in the experimental probe and then to read the same words. In order to obtain spelling responses, each word was presented first in isolation, then as part of a sentence, and finally once again in isolation. The reading probe was presented as part of a much larger set of words that included 180 additional items. To obtain reading responses, the items in the probe were printed on A4 paper in size 16 Times Roman font with 60 words per page. After the experimental group had completed the intervention program (Time 2), all participants were retested on the experimental reading and spelling probes and the same standardized tests of reading and spelling that were administered before intervention. The children in the control group then completed the intervention program in the same manner as those in the experimental group. When the control group had completed the intervention program (Time 3), all participants were retested on both the experimental and standardized measures of reading and spelling.

Each participant required three sessions to complete the preintervention assessments. Two sessions were required to complete the assessments at Time 2 and Time 3. The experimental probe was always administered over two sessions. Each assessment session lasted between 20 and 50 min. Participants received an average of 19.4 intervention sessions over 3 months. The number of intervention sessions attended by each participant ranged from 16 to 22 (*SD* = 1.3). Intervention sessions lasted approximately 45 min and consisted of one individual session and one group session (4 children in each group) each week. All assessments and intervention sessions took place during school time in a quiet room at the child's school and were administered either by the first author or by one of two trained, supervised speech-language pathology students. Assessments and intervention sessions were digitally recorded using a Sony ECM-MS907 stereo condenser microphone that was placed on the table in front of the child.

Intervention Materials and Implementation

The intervention program was designed and implemented by the first author. The intervention focused on teaching participants to coordinate morphological awareness with other types of linguistic awareness, including knowledge of phonology, orthography, syntax, and semantics. Following Apel and Masterson (2001), and Apel et al. (2004), simultaneous attention to multiple linguistic factors was promoted, rather than stage-like attention to each linguistic factor. A stage-like approach to multiple linguistic factors focuses on mastering one type of linguistic awareness before a new type of linguistic awareness is introduced. Simultaneous attention to multiple linguistic factors, on the other hand, promotes integration of the various types of linguistic awareness within a single session. The specific activities used to encourage simultaneous attention to multiple linguistic factors are discussed in the following section. The focus of the intervention program was on mastering a few frequently occurring orthographic patterns instead of on learning to read and spell particular words. It was hoped that this would enable participants to generalize what they learned in the intervention sessions to a large number of words.

Two types of orthographic patterns were the focus of the intervention:

- Patterns in morphologically simple words where vowel length determined the spelling of the final sound in the word: magic *e* (e.g., *cute, cut*), *-ke* and *-ck* (e.g., *bake, back*), *-ch* and *-tch* (e.g., *peach, patch*), and *-g, -ge,* and *-dge* (e.g., *hug, huge, hedge*).
- Patterns in morphologically complex words that involved modification to the spelling of the base word when a suffix was added: consonant doubling (e.g., *slopping*), *e*-drop (e.g., *sloping*), *y* → *i* (e.g., *funniest*). These modifications of the base word were used with the following suffixes: *-er, -est, -ing, -y, -ed, -iest, -ier, -ly, -ish, -en,* and *-ened*.

Sixty experimental probe words were selected to represent the variety of orthographic patterns covered in the intervention program. Half of the items in the probe were explicitly taught during the intervention sessions (taught words); the remaining items were not included in any of the intervention sessions (untaught words). Each taught word was matched with an untaught word that was similar in orthographic shape. For example, the taught word *choke* was matched with the untaught word *trike* to test knowledge of the correct orthography for the phoneme /k/ after a long vowel. In addition, morphologically complex words were matched for suffix. For example, the taught word *flabby* was matched with the untaught word *floppy* to test knowledge of the correct orthography for the *-y* suffix, as well as knowledge of the consonant doubling rule after short vowels.

Intervention Tasks

Two types of intervention task were used to improve the children's reading and spelling skills: sorting activities and spelling with

prompts. Words sorts were used to promote the discovery of linguistic regularities. The word sort task involved sorting words that were printed on individual cards according to various morphological, phonological, orthographic, syntactic, or semantic patterns. Word sorts have been shown to provide an effective way of encouraging children to recognize shared patterns across words (Zutell, 1998). The concept of sorting words in this way was inspired by the work of Bear, Invernizzi, Templeton, and Johnson (2000). However, unlike the word sorts of Bear et al., our word sorts did not include words that were inconsistent with the targeted pattern. For example, the word *have* is an exception to the rule that the grapheme *e* in word-final position makes the preceding vowel long. The inclusion of such oddballs can be used to increase the difficulty of a word sort. Given the relatively short duration of our intervention program, it was decided to avoid adding this extra level of difficulty.

Picture sorts for the identification of vowel length. Sorting tasks were used to encourage the identification of long and short vowels. This was achieved by sorting pictures of monosyllabic words according to the length of the vowel. Sorting pictures allowed participants to focus on the sound of the vowel without being distracted by orthography. The accurate identification of vowel length was essential for learning many of the orthographic patterns that were included in the intervention program.

Words sorts for morphologically simple words. To encourage the realization that vowel length can influence the spelling of word-final phonemes in morphologically simple words, participants were asked to sort words that were phonologically identical except for the length of the vowel. These minimal pairs focused on the orthographic alternations of *-ke* and *-ck* (e.g., *bake, back*), *-ch* and *-tch* (e.g., *peach, patch*), and *-ge* and *-dge* (e.g., *huge, hedge*). Because of the scarcity of true minimal pairs for the *–ge* and *-dge* alternation, this particular sort relied heavily on nonword minimal pairs (e.g., *poge, podge*) as well as near mimimal pairs (e.g., *huge, hedge*). Participants were encouraged to sort words with these orthographic alternations according to whether the vowel in each of the words was long or short. It was intended that participants would come to realize that words with short vowels contained an extra consonant compared to the minimally different word with a long vowel ("short vowels are greedy, they need an extra consonant"). Furthermore, because struggling readers frequently confuse hard *g* with soft *g* in word-final position, minimal pairs involving this alternation were also included (e.g., *wag, wage; fug, fudge*).

Word sorts for morphologically complex words. To introduce the idea that some words are morphologically complex, word sorts containing base words and suffixes that are orthographically and semantically transparent were used. For example, the word *leader* is semantically transparent because it is the sum of the meaning of its two component morphemes; the agentive *-er* suffix means "someone who Xs" (where "X" stands for the base word). The word *leader* is also orthographically transparent; there is no change to the spelling of the base word when the suffix is added. In addition, comparison of the agentive *-er* suffix and the comparative *-er* suffix (e.g., *helper* vs. *smaller*) helped to make the point that suffixes are more than just a collection of graphemes, and that they alter the meaning of the base word in predictable ways. To encourage semantic awareness, participants were asked to put words into sentences. They were also encouraged to generate new words with a given suffix.

Word sorts that focused on the orthographic change to the base word were also used. For example, the words *spotty, icy,* and *dusty* all have the same suffix, but the spelling of the base word is altered in various ways when the suffix is added. The final consonant in *spot* is doubled to keep the vowel short, the final *e* in *ice* is dropped, and *dust* remains unchanged. Even though *dust* contains a short vowel, note that the final consonant is not doubled because the base word already ends in two consonants.

To encourage the realization that suffixes have a constant orthographic shape and are not always spelled as they sound, words were sorted by the phonological shape of the suffix. For example, *pinned* ends with a [d] sound, *picked* ends with a [t] sound, and *mated* ends with a [d] sound. In spite of these different allophonic variants of the past tense morpheme, the regular past tense is always spelled with the grapheme *ed*. This particular word sort helps to reinforce the importance of thinking about the meaning of a word when attempting to spell that word, thereby preventing confusion when spelling homophones like *missed* and *mist,* or *allowed* and *aloud*.

Participants were encouraged to verbalize the various rules that they discovered as a result of the word sorts. For example, "when *-ing* comes to stay, word-final *e* goes away" and "short vowels are greedy so consonants double after short vowels."

Increasing word sort complexity. In the early sessions, words presented to participants for sorting were blocked by final sound, or by suffix. The purpose of blocking words in this way was to draw attention to shared orthographic content for monosyllabic words and to shared morphosyntactic and semantic content for multimorphemic words. To make the word sorting task more difficult, words with different final sounds and suffixes were presented in the same list. When lists of words with mixed suffixes were presented, participants were asked to identify whether the base word was a noun, verb, or adjective so as to develop an awareness of different syntactic categories and how these categories interact with various suffixes. To discourage participants from guessing when asked to read the words, pairs of words that differed minimally in their phonological and orthographic shape were used whenever possible (e.g., *rip, ripe; wag, wage; hopping, hoping; slopped, sloped).*

Prompted spelling. After sorting words according to various criteria, participants were asked to spell some of the words. At first, participants received a series of prompts from the clinician. Here is an example of the prompts used for eliciting a morphologically simple word.

> I'd like you to spell the word *trick*. I'll use the word *trick* in a sentence so that you can think about what it means: *The magician performed a magic trick.* Now, before you write anything down, I want you to tell me the vowel sound in the word. That's right, the vowel sound is /ɪ/. Is /ɪ/ long or short? You are correct, the vowel sound in *trick* is short. If the vowel is short, how do we spell the final /k/ sound. That's right, you spell the final /k/ sound with the letters *ck* because short vowels are greedy, they like an extra consonant. Now write the word *trick*.

Here is an example of the prompts used for eliciting a morphologically complex word.

> I'd like you to spell the word *mopping*. I'll use the word *mopping* in a sentence so that you can think about what it means: *The boy was mopping the floor.* Before you write anything down, I want you to tell me the vowel sound in the base word. That's right, the vowel sound is /ɒ/. Is /ɒ/ long or short? You are correct, the vowel sound in *mop* is short. Now spell the base word. Do you have to make any changes to the base word when you add the suffix? Yes, you do. Because the vowel sound in *mop* is short, you will have to double the final *p* in *mop*. Now finish writing the word *mopping*.

The next step was to encourage self-prompting, that is, getting children to ask these questions for themselves. To make the

task more difficult, words with different final sounds and different suffixes were presented in the same spelling list. Finally, children were asked to spell words that they had not been exposed to in the word sorts to see if they could use the spelling prompts on new words.

Session format. Each session focused on sorting, reading, and spelling morphologically simple and morphologically complex words. A typical session included the following general format:

- Identification of long and short vowels with picture sorts
- Word sorts with morphologically simple words
- Prompted spelling with morphologically simple words
- Word sorts with morphologically complex words
- Prompted spelling with morphologically complex words

Treatment Fidelity

Thirty-one intervention sessions (i.e., 10% of the total sessions implemented) were randomly selected to assess the treatment fidelity of the intervention program. After viewing the videotapes of the selected sessions, an independent examiner confirmed that each intervention session included at least one activity that targeted sorting, reading, and spelling both morphologically simple and morphologically complex words.

Statistical Analysis

The effect size index, *f,* is used for measuring effect size when reporting the results of analyses of variance (ANOVAs; Portney & Watkins, 2000). Conventional effect sizes for the effect size index *f* are as follows: small $f = .10$, medium $f = .25$, large $f = .40$. The effect size index, partial eta squared (η_p^2) is used for measuring effect size when reporting the results of multivariate analyses of variance (MANOVAs; Portney & Watkins, 2000). Conventional effect sizes for η_p^2 are as follows: small $\eta_p^2 = .01$, medium $\eta_p^2 = .06$, large $\eta_p^2 = .14$. Where multiple pairwise comparisons were conducted, the Bonferroni procedure was used to correct for Type 1 error.

RESULTS

Effect of Integrated Morphological Awareness Intervention on the Accuracy of the Experimental Probes

The first research question addressed the effectiveness of the intervention program on reading and spelling performance as measured by accuracy on the experimental probes. The two groups' raw scores on the experimental reading and spelling probes at three different points in time are shown in Table 2. Means, standard deviations, and the minimum and maximum scores are presented at the three different test times: before intervention for both groups (Time 1), immediately after intervention for the experimental group and before intervention for the control group (Time 2), and 6 months after intervention for the experimental group and immediately after intervention for the control group (Time 3).

A repeated-measures ANOVA was used to analyze group differences on the reading and spelling probes at the three different test times described above. Time (Time 1, Time 2, Time 3) served as the within-subjects variable, and group (experimental, control) served as the between-subjects variable. Participants' raw scores on the experimental probe served as the dependent variable.

Table 2. Means, standard deviations, and minimum and maximum scores for the experimental probe by group and time.

	Experimental group (n = *8)*				*Control group* (n = *8)*			
	Mean	SD	*Min*	*Max*	*Mean*	SD	*Min*	*Max*
Spelling probe								
Time 1	11.4	5.8	3	20	12.0	7.4	4	25
Time 2	30.1	14.2	10	47	14.8	9.5	6	33
Time 3	32.1	13.9	9	45	41.9	10.6	21	52
Reading probe								
Time 1	42.6	5.4	32	50	46.6	5.0	39	53
Time 2	50.6	4.5	42	56	45.3	8.0	32	58
Time 3	50.9	4.2	43	55	54.3	3.8	46	59

Spelling probe. Results of the ANOVA showed a significant main effect for time, $F(2, 28) = 69.74$, $p < .001$, $f = 2.23$, and a significant Time × Group interaction, $F(2, 28) = 19.1$, $p < .001$, $f = 1.12$. However, there was no main effect for group, $F(1, 14) = .12$, $p < .73$, $f = 0.09$. To investigate whether there was a significant improvement in spelling accuracy after all participants had received the intervention program, a paired comparison between Time 1 and Time 3 was conducted. This revealed a significant effect of time averaging across all participants, $F(1, 14) = 111.7$, $p < .001$, $f = 2.82$. This large-sized effect of time can be attributed to the large post-intervention change in spelling performance.

To investigate the Time × Group interaction, paired comparisons by group were conducted. If the intervention was effective, we would expect a significant improvement by participants in the experimental group between Time 1 and Time 2, but no significant improvement by those in the control group during this time. This is exactly what we found, with a significant improvement for the experimental group at Time 1 compared to Time 2, $F(1, 7) = 31.78$, $p = .012$, $f = 2.13$, but not for the control group, $F(1, 7) = 2.33$, $p > 1$, $f = 0.57$. The effectiveness of the intervention was replicated with a significant improvement for the control group between Time 2 and Time 3, $F(1, 7) = 68.5$, $p = .001$, $f = 3.13$. There was no significant improvement in performance by the experimental group during this time, $F(1, 7) = 0.53$, $p > 1$, $f = 0.28$.

Reading probe. Results of the ANOVA showed a significant main effect of reading accuracy for time, $F(2, 28) = 33.76$, $p < .001$, $f = 1.55$, and a significant Time × Group interaction, $F(2, 28) = 14.59$, $p < .001$, $f = 1.02$. However, there was no main effect for group, $F(1, 14) = 0.08$, $p = .79$, $f = 0.28$. To investigate whether there was a significant improvement in reading accuracy after all participants had received the intervention program, a paired comparison between Time 1 and Time 3 was conducted. This revealed a significant effect of time averaging across all participants, $F(1, 15) = 97.59$, $p < .001$, $f = 2.55$. This large-sized effect of time can be attributed to the large postintervention change in reading performance.

To investigate the Time × Group interaction, paired comparisons by group were conducted. If the intervention was effective, we would expect a significant improvement by participants in the

experimental group between Time 1 and Time 2, but no significant improvement by those in the control group during this time. This is exactly what we found, with a significant improvement for the experimental group at Time 1 compared to Time 2, $F(1, 7) = 66.3$, $p = .001$, $f = 3.08$, but not for the control group, $F(1, 7) = .67$, $p > 1$, $f = 0.31$. The effectiveness of the intervention was replicated with a significant improvement for the control group between Time 2 and Time 3, $F(1, 7) = 27.6$, $p = .018$, $f = 1.99$. There was no significant change in performance by the experimental group during this time, $F(1, 7) = .03$, $p > 1$, $f = 0.07$.

Generalization to New Words

The second research question asked whether reading and spelling accuracy generalized to words that were not taught during the intervention program. To address this question, a repeated-measures MANOVA was used to analyze differences between taught and untaught words at two different points in time: before any intervention had taken place (Time 1), and then again when all participants had received intervention (Time 3). The two within-subjects factors were items (taught, untaught) and time (Time 1, Time 3). Participants' raw scores on taught words (out of a possible total of 30) and untaught words (also out of a possible total of 30) before and after intervention served as dependent variables. Participants' scores on taught and untaught words before and after intervention are shown in Table 3.

Spelling probe. Results of the MANOVA showed a significant main effect for time, $F(1, 15) = 95.07$, $p < .001$, $\eta_p^2 = .86$. There was no significant main effect for items, $F(1, 15) = 1.60$, $p < .23$, $\eta_p^2 = .10$, and no significant Items × Time interaction, $F(1, 15) = 2.76$, $p = .12$, $\eta_p^2 = .16$. The lack of an interaction shows that there was no difference in the spelling accuracy of taught and untaught words over time. Thus, generalization to new words did take place as measured by spelling accuracy.

Reading probe. Results of the MANOVA showed a significant main effect for items, $F(1, 15) = 4.88$, $p = .04$, $\eta_p^2 = 0.25$; and time, $F(1, 15) = 97.59$, $p < .001$, $\eta_p^2 = 0.87$; and a significant Items × Time interaction, $F(1, 15) = 12.70$, $p = .003$, $\eta_p^2 = 0.46$. Univariate analyses of the interaction showed no significant difference between taught and untaught words before intervention, $F(1, 15) = 0.34$, $p = .57$, $f = 0.15$. However, there was a significant postintervention difference between taught words ($M = 27.4$, $SD = 2.4$) and untaught words ($M = 25.1$, $SD = 2.6$), $F(1, 15) = 11.31$, $p = .004$, $f = 0.87$. This difference between taught and untaught words after intervention (an average difference of 3.3 points) was the result of greater improvement on taught words than on untaught words. It should be noted, however, that there was a significant improvement on the untaught words when measured before and after intervention, $F(1, 15) = 34.84$, $p < .001$, $f = 1.52$, with an average improvement of 3.0 points. Thus, improved accuracy on the reading probe when measured after intervention was not entirely due to improved performance on the taught words. These results indicate that generalization to untaught words did take place, although not to the same degree as for taught words.

It is possible that the slightly better postintervention performance on the taught words than on the untaught words can be accounted for by the fact that only some of the untaught words (9/30) shared a rime with one of the taught words (e.g., the taught word *hoping* shares the same rime as the untaught word *sloping*). This could lead to better performance on untaught words that share a rime than on untaught words that do not. To investigate whether this was the case, we used a repeated-measures ANOVA to analyze the postintervention difference between rimed untaught words ($n = 9$) and unrimed untaught words ($n = 21$). Rime type (rimed, unrimed) served as the within-subjects factor. The proportion of correctly read words normalized by the arcsine transformation was used as the dependent variable. Results of the ANOVA revealed no effect of rime type on the accuracy with which untaught words were read, $F(1, 15) = 0.7$, $p = .59$. We can, therefore, conclude that although only some of the untaught words shared a rime with words that were explicitly taught during the intervention, this did not contribute to the slightly poorer accuracy on the untaught words than on the taught words.

Table 3. Means, standard deviations, and minimum and maximum scores for taught and untaught words by time.

	Time 1 (n = *16*)				*Time 3* (n = *16*)			
	Mean	SD	*Min*	*Max*	*Mean*	SD	*Min*	*Max*
Spelling probe								
Taught	5.8	3.8	1	13	19.3	7.2	3	28
Untaught	5.9	3.2	2	13	17.7	6.1	6	26
Reading probe								
Taught	22.5	2.6	17	26	27.4	2.4	22	30
Untaught	22.1	3.4	15	27	25.1	2.6	19	29

Effect of Integrated Morphological Awareness Intervention on Standardized Measures of Spelling and Reading

The third research question addressed the effectiveness of the intervention program as measured by performance on standardized measures of spelling (TWS–4) and reading (Word Identification and Word Attack subtests of the WRMT–R). The two groups' age-equivalent standard scores on these measures of reading and spelling are shown in Table 4. A repeated-measures ANOVA was used to analyze differences on these measures at three different points in time: before any intervention had taken place (Time 1), immediately after Group 1 had completed the intervention but before Group 2 had received the intervention (Time 2), and then again when all participants had received the intervention (Time 3). Time (Time 1, Time 2, Time 3) served as the within-subjects variable and group (experimental, control) served as the between-subjects variable. Participants' standard scores based on age served as the dependent variable.

Standardized measures of spelling. Results of the ANOVA showed a significant main effect of time, $F(2, 28) = 6.85$, $p = .004$, $f = 0.70$. There was no main effect for group, $F(1, 14) = .68$, $p = .42$, $f = .82$, and no Time × Group interaction, $F(2, 13) = 1.52$, $p = .24$, $f = 0.33$. To investigate whether there was a significant improvement on the TWS–4 subtest after all participants had received the intervention program, a paired comparison between Time 1 and Time 3 was conducted. This revealed a significant effect of time averaging across all participants, $F(1, 15) = 11.38$, $p = .004$, $f = .87$. This large-sized effect can be attributed to an improvement of 8.1 standard score points between pre- and postintervention testing.

Table 4. Means, standard deviations, and minimum and maximum scores for standardized spelling and reading assessments by group and time.

	*Experimental group (*n = *8)*				*Control group (*n = *8)*			
	Mean	SD	*Min*	*Max*	*Mean*	SD	*Min*	*Max*
TWS–4								
Time 1	77.9	3.5	77	84	77.8	3.9	72	85
Time 2	85.4	8.1	76	99	78.5	5.3	70	84
Time 3	86.1	8.7	72	96	85.8	13.1	65	108
WRMT–R: Word Attack								
Time 1	92.5	3.9	85	97	95.6	8.8	89	117
Time 2	96.5	4.8	88	104	95.4	8.4	88	115
Time 3	95.4	3.7	89	101	101.5	13.1	89	128
WRMT–R: Word Identification								
Time 1	94.9	6.8	81	104	99.5	9.7	91	122
Time 2	93.1	4.3	85	98	98.5	12.4	85	125
Time 3	93.3	7.1	79	101	97.5	9.4	88	117

Note. TWS–4 = Test of Written Spelling—Fourth Edition (Larsen, Hammill, & Moats, 1999); WRMT–R = Woodcock Reading Mastery Tests—Revised (Woodcock, 1987).

Pairwise comparisons by group showed that although the experimental group improved by 7.5 standard points between Time 1 and Time 2, this improvement was not significant, $F(1, 7) = 9.60$, $p = .26$, $f = 1.17$. However, the large effect size suggests that this difference may be of some importance. The control group made no significant improvement during this time, $F(1, 7) = .27$, $p > 1$, $f = 0.20$. Although the control group improved by 7.3 standard points between Time 2 and Time 3, this improvement was not significant $F(1, 7) = 2.69$, $p > 1$, $f = .62$. There was no significant improvement in performance by the experimental group during this time, $F(1, 7) = 0.53$, $p > 1$, $f = 0.28$.

Standardized measures of reading. Results of the ANOVA showed a significant main effect of time for the Word Attack subtest of the WRMT–R, $F(2, 28) = 5.46$, $p = .01$, $f = .62$, and a significant Time × Group interaction, $F(2, 28) = 3.76$, $p = .04$, $f = .52$. There was no main effect of group, $F(1, 14) = 0.56$, $p = .47$, $f = 0.22$. To investigate whether there was a significant improvement on the Word Attack subtest after all participants had received the intervention program, a paired comparison between Time 1 and Time 3 was conducted. This revealed a significant effect of time averaging across all participants, $F(1, 15) = 13.08$, $p = .01$, $f = .97$. This large-sized effect can be attributed to the change between preintervention and postintervention testing of 4.3 standard score points in nonword decoding.

To investigate the Time × Group interaction, paired comparisons by group were conducted. There was no significant improvement for the experimental group at Time 1 compared to Time 2, $F(1, 7) = 2.97$, $p > 1$, $f = 0.65$, although the large effect size suggests that this difference may be of some importance. There was no improvement for the control group during this time, $F(1, 7) = .08$, $p > 1$, $f = 0.31$. There was no significant improvement for the control group between Time 2 and Time 3, $F(1, 7) = 7.64$, $p = .42$, $f = 1.04$, although the large effect size suggests that this difference may be of some importance. There was no significant improvement in performance by the experimental group during this time, $F(1, 7) = .30$, $p > 1$, $f = 0.07$.

Results for the Word Identification subtest of the WRMT–R showed no significant main effect of time, $F(2, 28) = 2.61$, $p = .09$, $f = .41$, no main effect of group, $F(1, 14) = 1.19$, $p = .29$, $f = .28$, and no Time × Group interaction, $F(2, 28) = .39$, $p = .68$, $f = .17$. When collapsing over the two groups (experimental and control), there was a significant difference between Time 1 and Time 3, $F(1, 15) = 8.58$, $p = .04$, $f = .75$, although not in the direction expected. On average, participants decreased in performance on the identification of real words by 2.1 standard score points between pre- and postintervention testing.

DISCUSSION

The results of this study provide evidence for the usefulness of an intervention program that focuses on teaching participants to coordinate morphological awareness with other types of linguistic awareness as a means of improving their literacy skills. This study is one of the first to show that an integrated approach to literacy development facilitates reading and spelling in children with specific spelling difficulties. In the current study, participants in the experimental group showed better reading and spelling performance than the control group on both experimental and standardized measures of reading and spelling after receiving the intervention program. Furthermore, the improved spelling and reading performance of the experimental group was maintained when it was measured 6 months after intervention. In addition, the control group showed improved reading and spelling performance after receiving intervention.

The focus of the intervention program was on learning regular orthographic patterns rather than memorizing lists of words. Once these regular orthographic patterns had been assimilated, they could then be generalized to large classes of words. Improved accuracy in both reading and spelling was obtained for words that were taught during the intervention program as well as words that were not taught during the program, thus revealing that participants were able to generalize what they had learned to new words.

There was, however, no improvement on the standardized measure of word identification when compared before and after

intervention. This is perhaps not surprising given that this subtest included many irregular words that did not follow the linguistic patterns that were directly targeted in the intervention. Contrast this result with the improvement of 4.3 standard score points on the standardized measure of nonword decoding. This subtest included many of the orthographic and morphological patterns that were the focus of the intervention program. For example, the Word Attack subtest of the WRMT–R includes test items that contain the following orthographic patterns: magic *e,* as well as the postvocalic alternation of *-k* and *-ck, -ch* and *-tch,* and *-ge* and *-dge*. In addition, test items in this subtest contain the following suffixes: *-er, -est, -ing, -y, -ed,* and *-ful,* all of which were targeted in the intervention, except for the suffix *-ful*.

Improvement in accuracy over the course of the intervention as measured by the experimental probe was much greater for spelling than for reading, with an average improvement of 43% (range = 10%–79%) on the spelling probe compared with an average improvement of only 13% (range = 5%–23%) on the reading probe. This finding may be explained in part by ceiling effects on the reading probe after intervention where the average score was 87% correct (range = 72%–98%). However, an additional factor that may have contributed to greater improvement on the spelling probe is the content of the intervention program itself. It should be noted that when tested on the spelling probe after intervention, most of the participants were heard to be self-prompting, that is, audibly going through the set of spelling prompts that had been the focus of the intervention. When tested on the reading probe, on the other hand, there was no overt evidence that analysis of the morphological phonological, orthographic,, syntactic, and semantic structure of the word was taking place. It is possible that participants were using linguistically based strategies when responding to the spelling probe but were resorting to guessing strategies (at least some of the time) when deciphering the reading probe. However, this is pure speculation, and future studies would be useful to determine whether struggling readers and spellers are able to adopt linguistically based strategies for both reading and spelling. The reliability of participants' responses within a single session may be a useful way of determining whether guessing is a more likely strategy for reading than spelling.

Clinical Implications

It is hoped that the results of this study will guide instructional practice. In the United States, the most common form of spelling instruction is the rote memorization of weekly target lists that are based on the most frequently read or written words by grade level (Apel et al., 2004). In New Zealand, the spelling curriculum is not standardized, but memorization of weekly spelling lists is also common. These lists often have a thematic basis containing words related to a topic being studied within the classroom. However, it is rare for the linguistic properties of words to be taken into consideration when constructing these lists. When selecting words for spelling and word study curricula, it is critical that items be grouped so that regularities in morphological phonological, orthographic, syntactic, and semantic structure are obvious. Although good spellers and readers may be able to discover these regularities for themselves, those struggling with literacy appear to benefit from explicit instruction in linguistic analysis. Teachers and clinicians should consider the likely benefits of intervention that focuses on developing morphological awareness skills in tandem with other forms of linguistic analysis. This type of program is likely to have the greatest chance of success if speech-language pathologists collaborate with classroom teachers to mutually reinforce the linguistic basis of reading and spelling.

Limitations and Future Directions

Although the intervention program led to improved reading and spelling, it is not clear which aspects of the program best support improved literacy skills. The order in which the various orthographic patterns were introduced seemed to be important. For example, care was taken to ensure that the concepts of base word and suffix were understood before introducing multimorphemic words such as *icy* or *mating,* where the base word is orthographically opaque (i.e., the base word undergoes a spelling change when the suffix is added). Furthermore, the suffixes *-ing* and *-y,* which have only single allomorphs, were introduced before the *-ed* suffix, which has a more complex phonological structure, with three allomorphs, [t], [d], and [d].

In addition to considerations of phonological and orthographic transparency, the semantic transparency of the individual morphemes that constitute a morphologically complex word was a factor in selecting the intervention materials. The intervention targets that were presented early in the program were chosen so that opportunities for recognizing morphosyntactic and semantic relationships between morphemes embedded in words would be maximized. As the intervention progressed, the linguistic transparency of the target words was gradually reduced. In addition, the use of minimal pairs, and especially the use of minimal pairs where one word in the pair was a nonword (e.g., *scrappy* vs. *scrapy*), appeared to provide a useful way of ensuring that guessing was kept to a minimum. However, further research is needed to determine the exact worth of each of these variables by manipulating them independently.

Data collection for this study was limited to recording the accuracy with which words were read and spelled in list form. This ignores the more naturalistic context of reading and writing connected text. It is possible that when the focus is on the effective communication of ideas rather than reading and spelling individual words presented in isolation, participants' responses would include more errors than when tested in list form, at least until full mastery of relevant orthographic patterns had taken place. Speed of response provides a measure of task automaticity and has been used to assess improved spelling proficiency (Kwong & Varnhagen, 2005; Ormrod & Lounge, 1990). Although the current study did not measure response speed, these data would be useful for tracking improvements in reading and spelling that go beyond measures of accuracy. Furthermore, no data were collected on whether or not the intervention program improved the comprehension of morphologically complex words. Wysocki and Jenkins (1987) have shown that students use both semantic information from the base word and awareness of the grammatical role of the suffix to provide definitions of unfamiliar words. We might expect that the current intervention program would lead to improved comprehension as participants were encouraged to decompose a word into its component morphemes and undertake a syntactic and semantic analysis of these individual morphemes. It is clearly outside the scope of the current study to investigate these issues, and they remain important areas for future research.

This intervention was administered in two 45-min sessions each week. However, more frequent contact with participants may have resulted in stronger effect sizes. The participants in the study had

been struggling with spelling (and most of them were struggling readers as well) for several years and had developed a number of well-entrenched but ineffective strategies for reading and spelling. Four 30-min sessions each week may have been more effective in breaking down these old habits and encouraging new, more useful strategies. The effectiveness of the program may have been further enhanced by working with the classroom teachers of the children who were receiving the intervention program. By integrating the program with regular classroom instruction, participants would have the opportunity to reinforce their newly learned literacy skills in different contexts.

An additional limitation of the study is the small number of participants. There were only 8 children in the experimental group and a further 8 children in the control group. A replication of this study on a much larger scale would help to validate the findings presented here.

Conclusion

Understanding the linguistic strategies that influence how children learn to read and spell makes it possible to develop effective practices for literacy intervention. This study has made an important contribution by identifying a number of factors that support improved literacy skills in children with specific spelling difficulties. However, as discussed above, there is still much work to be done in refining the details of an intervention program that focuses on integrating awareness of multiple linguistic factors. By identifying exactly which aspects of the intervention program were responsible for improvements in reading and spelling, the effectiveness of the program will be maximized.

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APPENDIX. EXPERIMENTAL PROBE

Taught words	Untaught words
patch	retch
peach	reach
hug	jug
huge	judge
choke	trike
chock	trick
moping	robing
mopping	robbing
hoping	sloping
hopping	slopping
hazy	lazy
crabby	scrappy
flabby	floppy
icy	spicy
striped	filed
stripped	filled
pinned	canned
lengthen	strengthen
brighten	frighten
fatten	flatten
weaken	harden
sunnier	funnier
dirtiest	bossiest
saddest	biggest
whitish	stylish
biggish	thinnish
sweetish	warmish
shapely	thickly
happily	sloppily
tidily	crazily