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Effects of Affix Type and Base Word Transparency on Students' Performance on Different Morphological Awareness Measures

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ABSTRACT

Purpose: We examined whether affix type and base word transparency explained variation in third- through sixth-grade students' performance on a number of morphological awareness tasks.
Method: Third- through sixth-grade students (n > 500 at each grade) completed morphological awareness tasks from the Morphological Awareness Test for Reading and Spelling, which represent the ways individuals may use their morphological awareness to support reading and spelling. Explanatory item response models were used to understand the role of affix type and base word transparency on students' performance on six morphological awareness tasks.
Results: For all grades, 73%–83% of variance in students' performance was due to differences across individual items. Furthermore, when task effects, affix type, and base word transparency were included simultaneously in the model, affix type was not a significant predictor; there was a significant effect of base word transparency and task. Specifically, the probability of a correct response was greater on task items in which inflected or derived words were transparent with their base word (e.g., *friend* > *friendly*) compared to items in which there was a shift in both the phonological and orthographic aspects of the base word (e.g., *attend* > *attention*).
Conclusions: These findings emphasize the importance of considering base word transparency when assessing students' morphological awareness skills with less emphasis on affix type, at least for third- through sixth-grade students. Our results also point to the importance of administering a variety of morphological awareness tasks to fully capture an individual's morphological awareness skills. Collectively, researchers and practitioners should ensure assessment items on multiple measures of morphological awareness vary in their base word transparency to potentially capture a range of student performances.

Morphemes are the smallest units of meaning in a language. They can be base words (i.e., free bases), such as *teach, bat,* and *like*; bound base elements (sometimes referred to as roots); and affixes (i.e., prefixes and suffixes) that attach to base words (e.g., *teacher, bats, dislike*). Broadly, morphological awareness, a metalinguistic skill, involves consciously thinking about and reflecting on these small linguistic units of meaning. Specifically, it includes the ability to consciously think about (a) morphemes in both spoken and written language; (b) what prefixes and suffixes mean and how they change the meaning and, at times, the grammatical class of base words when they are attached; (c) how written forms of base words may be modified when affixes are attached; and (d) how base words and their inflected or derived forms (e.g., *tire, tired, tirelessly*) are related by meaning (Apel, 2014). These four different aspects of morphological awareness depict the skill as a multidimensional ability (e.g., Apel et al., 2021; Goodwin et al., 2017). In this study, we examined simultaneously two factors that have been shown, independently, to impact

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students' performances on tasks assessing their morphological awareness abilities.

Morphological awareness contributes notably to literacy abilities. When researchers have examined the contributions that morphological awareness makes to word-level reading, reading comprehension, and spelling, they repeatedly have found that it contributes uniquely to those literacy skills, even when other supportive skills, such as phonemic awareness, vocabulary, and/or listening comprehension abilities, are considered (e.g., Apel et al., 2012; Deacon et al., 2009; Desrochers et al., 2018; Goodwin et al., 2017; James et al., 2021; Metsala et al., 2021; Roman et al., 2009). These important contributions of morphological awareness are not surprising; English written words containing more than one morpheme are prevalent in academic texts across the school years (e.g., Hiebert et al., 2017). Indeed, experts have suggested that among the most frequent words in written English, more than half (58%) are multimorphemic (or polymorphemic) words belonging to a relatively small number of morphological families (i.e., groups of word related by their shared base form; Hiebert et al., 2017). Given these facts, morphological awareness should be measured when investigating factors that influence reading and spelling abilities as well as targeted when teaching reading and spelling (e.g., Apel & Werfel, 2014; Carlisle, 2003).

Considering how to assess morphological awareness abilities is crucial for both research and educational objectives. Currently, there is minimal consistency for how this linguistic awareness skill is measured. Across myriad investigations, the number and types of tasks used have varied markedly. In some cases, investigators have used only one task to measure this multidimensional skill (e.g., Kirby et al., 2012). Without including multiple tasks representing the different dimensions of morphological awareness, a thorough understanding of individuals' morphological awareness skills may not be obtained (e.g., Apel et al., 2022; Tyler & Nagy, 1989). As importantly, factors that potentially affect performance on morphological awareness tasks have not always been considered or, at times, have been assessed incorrectly. Two factors reported to impact morphological awareness performance are affix type (inflectional or derivational affixed words) and the phonological and/or orthographic transparency between base words and their inflected and derived forms (i.e., base word transparency; e.g., Apel & Lawrence, 2011; Carlisle, 2000; Carlisle & Nomanbhoy, 1993; Goodwin et al., 2013; Levesque et al., 2017). In the case of base word transparency, either the phonological and orthographic forms of base words are completely present in their inflected and derived forms (e.g., *teach* > *teaches, teacher*) or a "shift" occurs, with the phonological and/or orthographic form of base words becoming less transparent (e.g., music/musician, envy/envious, admit/admission).

The purpose of this study, then, was to examine how these two potential sources of influence, affix type and base word transparency, together influence performance on six different morphological awareness tasks administered to third- through sixth-grade students. In doing so, we intended to better understand the factors that affect performance on tasks measuring the metalinguistic skill across a span of grades when morphological awareness is actively developing (Berninger et al., 2010). With an increase in this knowledge, educational practices may be better informed. Below, we review past investigations on these two potentially influential factors.

Affix Type

In the past, researchers interested in individuals' morphological awareness skills have administered tasks that solely targeted inflectional morphology (e.g., Berko, 1958; Desrochers et al., 2018). Most of these studies involved relatively young children. For example, in one of the first investigations assessing 4- through 7-year-old children's knowledge of inflectional morphology, Berko required students to modify a given pseudoword into its inflected form (e.g., "This is a wug...Now there are two [wugs]"). Berko's results demonstrated that preschool children have some morphological awareness and that this linguistic awareness skill improves across the early elementary school years. Since Berko's study, other investigators also have examined awareness of inflectional morphology in young, elementary-age students using a variety of different tasks, including sentence analogy, sentence completion, and pattern completion tasks (e.g., Apel & Lawrence, 2011; Desrochers et al., 2018; James et al., 2021; Spencer et al., 2015). Across these multiple studies, the researchers' findings have been similar to those of Berko's; children in kindergarten through second grade demonstrate an awareness of inflectional morphology.

Other investigators have administered a variety of tasks that have targeted derivational morphology solely (e.g., Carlisle, 2000; Goodwin et al., 2017; Levesque et al., 2017, 2018; Spencer et al., 2015). Many of these investigations involved students in third grade or higher. As an example, Carlisle administered her Test of Morphological Structure (TMS) to third- and fifth-grade students. On this task, the students were provided either a spoken base word and then asked to complete a sentence using its derived form (e.g., "Teach. Mr. Smith is a good _____") or a spoken derived form and asked to complete the sentence with its base word (e.g., "Friendly. I want to be her _____"). All of the students demonstrated awareness of derivational morphology. Carlisle's findings have been echoed by numerous investigative teams using a number of tasks, including measures based on Carlisle's TMS task, as well as morphological generation and multimorphemic word-reading tasks (e.g., Apel & Thomas-Tate, 2009; Desrochers et al., 2018; Levesque et al., 2017; Spencer et al., 2015).

Finally, some research teams have included both inflectional and derivational items within the same task (e.g., Apel & Lawrence, 2011; Carlisle & Nomanbhoy, 1993; Deacon, 2008; Desrochers et al., 2018; Levesque et al., 2017, 2018; Spencer et al., 2015). Not all of these investigators, though, reported on differences in accuracy for the two types of items and whether those differences were significant (e.g., Desrochers et al., 2018; Levesque et al., 2017, 2018; Spencer et al., 2015). In one investigation with first-grade students that reported means for inflectional and derivational items on the same task (Apel & Lawrence, 2011), inspection of the data showed that the mean performance on inflectional items of a spoken task similar to Carlisle's (2000) TMS task (e.g., "Help. Father tells me I am a good _____"; p. 183) was higher than that of derivational items, although performance on the derivational items was above chance level. This finding suggests that first-grade students demonstrate some awareness of derivational forms, although to a lesser degree than inflectional. The researchers, however, did not examine whether those differences were significant.

Two other studies specifically assessed whether accuracy for inflectional items on a task differed significantly from that for derivational items. Carlisle and Nomanbhoy (1993) examined first-grade students' ability to complete a spoken morphological awareness task similar to Carlisle's (2000) TMS task. Approximately one third of the task's items on the task were inflectional, whereas the other two thirds were derivational. The investigators' young participants were significantly more accurate in their responses when the answer was an inflected form of the base word than a derived form. Their findings, along with those of Apel and Lawrence (2011), may have occurred because of the relatively young age of their participants (i.e., under third grade). Deacon (2008) examined the ability of second- to fourth-grade students to spell inflected and derived words versus one-morpheme words. The children spelled either whole words or the first part of them (e.g., ____*ly* or ___*ze* for *freely* and *freeze*). The students were more accurate in spelling affixed words than one-morpheme words, and that effect was greater for inflected words than derived words. Furthermore, spelling accuracy for affixed words increased across the three grades.

Although the data are limited by type of task and grade, it appears that affix type may impact students' performance on measures of morphological awareness. To better understand the influence of affix type on performance, research focused on the morphological awareness skills of school-age children should include tasks that contain both inflectional and derivational items. Furthermore, the potential relation between affix type and performance should be examined across a range of morphological awareness tasks to determine whether the type of task is related to any possible effect of affix type. Thus, one of our goals for this investigation was to determine whether affix type affected performance on a series of morphological awareness tasks across third through sixth grade.

Base Word Transparency

Inflectional forms of base words frequently retain both the phonological and orthographic characteristics of their base words (e.g., *cats, pasted, flashes, running*), although they also may represent a change in the orthographic form of the base word (e.g., *happy/happiest, bunny/bunnies, octopus/octopi*). Derivational forms of base words vary in how much they retain the phonological and/or orthographic form of their bases. Some derived words retain the full phonological and orthographic form of their base word (e.g., *friend/friendly*), whereas others result in a change to the phonological (e.g., *add/addition*), orthographic (e.g., *silly/silliness*), or phonological and orthographic forms of their bases (e.g., *telephone/telephonic*). The degree to which a base word's phonological and/or orthographic form is maintained in its inflected and derived forms is often discussed in terms of transparency. When a base word's phonological and orthographic form is completely retained in its inflected and derived versions, that relationship is considered transparent. When a shift in the phonological and/or orthographic form of a base word has occurred in the construction of a semantically related inflected or derived word, then there is some degree of opacity between the base and its related, multimorphemic forms.

Not all studies of morphological awareness have considered the effect of base word transparency when investigating individuals' morphological awareness (e.g., Deacon, 2008; Kotzer et al., 2021); however, a number of investigations have purposely manipulated base word transparency when investigating individuals' morphological awareness, specifically for derivational morphology[1] (e.g., Apel & Thomas-Tate, 2009; Carlisle, 1988; Clin et al., 2009; Goodwin et al., 2013; James et al., 2021; Levesque et al., 2017; To et al., 2016). As an example, in the Goodwin et al. investigation, the researchers examined the effect of base word transparency on performance on morphological awareness tasks administered to seventh- and eighth-grade students. The research team administered several tasks, such as asking students to determine whether one written word came from another written word (e.g., *add/additive*, *alto/altogether*; p. 47). Task

[1]To our knowledge, there have been no investigations specifically focused on the effect of base word transparency on inflectional morphology within a morphological awareness task.

items varied in whether the relation between a base word and its derived form was transparent or represented a phonological or phonological and orthographic shift. Goodwin et al. found that task items with phonological opaqueness, with or without orthographic opaqueness, had a lower probability in being answered accurately than transparent items. However, Goodwin et al. did not control for the different task types when investigating the effects of transparency on performance. Given the tasks required different responses, it may be that the results were affected by the type of task. Similarly, To et al. (2016) studied the morphological awareness skills of adults with or without low literacy skills using an adaptation of the TMS (Carlisle, 2000). The task items varied in whether the base and derived word relationships were transparent or represented a phonological shift, an orthographical shift, or both a phonological and orthographical shift between the base word and its derived form. All task items were administered orally, and participants provided spoken responses. The research team reported that, for both groups of participants, response accuracies for transparent and orthographic shift items were similar. Both groups were less accurate on items containing a phonological shift. This latter finding was not surprising given the task was administered and responses were provided via spoken language so the items with orthographic shifts were not presented in written form.

Both Goodwin et al. (2013) and To et al. (2016) included task items that aligned with the traditional definitions of transparency and phonological and orthographic shifts. However, in several other studies of the influence of base word transparency on accuracy on morphological awareness tasks, the items reported to depict specific types of transparency relationships did not always represent those associations between the base words and their derived forms. For example, in Carlisle (1988) and Carlisle and Stone (2005), task items reported to represent an orthographic change to a base word were, instead, transparent relations (e.g., *sun* > *sunny*, *begin* > *beginner*). In these two examples, although the letter representing the final consonant of the base word is doubled, the orthographic forms of the base words (i.e., sun and begin) are contained in the items labeled as orthographic changes. In other investigations (e.g., Mahony et al., 2000), items considered to be transparent or "neutral" represented orthographic only or orthographic and phonological changes (e.g., *beauty* > *beautiful*, *pity* > *pitiful*). Finally, other research teams have examined the effect of base word transparency on task performance, contrasting transparency with "shift" relations (sometimes referred to as neutral and nonneutral), yet did not specify the type of shifts that occurred (i.e., whether the shift was phonological, orthographic, or both; e.g., Apel & Lawrence, 2011; Apel & Thomas-Tate, 2009; Tyler & Nagy, 1989). Additional research is needed, then, that includes task items that accurately depict the varying types of base word transparency to examine their influence on performance on morphological awareness measures. Thus, an additional goal for this investigation was to determine whether base word transparency type affected performance on the same set of morphological awareness tasks administered to third- through sixth-grade students.

To our knowledge, no investigative team to date has simultaneously assessed whether the two potentially influential factors, affix type and base word transparency, differentially impact the probability of correct responses on tasks assessing morphological awareness. In the previously mentioned study by Carlisle and Nomanbhoy (1993), the researchers included items in their task that were either inflected forms, transparent derivational forms, or phonological shift derivational forms. They did not, however, report any significant differences between the two types of derivational items, and they did not investigate whether inflected forms that varied in phonological transparency resulted in significantly different results. Without simultaneously investigating both factors, affix type and base word transparency, a clear understanding of whether one or both factors influence morphological awareness is unknown. It may be that both affix type and base word transparency independently impact task performance. It also is possible that only one of those two factors is related to task results when examined concurrently with the other factor. For example, it may be that past findings that performance on inflectional items was greater than that for derivational items (e.g., Apel & Lawrence, 2011; Carlisle & Nomanbhoy, 1993) were due to the increased possibility of types of transparency shifts (e.g., phonological shifts, both orthographic and phonological shifts) with derivational items. With either possible finding on the simultaneous contributions of affix type and base word transparency to students' performance on measures of morphological awareness, the development of assessment tools will be better informed.

Taken as a whole, both affix type and base word transparency may affect students' morphological awareness performance. An understanding of how these factors relate to morphological awareness performance when considered in the same context is crucial for the further study of morphological awareness and the implementation of educational practices. Thus, the purpose of this study was to examine simultaneously how affix type and base word transparency predicted the accuracy of responses on a series of different tasks that aligned with a multidimensional definition of morphological awareness (Apel, 2014). We examined the potential contributions of these factors on morphological awareness task performance with students in the third through sixth grade. As a first step for our analyses, we examined whether the majority of the variance in item accuracy was due to between-item differences compared to between-person differences. In addition, given that different morphological awareness tasks vary in the skills being assessed and their demands/requirements, we controlled for the effects of the different task types when measuring the effects of affix type and base word transparency. We then examined the roles of affix type and base word transparency on students' accurate answers when considered alone and simultaneously. Based on previous investigations (Carlisle & Nomanbhoy, 1993; Goodwin et al., 2013; To et al., 2016; Tyler & Nagy, 1989), we hypothesized that both affix type and base word transparency would explain variance in students' responses when considered at the same time. Specifically, we thought that inflectional items would have a higher probability for correct responses compared to derivational items and that transparent items would be more likely to yield accurate responses than items involving a shift from the base word. We also hypothesized that the variance explained by base word transparency and affix type might be more notable for the younger compared to older students in our participant sample, given younger students by definition have had less experience in thinking about more complex multimorphemic words.

Method

Participants

This study was part of a larger, 3-year project focused on developing a valid and reliable morphological awareness assessment tool: Morphological Awareness Test for Reading and Spelling (MATRS; Apel et al., 2021). Our data are from Year 1 of the project. For this study, we included students in third through sixth grade (Grade 3: N = 756, Grade 4: N = 644, Grade 5: N = 626, Grade 6: N = 501). First- and second-grade students were not included for this investigation because they were not administered all of the MATRS tasks examined (Apel et al., 2021). The recruited students attended a variety of schools, including public and private schools, within the southeastern area of the United States. Based on school-reported percentages of students receiving free and reduced lunches, the schools represented low-, middle-, and high-income neighborhoods. Consent forms, approved by the local institutional review board, were distributed within the target schools; teachers then sent them home for parental consent. Participating students were required to have a returned, signed parental/guardian consent form. Across the four grades, the sample demographics were 53.97% female; race/ethnicity was 43.81% White, 37.70% Black, 9% multiracial, 5.24% Latinx, 1.50% Asian, < 1% Native American, and 1.75% no response. Nearly all parents (greater than 90%) reported at least a high school degree or General Educational Development (GED) and that they spoke English in the home (greater than 90%). A small number of parents reported speaking Spanish (5%) or another primary language (1%). The majority of the students had not received, and were not receiving, any special educational services from school personnel (69%). The remaining students were reported to have received or were currently receiving speech services (7%), reading/writing services (5%), multiple special services (12%), or other services (7%).

Students were excluded from participating in the study if they did not spend most of their instructional time in a general education classroom. Across the four grades, similar numbers of male and female students participated. Furthermore, the participants represented a range of races and ethnicity. Table 1 provides the demographic characteristics of the participating students per grade.

MATRS

The MATRS (Apel et al., 2021) is a comprehensive, reliable, and valid measure of morphological awareness that contains eight different tasks (Apel et al., 2021). The eight tasks, which assess students' spoken and written morphological awareness abilities, are aligned with Apel's (2014) multidimensional view of the metalinguistic skill. Specifically, the measure was designed to capture the multiple ways individuals use their morphological awareness for reading and spelling: the awareness of spoken and written morphemes, the meaning of affixes and how they can change base word meaning and grammatical class, the modifications to written base words that can occur when suffixes are added, and the meaning relations between base words and their inflected and derived forms (Apel, 2014). For this investigation, data from six tasks from the MATRS test were used. Task 2 of the MATRS, Affix Identification, was not included in the current study because reliability was poor in Year 1 and did not demonstrate adequate psychometric properties (Apel et al., 2021). Task 3, Affix Meaning, was excluded because the task stimuli contained pseudowords. Because we were interested in linguistic shifts in real base words when suffixes are added, this particular task was not relevant to our research question.

At each of the four grade levels, each MATRS task had the same number of items and similar item characteristics. For example, all task items had similar word frequency levels (Zeno et al., 1995) and no low-frequency words were included (no standard frequency indexes below 30; e.g., Carlisle & Katz, 2006). For each task, the number of items representing inflectional or derivational morphology (affix type) was the same across the four grades. Items representing derivational morphology included both prefixes and suffixes. Inflectional morpheme items contained

Table 1. Demographic characteristics by grade level.

Demographic	Category	Grade 3	Grade 4	Grade 5	Grade 6
Sex	Female	59	50	56	54
	Male	41	50	44	46
Race/ethnicity	White	48	42	45	46
	Black	35	34	30	36
	Multiracial	8	11	10	7
	Latinx	5	10	8	7
	Asian	2	< 1	3	< 1
	Native American	0	0	0	1
	Other	0	0	0	0
	N/A	2	2	4	1
Parent education	HS/GED+	93	94	90	90
Home language	English	95	91	93	93
	Spanish	4	7	6	6
	Other	1	2	1	1
Services	None	66	69	67	74
	Speech	8	7	6	6
	Reading/writing	7	9	6	3
	Multiple	11	10	14	9
	Other	8	5	7	8

Note. All values are proportions. N/A indicates race/ethnicity information was not reported. HS = high school; GED = General Educational Development.

only suffixes. For all tasks that required a written response (i.e., Suffix Choice, Spelling Multimorphemic Words, Suffix Spelling, Written Relatives), there were five items each for the following word types: inflectional, derivational–transparent, derivational–phonological, derivational–orthographic, and derivational–both phonological and orthographic shift. For the tasks that required a manual (Segmenting) or spoken (Spoken Relatives) response, there were five items each for inflectional, derivational–transparent, and derivational–phonological shift. Transparent items maintained the phonological and orthographic forms of the base word in the target item (e.g., *love*/*lovely*). Phonological shift items maintained the orthographic form of the base word in the target item, but a change in the pronunciation of the base word occurred (e.g., electric/electrician). Orthographic shift items maintained the pronunciation of the base word in the target item, but the spelling of the base word was modified (e.g., happy/happiness). Finally, phonological and orthographic shift items, hereafter referred to as "opaque" items, were those for which both the pronunciation and spelling of the base word were modified in the target item (e.g., *glory*/*glorify*). Because of the characteristics of the tasks themselves, not all tasks included all types of base word transparency. Tasks 4, 5, 6, and 8 contained all four types of base word transparencies. Tasks 1 and 7 only contained transparent and phonological shift items because the tasks required spoken responses. For further information on the task items, including affix and base word transparency types, see Table 2.

For all grades, the base words that were represented either directly or as their inflected or derived forms were at grade level (e.g., Learning By Design Inc., 2010; Zeno et al., 1995). Bound base morphemes (sometimes referred to as "root words") were not used as part of the stimuli given there is no resource that provides grade-level information for these morphemic elements, as they do not "stand alone." See Apel et al. (2021) for specific information about the composition of the test and its reliability and validity. The following is a description of each task. Numbers assigned to the six tasks used in this study align with the task numbers contained in MATRS (Apel et al., 2021). As noted above, Tasks 2 and 3 were not included in this study.

Task 1: Segmenting

Based on similar tasks by Apel et al. (2013) and Casalis et al. (2004), the students were required to tap out with a wooden block the number of "meaningful parts" or morphemes of spoken, multimorphemic words. A correct answer was a response that tapped out the same number of morphemes contained in the task item (e.g., two taps for *waiting*). Because this task was administered only in spoken form and required only spoken responses, transparency types considered on this task were either no shift (transparent) or phonological shift. This task assessed students' awareness of spoken morphemes. There were 15 items on the task. Marginal reliability from item response theory analyses ranged from .67 to .77 across the four grades.

Task 4: Suffix Choice

For the Suffix Choice task, which was based on the work of Nagy et al. (2006), the students read sentences that were missing words and were required to choose affixed words that best fit those sentences, given choices of four potential options (e.g., "Yesterday, I _____ French

Table 2. Sample items from each of the administered Morphological Awareness Test for Reading and Spelling tasks including administration and response modalities, aspect of morphological awareness assessed, and the type of linguistic shift for affixed words.

Task number: name	Administration/student response modality	Definition component	Shift characteristic	Sample items
1: Segmenting	Spoken/manual	Awareness of spoken morphemes	I	Ask-ed
			D_t	Un-interest-ed
			D_{phon}	Collect-ion
4: Suffix choice	Written/written	Awareness of the meaning of affixes and how they can change base word meaning and grammatical class	I	Yesterday, I ____ French fries with my hamburger. [ordered, orderly, orders, ordering]
			D_t	The kind old man was known for being overly _______. [thought, thoughts, thoughtful, thoughtless]
			D_{phon}	The woman was asked to make a ___from among the various jewelry items. [selects, selective, selecting, selection]
			D_{orth}	The house was great, except outside, it was too ____ [noisy, noise, noises, noiseless]
			D_b	It is my great ____ to inform you that you won the lottery! [pleasure, pleasing, pleased, pleasant]
5: Spelling multimorphemic words	Spoken/written	Awareness of the modifications to written base words that can occur when suffixes are added	I	Clean*est*
			D_t	Plain*ly*
			D_{phon}	Process*ion*
			D_{orth}	Sens*itive*
			D_b	Hibernat*ion*
6: Suffix spelling	Spoken and written/written	Awareness of the modifications to written base words that can occur when suffixes are added	I	Their favorite sport was bowl__ [–ling, –ing, –eng]
			D_t	The envelope was missing the name of the address__ [–or, –ar, –ir]
			D_{phon}	When the storm hit, we had no electric___ [–ity, –uty, –itie]
			D_{orth}	His interesting story was believ___ [–uble, –ible, –able]
			D_b	With the rolling hills and the large castle, the grounds were incredibly pala__ [–shul, –tiul, –tial]
7: Spoken relatives	Spoken/spoken	Awareness of the meaning relations between base words and their inflected and derived forms	I	Chairs: The dining set was missing a broken ________. (chair)
			D_t	Attack: The victim was asked to point to the _______. (attacker)
			D_{phon}	Fact: The crowd had a difficult time believing the speaker's information was ______. (factual)
8: Written relatives	Written/written		I	Insects: I was stung by an ___. (insect)
			D_t	Possible: Because I had so much to do, getting the job completed by dinner seemed nearly _____. (impossible)
			D_{phon}	Express: The clown had the oddest ____ on his face. (expression)
			D_{orth}	Drivable: I had to ____ my car to the market. (drive)
			D_b	Energetic: After running the race, I had no _____ to do anything else. (energy)

Note. For the "Shift Characteristics" column: I = inflectional; D_t = derivational–transparent; D_{phon} = derivational–phonological shift; D_{orth} = derivational–orthographic shift; D_b = derivational–both phonological and orthographic shift. All sample items are from the third-grade tasks.

fries with my hamburger" [ordered, *orderly, orders, ordering*]). Like Task 2, this task also assessed students' awareness of affixes and how meaning and grammatical class of base words can change when affixes are added. There were 25 items on the task. Marginal reliability from item response theory analyses ranged from .89 to .94 across the four grades.

Task 5: Spelling Multimorphemic Words

For Task 5, the students spelled words containing two or more morphemes (Apel et al., 2013). The examiner stated the target word, used it in a sentence, and then stated the word again. Responses were scored as accurate when the whole word was spelled correctly. There were 25 items on this task that assessed students' awareness of the modifications to base words when certain suffixes are attached. Marginal reliability from item response theory analyses ranged from .92 to .95 across the four grades.

Task 6: Suffix Spelling

Slightly modified from Sangster and Deacon (2011), while the examiner read them aloud, the students silently read sentences containing base words without their suffixes (e.g., *bowl*) or base words without the junctures that occur between base words and their suffix (e.g., "believ"). The students then chose the correctly spelled suffix or suffix with the juncture change (e.g., "The warm winds seemed to be more coast___[*–il, –al, –ol*]"; "I think my cat is much heav___[*–ier, –yer, –ior*]"). In the latter example, the correct answer included the juncture modification that occurs with a base word when a suffix is added (e.g., "His interesting story was believ___[*−uble, −ier, −ier*]"). In these test items, that juncture item changed the spelling of the original base word, requiring active knowledge of orthographic changes to the base word due to the suffix addition. There were 25 items on the task. Marginal reliability from item response theory analyses ranged from .85 to .90 across the four grades.

Task 7: Spoken Relatives

The Spoken Relatives task was a modification of Carlisle's (2000) TMS task that had been used in previous investigations (e.g., Apel et al., 2013). The task, which contained 15 items, measured students' awareness of the semantic relations between base words and their inflected and derived forms. For seven of the items, students heard a base word and then a sentence missing an inflected or derived form of that base word. They then were required to provide the correct affixed form (e.g., "Collect. The man was known for his very odd ____[*collection*]"). For the other eight items, the students heard either an inflected or derived word and then were required to provide the base form of that affixed word to fill in a sentence (e.g., "Dramatic. The movie was not a comedy, but a ___[*drama*]"). Marginal reliability from item response theory analyses ranged from .82 to .88 across the four grades.

Task 8: Written Relatives

This task was similar to the Spoken Relatives task, except the stimuli were read by the students versus heard and the base and derived word targets were different. In addition, there were 25 items on the task; 12 involved providing an affixed word based on a presented base word, and 13 involved providing a base word when provided the inflected or derived form of that word. Responses were scored as accurate when the whole word was spelled correctly. The task assessed students' awareness of the semantic relations between written base words and their written inflected and derived forms. Marginal reliability from item response theory analyses ranged from .93 to .95 across the four grades.

Procedure

All tasks were administered by research assistants who had received training specific to task administration. Research assistants received specific feedback on their administrations until they achieved 100% accuracy. These research assistants conducted testing during school hours approved by the students' classroom teachers. All testing was conducted in the students' home school in a location free of noise and distraction (e.g., library, conference room). Students were assessed from mid-fall through mid-spring. Administration of tasks was counterbalanced across students. For this study, Tasks 1 and 7 were administered individually to each student; each of those tasks required 10–15 min to complete. The remaining four tasks were administered with groups of children. The total time to administer these four tasks was approximately 60 min. Sometimes, group tasks were administered across two sessions, with no more than 1 week between sessions.

All tasks, except for Task 5, included two to four modeled examples before actual task items were administered. For Task 5, the students were given the standard instructions for a traditional spelling task; they heard a word, heard that word in a sentence, heard the word again, and then were required to write the word. Tasks 1 and 6 were conducted one-on-one with students. The remaining tasks were administered in small groups of same-grade peers. All task items were scored as correct or incorrect. Reliability in scoring and entering data was conducted on 15% of all students' responses. Average interscorer agreement and fidelity of data entry were 98.5% and 99.1%, respectively.

Data Analysis

Explanatory item response models (EIRMs; De Boeck & Wilson, 2004) were used at each grade level to understand the role of affix type and transparency on item-level accuracy. EIRMs blend principles of multilevel modeling and psychometric modeling to estimate person-level and item-level coefficients under various sets of fixed or random effect specifications. We used a Rasch double-explanatory EIRM that included random effects for item accuracy to vary along levels of both person and item. Our primary hypotheses were oriented toward the role of understanding item attributes; thus, one argument could be made to use a linear logistic test model (i.e., random effect for items and fixed effect for persons). We opted to use the double-explanatory model to provide a variance composition index (VDI; Petscher et al., 2020) so that the variance due to persons and items could be described and used to appropriately contextualize the role of item predictors.

Five total EIRMs were estimated at each grade level: (a) an unconditional model to obtain log-odds fixed effects and variance components for item- and person-level effects; (b) a model that included $k - 1$ dummy-coded covariates representing task-level effects; (c) a model that included task effects and affix type; (d) a model that included task effects and transparency type; and (e) a model that included task effects, affix type, and transparency type. Each of the covariate-inclusive models was compared to the unconditional model via pseudo-R^2 statistics to understand the respective proportion of variance explained based on the included covariates. For our analyses, Task 1 was chosen as the referent for task, derivational items were chosen as the referent for affix type, and opaque items were chosen as the referent for base word transparency.

It is important to note that the intercept in an EIRM can be simultaneously interpreted to understand person-level ability and item-level difficulty (i.e., the difficulty of an item is the negative of the intercept value). The focus of our research questions primarily lies with understanding person-level ability considering item characteristics. Our interpretations in the models, therefore, focus on person-level log odds of success and not the item-level difficulty. All analyses were conducted using the lme4 package (Bates et al., 2014). No missing data were present in this study. See Table 3 for accuracy across tasks for each grade level.

Results

Grade 3

The decomposition of variances in item accuracy for Grade 3 (see Table 4) showed that the majority of the variance in item accuracy was due to between-item differences (83%) compared to between-person differences (17%). Unconditional model results included an estimated mean item accuracy log-odds of −0.96 ($p < .001$; see Table 5), meaning that the average probability of a child correctly answering an item from any of the tasks was .28. The inclusion of the task-type dummy codes indicated that item accuracies on Tasks 4 (1.63, $p < .001$), Task 5 (−1.70, $p = .001$), Task 6 (1.48, $p < .001$), and Task 8 (−1.45, $p < .001$) were statistically distinguished from the referent (i.e., Task 1 item accuracy; −0.91, $p = .018$) such that the probability of a correct Task 1 item was .29 compared with .67 for Task 4 items, .07 for Task 5 items, .64 for Task 6 items, and .09 for Task 8 items. There was no significant difference in item accuracy between Task 1 and Task 7 items ($p > .500$). The inclusion of task predictors resulted in 49% of the item-level variance explained (see Table 4).

The task and affix predictor model (see Table 5) yielded a significant effect for affix type such that inflectional-type items were easier (i.e., log-odds = 1.07,

Table 3. Mean performance and range on the Morphological Awareness Test for Reading and Spelling (MATRS) tasks by grade (standard deviations in parentheses).

	MATRS task					
Grade	Task 1 Segmenting/15	Task 4 Suffix choice/25	Task 5 Spelling multimorphemic words/25	Task 6 Suffix spelling/25	Task 7 Spoken relatives/15	Task 8 Written relatives/25
3	5.11 (2.43) 1–14	15.95 (6.37) 0–25	3.82 (3.98) 0–19	15.0 (3.96) 0–23	5.30 (2.70) 0–13	4.87 (4.75) 0–21
4	5.89 (2.18) 0–12	17.00 (5.66) 0–25	5.89 (5.51) 0–20	18.42 (4.80) 0–25	7.55 (2.93) 0–14	9.0 (5.20) 0–20
5	5.73 (2.01) 0–13	14.52 (5.36) 0–25	4.26 (4.42) 0–20	17.77 (4.20) 0–25	6.17 (2.48) 0–12	7.73 (5.06) 0–22
6	8.52 (1.66) 0–13	15.16 (5.84) 0–24	6.22 (4.97) 0–19	18.47 (5.42) 0–25	7.11 (3.27) 0–13	9.99 (5.34) 0–20

Note. The number after the "/" indicates the number of possible points for the task.

Table 4. Random effects and pseudo-R^2 statistics for unconditional and conditional explanatory item response models by grade level.

		Unconditional		Task only		Task + morph		Task + trans		Full model	
Grade	Effect	Variance	VDI	Variance	Pseudo-R^2	Variance	Pseudo-R^2	Variance	Pseudo-R^2	Variance	Pseudo-R^2
3	Person	0.88	0.17	0.88	.00	0.88	.00	0.88	.00	0.88	.00
	Item	4.18	0.83	2.13	.49	1.92	.54	1.74	.58	1.71	.59
4	Person	1.17	0.23	1.17	.00	1.17	.00	1.17	.00	1.17	.00
	Item	3.86	0.77	2.24	.42	2.21	.43	2.07	.46	2.04	.47
5	Person	0.90	0.21	0.90	.00	0.90	.00	0.90	.00	0.90	.00
	Item	3.48	0.79	2.03	.42	2.00	.43	1.75	.50	1.74	.50
6	Person	1.39	0.27	1.39	.00	1.39	.00	1.39	.00	1.39	.00
	Item	3.77	0.73	2.65	.30	2.63	.30	2.48	.34	2.49	.34

Note. All pseudo-R^2 values are computed based on a comparison of the individual conditional model relative to the unconditional model. morph = morpheme/affix type; trans = transparency type; VDI = variance decomposition index.

$p < .001$) compared with derivational items, and the inclusion of both item feature types resulted in 54% of the item-level variance explained, which was a 5% increase compared with the task-only model. The task and transparency type of model (see Table 5) showed that transparent items were easier (1.26, $p = .001$) than the referent, opaque items; phonological or orthographic shift items were not statistically distinguished from opaque items in terms of item-level accuracy ($p > .500$). The inclusion of task and transparency predictors resulted in 58% of the item-level variance explained, which was a 9% increase compared with the task-only model and a 4% increase compared to the task and affix predictor model. The full model that included task, affix, and transparency item features showed significant effects for Task 4 (1.89, $p < .001$), Task 5 (−1.41, $p < .001$), Task 6 (1.67, $p < .001$), Task 8 (−1.10, $p < .001$), and transparent items (1.04, $p = .008$), with 59% of the item-level variance explained (see Table 5).

Grade 4

The VDI for item accuracy in Grade 4 (see Table 4) showed that the majority of the variance in item accuracy was due to between-item differences (77%) compared to between-person differences (23%). Unconditional model results included an estimated mean item accuracy log-odds of −0.17 ($p = .367$; see Table 6), meaning that the average probability of a child correctly answering an item from any of the tasks was .46. The inclusion of the task-type dummy codes indicated that item accuracy on Tasks 4 (1.59, $p < .001$), 5 (−1.31, $p = .009$), and 6 (2.02, $p < .001$) was statistically distinguished from the referent (i.e., Task 1 item accuracy; −0.57, $p = .151$), such that the probability of a correct Task 4 item was .74 compared with .13 for Task 5 items and .81 for Task 6 items. There was no significant difference in item accuracy between Task 1 and either Task 7 or 8 items ($p = .266$ and $p = .255$, respectively). The inclusion of task predictors resulted in 42% of the item-level variance explained (see Table 4).

The task and affix predictor model (see Table 6) yielded a significant effect for affix type such that inflectional items were easier (i.e., log-odds = 0.85, $p = .031$) compared with derivational items; the inclusion of both item feature types resulted in 43% of the item-level variance explained, which was a 1% increase compared with the task-only model. The task and transparency type of model (see Table 6) showed that transparent items were easier (1.17, $p = .003$) than the referent, opaque items; phonological or orthographic shift was not statistically distinguished from opaque items in terms of item-level accuracy ($p = .171$ and $p = .218$, respectively). The inclusion of task and transparency predictors resulted in 46% of the item-level variance explained, which was a 4% increase compared with the task-only model and a 3% increase compared with the task and affix predictor model. The full model that included task, affix, and transparency item features showed significant effects for Task 4 (1.87, $p < .001$), Task 5 (−1.00, $p = .039$), Task 6 (2.33, $p < .001$), and transparent items (0.93, $p = .029$), with 47% of the item-level variance explained.

Grade 5

VDI in Grade 5 (see Table 4) showed that the majority of the variance in item accuracy was due to between-item differences (79%) compared with between-person differences (21%). Unconditional model results included an estimated mean item accuracy log-odds of −0.54 ($p = .002$; see Table 7), meaning that the average probability of a child correctly answering an item from any of the tasks was .37. The inclusion of the task-type dummy codes indicated that item accuracy on Tasks 4 (1.13, $p = .017$), 5 (−1.43, $p = .003$), and 6 (1.95, $p < .001$) was statistically distinguished from the referent (i.e.,

Table 5. Grade 3 fixed effects for unconditional and conditional explanatory item response models.

Predictors	Unconditional			Task			Task + morph			Task + trans			Full model		
	Coef.	***SE***	***p***	**Coef.**	***SE***	***p***	**Coef.**	***SE***	***p***	**Coef.**	***SE***	***p***	**Coef.**	***SE***	***p***
(Intercept)	–0.96	0.20	**< .001**	–0.91	0.38	**.018**	–1.27	0.38	**.001**	–1.63	0.50	**.001**	–1.67	0.50	**.001**
T4				1.63	0.48	**.001**	1.78	0.46	**< .001**	1.85	0.45	**< .001**	1.89	0.45	**< .001**
T5				–1.70	0.48	**< .001**	–1.56	0.46	**.001**	–1.45	0.46	**.002**	–1.41	0.46	**.002**
T6				1.48	0.48	**.002**	1.61	0.46	**< .001**	1.62	0.45	**< .001**	1.67	0.45	**< .001**
T7				–0.12	0.54	.827	–0.18	0.51	.718	–0.20	0.49	.678	–0.22	0.49	.654
T8				–1.45	0.48	**.003**	–1.30	0.46	**.005**	–1.13	0.46	**.014**	–1.10	0.46	**.016**
morph1							1.07	0.29	**< .001**				0.49	0.32	.127
Trans1										1.26	0.36	**.001**	1.04	0.39	**.008**
Trans2										0.13	0.42	.761	0.03	0.42	.939
Trans3										–0.07	0.41	.856	–0.06	0.40	.884

Note. *p* values < .05 are in bold font. Coef. = coefficient; *SE* = standard error; T4 = Task 4; T5 = Task 5; T6 = Task 6; T7 = Task 7; T8 = Task 8; morph1 = inflectional items; Trans1 = transparent items; Trans2 = phonological shift items; Trans3 = orthographic shift items.

Table 6. Grade 4 fixed effects for unconditional and conditional explanatory item response models.

Predictors	Unconditional			Task			Task + morph			Task + trans			Full model		
	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*
(Intercept)	−0.17	0.19	.367	−0.57	0.40	.151	−0.86	0.40	**.031**	−1.58	0.54	**.003**	−1.57	0.53	**.003**
T4				1.59	0.49	**.001**	1.71	0.48	**< .001**	1.87	0.49	**< .001**	1.87	0.48	**< .001**
T5				−1.31	0.50	**.009**	−1.19	0.48	**.014**	−1.00	0.49	**.042**	−1.00	0.49	**.039**
T6				2.02	0.49	**< .001**	2.14	0.48	**< .001**	2.35	0.49	**< .001**	2.33	0.49	**< .001**
T7				0.63	0.56	.266	0.67	0.54	.216	0.68	0.54	.205	0.69	0.54	.199
T8				−0.56	0.50	.255	−0.45	0.48	.349	−0.27	0.49	.582	−0.28	0.48	.568
morph1							0.85	0.31	**.006**				0.52	0.36	.148
Trans1										1.17	0.39	**.003**	0.93	0.42	**.029**
Trans2										0.62	0.46	.171	0.60	0.45	.184
Trans3										0.54	0.44	.218	0.54	0.44	.215

Note. *p* values < .05 are in bold font. Coef. = coefficient; *SE* = standard error; T4 = Task 4; T5 = Task 5; T6 = Task 6; T7 = Task 7; T8 = Task 8; morph1 = inflectional items; Trans1 = transparent items; Trans2 = orthographic shift items; Trans3 = phonological shift items.

Task 1 item accuracy; −0.71, p = .061), such that the probability of a correct Task 4 item was .60 compared with .11 for Task 5 items and .78 for Task 6 items. There was no significant difference in item accuracy between Task 1 and either Task 7 or 8 items (p > .500 and p = .210, respectively). The inclusion of task predictors resulted in 42% of the item-level variance explained (see Table 4). The task and affix predictor model (see Table 7) yielded a nonsignificant effect for affix type (0.43, p = .173) with 43% of the item-level variance explained, which was a 1% increase compared with the task-only model.

The task and transparency type of model (see Table 7) showed that transparent items were easier (1.37, p < .001) than the referent, opaque items; phonological or orthographic shift items were not statistically distinguished from opaque items in terms of item-level accuracy (p = .412 and p = .312, respectively). The inclusion of task and transparency predictors resulted in 50% of the item-level variance explained, which was an 8% increase compared with the task-only model and a 7% increase compared with the task and affix predictor model. The full model that included task, affix, and transparency item features showed significant effects for Task 4 (1.51, p = .001), Task 5 (−0.97, p = .035), Task 6 (2.52, p < .001), and transparent items (1.45, p = .029), with 50% of the item-level variance explained (see Table 7).

Grade 6

VDI in Grade 6 (see Table 4) showed that the majority of the variance in item accuracy was due to between-item differences (73%) compared with between-person differences (27%). Unconditional model results included an estimated mean item accuracy log-odds of −0.07 (p < .500; see Table 8), meaning that the average probability of a child correctly answering an item from any of the tasks was .48. The inclusion of the task-type dummy codes indicated that item accuracy on Tasks 5 (−1.43, p = .002) and 6 (1.39, p = .004) was statistically distinguished from the referent (i.e., Task 1 item accuracy; −0.01, p > .500), such that the probability of a correct Task 5 item was .19 compared with .80 for Task 6 items. There was no significant difference in item accuracy between Task 1 and either Task 4, 7, or 8 items (p = .081,

Table 7. Grade 5 fixed effects for unconditional and conditional explanatory item response models.

Predictors	Unconditional			Task			Task + morph			Task + trans			Full model		
	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*
(Intercept)	−0.54	0.18	**.002**	−0.71	0.38	.061	−0.86	0.39	**.029**	−1.82	0.50	**< .001**	−1.82	0.50	**< .001**
T4				1.13	0.47	**.017**	1.15	0.47	**.015**	1.52	0.46	**.001**	1.51	0.45	**.001**
T5				−1.43	0.47	**.003**	−1.37	0.47	**.004**	−0.97	0.46	**.037**	−0.97	0.46	**.035**
T6				1.95	0.48	**< .001**	2.03	0.48	**< .001**	2.53	0.47	**< .001**	2.52	0.47	**< .001**
T7				−0.11	0.53	.837	−0.11	0.53	.833	−0.05	0.50	.926	−0.04	0.49	.935
T8				−0.59	0.47	.210	−0.54	0.47	.255	−0.18	0.46	.689	−0.19	0.45	.679
morph1							0.43	0.32	.173				−0.20	0.33	.544
Trans1										1.37	0.37	**< .001**	1.45	0.39	**< .001**
Trans2										0.34	0.41	.412	0.36	0.41	.377
Trans3										0.41	0.40	.312	0.40	0.40	.312

Note. *p* values < .05 are in bold font. Coef. = coefficient; *SE* = standard error; T4 = Task 4; T5 = Task 5; T6 = Task 6; T7 = Task 7; T8 = Task 8; morph1 = inflectional items; Trans1 = transparent items; Trans2 = orthographic shift items; Trans3 = phonological shift items.

Table 8. Grade 6 fixed effects for unconditional and conditional explanatory item response models.

Predictors	Unconditional			Task			Task + morph			Task + trans			Full model		
	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*	Coef.	*SE*	*p*
(Intercept)	−0.07	0.19	.702	−0.01	0.39	.977	−0.12	0.40	.765	−0.63	0.52	.232	−0.62	0.53	.235
T4				0.83	0.48	.081	0.86	0.48	.073	1.08	0.48	**.025**	1.08	0.48	**.024**
T5				−1.43	0.47	**.002**	−1.39	0.48	**.003**	−1.14	0.48	**.018**	−1.14	0.48	**.018**
T6				1.39	0.48	**.004**	1.43	0.48	**.003**	1.67	0.49	**.001**	1.67	0.49	**.001**
T7				−0.41	0.53	.439	−0.41	0.53	.432	−0.33	0.51	.524	−0.32	0.51	.539
T8				−0.91	0.47	.053	−0.87	0.47	.066	−0.64	0.48	.181	−0.64	0.48	.181
morph1							0.34	0.30	.259				−0.20	0.34	.548
Trans1										0.89	0.38	**.019**	0.98	0.41	**.016**
Trans2										0.28	0.44	.517	0.32	0.44	.463
Trans3										−0.17	0.41	.673	−0.18	0.41	.659

Note. *p* values < .05 are in bold font. Coef. = coefficient; *SE* = standard error; T4 = Task 4; T5 = Task 5; T6 = Task 6; T7 = Task 7; T8 = Task 8; morph1 = inflectional items; Trans1 = transparent items; Trans2 = orthographic shift items; Trans3 = phonological shift items.

p = .439, and p = .053, respectively). The inclusion of task predictors resulted in 30% of the item-level variance explained (see Table 4). The task and affix predictor model (see Table 8) yielded a nonsignificant effect for affix type (0.34, p = .259) with 30% of the item-level variance explained, which was equivalent to the task-only model.

The task and transparency type of model (see Table 8) showed that transparent items were easier (0.89, p = .019) than the referent, opaque items; phonological or orthographic shift items were not statistically distinguished from opaque items in terms of item-level accuracy ($p >$ .500). The inclusion of task and transparency predictors resulted in 34% of the item-level variance explained, which was a 4% increase compared with the task-only model and the task and affix predictor model. The full model that included task, affix, and transparency item features showed significant effects for Task 4 (1.08, p = .024), Task 5 (−1.14, p = .018), Task 6 (1.67, p < .001), and transparent items (0.98, p = .016), with 34% of the item-level variance explained (see Table 8).

Discussion

Performance on morphological awareness tasks can be impacted by the characteristics of the task items (e.g., Apel & Lawrence, 2011; Carlisle & Nomanbhoy, 1993; Desrochers et al., 2018; Spencer et al., 2015). In this investigation, we sought to determine whether students' item accuracy was influenced by affix type and/or base word transparency. Researchers and practitioners would benefit from this knowledge, for both assessment and instructional purposes.

To ensure the contributions of affix type and/or base word transparency were investigated within the proper context, we first determined whether variance in item accuracy was due to differences between items or to differences between students. Across all four grades, the largest proportion of variance (73%–83%) in item accuracy was due to differences between items. That is, the majority of accurate performance was due to items differing from one another compared to students varying from each other. Given our investigation focused on two item characteristics, affix type and base word transparency, this finding allowed us to better understand the role of those two factors on item-level accuracy.

As the direct focus of this investigation, we then examined whether affix type and/or base word transparency explained the item-level differences when controlling for the type of task. For the earlier grades, third and fourth grade, when accounting for between-task differences, both affix type and base word transparency, when each was considered individually, significantly affected students' performance on the tasks. However, when affix type was considered simultaneously with base word transparency and task, only base word transparency and task affected performance on some of the tasks. For the two later grades, fifth and sixth grade, base word transparency and task affected performance in all contexts (i.e., either separately or concurrently with affix type). For both grades, the full model (i.e., task, affix type, transparency) was significant for task and transparency on three tasks. Affix type was not a significant predictor either when viewed independently from base word transparency or when considered along with base word transparency and task. Across all four grades, then, students had a higher probability of a correct response for inflectional and derivational items that were transparent with their base word form (i.e., no phonological and/or orthographic shift) compared to those that represented both a phonological and orthographic shift (i.e., opaque items). Furthermore, items that represented either a phonological or orthographic shift were not different than opaque items. Collectively, then, these finding suggested that it is primarily base word transparency type that significantly relates to item accuracy and that items that are opaque (e.g., attend > attention) are more difficult than items that are transparent; there are no significant relations between morphological awareness performance and affix type when examined simultaneously with base word transparency.

The finding that items that were transparent with their base word forms resulted in the greatest item accuracy supports previous outcomes. For example, Goodwin et al. (2013), in their study of seventh- and eighth-grade students, found that derivational items representing a phonological shift, whether with or without an orthographic shift, led to a lower probability of accurateness compared to transparent derivations. To et al. (2016) reported a similar finding with their adult participants. The adults were less accurate on derivational items containing a phonological shift compared to items with no shift. Our findings corroborate and expand on these former studies. Importantly, base word transparency is an influential factor not only for tasks targeting awareness of derivational morphology but also for tasks focusing on inflectional morphology. Previous studies have not examined the impact of base word transparency on items directed to awareness of inflections. This study then adds to previous findings by highlighting the impact of base word transparency on both deviational and inflectional morphological items on morphological awareness measures. Our finding supports previous suggestions that when multimorphemic words are transparent, whether they are inflectional or derivational in nature, an awareness of each of the morphemes within that word, and their meanings, is likely more attainable (Raveh & Rueckl, 2000).

Our nonsignificant finding for the effect of affix type, when considered simultaneously with the impact of base word transparency, differs from previous studies' results on the impact of affix type on item accuracy. In past investigations, researchers have found that item accuracy on measures of morphological awareness was greater for inflectional items than for derivational items (e.g., Apel & Lawrence, 2011; Carlisle & Nomanbhoy, 1993; Deacon, 2008). The difference in findings may be due to the sole focus on affix type in previous studies without a concurrent consideration of base word transparency. Indeed, past findings for greater performance on inflectional items may have been spurious given base word transparency was not examined, resulting in the use of inflectional morphology items representing mostly transparent items and derivational morphology items containing more examples of orthographic and/or phonological shifts. As we found in our study, when considered simultaneously, affix type does not have the significant impact on performance as seen with base word transparency.

As noted earlier, there were two noteworthy grade-level variations in performance across the four grades. First, when accounting for task-level differences, for students in the two earlier grades (third and fourth), affix type was a significant factor influencing item performance when base word transparency was not taken into consideration. With those two grades, inflectional affix–type items resulted in greater accuracy than derivational-type items. This finding was not true for the two later grades; affix type did not influence performance when considered only alongside task differences, but without consideration of base word transparency.

One possible explanation for this finding may be tied to the growth of morphology in conversational and written language. Experts have suggested that increases across grades in the ability to think about morphemes are related to growth of morphology in the productive use of spoken and written language (e.g., Apel & Apel, 2011; Berninger et al., 2010; Green et al., 2003). Generally, students have achieved relative accuracy in the conversational use of inflectional morphology by kindergarten and first grade (Apel & Masterson, 2012; Brown, 2013; Clark & Cohen, 1984; Ebbers, 2004). The same holds true for the productive use of inflected and derived morphemes during spontaneous writing; the use of inflectional morphology in spontaneous written language occurs before the use of derivational morphology—the latter is accomplished beginning in third grade and continues across the next several years (e.g., Green et al., 2003; Moats & Smith, 1992). Active or conscious awareness of any aspect of language, including inflectional and derivational morphology, only follows use of those parts of language in conversational language (Apel & Apel, 2011). Thus, because of the longer accurate use of inflectional morphology in conversational language and shorter length of time using accurate derivational morphology, students in third and fourth grade appear to demonstrate a greater ability to actively and accurately think about inflectional morphology than derivational morphology on measures of morphological awareness (e.g., Deacon & Bryant, 2005; Kieffer & Lesaux, 2007). By the later grades, fifth and sixth grade, students have had a lengthier amount of time to achieve accuracy in the conversational language use of derivational morphology and, consequently, a greater amount of time to actively considering derivational morphology. Thus, in those later grades, the students demonstrated similar metalinguistic awareness skills for both inflectional and derivational items.

A second notable grade-level difference was that, after accounting for task differences, the amount of item-level differences explained by base word transparency varied across the four grades. For third grade, 58% of item-level differences were due to base word transparency and task type. By sixth grade, only 34% of the item-level differences were explained by task and base word transparency. This finding may be related to the students' familiarity with common morphological families. In kindergarten and first-grade texts, 96% of the words come from the most common 2,451 morphological families (Hiebert et al., 2017). However, that percentage drops across each consecutive grade to about 72% in sixth grade. Core words of common curricula are more prevalent in texts at the lower grade levels, and less frequently occurring words begin to replace those words as texts become more complex in higher grades (Hiebert et al., 2017). Thus, for earlier grades, greater familiarity with common multimorphemic words may have enabled the students to perform morphological problem solving (e.g., Anglin, 1993) on a greater amount of words. That is, familiarity with the base words of the multimorphemic words, along with an awareness of affixes and their meanings, may have resulted in greater use of morphological awareness skills. With the later grades, words from less common morphological families and/or less common multimorphemic words are more present in those grades' texts. Furthermore, as Goodwin et al. (2013) reported, at older grades, complex words are often constructed of a root and multiple affixes (e.g., *in/k – 1/k – 1*). Given that, in English, roots (e.g., *spect*) are not encountered in isolation during reading and spelling tasks but instead have prefixes and suffixes attached to them; it may be that students consider root-based multimorphemic words as isolated vocabulary items outside a morphological family. In that situation, then, active consideration of the individual components of the word (i.e., the free base form within the word and the attached affixes) may not lead to successful comprehension of its meaning, leading to less application of morphological awareness skills to comprehend those words.

Educational Implications

Our results provide some initial educational implications, for both assessment and instruction. Across all four grades, about three fourths or more of item accuracy was due to the item differences; a much smaller percentage was due to student differences. We found this result encouraging because this means a student's performance on the different tasks was likely due more to the task items themselves rather than student characteristics that are less easily manipulated or built into a test. Furthermore, it was base word transparency that primarily explained performance rather than affix type. These findings suggest that, when developing tasks to assess morphological awareness, researchers and practitioners should ensure items vary in their base word transparency to ensure a range of student performances; less attention about affix type may be required when constructing items. A related instructional implication is that lessons targeting awareness of derivational morphemes can be implemented at least as early as third grade, albeit using transparent examples at first. Second, in our investigation, affix type by itself explained performance of the third- and fourth-grade participants, although it no longer had a significant effect when base word transparency also was considered. Nevertheless, practitioners are cautioned against ignoring affix type (i.e., inflectional vs. derivational) when assessing morphological awareness for children in earlier grades. Based on results from previous investigations assessing the morphological awareness skills of students in the first few years of school, affix type may be an influential factor on various tasks of morphological awareness for young learners (e.g., Apel & Lawrence, 2011).

Our findings about the significant influence of base word transparency, regardless of affix type, also have implications for instruction. Educators and specialists working with third- through sixth-grade students on their morphological awareness skills likely should begin morphological awareness instruction using transparent inflected and derived forms of base words. Educators have not always suggested this particular process (e.g., Glaser, 2020). As students begin to demonstrate an awareness between base words and their transparent forms, then practitioners can introduce inflected and derived words that represent some level of phonological and/or orthographic shift from its base word. One caveat to these assessment and instruction implications is that they only pertain to students in the third through sixth grade.

Although not a primary focus of this investigation, we would be remiss not to restate that, for the third- through sixth-grade students in our investigation, the majority of variance explained in item performance was accounted for by task-level differences. This, too, is important for practitioners and researchers to keep in mind when developing or selecting task(s) that measure morphological awareness. Performance on one task may not sufficiently capture a child's full range of morphological awareness. Thus, our findings, together with the extant literature, suggest that to fully understand a student's awareness of morphology, multiple tasks that are aligned with a multicomponent definition of morphological awareness should be administered (Apel, 2014), keeping in mind that performance on one task does not necessarily equate to how a student will perform on another (Apel et al., 2022). In doing so, a more complete picture of students' strengths and weaknesses in morphological awareness will be obtained.

Future Directions

This initial investigation examining the effects of affix type and base word transparency on children's morphological awareness performance on a number of tasks across Grades 3–6 spurs several avenues for future investigations. To determine whether similar assessment and instructional implications are applicable across the elementary-age years, the obvious first next step is to target students in the first and second grade to clarify whether affix type and base word transparency influence performance on morphological awareness tasks. Another next step is to compare children's performance on spoken morphological awareness tasks to those requiring written responses. Given extended experience with morphology in spoken language compared to written, the implications for the two modalities may be different. Relatedly, measuring the relation between productive morphology and performance on inflectional and derivational morphological awareness tasks would shed light on the relation between morphological use during authentic communication and contrived morphological awareness tasks, leading to potentially important implications for early assessment and instruction/intervention. Researchers also may wish to compare the influences of orthographic versus phonological shifts specifically for performance on written morphological awareness tasks. This was not examined in the current study because the tasks contained real words making it unknown whether the children were able to read the words by sight or if they specifically accessed their phonological and/or orthographic knowledge. It is reasonable to hypothesize that student performance may be differentially influenced by orthographic compared to phonological shifts for written tasks. In future investigations, researchers may want to consider developing tasks similar to those used in the current study, which contain pseudowords rather than real words to examine this relationship.

It is possible that factors not measured in this investigation serve as alternate explanations of our findings. Specifically, we did not control for vocabulary knowledge or reading performance in this study. Given that vocabulary and morphology are inherently related, examining the contribution of vocabulary knowledge on morphological awareness performance is a notable line for future inquiry. It may be that the effects of affix type and base word transparency would be different when considered alongside vocabulary. Although the majority of the participants in the current study were not receiving special education services and task items were based on grade-level base words, it is likely that some students who participated had reading and spelling deficits. Researchers could conduct a similar study and could control for, or examine the effect of, reading and spelling abilities on students' performance.

Although not the purpose of the current investigation, it is important that future investigations examine any possible effects of dialect on students' performance. At least one previous investigation (Apel & Thomas-Tate, 2009) reported that the degree of use of African American English was not associated with African American fourth-grade students' morphological awareness abilities. Nevertheless, future studies could examine in more depth the effect of dialect on students' performance on a range of morphological awareness tasks. Finally, the MATRS tasks and associated items largely contained free base words and, at times, words that individuals likely consider as a free base, perhaps because they are unfamiliar or unaware with more complex morphological structures within the words. Given that some researchers encourage using a word's etymology (i.e., roots/bound base words) to guide morphological awareness instruction (e.g., Bowers & Bowers, 2017; Murphy & Diehm, 2020), future investigations could compare the difference in performance for items containing free versus bound bases. These above-mentioned suggestions along with previous literature and the current study will lead to a more robust understanding of a variety factors that may play a role in children's development of morphological awareness skills for reading and spelling.

Data Availability Statement

Data are not currently available for public access given continued use for product development. Data may be available in the future and would be accessible by contacting the corresponding author: kennapel@sc.edu.

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