Reciprocal Relationship: Children’s Morphological Awareness and Their Reading Accuracy Across Grades 2 to 3

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Across all the domains of child development, we need to understand the temporal relationship between variables suspected to underpin growth; reading research is no exception. We conducted a preliminary evaluation of the direction of the relationship between children’s morphological awareness, or the awareness of and ability to manipulate the smallest meaningful units in words, and their reading accuracy. Participants were 100 Grade 2 children who were tested again in Grade 3. We evaluated the children’s morphological awareness and reading accuracy, each with 2 measures, in both Grades 2 and 3. We evaluated the outcomes in a robust measurement model including controls for phonological awareness, vocabulary, and nonverbal ability. These analyses included autoregressor controls designed to provide insight into the temporal relationship between these 2 skills. We found that children’s early morphological awareness was associated with their growth in reading accuracy to the same extent that their early reading accuracy was associated with their growth in morphological awareness. Our results suggest a bidirectional relationship between children’s morphological awareness and their reading accuracy, a finding that informs current models of reading development.

Keywords: morphological awareness, word reading, child development

Reading is perhaps the single most important skill that children learn during their elementary school years (e.g., Lyon, 1997). It is related to social, economic, and health outcomes across the lifespan (e.g., Coulombe, Tremblay, & Marchand, 2004). It is vital, then, that we have a full understanding of the skills that children draw on in their reading acquisition; children’s awareness of morphemes in the oral language is one likely skill. The English orthography is morphophonemic (Chomsky & Halle, 1968; Venezky, 1970); the spellings of words are determined by both the sound and meaning units that make them up. The spelling of the word national, for example, preserves the unusual spelling of its root nation despite changes in sound. These patterns are ubiquitous; more than half of English words are made up of more than one morpheme (Anglin, 1993; Nagy & Anderson, 1984), and morphologically complex words are made up of more than half of the new words that children encounter in texts (Nagy, Osborn, Winsor, & O’Flahavan, 1993). These features of English likely underpin the recent evidence that children’s morphological awareness, the awareness of and the ability to manipulate morphemes in the oral language (Carlisle, 1988), is related to their reading performance, beyond substantial controls (e.g., Nagy, Berninger, & Abbott, 2006; Wold, Wood, & D’zatko, 2009). This relationship might be more than correlational at a single point in time; morphological awareness might, in fact, be associated with children’s progress in reading. Kuo and Anderson (2006) noted this possibility, stating that “the assumption underlying most studies is that morphological awareness is a contributing cause of reading development” (p. 175). Yet, as they also noted, it remains possible that “extensive exposure to print could lead to better morphological awareness” (p. 175). We evaluate here the temporal relationships between morphological awareness and reading accuracy for children learning to read in English as they move from Grade 2 to Grade 3.

Across all domains of development, we need to understand the temporal relationships between related variables (e.g., Ruffman, Slade, & Crowe, 2002); reading research is no exception. Correlational approaches are a valuable first step in identifying which skills are related. Critically, investigations need to take the next step of providing insight into the temporal order of such relationships. This was an important move in our understanding of phonological awareness, or the ability to manipulate the units of sound within words in the oral domain. There is now a substantial body of evidence that phonological awareness is causally related to children’s progress in learning to read (Adams, 1990; Bradley & Bryant, 1983; National Reading Panel, 2000) and that learning to read changes the perception of the sound units within words (e.g., Goswami & Bryant, 1990; Morais, Bertelson, Cary, & Alegra, 1986; Perfetti, Beck, Bell, & Hughes, 1987). Notably, this body of evidence combines both longitudinal and intervention studies. The bidirectional relationship between phonological awareness and

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reading encourages the investigation of the direction of the temporal relationship between morphological awareness and reading accuracy.

Providing insight into the direction of the relationship between morphological awareness and reading accuracy is important to the development of precise models of reading development. The dominant current view in theories of reading development is that children’s knowledge of grapheme-phoneme correspondences and their phonological awareness drives reading development. This is certainly the proposal of Ehri’s (2005) phase model. According to this model, children first acquire the ability to read words by forming connections based on their knowledge of the alphabetic system, which includes phonemic awareness and knowledge of grapheme-phoneme correspondences. In the consolidated alphabetic phase, around 8 years of age, children learn about letter patterns that are both morphemes and not (e.g., -ment and -ight, respectively). Although there is no explicit role for morphological awareness (which operates specifically in the oral domain) in this model of children’s reading development, this model could be interpreted to suggest that children become more aware of morphemes in the oral language through their reading of morphemes as parts of written words encountered in text. The prediction then would be that children’s early reading should be associated with increases in their morphological awareness over time. In his self-teaching hypothesis, Share (1999) put forward that children acquire orthographic representations of words through their decoding attempts. In this model, morphological awareness is viewed as an index of efficient reading. A likely prediction of this model is that morphological awareness would be correlated with reading but that young children’s morphological awareness would not be associated with their growth in reading skill. The emphasis in both of these models on the role of phonological awareness and its application in decoding words is entirely appropriate given the demonstrated centrality of phonological awareness in reading outcomes (see National Reading Panel, 2000). Notably, neither model puts forward that morphological awareness might be associated with reading development, though Ehri’s might be interpreted to suggest that earlier reading skill might be associated with growth in children’s morphological awareness.

Considering how morphemes are connected to print in English encourages us to evaluate the possibility that morphological awareness could determine, at least in part, children’s acquisition of the ability to read accurately. As we noted earlier, English spellings are determined by the units of sound and of meaning that make them up (Chomsky & Halle, 1968), and so awareness of both of these units in the oral language might make independent contributions to children’s progress in learning to read. Consider the words reading and react. The letters ea are pronounced together as one sound in the word reading because they are a part of the same morpheme (read). They are pronounced separately in react because they are each a part of a different morpheme in that word (re + act). An appreciation of the morphemic make-up of the words reading and react could clearly help children as they work out how to read these individual words. Awareness of individual morphemes might also help children to read words that they have never encountered before; as an example, children’s awareness of the morphemes dry and ness might help them to read the word dryness for the first time. Such effects might even emerge for the nonwords that make up nonword reading tasks, such as nonwords ending in -ing in Word Attack (Woodcock, 1998; see also Method). This is one potential way in which morphological awareness might support the development of reading accuracy.

There is an alternative, and not mutually exclusive, possibility that children might also learn about the morphological composition of words through their reading of them. Take, for example, the word breakfast. As children read the word, they will see the components break and fast within it. This might encourage children to think about the morphological origins of this compound word: to break the overnight fast. These origins are obscured in the pronunciation of this particular word, but they are clear in the written representation of the word. Children are likely to encounter many morphologically complex words in their reading; they make up at least 40% of all the new words that children encounter in texts (Nagy & Anderson, 1984; Nagy et al., 1993). Further, Chafe and Danielewicz (1987) suggested that children are even more likely to encounter morphologically complex words in written language than in oral language. The abundance of morphologically complex words in written texts increases the likelihood that children might become aware of morphemes through their reading.

The above examples support the plausibility of a bidirectional relationship between morphological awareness and reading accuracy. Children might rely on their awareness of the units of meaning in words in learning to read, just as their reading might support the development of morphological awareness. Providing a preliminary empirical evaluation of these possibilities would contribute to the conceptualization of the place of morphological awareness in models of children’s reading development.

There is strong evidence to date of a correlation between children’s morphological awareness and their reading achievement (Carlisle, 2000) that survives substantive control variables. We focus here and throughout this article on the evidence of this relationship for reading accuracy, both of real words and nonwords, rather than reading comprehension. Phonological awareness is perhaps the most important control in evaluating the relationship between morphological awareness and their reading accuracy. An early concern was that the association between children’s ability to manipulate the roots and affixes in words and reading accuracy might simply reflect the more general relationship between children’s ability to manipulate the sounds in words and their reading accuracy. While morphological and phonological awareness are clearly correlated (Carlisle & Nomanbhoy, 1993), the relationship between morphological awareness and reading accuracy remains even after controlling for phonological awareness (e.g., Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Kirby et al., 2012; Nagy et al., 2006; Wolter et al., 2009). It also remains after controlling for alternative variables, such as vocabulary (e.g., Fowler & Liberman, 1995; Mahony, Singson, & Mann, 2000), verbal short-term memory (Singson, Mahony, & Mann, 2000), intelligence (Brittain, 1970), and orthographic processing (e.g., Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009).

Correlational relationships, after substantive controls, have also been demonstrated between early morphological awareness and later reading accuracy; these findings take us one step closer to demonstrating temporal priority. Deacon and Kirby (2004) found that morphological awareness assessed at Grade 2 contributed significantly to word and nonword reading accuracy, as well as to reading comprehension at Grade 5, after controlling for phonological awareness and vocabulary and nonverbal intelligence. Simi-
larly, Carlisle (1995) showed that morphological awareness assessed at Grade 1 determined a significant proportion of the variance in reading comprehension and nonword reading in Grade 2, after controlling for phonological awareness. However, morphological awareness assessed at kindergarten was not related to reading comprehension or nonword reading at either Grade 1 or Grade 2. Nevertheless, the evidence that early morphological awareness, at least as measured from Grade 1, is related to aspects of children’s later reading encourages the consideration of the possibility that morphological awareness supports children’s progress in learning to read accurately.

Another way to approach the investigation into the direction of relationships between variables comes from the inclusion of an autoregressive control (Kenny, 1975). This analysis approach has been applied across many areas of developmental research (e.g., Ruffman et al., 2002). As an example, Perfetti et al. (1987) used this approach to investigate the bidirectional relationship between phonological awareness and reading. Perfetti et al. showed that phonological awareness assessed at the beginning of Grade 1 was related to reading skill later in Grade 1, even after controlling for reading ability at the beginning of Grade 1. Similarly, earlier phonological awareness was controlled in establishing the relationship between early reading ability and later phonological awareness. The inclusion of these controls sheds valuable light on the temporal relationships between variables: In this case, showing that earlier phonological awareness is associated with growth in reading skill, just as earlier reading skill is associated with growth in phonological awareness. Of course, any of these associations could be due to a spurious third variable, a possibility that cannot be dismissed hastily. Nevertheless, the inclusion of an autoregressor as a control helps to isolate effects of earlier abilities on children’s gains in skill from simple correlations, whether these are at a single point in time or across time.

In applying this approach to morphological awareness, Time 1 reading accuracy must be included as a prior step in order to establish that Time 1 morphological awareness is associated with progress in learning to read at Time 2. Similarly, Time 1 morphological awareness must be included as a control in order to demonstrate that Time 1 reading accuracy is associated with progress in morphological awareness at Time 2. We evaluate both of these directions in the study reported here.

We can gather a preliminary sense of these relationships from an earlier longitudinal study conducted with children learning to read in English. Although not designed to evaluate bidirectional relationships, Deacon and Kirby (2004) included some analyses that address one direction of this developmental relationship. They included an additional set of analyses evaluating the contribution of early morphological awareness (at Grade 2) to several aspects of reading at Grades 3 to 5, after the additional control of Grade 2 reading. These analyses were conducted separately for word reading, nonword reading, and reading comprehension. Grade 2 morphological awareness contributed significantly to both nonword reading and reading comprehension at Grades 3 to 5, after controlling phonological awareness, vocabulary and nonverbal intelligence and, critically, reading ability at Grade 2. However, the inclusion of the autoregressor reduced the contribution of Grade 2 morphological awareness to Grades 3 to 5 word reading to nonsignificance. This study was not designed to evaluate the relationships in the other direction; it did not include measures of morphological awareness in the upper grades. Further, the mixed picture across different measures of reading in this study suggests the need to evaluate these relationships with analyses that reduce the impact of measurement error, such as with the creation of latent factors (Kline, 2011).

The possibility that early reading accuracy is associated with improvement in morphological awareness has received little empirical attention in English (but see Wu et al., 2009, for work in Chinese; see also Discussion). Kuo and Anderson (2006) suggested that children might learn about morphological structures of words through their reading. As we outlined earlier, this possibility is pertinent given that there is an increasing number of morphologically complex words in children’s texts as they move through the elementary school years (e.g., Nagy et al., 1993). Certainly, reading morphologically complex words in texts could help children to learn about the morphological structure of these words and about morphemes more generally. Clearly, it would be useful to investigate the bidirectional relationships between morphological awareness and reading accuracy. This present study is designed to provide insight into the temporal relationships between morphological awareness and reading accuracy. We tracked a group of children from Grade 2 to Grade 3, a period during which reading acquisition is in full swing. It is also a time during which, according to Ehri’s (2005) theory, children begin to attend to letter-patterns, including morphemes, in print. We included multiple control measures, specifically phonological awareness, vocabulary, and nonverbal ability, to reduce the possibility that any uncovered relationships are due to a spurious third variable. Nonverbal ability is measured at a single point in time given its relative stability (Wechsler, 1999). On a theoretical level, these two control measures are important given that morphological awareness tasks are likely to involve the ability to parse words into their components sounds (phonological awareness) and the ability to hold in mind and to manipulate both linguistic and nonlinguistic information (vocabulary and nonverbal ability). Empirically, each of these has a known association with morphological awareness (e.g., Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004). The inclusion of two measures each for morphological awareness and reading accuracy increases construct validity. The creation of latent variables for reading accuracy and morphological awareness reduces the effect of measurement error (Kline, 2011). We included two measures of morphological awareness. The first was a sentence analogy task that involved past tense manipulations (Nunes, Bryant, & Bindman, 1997). It is noteworthy that children’s performance on sentence analogy tasks involving past tense manipulations at this age range is far below their ability to produce these forms orally. Performance on sentence analogy tasks with past tense manipulations at ages 6 to 10 years ranges from 21% to 63% correct (Deacon & Kirby, 2004; Nunes et al., 1997). In contrast, typically developing children in this age range show near ceiling performance in producing past tense forms in their spontaneous and elicited speech (e.g., Marshall & van der Lely, 2006; Nicoladis, Palmer, & Marentette, 2007). We argue that the key difference in levels of performance across these different task forms reflects the metalinguistic nature of the morphological awareness task. The sentence analogy task is designed to evaluate children’s morphological awareness, or their awareness of and ability to manipulate morphemes in oral language (Carlisle, 1988),
remained in the study and those who did not (tests revealed no significant differences between children who and they remained in the study through to Grade 3. A series of boys. In Grade 2, the children were an average age of 7 years 11
90%. We report here on the data collected when the children were participate; we tested all children with parental consent and child children in Grade 1 in the participating schools were invited to
schools in northeastern North America as part of a larger longitu-
gested that children might be “processing pseudowords, such as
subtests (Woodcock, 1998) that we use here contain a substantial proportion of real or plausible morphologically complex words. Several models of reading development (e.g., Ehri, 2005) raise the possibility that children are reading words with real references to
their morphological units. Further, Deacon and Kirby (2004) sug-
ggested that children might be “processing pseudowords, such as
gaked and mancingful (both items in Word Attack), with an eye to morphemic units” (p. 235). In support of this suggestion, several prior studies have demonstrated a relationship between morpho-
logical awareness and nonword reading (e.g., Carlisle, 1995; Mah-
ony et al., 2000).

Method

Participants and Procedure

Participants were 100 children recruited from seven rural schools in northeastern North America as part of a larger longitudi-
dinal study of reading development. The study began when the children were in Grade 1, with a total of 126 children recruited. All children in Grade 1 in the participating schools were invited to participate; we tested all children with parental consent and child assent. Average participation rate was 62%, ranging from 34% to 90%. We report here on the data collected when the children were in Grades 2 and 3.

We report results for 100 children, a group of 53 girls and 47 boys. In Grade 2, the children were an average age of 7 years 11 months (SD = 3.47 months), ranging in age from 7 years 4 months to 8 years 6 months at the time of testing. No children were overage for their grade. All children were Caucasian, in keeping with the rural location of the schools where there is limited immigration. These children all had English as a first language, and they remained in the study through to Grade 3. A series of t tests revealed no significant differences between children who remained in the study and those who did not (ps > .05) on any measures included in analyses here. Finally, only one participant was identified as a multivariate outlier and excluded from analyses on this basis; no participants were univariate outliers.

Parents of the participating children completed a background ques-
tionnaire, with 93 of these completed by the mother of the child and seven completed by the father. All parents answered the questions about the educational background of their child and reading habits in the home. According to parents’ responses, all children had completed kindergarten, which is compulsory in the region. Children came from families with an average of 2.28 children (SD = 0.84). Parents reported reading with their children an average of 5.47 (SD = 1.45) days a week, for an average of 29.30 min (SD = 10.94). Parents reported that there were an average of 152.46 children’s books (SD = 63.19) in the home. A total of 89 of the 100 participants completed the questions regarding education and occupation. The average socioeco-
nomic status (based on Hollingshead, 1957, and that includes both education and occupation) of the parents was 4.17 (SD = 1.77). This mean represents working class, with scores for individual families ranging from 1 to 7.

Procedure

In each year of the study, children completed a series of tasks conducted one-on-one by a trained researcher in a quiet room in their school. Total testing time per child was approximately 1.5 hr. Task administration for each child was broken up into shorter sessions that varied in length depending on the attention span of the child and class schedules. Task order was kept constant across all children, as is appropriate for analyses of relationships between measures. All control measures (vocabulary, phonological aware-
ness, and nonverbal ability) were measured at a single time point, and the two morphological awareness and two reading accuracy measures were assessed in both Grades 2 and 3. Reliabilities for each task are presented in Table 1.

Measures

Vocabulary. Receptive vocabulary was measured in Grade 2 with a modified version of the Peabody Picture Vocabulary Test–Third Edition (PPVT-III; Dunn & Dunn, 1997), referred to here as the M-PPVT. The M-PPVT was administered and scored in the same way as the full PPVT-III; for each item, a child heard a word, and the child was then asked to identify which of four pictures best corresponded to the definition of the word. In this modified version, every fourth item from the PPVT-III was administered (for a maximum of 51 items); this maintains the progression of item difficulty found in the full PPVT-III and ensures that it remains sensitive to developmental change but reduces testing time to limits appropriate for school-based testing. Testing was discontinued following six consecutive incorrect responses. Reliability re-
ported in Table 1 is good at .86.

Phonological awareness. Phonological awareness was eval-
uated in Grade 2 with an elision task based on Rosner and Simons (1971). For each item, the experimenter said a word, and the child was asked to repeat it. The child was then asked to say the word again without saying a particular syllable or phoneme (e.g., “say cup. Now say cup without the /k/”). Testing was discontinued

1 This same group of children completed the full PPVT-III (all items) at Grade 1. To evaluate developmental sensitivity of the subset of items in the M-PPVT, we calculated the children’s scores on the subset of items (administered within the full task) at Grade 1. Scores on the full PPVT-III at Grade 1 correlated to a similar degree with the scores on the shorter subset of items at Grade 1 and the scores on the shorter set administered at Grade 2 (.59 and .57, respectively).
when the child responded incorrectly to four consecutive items. The total score was the sum of all correct responses. The elision task contained 20 items.

**Nonverbal reasoning.** Nonverbal reasoning was assessed in Grade 3 with the Matrix Reasoning subtest of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). Following manual instructions, the measure was administered only once during the span of the study. The Matrix Reasoning subtest is made up of 35 incomplete patterns. Children are presented with an incomplete pattern and five possible answer choices to select from. The task was discontinued when the child selected four consecutive incorrect responses.

**Sentence analogy morphological awareness task.** This task followed the form A:B:C:D (based on Nunes et al., 1997). The sentence analogy task was administered to children with the assistance of two puppets. The first puppet would say one sentence and the second puppet would repeat the sentence with a change in the verb tense (e.g., Puppet A would say, "Tony hops on the ground," and Puppet B would then say, "Tony hopped on the ground"). The first puppet would then say another sentence, and the child was asked to make the same kind of change to this new sentence (e.g., Puppet A would say, "Tony skates on the ice," with the child asked to change the sentence as appropriate). The child was given full points on an item if they said the correct form of the verb (e.g., "skated"), regardless of the accuracy of the rest of the sentence. The sentence analogy task consisted of three example items followed by eight test items (listed in Table A1). The child’s score on the sentence analogy task was the total number of items answered correctly. The mean surface frequency at Grade 2 of the item to be produced by the child was 50.88 (according to Zeno, 1995), with mean base frequency of these items of 150.00.

Three tasks prior to the administration of the sentence analogy task (roughly 30 min), a vocabulary check was administered in which the experimenter read the first sentence of each sentence analogy pair orally, and the child was required to identify which of four pictures best corresponded with the sentence. This vocabulary check made certain that the child understood the sentences that they were later asked to manipulate using morphological transformations. We checked the child’s vocabulary knowledge for the first sentence in each pair. Children were over 97% accurate on this vocabulary check in both grades.

**Word analogy morphological awareness task.** The word analogy task also followed the A:B:C:D form. The same puppets used in the sentence analogy task presented an initial word pair (e.g., Puppet A, "ran" and Puppet B, "ran"). The first puppet then said a third word (e.g., "walk"). Children were asked to change this word in the same way that Puppet B had for the first word (e.g., run:ran::walk:?)). The child was given full points on an item if they accurately produced the target word (e.g., "walked"). The word analogy task included three example items followed by 21 test items (listed in Table A2). The mean surface frequency at Grade 2 of the target item was 21.48 (according to Zeno, 1995, who allocated texts to grades based on readability), with mean base frequency of these items of 93.57 (at the same grade). The word analogy items consisted of both inflectional and derivational items (indicated in the Appendix), as well as items with and without a phonological change (e.g., stand–stood and walk–walked, respectively). The score on this task was the total number of items answered correctly.

**Reading accuracy.** Real and nonword reading accuracy were assessed using subtests from the Woodcock Reading Mastery Test–Revised (Woodcock, 1998). Real word reading accuracy was assessed using the Word Identification subtest and nonword reading accuracy was assessed using the Word Attack subtest. The Word Identification subtest consists of 106 words presented in order of increasing difficulty. Children were presented with words on a page and asked to read them aloud. Testing was discontinued
when the child got six consecutive items incorrect, ending with the last item on the page. The Word Identification raw score was calculated by subtracting the number of items read incorrectly from the number of the last item administered. The Word Attack subtest consists of 45 nonwords that are administered and scored in the same fashion as the Word Identification items.

These two tasks contain similar proportions of morphologically complex or plausibly morphologically complex items. A total of 36 of the 104 Word Identification items are morphologically complex (34%). A total of 14 of the 45 Word Attack items contain plausible morphemes, with nonwords ending in suffixes such as -ing and -ful (31%).

**Results**

**Description of Performance on Individual Measures**

Descriptive statistics for age and all variables organized by grade are displayed in Table 1. All standardized assessment measures (Matrix Reasoning, Word ID, and Word Attack) are reported in Table 1 as both raw and standard scores. Standard scores are included for ease of interpretation. All analyses were conducted with raw scores (or transformed scores, as appropriate); note that, following standard practice, raw scores were mean centered prior to inclusion in the structural equation modeling. The standard scores reported in Table 1 indicate that the participants in the current study scored within the average range on nonverbal ability and both reading accuracy measures. All nonstandardized tasks are reported as the percentage of items answered correctly.

The data were examined for deviations from missing values and normality. A total of seven missing data points (i.e., individual task items) were found across all tasks across the two testing points. Given that the missing data accounted for less than 1% of the cases, multiple imputation procedures were performed to replace missing data using an expected maximization (EM) algorithm in LISREL 8.8 (Jöreskog & Sörbom, 2001). Violations in normality were found for two variables. Grade 3 real word reading accuracy and sentence analogy were negatively skewed and were corrected with reflected square root transformations. The remaining analyses were conducted with transformed scores for the two above-mentioned variables.

**Relationships Between Individual Measures**

Table 2 displays zero-order correlations among all variables, across all grades. All predictor variables (vocabulary, nonverbal ability, phonological awareness, and morphological awareness) were significantly positively correlated with all real word and nonword reading accuracy measures, both within and across all grades.

**Construction and Comparison of Structural Models**

We used structural equation modeling (SEM) to examine the direction of the longitudinal relationships between morphological awareness and reading accuracy across Grades 2 and 3. To do so, we created latent factors for morphological awareness and reading accuracy at each grade. One latent factor for each grade for morphological awareness was created with the two measures of morphological awareness (word and sentence analogy) at each grade. The latent factors for reading accuracy at each grade were created with the real word and nonword reading accuracy measures. We then used the latent factors to construct a set of structural models that tested the direction of the longitudinal relationships between morphological awareness and reading accuracy. The structural models controlled for age, vocabulary, nonverbal ability, and phonological awareness on the Grade 2 and Grade 3 latent factors. Autoregressors were included to control for the effects of prior reading accuracy (Grade 2) on later reading accuracy and to control for the effects of prior morphological awareness (Grade 2) on later morphological awareness (Grade 3; see Figure 1A). Cross-lagged paths from morphological awareness in Grade 2 to reading accuracy in Grade 3, and from reading accuracy in Grade 2 to morphological awareness in Grade 3 were then added as the specific test of temporal relationships between morphological awareness and reading accuracy (see Figure 1B). Models without (i.e., Models 1 and 2) and with (i.e., Model 3 and 4) the cross-lagged paths were compared to identify whether the addition of the cross-lagged paths significantly improved model fit and the prediction of individual differences in morphological awareness and reading accuracy in Grade 3.

Structural models were created and assessed with AMOS 20.0, and parameters were estimated using the maximum likelihood.

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<td>.67</td>
<td>.31</td>
<td>.52</td>
<td>.53</td>
<td>.90</td>
<td>.79</td>
<td>.44</td>
<td>.63</td>
<td>.64</td>
<td>.86</td>
</tr>
<tr>
<td>11. Grade 3 nonword reading</td>
<td>.65</td>
<td>.28</td>
<td>.58</td>
<td>.46</td>
<td>.83</td>
<td>.84</td>
<td>.44</td>
<td>.58</td>
<td>.53</td>
<td>.86</td>
</tr>
</tbody>
</table>

*Note.* PPVT = Peabody Picture Vocabulary Test; MA = morphological awareness.

*p < .05.  **p < .01.*
fitting function. All scores were mean centered before analysis to increase interpretability when comparing parameter values. Multiple fit indices were used to assess model fit, including the chi-square test, Akaike information criterion (AIC), Browne-Cudeck criterion (BCC), the root-mean-square error of approximation (RMSEA), and the comparative fit index (CFI). A \( \chi^2 \) to \( df \) ratio < 2 and a CFI > .95 suggest good fit. RMSEA values \( \leq .05 \) suggest good fit, <.08 reflect satisfactory fit, and \( \geq .10 \) suggest poor fit. Deviance statistics were calculated by taking the difference of the \( \chi^2 \), df, AIC and BCC values between models. If the deviance statistics are significant, the model with the lower values is the preferred model (Browne & Cudeck, 1993; Kenny, Kashy, & Cook, 2006). After identifying the preferred model, the paths within the preferred model are interpreted (Kline, 2011; Raifery, 1995).

Creating latent factors. Separate latent factors were created for morphological awareness and for reading accuracy, in each of Grades 2 and 3. Shown in Figure 2, factor loadings ranged from .67 to .79 for the morphological awareness measures and from .88 to .96 for the reading accuracy measures (all \( ps < .001 \)). Variance explained, also in Figure 2, ranged between .45 and .62 for the morphological awareness measures and .78 to .92 for the reading accuracy measures. The significant factor loadings suggested that the latent factors of morphological awareness and reading accuracy in Grades 2 and 3 were reliable and interpretable.

Comparison of structural models. Table 3 compared the model fit indices and deviance statistics of four models to evaluate constraints placed on error variances (Models 1 and 2) and whether cross-lagged paths between reading accuracy and morphological awareness are significant and improved model fit (Models 3 and 4).\(^2\)

Within Models 1 and 2, cross-lagged paths were not included in the models. Only relationships between control variables, latent factors, and autoregressors were added to the model (see Figure 1A). Typically, error variances should be free to vary across time points, and so our first model (Model 1) included error variances for the reading accuracy and morphological awareness measures that were heterogeneous. Fit indices for this model are reported in Table 3. Given that fit indices are good for this model, but not excellent, we evaluated whether constraining error variances to be equal across tasks might improve model fit (Kenny et al., 2006). Accordingly, in Model 2, error variances for the reading accuracy and morphological awareness tasks across grades were fixed to be equal. The top portion of Table 3 displays the model fit indices and deviance statistics for Models 1 and 2. Model 1, with heterogeneous error variances, fit significantly better than Model 2 on all indices of model fit, \( \Delta \chi^2(5) = 142.38, \Delta \text{AIC}(5) = 132.38, \Delta \text{BCC}(5) = 130.87, p < .001 \). Therefore, we retain Model 1 as the initially preferred structural model.\(^3\)

The next comparisons were conducted to determine whether the addition of cross-lagged paths, which are absent in Model 1, significantly improved the fit of the model. This was tested by contrasting Model 1 against two different models, both of which contained cross-lagged coefficients from reading accuracy in Grade 2 to morphological awareness in Grade 3 and from morphological awareness in Grade 2 to reading accuracy in Grade 3 (see Figure 1B). In Model 3, these cross-lagged coefficients were not fixed to be equal; this allowed the cross-lagged coefficients to vary so that one of these coefficients might be reduced to nonsignificance. Doing so allowed us to test whether the relationship between morphological awareness and reading accuracy might be unidirectional. In Model 4, these paths were fixed to be equal. Models 1, 3, and 4 had heterogeneous error variances. Contrasting Model 1 without cross-lagged paths against these two models with cross-lagged paths informs us as to whether the addition of cross-lagged paths improves model fit. There were no significant differences in fit indices between Models 1 and 3, \( \Delta \chi^2(2) = 5.21, \Delta \text{AIC}(2) = 1.15, \Delta \text{BCC}(2) = 0.59, p > .05 \). Fit was significantly better for Model 4 than for Model 1 on the chi-square test, \( \Delta \chi^2(1) = 5.10, p < .05 \), and this difference was marginally significant for the other tests, \( \Delta \text{AIC}(1) = 3.08, \Delta \text{BCC}(1) = 2.93, p < .10 \). A power calculation for a

---

\(^2\)The same set of models was constructed and compared using \( z \) score transformations to confirm results with models in which parameters have the same scale and distribution. Fit statistics between models with mean-centered raw scores and those with \( z \) scores were very similar and displayed the same patterns of significance when comparing models. In keeping with recommended practice (Kline, 2011) and to retain the observed variance captured with the measures, only models with mean-centered raw scores are reported and discussed.

\(^3\)Comparisons were also made between a series of models that systematically released the constraints placed on error variances. Of these, the model with heterogeneous error variances for all measures fit the data best. To be as concise as possible, we have not presented all comparisons where constraints were released.
small difference between model fit indices, based on the methods outlined by MacCallum, Browne, and Cai (2006), revealed good power (.91) for the comparison of Models 1 and 4. The trend uncovered for the AIC and BCC tests is likely due to the fact that these are more conservative tests than the chi-squared test (Kenny et al., 2006); as such, it is not uncommon to see slight divergences in results.

In summary, the model with cross-lagged paths constrained to have the same unstandardized coefficients (Model 4) appears to offer a small but significant improvement in model fit over a model without cross-lagged paths. This result suggests that the cross-lagged paths add unique prediction to explaining individual differences in reading accuracy and morphological awareness. Furthermore, it suggests that there are nonsignificant differences between these parameter estimates. Model 4 is in keeping with theory, and it produced the best fit characteristics; accordingly, it is chosen as the model that explained the data best.

Table 3
Fit Indices and Comparisons Between Them

<table>
<thead>
<tr>
<th>Model number</th>
<th>(\chi^2)</th>
<th>df</th>
<th>(p)</th>
<th>(\chi^2/df)</th>
<th>AIC</th>
<th>BCC</th>
<th>RMSEA</th>
<th>CFI</th>
<th>(\Delta\chi^2)</th>
<th>(\Delta\text{AIC})</th>
<th>(\Delta\text{BCC})</th>
<th>(\Delta\text{df})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>84.55</td>
<td>48</td>
<td>.001</td>
<td>1.76</td>
<td>168.55</td>
<td>181.24</td>
<td>.09</td>
<td>.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2</td>
<td>226.93</td>
<td>53</td>
<td>&lt;.001</td>
<td>4.28</td>
<td>300.93</td>
<td>312.11</td>
<td>.18</td>
<td>.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference between Models 1 and 2</td>
<td>142.38***</td>
<td>132.38***</td>
<td>130.87***</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 3</td>
<td>79.34</td>
<td>46</td>
<td>.002</td>
<td>1.73</td>
<td>167.34</td>
<td>180.65</td>
<td>.09</td>
<td>.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference between Models 1 and 3</td>
<td>5.21</td>
<td>1.15</td>
<td>.59</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 4</td>
<td>79.45</td>
<td>47</td>
<td>.002</td>
<td>1.69</td>
<td>165.47</td>
<td>178.47</td>
<td>.07</td>
<td>.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference between Models 1 and 4</td>
<td>5.10*</td>
<td>3.08†</td>
<td>2.93†</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* AIC = Akaike information criterion; BCC = Browne-Cudeck criterion; RMSEA = root-mean-square error of approximation; CFI = comparative fit index.

* p < .10. * p < .05. *** p < .001.
Power of the preferred model (Model 4), calculated according to MacCallum et al.’s (2006) methods, was .84 for the RMSEA fit statistic. This suggests good power of the preferred model, with .80 considered to be the minimum value for adequate power. Furthermore, the required sample size based on the fit statistics and number of degrees of freedom for this model was 95, which is less than the actual sample of 99 (MacCallum et al.).

Following a reviewer’s suggestion, we conducted a further analysis of Model 4. In Model 4, the unstandardized coefficients for the two cross-lagged paths are constrained to be the same but are on different scales. Using z scores instead of mean-centered raw scores confirmed the findings in a model in which the cross-lagged paths are compared on a common scale and a common standard deviation. The results of this model confirmed significant bidirectional relationships between morphological awareness and reading accuracy across Grades 2 and 3.

Interpretation of the preferred model. The preferred theoretical model (Model 4) provided good fit to the data, $\chi^2(47, N = 100) = 79.45, p = .002$, RMSEA = .07, CFI = .96. Figure 2 shows the estimates of the standardized path coefficients and factor loadings of the individual tasks on the latent constructs. All the path coefficients shown were significant.

Control variables were significantly correlated with Grade 2, but not Grade 3, reading accuracy and morphological awareness factors; therefore, only paths from control variables to Grade 2 latent factors remained in the model. Specifically, phonological awareness was the only significant predictor of reading accuracy in Grade 2 ($\beta = .73, p < .001$). Age, vocabulary, and nonverbal ability were not significantly related to reading accuracy, and these paths were deleted to create a more parsimonious model. For morphological awareness in Grade 2, vocabulary ($\beta = .40, p < .001$), nonverbal ability ($\beta = .23, p = .01$), and phonological awareness ($\beta = .51, p < .001$) were all significant predictors. Age was not significantly related to morphological awareness in Grade 2. This path was also deleted to create the most parsimonious model. Even though control variables were not directly related to Grade 3 latent factors, there were significant indirect effects of the control variables on Grade 3 factors, which were mediated through Grade 2 latent factors. The indirect relationships between phonological awareness in Grade 2 and reading accuracy in Grade 3 was $.71 (p = .014)$. For morphological awareness in Grade 3, phonological awareness ($\beta = .55, p = .004$), nonverbal ability ($\beta = .16, p = .015$), and vocabulary ($\beta = .28, p = .036$) were all significant indirect predictors. The influence of the control variables is accounted for in the Grade 3 latent factors.

After nonsignificant paths were removed and with autoregressors controlled, the model explained 73% and 53% of the variance of the Grade 2 morphological awareness and reading accuracy latent factors, respectively. In Grade 3, the model explained virtually all the variance for morphological awareness (82%) and reading accuracy (95%) latent factors, after nonsignificant paths were removed.

Error variance of these latent factors were significantly correlated in Grade 2 ($\beta = .53, p = .002$), but not in Grade 3. Error variance can comprise several dimensions, including residual skills not captured by the latent factor and measurement error. Accordingly, correlations between error variances are not easy to interpret because they could be due to commonalities on any of these dimensions. Given that the nature of the tasks differ across the morphological awareness and reading accuracy constructs, it seems unlikely that the correlation in error variance is due to similarity in measurement type. There are two more plausible explanations. The first is that error variances are correlated because there is some commonality in the residual skills not captured by the latent factors. More specifically, there is some relationship between reading accuracy and morphological awareness that is not captured by the latent factors. The second is that there is some commonality in the measurement error, perhaps because measurement occurred at the same point in time. We cannot disentangle these potential explanations with the present data set.

Turning to Grade 3, the nonsignificant relationship between error variances could also be due to multiple factors. The large amount of variance explained in Grade 3 latent factors leaves little variance left for relationships among error variances. It also might be accounted for by the existence of the cross-lagged relationships. Alternatively, the correlation in error variances at Grade 2 may effectively account for any possible correlation in error variance in Grade 3 that might exist otherwise.

As we noted earlier, the preferred model included autoregressors to control for prior reading accuracy (Grade 2) on later reading accuracy and to control prior morphological awareness (Grade 2) on later morphological awareness (Grade 3). Path analyses confirmed paths between Grades 2 and 3 for each of the variables used as autoregressors. The path from Grade 2 to Grade 3 morphological awareness was strong and significant ($\beta = .70, p < .001$), as was that for reading accuracy across grades ($\beta = .90, p < .001$). The final model confirmed the significant bidirectional relationship between morphological awareness and reading accuracy across Grades 2 and 3. Specifically, morphological awareness in Grade 2 was a significant predictor of reading accuracy in Grade 3 ($\beta = .11, p = .007$). In addition, reading accuracy in Grade 2 was a significant predictor of morphological awareness in Grade 3 ($\beta = .27, p = .007$).

Discussion

The goal of this study was to evaluate the temporal relationships between children’s morphological awareness and their reading accuracy across Grades 2 to 3. We found evidence of bidirectionality in the relationship between morphological awareness and reading accuracy. Morphological awareness at Grade 2 was associated with progress in learning to read accurately between Grades 2 and 3. Similarly, reading accuracy at Grade 2 was associated with growth in morphological awareness between Grades 2 and 3. These relationships emerged in a robust measurement model accounting for multiple control variables and reducing measurement error. The model offering best fit was one in which the standardized weights of the two paths were similar. The weights of these unique bidirectional paths are small (Cohen, 1988), though

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4 Fit characteristics for the Model 4 with z scores was $\chi^2(47) = 81.47, p = .001$, CFI = .96, RMSEA = .07. Similar to the model using raw scores, morphological awareness in Grade 2 was a unique predictor of word reading in Grade 3 ($\beta = .18, p = .011$). Also, word reading in Grade 2 was a significant predictor of morphological awareness in Grade 3 ($\beta = .18, p = .011$). Note that a model with z scores rather than raw scores does not produce unstandardized estimates, and it is not recommended to be reported (Kline, 2011).
these effects are of a reasonable size given the strength of the autoregressors and the number of control variables in the model. This study provides beginning evidence that, as suspected by Kuo and Anderson (2006), the relationship between morphological awareness and reading accuracy works in both directions.

These findings build on prior research. Specifically, they provide some insight into the possible direction(s) for the relationship between measures of morphological awareness and reading accuracy uncovered in prior cross-sectional and longitudinal studies (e.g., Carlisle, 1995; Deacon & Kirby, 2004; Wolter et al., 2009). Kuo and Anderson (2006) suggested that the assumption guiding this earlier work was that children’s morphological awareness supports their learning to read; our results bolster this supposition. Our results also provide preliminary evidence that children’s early reading accuracy might also support learning about morphological awareness. It seems that the relationship between morphological awareness and reading accuracy across children’s development might be bidirectional.

These results help to specify theories of reading development. Current models of reading development put forward phonological awareness and phonological decoding as the drivers of children’s reading acquisition. We support this suggestion, but we think that morphological awareness might also deserve consideration as a possible determinant of reading accuracy outcomes, at least between Grades 2 and 3. Ehri (2005) suggested that the connections that children form between oral and written language for individual words are supported by their awareness of units of sound in oral language; it seems that this connection-forming process might also be supported by children’s awareness of units of meaning in oral language. Certainly, morphological awareness does much more than index reading skill, contrary to Share’s (1999) prediction; morphological awareness is associated with the rate of children’s acquisition of reading accuracy, and morphological awareness also appears to be learned, in part, through their accuracy in reading. Morphological awareness appears to deserve a unique place in models of reading development.

These findings leave us speculating as to just how these relationships might work. We return to our prior suggestions; children learning to read in English, a morphophonemic writing system, would do well to be aware of morphemes in oral language as they work out why words are spelled the way that they are. This morphological awareness in the oral domain might help children to discover the role of morphemes in determining the way in which words are represented on the page. We think that, just as phonological awareness strengthens children’s skill in reading words that abide by letter–sound correspondences and those that do not, too might children’s morphological awareness support children’s reading of all sorts of complex words, including words that are morphologically complex and those that are not. On the other side of the equation, we think that children learn about morphemes by reading complex words, especially those with morphemes that are clearer in print than in oral language. We return to our example of the word breakfast; its morphemes are more easily seen than heard and so they might be “discovered” through exposure to written rather than oral language. In this direction, we speculate that it is through reading of morphologically complex words in particular that children build up their increased awareness of morphological forms.

Future research needs to examine empirically these speculations. One key dimension to test lies in whether the relationship between morphological awareness and reading holds across both morphologically complex and morphologically simple words (e.g., Casalis, Deacon, & Pacton, 2011). On the encouragement of a reviewer, we conducted such post hoc analyses. For each of the Word Identification and Word Attack subtests, we calculated a score for children’s accuracy in reading the morphologically complex items within the test and another for the morphologically simple items. Correlations between performance on the two morphological awareness tasks and reading of the morphological complex items on the Word ID and Word Attack tasks at each grade ranged from .39 to .64 (ps < .001), while those with reading of the morphologically simple items ranged from .43 to .60 (all significant at ps < .001). The range of these correlations is remarkably similar for the morphologically complex and morphologically simple items. Future studies might include tasks specifically designed to evaluate use of morphological skill in reading individual words (e.g., Carlisle & Stone, 2005; Mann & Singson, 2003). Such tasks might help to specify just how children’s reading improves their morphological awareness and vice versa.

Another important step for future research lies in evaluating these relationships with other age groups and other languages. We focused on Grades 2 to 3, based on children’s rapid learning about both morphological structures (e.g., Carlisle & Fleming, 2003) and reading (e.g., Ehri, 2005) in this age range. It would be important to evaluate the nature of these relationships at the outset of children’s reading acquisition, particularly given Carlisle’s (2000) evidence that these relationships might not occur in kindergarten. It would also be important to evaluate these relationships in Grades 3 and up, when children rapidly learn about derived forms (e.g., Anglin, 1993; Carlisle, 1988). Contrasting our findings with those in other languages would also be important. A recent study with Chinese children modeled the relationship between morphological awareness and reading at Grades 2 and 3 (Wu et al., 2009). Wu et al.’s study included a range of reading measures in their latent reading factor, such as reading comprehension and reading fluency. At Grade 2, the best fitting model was one in which morphological awareness had a unidirectional influence on word reading. Interestingly, by Grade 3, the best fitting model was one in which morphological awareness and reading shared a reciprocal relationship. Our results between Grades 2 and 3 with English-speaking children converge with these findings of bidirectional relationships at Grade 3 with Chinese-speaking children. The difference in findings at Grade 2 between the two studies points to the need to evaluate the direction of relationships at earlier points in time, as well as across writing systems.

Next steps for research also emerge from linking our findings here to the results of prior studies of children’s spelling. In a study of Hebrew-speaking children, Levin, Ravid, and Rapaport (1999) found that children with more advanced morphological awareness in kindergarten made more progress in learning to write vowels from kindergarten to first grade. In the other direction, children who were more advanced writers in kindergarten improved more in their performance on oral derivational morphology tasks between kindergarten and Grade 1. Turning to research with English-speaking children, Nunes and her colleagues (1997) demonstrated that children’s awareness of morphemes in early elementary school was associated with their progress in learning to spell past
tense verbs. Nunes et al. did not test the relationship from spelling to morphological awareness. These studies point to the need to investigate the potential bidirectional relationship between morphological awareness and spelling in English speaking children. These studies resonate with our suggestion above as to the need to examine these relationships specifically for children’s reading and spelling of the components of words that are morphologically determined.

There are several limitations to our work. The first set emerges from limitations within the measures included in our study. Our inclusion of a range of morphological forms with two measurement approaches increased construct validity, while our factor analyses reduced measurement error. We chose the analogy format on the basis of prior arguments that it taps children’s awareness of and ability to manipulate morphological forms, in other words, their morphological awareness (e.g., Nunes et al., 1997; Kemp, 2006). That said, one cannot eliminate other possible influences on children’s performance. As an example, the analogy format likely involves memory demands, the influence of which is reduced but not eliminated by controlling for nonverbal ability. Further, the relatively low reliability of the sentence analogy task in particular encourages further measure development. More extensive measures of morphological awareness, particularly across a greater range of morphological forms, could be included in future studies. A further limitation lies in the use of a shortened measure of vocabulary. This test is likely sensitive to developmental change in its retention of a subset of the original items given in rank order. The full PPVT-III administered to this sample at Grade 1 and the subset within the scores at Grade 1 correlate at a similar level with the subset of items administered at Grade 2. Nevertheless, a full administration of the vocabulary measure would have been ideal.

A second substantial limitation lies in the possibility, as in any study of associations between variables, that the relationships that we uncovered are due to a spurious third variable. As suggested by a reviewer, children’s language and literacy experiences in the home might cause both higher levels of morphological awareness at Grade 2 and growth in reading accuracy between Grades 2 and 3. There are other possible mediating variables too, such as vocabulary depth, that we might consider. The combination of longitudinal and intervention data would provide a higher level of confidence in the temporal associations uncovered here. As a case in point, the pairing of longitudinal and intervention evidence (Bradley & Bryant, 1983) brought the possible causal role of phonological awareness in learning to read into serious consideration. For morphological awareness, there is evidence that training in morphological awareness, particularly across a greater range of morphological forms, could be included in future studies. A further limitation lies in the use of a shortened measure of vocabulary. This test is likely sensitive to developmental change in its retention of a subset of the original items given in rank order. The full PPVT-III administered to this sample at Grade 1 and the subset within the scores at Grade 1 correlate at a similar level with the subset of items administered at Grade 2. Nevertheless, a full administration of the vocabulary measure would have been ideal.

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The possible educational implications of our findings are highlighted by recent meta-analyses of intervention studies (e.g., Bowers et al., 2010); these reviews motivate us to consider the potential value of explicitly teaching children about morphemes. One key next step lies in defining the best way to do so, an issue raised in several meta-analyses (e.g., Bowers et al., 2010; see also Apel, Masterson, & Niessen, 2004). Another step lies in determining the impact of the language and writing system on such relationships. The strength of these relationships might be even greater in Chinese (see e.g., McBride-Chang & Ho, 2005), a writing system in which morphology is more prominently represented. These possibilities deserve exploration.

Our results provide preliminary evidence that children’s early morphological awareness is associated with their progress in learning to read accurately, just as their early reading accuracy is associated with growth in their morphological awareness. These findings suggest that morphological awareness deserves a unique role in models of reading development. They also encourage us to consider the possible effects of children’s reading accuracy on their acquisition of linguistic awareness.

References

Carlisle, J. F., & Fleming, J. (2003). Lexical processing of morphologically...


## Appendix

### Items in the Morphological Awareness Tasks

#### Table A1

<table>
<thead>
<tr>
<th>Item number</th>
<th>Item From the Sentence Analogy Morphological Awareness Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jenny turns the television on. : Jenny turned the television on. :: Jenny plugs the kettle in. : Jenny <em>plugged</em> the kettle in.</td>
</tr>
<tr>
<td>2</td>
<td>The boy flew a kite. : The boy flies a kite. :: The boy chased a frisbee. : The boy <em>chases</em> a frisbee.</td>
</tr>
<tr>
<td>3</td>
<td>Mary stopped the ball. : Mary stops the ball. :: Mary slammed the door. : Mary <em>slams</em> the door.</td>
</tr>
<tr>
<td>4</td>
<td>Tom holds the puppy. : Tom held the puppy. :: Tom feeds the fish. : Tom <em>fed</em> the fish.</td>
</tr>
<tr>
<td>5</td>
<td>Catherine went very fast on her scooter. : Catherine goes very fast on her scooter. :: Catherine crept through the forest. : Catherine <em>creeps</em> through the forest.</td>
</tr>
<tr>
<td>6</td>
<td>Sally buys licorice. : Sally bought licorice. :: Sally sells chocolates. : Sally <em>sold</em> chocolates.</td>
</tr>
<tr>
<td>7</td>
<td>Andy walked to the store. : Andy walks to the store. :: Andy ran to school. : Andy <em>runs</em> to school.</td>
</tr>
<tr>
<td>8</td>
<td>Sara finds treasure. : Sara found treasure. :: Sara opens the gift. : Sara <em>opened</em> the gift.</td>
</tr>
</tbody>
</table>

*Note.* The correct answer (on which scores were based) is in italics.

(Appendix continues)
Table A2

Items From the Word Analogy Morphological Awareness Task

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
<th>M-type</th>
<th>Number</th>
<th>Item</th>
<th>M-type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>tall: tallest :: strong: strongest</td>
<td>I</td>
<td>12</td>
<td>doll: dolls :: mouse: mice</td>
<td>I</td>
</tr>
<tr>
<td>2</td>
<td>smell: smelly :: chill: chilly</td>
<td>D</td>
<td>13</td>
<td>scrape: scraped :: scratch: scratched</td>
<td>I</td>
</tr>
<tr>
<td>3</td>
<td>art: artist :: write: writer</td>
<td>D</td>
<td>14</td>
<td>mad: madness :: true: truth</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>luck: lucky :: curl: curly</td>
<td>D</td>
<td>15</td>
<td>swim: swimmer :: farm: farmer</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>cover: coverage :: store: storage</td>
<td>D</td>
<td>16</td>
<td>sad: sadly :: mild: mildly</td>
<td>D</td>
</tr>
<tr>
<td>6</td>
<td>chew: chewing :: bite: biting</td>
<td>I</td>
<td>17</td>
<td>creep: crept :: sing: sang</td>
<td>I</td>
</tr>
<tr>
<td>7</td>
<td>duck: ducks :: goose: geese</td>
<td>I</td>
<td>18</td>
<td>build: builder :: science: scientist</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td>intelligent: intelligence :: obedient: obedience</td>
<td>D</td>
<td>19</td>
<td>wreck: wreckage :: shrink: shrinkage</td>
<td>D</td>
</tr>
<tr>
<td>9</td>
<td>sweet: sweetness :: strong: strength</td>
<td>D</td>
<td>20</td>
<td>rude: rudely :: bold: boldly</td>
<td>D</td>
</tr>
<tr>
<td>10</td>
<td>serve: servant :: clean: cleaner</td>
<td>D</td>
<td>21</td>
<td>check: checking :: fly: flying</td>
<td>I</td>
</tr>
<tr>
<td>11</td>
<td>wide: width :: deep: depth</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. The correct answer (on which scores were based) is in italics. I indicates inflectional item, and D indicates derivational item. M-type = morphological type.