INTRODUCTION

Reading development, including that in a second language (L2), necessitates an array of knowledge and skills (Grabe 2009). Recently, morphological awareness, a type of metalinguistic awareness, has received increasing attention from reading researchers in their examination of reading development among English-speaking students as well as learners of English as a Second Language (ESL). Morphological awareness pertains to the ability to reflect upon and manipulate morphemes, the smallest unit of meaning (Carlisle 2003; Kuo and Anderson 2006). As it entails the ability to segment complex words into its constituent morphemes, morphological awareness logically facilitates the accuracy and efficiency of recognizing those words in print. Empirically, previous studies have found that English-speaking children's morphological awareness uniquely contributes to word reading even after accounting for the influence of phonological awareness (e.g., Deacon and Kirby 2004). Such a result tends to hold for English L2 learners as well (Cheung et al. 2010; Ramirez et al. 2010). Ramirez et al. (2010), for example, reported that the ability to produce derived words with given bases uniquely and significantly predicted English word decoding of Spanish-speaking English Language Learners (ELLs) in Canada, after accounting for their English vocabulary, phonological awareness, and other related variables. Studies on Chinese-speaking learners of English in different cultural contexts (e.g., the United States, Canada, and Hong Kong) revealed a similar finding (e.g., Cheung et al. 2010; Ramirez et al. 2011)

In addition to its close relationship with word reading, morphological awareness also promotes a componential approach to word learning in that the meaning of an unfamiliar multimorphemic word (e.g., *uncontrollable*) can be inferred by first decomposing the word into its meaningful components (the prefix *un-,* the suffix *–able*, and the base *control*) and then synthesizing the meanings of those components on the basis of their structural and semantic relationships. Such “morphological problem-solving” (Anglin 1993: 5) has been found as a major mechanism in children’s expansion of their vocabulary repertoire (Anglin 1993; Nagy and Anderson 1984). Studies that directly tested the relationship between morphological awareness and vocabulary breadth have consistently found the former is as a unique predictor of the latter, among English-speaking children as well as L2 learners of English (Chen et al. 2012; Cheung et al. 2010; Kieffer and Lesaux 2012b; Lam et al. 2012). Chen et al. (2012), for example, found that Spanish- as well as Chinese-speaking ELLs’ English derivational awareness uniquely predicted their vocabulary size after controlling for such variables as phonological awareness and nonverbal intelligence. Cheung et al. (2010) reported a similar predictive relationship between English morphological awareness and vocabulary among young Chinese-speaking learners of English in Hong Kong.

Recently, researchers’ interests, including those of ESL researchers, in morphological contribution to reading development have moved beyond the lexical level (word reading and vocabulary knowledge) to the textual level (e.g., Authors 2012a, 2013; Kieffer et al. 2013; Kieffer and Box 2013; Kieffer and Lesaux 2012a; Nagy et al. 2006). There has been an interest in exploring whether and how morphological awareness would contribute to the development of reading comprehension. Theoretically, because morphology serves as an agent that binds together orthographic, phonological, grammatical, and semantic features of words (Bowers et al. 2010), learners with refined morphological awareness presumably have a high quality representation of words, which, according to the Lexical Quality Hypothesis (Perfetti 2007), is essential to successful reading comprehension. A more refined morphological knowledge likely leads to easier and more rapid decoding of morphologically complex words and access to their meanings, which has been reported in many studies, as reviewed earlier. Given the close relationship of efficient word decoding and vocabulary to comprehension, “the Golden Triangle of Reading Skill” (Perfetti 2010), morphological awareness is expected to contribute to reading comprehension, indirectly, through its shared relationship with lexical-level skills. In addition to its effect possibly mediated by word decoding fluency and vocabulary knowledge, morphological awareness may also facilitate comprehension through learners’ instantaneous resolution of vocabulary gaps during reading, that is, morphology-based lexical inferencing during reading or “on the spot vocabulary learning” (Nagy 2007: 64). In addition, the use of the syntactic signals provided by English suffixes may also help learners to parse complex sentences and construct sentence-level meanings. In the latter case, for example, by using the suffix information alone, students could differentiate the following two sentences: *Observant investigators proceed carefully* and *Observe investigators proceed carefully* (Nagy 2007).

Given the above theoretical delineations, morphological awareness may presumably indirectly contribute to reading comprehension through the mediation of decoding fluency and vocabulary knowledge, as well as over and above the two lexical competencies. Empirically, an increasing number of studies, including those on ESL learners, have aimed to test whether morphological awareness directly contributes to reading comprehension or whether its contribution is primarily indirect. The investigation of such an issue, however, has not been satisfactory, and often times, mixed findings have been reported.

To illustrate, some studies reported morphological awareness as a unique predictor of reading comprehension, but failed to consider in their models either word reading or vocabulary knowledge (e.g., Authors 2013; Deacon and Kirby 2004; Wang et al. 2006). The lack of control for a lexical variable(s) leaves the question as to if the identified unique contribution of morphological awareness to reading comprehension is indeed unique. In other words, the effect might have disappeared if one or both of the lexical skills, which are significant correlates of both morphological awareness and reading comprehension, had been included in the correlation/covariance-based models that tested the relationship. For example, Wang et al. (2006) found that after controlling for phonological awareness and oral receptive vocabulary, English morphological awareness was a unique predictor of reading comprehension among young Chinese-speaking learners of English in the United States. Zhang and Koda's (2013) study on young Chinese learners of English as a Foreign Language in China revealed a similar finding about the contribution of morphological awareness to reading comprehension after controlling for learners' vocabulary knowledge and other related abilities. In neither studies, however, was word reading included as a control variable, which left unknown whether the identified unique effect would remain if word reading ability had also been considered.

Only a very small number of studies have considered both word reading and vocabulary knowledge in their models of predicting ESL reading comprehension with morphological awareness. Mixed findings, however, were often produced. Sometimes, a unique effect of morphological awareness was found (e.g., Kieffer and Box, 2013; Kieffer and Lesaux 2012a; Kieffer et al. 2013); other times, it failed to appear (e.g., Goodwin et al. 2013; Lam et al. 2012). In a study on sixth grade native English speakers and ELLs of different ethnic language backgrounds, Kieffer and Lesaux (2012a) found a consistent pattern across all groups of learners that derivational awareness contributed directly to reading comprehension over and above reading vocabulary and word reading fluency; as well as indirectly to reading comprehension through the mediation of reading vocabulary (but not word reading fluency). Lam et al. (2012) followed the development of morphological awareness and reading abilities of two cohorts of

Chinese ELLs (i.e., kindergarteners and first graders) for a year. It was found the kindergarten cohort's Time 2 morphological awareness, including both derivation and compound awareness, failed to predict their Time 2 reading comprehension over and above word decoding, receptive vocabulary, and other related variables. A similar pattern was found among the first grade cohort at both Time 1 and Time 2. Interestingly, however, Grade 1 cohort's Time 1 derivational awareness significantly predicted their Time 2 reading comprehension, after controlling for Time 1 reading comprehension as well as Time 1 word reading and vocabulary knowledge. No test, however, was made on any possible indirect effect of any type of morphological awareness on reading comprehension.

While the different findings of the above studies could be attributed to many factors, one might be the varied focus of the studies' word reading measures. For example, Kieffer and Lesaux (2012a) aimed to test learners' word reading fluency by asking learners to segment unrelated single-syllable/morpheme words in a string (e.g., *dim/how/fig/blue*), whereas Lam et al.'s (2012) task focused on the basic accuracy of word decoding. In neither study did the task seem to immediately tap morphology. Given the nature of morphological awareness, it seems logical and essential that a word reading task pertaining to morphologically complex words be used when modeling how that skill is functional in reading development. In addition, as it is efficiency rather than basic accuracy of decoding that needs to be achieved for fluent reading comprehension (Perfetti, 2007), it would be more interesting to examine how fluency of decoding morphologically complex words functions when the contribution of morphological awareness to reading comprehension is modeled.

THE PRESENT STUDY

The review above shows no consistent evidence on whether morphological awareness would have any significant direct effect on ESL learners' reading comprehension, and if word decoding fluency and vocabulary breadth would mediate the relationship between morphological awareness and reading comprehension. In addition, an issue that has received little if any attention in research on ESL learners is whether the relationship of morphological awareness to reading comprehension would change as learners progress in their English learning. Recently, Foorman et al. (2012) found an incremental variance in reading comprehension explained by English-speaking students' morphological knowledge from Grades 3 through 10. Such a strengthened relationship has rarely been directly tested among ESL learners. Another longitudinal issue that has received little attention in the literature is whether morphological awareness at an earlier time would contribute to reading comprehension at a later time, that is, the longitudinal effect of morphological awareness on ESL reading comprehension development. Finally, previous studies tended to focus largely on learners in a primarily English-monolingual learning context, such as the United States and Canada (e.g., Kieffer and Lesaux 2012a; Goodwin et al. 2013; Lam et al. 2012), which leaves a question as to if similar patterns would surface among L2 learners of English in other contexts where English is not necessarily the sole primary or societal language.

To address the aforementioned issues about the contribution of morphological awareness to ESL reading comprehension, we conducted the present longitudinal study with a focus on young Chinese learners of English in Singapore, a multilingual society where English is a lingua franca for different ethnic groups and the medium of school instruction. Specifically, we aimed to answer the following three questions.

1. Does ESL learners' derivational awareness directly contribute to their reading comprehension over and above their fluency of derived word decoding and breadth of vocabulary knowledge, or is the contribution primarily indirect through the mediation of the two lexical competencies, or do both direct and indirect effects exist?

2. Does the relationship (direct and/or indirect) between morphological awareness and reading comprehension become stronger as learners progress in their learning of English?

3. Does morphological awareness have a longitudinal effect on reading comprehension development?

METHODS

Participants

The participants were 108 third-grade, ethnic Chinese students in Singapore, an island country in Southeast Asia. They included 49 girls and 59 boys; their average age was 9.48 years (*SD* = 0.47) when they were first tested at the end of Grade 3. These students were from three neighborhood schools, which are public schools with an ethnically diverse student population. They were selected for the present study on young ESL learners because it was reported that they all mostly used Chinese as opposed to English for communication with both parents in a home language survey that asked parents if their child mostly used Chinese or English or a balanced use of both languages at home.

Singapore is a multilingual society with four official languages that include English and the mother tongues (MT) of its three major ethnic groups (i.e., Chinese, Malay, and Tamil) (Shepherd 2005). Ever since the founding of the Republic in 1965, Singapore has adopted a policy of "English-knowing bilingualism" (Pakir 1991). That is, it is mandated that all students become proficient in English, which is the medium of school instruction in addition to being a school subject itself, and at the same time, learn their respective MT in school. Such formal bilingual and biliteracy learning of English and MT starts at the commencement of primary schooling (Grade 1) and continues for 12 years until students finish junior college (Grade 12).

In the past few decades, the globalized influence of English as a lingua franca has had strong ramifications on the sociolinguistic milieu in Singapore. A significant one is gradual home language shift from MT to English. Sociolinguistic and educational surveys have revealed a growing proportion of students speaking English as their dominant home language in Singapore (Ministry of Education 2009). On the other hand, some research reports also noted that a significant proportion of elementary school students in the country still use their MT as the primary language of communication at home, and learn English as a Second Language in schools (English Language Curriculum & Pedagogy Review Committee 2006). To accommodate the diversity of students' backgrounds in English, the English curriculum or STELLAR (Strategies for English Language Learning and Reading) is characterized by a pedagogical model comprised of a set of strategies, such as teacher-guided reading, explicit instruction on language structures, focused and contextualized practice of linguistic knowledge and skills, that aim not only for literacy development as typical of any language arts curriculum common to an English first language setting, but English language learning as well (e.g., spoken communication, grammatical knowledge), or to achieve "a principled blend of first language (L1) and second language (L2) teaching methods" (Ministry of Education 2008: 8).

Tasks

The following tasks were administered twice with an interval of about a year, first at the end of Grade 3 (Time 1) and the second time at the end of Grade 4 (Time 2).

Morphological relatedness. This morphological awareness task measured the ability to perform morphological segmentation of affixed words. Learners were to judge whether the second word in a word pair “came from” the first word. Such a task has been widely used in the literature to measure the morphological awareness of English-speaking children as well as L2 learners of English (e.g., Authors 2013; Ku and Anderson 2003; Nagy et al. 2006). The task included 30 items, 15 related (e.g., *think* and *thinker*) and 15 unrelated (e.g., *too* and *tooth*) word pairs. The maximum score possible (MSP) was 30. The reliability (Cronbach’s α) of the task was .815 and .853 for Time 1 and Time 2, respectively.

Affix choice (real). Modeled on Nagy et al. (2006) and Authors (2013), this morphological awareness task measured learners’ knowledge about the grammatical functions of derivational affixes. They were to select an appropriate derived form to fill into a sentence (e.g., *It is not easy to measure the ___of light*.) – simple both lexically and grammatically – followed by three real derived words that shared a same base (*intensely, intensify, intensity*). To choose *intensit*y as the answer, children would need to know that a noun is required of the blank and the suffix -*ity* nominalizes an adjective. The task had 15 test items, with an MSP of 15. The reliability was .707 and .817 for Time 1 and Time 2, respectively.

Affix choice (pseudo). This morphological awareness task was the same as the Affix Choice (Real) task except that it had three pseudo derivatives formed with the same decodable base. For example, *I could feel the* ___. (*froody, froodful, froodment*). If a child knew that -*ment* is a nominalizer suffix, he/she would be able to choose *froodment* as the answer. The task had 15 test items with an MSP of 15. Time 1 and Time 2 reliability was .671 and .777, respectively.

Word reading fluency. Learners were instructed to read a maximum of 60 derived words as fast and as accurately as possible without skipping any word in 30 seconds. They were given six words to practice as many times as they felt needed before they moved onto the test words. The 60 derived words included those that were phonologically and/or orthographically regular as well as those that involved phonological and/or orthographic changes, such as *successful*, *various*, *musician*, and *natural*. All words of different types of regularity were randomized and presented to learners on paper. The MSP was 60, with one point awarded for each word correctly read aloud. The reliability at Time 1 and Time 2 was .932 and .967, respectively.

Vocabulary knowledge. Learners' English oral, receptive vocabulary knowledge was measured with PPVT-IV (Dunn & Dunn, 2007), which has 19 sets of 12 words with each set for a different start age of English speakers. The 60 words adopted in the present study were from Set 7 (Start Age 8) to Set 11 (Start Age 13)[1], and the MSP was 60. All target words were read aloud to learners, and they were to circle the number of the picture out of four on an answer sheet that represented the meaning of a target word. The reliability was .891 and .915 for Time 1 and Time 2, respectively.

Reading comprehension. Reading comprehension was measured with a researcher-developed multiple-choice passage comprehension task. The task included three grade-appropriate passages, including one narrative and two informational texts, with a mean length of about 300 words. All passages were followed by five questions that tested different aspects of comprehension skills (e.g., resolution of co-referential relationships, textual inferencing, gist or main idea). Altogether there were 15 questions that had a maximum score of 15. The reliability was .629 and .716 for Time 1 and Time 2, respectively.

Procedure

The same set of tasks was administered twice to the participants with an interval of about a year. The three morphological awareness tasks and the vocabulary knowledge and reading comprehension tasks were group administered in the learners' regular English classes; word reading fluency was individually tested in a quite room in the learners' schools. The instructions and the items of each of the three morphological awareness tasks were read aloud to the learners as they worked on its written version so as to avoid possible influence of decoding on their performance. At each time of data collection, the morphological awareness tasks were administered first, followed by the word reading fluency and vocabulary tasks. The reading comprehension task was always the last one administered.

RESULTS

To address the three research questions about the concurrent and longitudinal relationship of ESL morphological awareness to reading comprehension, we drew primarily on the Structural Equation Modeling (SEM) method to analyze the data. SEM, also called covariance structure analysis, is a multivariate statistical method that enables one to test hypotheses related to the latent structure of variables and their predictive, or structural, relations (Kline 2005). All SEM analyses in this study were run on EQS 6.1 (Bentler 2006). To supplement significance testing of χ^2 values, different indexes have been proposed for the estimation of the goodness-of-fit of SEM models. As suggested by Hu and Bentler (1999), we report Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA). Different rule of thumb cutoff values have been proposed for different indexes. We adopted the criteria suggested by Hu and Bentler (1999) that a cutoff value of CFI $\geq .95$, SRMR $\leq .08$, and RMSEA $\leq .06$ indicates a model with good fit.

Performance on all tasks at Time 1 and Time 2

Table 1 presents the means and standard deviations of learners' performance on all tasks at both Time 1 and Time 2. T-tests revealed that all Time 2 scores were significantly higher than Time 1 scores, *p*s $< .001$.

[Table 1 Near Here]

Relationship of morphological awareness to reading comprehension at Time 1

Table 2 shows the bivariate correlations between the six tasks at Time 1 and Time 2. All correlations were positive and significant. Specifically, at Time 1, the three morphological awareness tasks were significantly correlated. More importantly, their correlations with word reading fluency, vocabulary knowledge, as well as reading comprehension were also all significant. Finally, the three reading variables also significantly correlated with each other.

[Table 2 Near Here]

SEM analysis was performed to further examine the relationship of morphological awareness to reading comprehension. Morphological Relatedness, Affix Choice (real), and Affix Choice (pseudo) were to load on a latent variable of Morphological Awareness. To account for measurement errors, single-indicator latent variables were created for Word Reading Fluency, Vocabulary Knowledge, and Reading Comprehension, with the error variance of each indicator fixed at the product of the observed variance and 1 minus reliability of the indicator (Kline, 2005). It was hypothesized that in a baseline model (see Figure 1), Morphological Awareness would predict Word Reading Fluency and Vocabulary Knowledge; it would also contribute to Reading Comprehension, together with the two lexical variables. Word Reading Fluency would also predict Reading Comprehension indirectly through Vocabulary Knowledge.

[Figure 1 Near Here]

Time 1 data fit the baseline model very well with very good model fit: $\chi^2(6) = 3.654$, $p = .723$, CFI = 1.000, SRMR = .027, and RMSEA = .000. Mardia's normalized estimate was -.341, which indicates multivariate normality of the data, as Bentler (2006: 106) suggests that only values greater than 3 indicate nontrivial kurtosis. The multivariate normality also implies bivariate and univariate normality of all the variables in the model (Raykov and Marcoulides 2006: 29). Table 3 shows the parameter estimates of the baseline model at Time 1. Specifically, the three morphological awareness tasks all significantly loaded on the factor of Morphological Awareness (βs = .531, .864, and .581, all ps < .001). In the baseline structural model, all path coefficients were significant, except the unique contribution of Word Reading Fluency ($\beta = -.083$, $p = .705$) and Morphological Awareness ($\beta = .473$, $p = .063$) to Reading Comprehension.

[Table 3 Near Here]

A Wald-test suggested that removing the path from Word Reading Fluency to Reading Comprehension would not significantly affect the goodness of model fit but make the model more parsimonious. The modified model with the path removed produced $\chi^2(7) = 3.797$, $p = .802$, CFI = 1.000, SRMR = .027, and RMSEA = .000. This modified model was not significantly different from the baseline model, $\Delta\chi^2$ (1) = 0.143, $p = .705$. Given its greater parsimony, it was, therefore, accepted as the final model at Time 1. In the final model, the factor loadings had little change from the baseline model, so they were not presented in Table 3. In the structural model, Morphological Awareness was a significant predictor of Word Reading Fluency and explained 59.0% of its variance, $\beta = .768$, $p < .001$. The unique contribution of both predictors of Vocabulary Knowledge was significant, $\beta = .363$, $p < .05$ and $\beta = .443$, $p < .01$ for Morphological Awareness and Word Reading Fluency, respectively. Together, the two predictors explained about 57.5% of the variance in Vocabulary Knowledge.

With the path from Word Reading Fluency removed, there were only two predictors that directly contributed to Reading Comprehension, that is, Morphological Awareness and Vocabulary Knowledge. Together they explained about 59.8% of the variance in Reading Comprehension. After controlling for Morphological Awareness, the unique effect of Vocabulary Knowledge on Reading Comprehension was significant, $\beta = .414$, $p < .05$. Over and above Vocabulary Knowledge, the direct effect of Morphological Awareness on Reading Comprehension was also significant, $\beta = .424$, $p < .05$. The indirect effect of Morphological Awareness on Reading Comprehension was also significant in the final model, $\beta = .298$, $p < .05$. Taken together, the findings suggest that learners' morphological awareness contributed to reading comprehension directly over and above the two lexical variables, as well as indirectly through their mediation. Figure 2 shows a graphic representation of the final model.

[Figure 2 Near Here]

As shown in Figure 2, Morphological Awareness could possibly contribute to Reading Comprehension indirectly via Vocabulary Knowledge and/or the joint influence of Word Reading Fluency and Vocabulary Knowledge. In other words, there could be two possible indirect paths through which Morphological Awareness had an indirect effect on Reading Comprehension. The SEM result above only reported the total indirect effect. To disentangle component indirect effects, a bootstrapping method is recommended (Shrout & Bolger, 2002; MacKinnon, 2007). Bootstrapping is a data-based simulation method for statistical inference. It uses an empirical sample of data to generate a certain number of bootstrap samples (typically 1000) through random sampling with replacement. Parameters relevant to any indirect effect are multiplied, and the frequency distribution of new parameters resulting from the multiplication (i.e., the product) is then examined across bootstrapped samples, and a Confidence Interval (CI;

typically 95%) of the distribution is then calculated. If a CI includes zero, it is inferred that the parameter or the component indirect effect is not significant, whereas a CI that does not include zero is inferred as a significant indirect effect.

The bootstrapping analysis based on the final model of Time 1 showed a 95% CI of -.004, .137 for the indirect path through Word Reading Fluency and then Vocabulary Knowledge, and a 95% CI of .001, .317 for the path through Vocabulary Knowledge only. It is thus concluded that only the indirect effect through the mediation of Vocabulary Knowledge alone was significant.

Relationship of morphological awareness to reading comprehension at Time 2

As shown in Table 2, all Time 2 correlations were also positive and significant. In particular, the correlations of all three morphological awareness measures with reading comprehension, as well as word reading fluency and vocabulary knowledge, appeared to be stronger than those at Time 1, suggesting a possibly strengthened relationship between morphological awareness and reading abilities longitudinally.

The same SEM analysis was performed to examine how morphological awareness contributed to reading comprehension at Time 2. The same baseline model was hypothesized and first tested. The result showed $\chi^2(6) = 7.041$, $p = .317$, CFI = .997, SRMR = .029, and RMSEA = .043, suggesting that the data fit the baseline model very well. Mardia's normalized estimate was .113, indicating multivariate normality. As shown in Table 4, the three tasks of morphological awareness all significantly loaded on the factor of Morphological Awareness (βs = .665, .907, and .782; all ps < .001). All path coefficients were also significant except that of Word Reading Fluency to Reading Comprehension (i.e., the unique contribution Word Reading Fluency over and above Morphological Awareness and Vocabulary Knowledge) ($\beta = .009$, $p = .955$).

[Table 4 Near Here]

Like Time 1 analysis, to seek for model modification, we performed a Wald-test, which revealed again that removing the path from Word Reading Fluency to Reading Comprehension would make the model more parsimonious without affecting the model fit significantly. The modified model with the path removed showed very good model fit: $\chi^2(7) = 7.044$, $p = .424$, CFI = 1.000, SRMR = .029, and RMSEA = .008; it was not significantly different from the baseline model, $\Delta\chi^2(1) = 0.003$, $p = .956$. Because the modified model was more parsimonious, it was accepted as the final model at Time 2. The factor loadings had little change from those of the baseline model and were thus not provided in Table 4. In the new model, Morphological Awareness remained a significant predictor of Word Reading Fluency ($\beta = .790$, $p < .001$) and explained about 62.5% of its variance. It was also a significant and unique predictor of Vocabulary Knowledge over and above Word Reading Fluency, $\beta = .480$, $p < .01$. Word Reading Fluency was also a unique and significant predictor of Vocabulary Knowledge, $\beta = .312$, $p < .05$. Together, Morphological Awareness and Word Reading Fluency explained about 56.5% of the variance in Vocabulary Knowledge.

In the final model, Morphological Awareness and Vocabulary Knowledge were the two predictors of Reading Comprehension. Together they explained about 77.2% of the variance in Reading Comprehension. The unique effect of both predictors on Reading Comprehension was significant after controlling each other's influence, $\beta = .526$, $p < .001$ and $\beta = .418$, $p < .01$ for Morphological Awareness and Vocabulary Knowledge, respectively. The indirect effect of Morphological Awareness on Reading Comprehension was also significant, $\beta = .304$, $p < .01$. Taken together, the findings suggest that learners' morphological awareness contributed to reading comprehension both directly and indirectly at Time 2.

[Figure 3 Near Here]

Once again, we performed bootstrapping analysis based on the final model of Time 2 to disentangle the component indirect effects of morphological awareness on reading comprehension. A 95% CI of .004, .215 was found for the indirect path through Word Reading Fluency and then Vocabulary Knowledge, and that of .037, .330 for the path through Vocabulary Knowledge alone. These CIs suggest that at Time 2, morphological awareness significantly contributed to reading comprehension indirectly via both the mediation of vocabulary knowledge alone and the joint mediation of word reading fluency and vocabulary knowledge.

To statistically compare the effect of morphological awareness on reading comprehension at Time 1 and Time 2, we conducted multiple-sample SEM analysis. A baseline or unconstrained model, that is, a model that allowed all pertinent parameters to be freely estimated, was first tested and showed $\chi^2(14) = 10.770$, $p = .704$, CFI = 1.000, SRMR = .028, and RMSEA = .000. To test measurement invariance, that is, if the three tasks of morphological awareness measured the same construct across time, a modified model was tested with the factor loadings of Morphological Awareness constrained (i.e., a more parsimonious model where the factors loadings were assumed to show no significant difference between Time 1 and Time 2). The new model produced $\chi^2(16) = 13.242$, $p = .655$, CFI = 1.000, SRMR = .045, and RMSEA = .000. A Lagrange Multiplier test did not suggest that releasing any constraint, that is, allowing any factor loading parameter to be freely estimated, would significantly improve the mode fit, which suggested measurement invariance between Time 1 and Time 2.

With the measurement invariance established, structural invariance was further tested between Time 1 and Time 2 SEM models. We first tested a baseline model where all parameters of structural relationships or paths were constrained. This was the most parsimonious model that assumed all structural relationships were not different between Time 1 and Time 2. It was found that $\chi^2(21) = 20.744$, $p = .475$, CFI = 1.000, SRMR = .065, and RMSEA = .000. A Lagrange Multiplier test suggested that releasing the constraints of the path from Morphological Awareness to Reading Comprehension on one hand and that of Word Reading Fluency to Vocabulary Knowledge on the other hand would significantly improve the model fit. A modified model with the two constraints released or the two path parameters freely estimated showed $\chi^2(19) = 14.098$, $p = .716$, CFI = 1.000, SRMR = .051, and RMSEA = .000; and the model fit was significantly better than that of the baseline model, $\Delta\chi^2(2) = 6.646$, $p = .036$. Therefore, the modified model, despite being less parsimonious, was accepted as better representing how the structural relationships at Time 1 and Time 2 were related. With reference to the actual path coefficients in Tables 3 and 4, it can be concluded that the contribution of morphological awareness to reading comprehension was significantly stronger at Time 2 than at Time 1.

Relationship of Time 1 morphological awareness to Time 2 reading comprehension

Table 2 shows that the longitudinal correlations between all variables were positive and significant. In particular, all three morphological awareness measures at Time 1 were correlated significantly with Time 2 reading comprehension, so were Time 1 word reading fluency and vocabulary knowledge.

SEM analysis was further performed to examine the longitudinal effect of morphological awareness on reading comprehension development. We first tested a longitudinal baseline model where morphological awareness at Time 1 was hypothesized to predict Time 2 reading comprehension together with Time 1 word reading fluency and vocabulary knowledge as well as Time 1 reading comprehension (i.e., the autoregressor). The SEM analysis showed $\chi^2(10) = 9.636$, $p = .473$, CFI = 1.000, SRMR = .036, and RMSEA = .000, suggesting very good model fit. Mardia's kappa was -1.031, indicating multivariate normality. As shown in Table 5, among the four predictors of Time 2 Reading Comprehension, only the unique effect of Time 1 Vocabulary Knowledge was significant.

[Table 5 Near Here]

A Wald-test suggested that removing the paths from Time 1 Word Reading Fluency and Time 1 Morphological Awareness to Time 2 Reading Comprehension would increase the parsimony of the model without resulting in a significant change of the model fit. The modified model with those paths removed showed very good model fit: $\chi^2(12) = 11.936$, $p = .451$, CFI = 1.000, SRMR = .038, and RMSEA = .000; and it was not significantly different from the baseline model, $\Delta\chi^2(2) = 2.3$, $p = .317$. Give its greater parsimony, the modified model was accepted as representing the longitudinal effect of morphological awareness on reading comprehension. (See Figure 4 for a diagram of the final longitudinal model.)

[Figure 4 Near Here]

As shown in Table 5, in the modified model of longitudinal relationships, Time 2 Reading Comprehension was only predicted by its autoregressor and Time 1 Vocabulary Knowledge; and the effects of both predictors were significant, $\beta = .524$ and $\beta = .560$ (both ps < .001), respectively. Time 1 Morphological Awareness only had an indirect effect on Time 1 Reading Comprehension, and such an effect was significant, $\beta = .841$, $p < .001$. Further bootstrapping analysis revealed that among the three possible indirect paths from Time 1 Morphological Awareness to Time 2 Reading Comprehension, only the paths through the mediation of Time 1 Vocabulary Knowledge (95% CI: .062-.589) and Time 1 Reading Comprehension (95% CI: .141-.695) were significant; the path through the joint mediation of Time 1 Word Reading Fluency and Vocabulary Knowledge was not significant (95% CI: -.050-.317).

DISCUSSION

Direct and indirect effects of morphological awareness on reading comprehension

To answer the research question, SEM analyses revealed that at both Time 1 (the end of Grade 3) and Time 2 (the end of Grade 4), ESL learners' derivational awareness uniquely predicted their reading comprehension directly over and above derived word decoding fluency and vocabulary knowledge, as well as indirectly through the (joint) mediation of these two lexical competencies. The existence of a direct as well as an indirect effect seems reasonable. To illustrate, as morphology serves as a binder of orthographic, phonological, grammatical, as well as semantic information (Bowers et al., 2010), morphological awareness facilitates more rapid and accurate decoding of morphologically complex words, and promotes an analytical approach to word learning or "morphological problem solving" (Anglin 1993: 5), and subsequently, facilitates the development of vocabulary breadth, as previous research and the present study showed (e.g., Cheung et al. 2010; Kieffer and Lesaux 2012b). Because rapid word decoding and strong vocabulary knowledge, i.e., high lexical quality, underline successful comprehension (Perfetti 2007), it is naturally expected that morphological awareness would contribute to reading comprehension indirectly through the mediation of lexical skills. The direct effect of morphological awareness was theoretically plausible, too. As it was discussed earlier in the literature review, morphological awareness constitutes a set of skills that can be functional in textual comprehension, such as instantaneous resolution of vocabulary gaps and more efficient parsing of sentences during textual reading (Nagy 2007). Consequently, morphological awareness can reasonably account for a unique proportion of variance in reading comprehension over and above lexical-level skills.

Overall, the findings of the present study corroborate those of Kieffer and associates (Kieffer and Lesaux 2012a; Kieffer et al. 2013) who examined ESL learners with diverse alphabetic languages as L1s (i.e., Spanish, Filipino, and Vietnamese) in the United States. This study also expanded Kieffer and his associates' research with its use of a more appropriate reading fluency measure, and a focus on ESL learners speaking Chinese as their L1, a language that is impoverished in derivational morphology (Li and Thompson 1989). By tracking ESL learners' competencies over a year and documenting a unified pattern across time, the present study also provides more robust evidence that supports a direct as well as an indirect effect of morphological awareness on ESL reading comprehension. Taken together, those findings seem to suggest that morphological awareness is a universally important skill that facilitates reading comprehension development among learners with diverse L2 backgrounds and in diverse contexts of ESL learning.

We also disentangled the component indirect effects of morphological awareness on reading comprehension. It was found that morphological awareness essentially contributed indirectly to reading comprehension via vocabulary knowledge. Specifically, at Time 1, the indirect path through vocabulary knowledge alone was significant; at Time 2, both routes of indirect effects (through vocabulary knowledge alone as well as the joint mediation of word reading fluency and vocabulary knowledge) were significant. At neither time did morphological awareness contribute to reading comprehension indirectly through their shared variance with word reading fluency. Theoretically, the finding that an indirect effect of morphological awareness on reading comprehension via word reading fluency had to be established through vocabulary knowledge agrees with Perfetti's (2010) articulation of the relationships between decoding (D), vocabulary knowledge (V), and reading comprehension (C). In his model of DVC or "Golden Triangle of Reading Skill," Perfetti (2010) acknowledges "a strong causal relationship between decoding and comprehension in that fluent or automatic decoding allows more processing resources to be available for comprehension;" he, however, also points out that "these causal effects depend on word meanings being produced by identification. Thus knowledge of word meanings (or vocabulary knowledge) has a pivotal position between word identification and comprehension" (Perfetti 2010: 204). Such theoretical reasoning about an essential role of word meanings in the DVC triangle seems to also explain why in the present study word decoding failed to predict reading comprehension directly over and above vocabulary knowledge (and morphological awareness).

Similar findings have been reported in previous studies of Kieffer and his associates with a focus in ESL learners in the United States (Kieffer et al. 2013; Kieffer and Box 2013; Kieffer and Lesaux 2012a). While the lack of a unique or direct effect of morphological awareness on ESL reading comprehension found in those studies might be attributed to their word reading fluency measure, which did not seem to immediately tap derivational morphology, the present study confirmed their findings with a more appropriate reading fluency measure and a focus on learners in a non-English-monolingual context. Taken together, the findings of previous studies and the present one across contexts of English learning provide clear evidence that word decoding fluency itself does not seem to play a significant mediating role in morphological contribution to reading comprehension; any indirect effect of morphological awareness on reading comprehension through word decoding fluency needs to be established through word meanings or vocabulary knowledge.

Increasing contribution of morphological awareness to reading comprehension

Our second research question addressed a possibly strengthened relationship of morphological awareness to ESL reading comprehension over time. The bivariate correlations appeared stronger at Grade 4 than at Grade 3. The parameter estimates shown in Tables 3 and 4 suggested that morphological awareness tended to have a stronger role in the model that predicted reading comprehension, and together with vocabulary knowledge, explained a larger proportion of variance in reading comprehension at Time 2. Multiple-group SEM analysis that directly compared path coefficients in the models of the two times further revealed a significantly greater direct effect of morphological awareness on reading comprehension at Time 2 than at Time 1.

The early stage of reading acquisition is characterized by a heavy reliance on phonological strategies rather than morphological strategies (e.g., Fowler and Liberman 1995). However, as learners progress in their development of English proficiency, morphological awareness tends to play a more important role in reading. On one hand, those with better morphological insights tend to be increasingly more strategic in word learning and identification of words in print, and subsequently, have a higher lexical quality and better textual comprehension; on the other hand, the increasingly refined morphological awareness may also better facilitate other processes in textual comprehension (Nagy 2007). Therefore, it can be expected that both direct and indirect effects of morphological awareness on reading comprehension could become stronger longitudinally. Such theoretical reasoning appeared to be supported by a few cross-sectional studies on English-speaking students (Foorman et al. 2012) as well as ESL learners (e.g., Kieffer and Lesaux 2008; Lam et al. 2012). The present longitudinal study expands previous research with the finding of a greater effect of morphological awareness on reading comprehension at a later stage of ESL learning. It provides more rigorous evidence that supports an increasingly important role of morphology in reading comprehension development among ESL learners.

Longitudinal effect of morphological awareness on ESL reading comprehension

To answer the third research question, our SEM analysis did not reveal a significant, unique longitudinal effect of Time 1 morphological awareness on Time 2 reading comprehension after accounting for Time 1 vocabulary knowledge and the autoregressive effect. However, Time 1 morphological awareness had a significant indirect effect on Time 2 reading comprehension through the mediation of vocabulary knowledge (and the autoregressor).

The pivotal, mediating role of vocabulary knowledge in establishing the above longitudinal relationship does not seem a surprise, given that morphology is essentially about meaning, and morphological analysis is a highly useful and reliable mechanism for acquiring meanings of new words or vocabulary growth, which is essential to textual comprehension (Authors 2012b; Perfetti, 2007; Quinn et al. 2015). Such a finding also corroborates that of Goodwin et al. (2013), which examined a similar topic with a focus on Spanish-speaking ELLs. The longitudinal SEM results of the study showed that learners' Grade 4 morphological awareness failed to have a unique effect on Grade 5 reading comprehension after accounting for the influence of concurrent word reading and reading vocabulary measures; Grade 4 morphological awareness only had a significant indirect effect on Grade 5 reading comprehension through the mediation of Grade 5 reading vocabulary.

Given the critical import of morphology in reading comprehension, it seems puzzling that a unique, longitudinal effect of morphological awareness failed to emerge in the current study. The lack of such an effect also seems to contradict a previous study that addressed a similar issue among young Chinese-speaking ESL learners in North America (Lam et al. 2012). Instead of simply concluding that morphological awareness does not play any direct or causal role in the development of reading comprehension among ESL learners in a non-English-monolingual context, we speculate that the divergence of findings might be related to the short span of the current study (no more than a year); and a significant longitudinal effect of morphological awareness might take a longer time to emerge. After all, the concurrent analysis in this study found that the unique effect of morphological awareness on reading comprehension tended to be small after controlling for word reading fluency and vocabulary knowledge.

A couple of limitations of the present study should be noted. Firstly, when measuring learners' derived word decoding skill, we focused only on decoding fluency without addressing basic decoding accuracy. It would be interesting to consider both fluency and accuracy in future research and examine how morphological awareness might or might not demonstrate differential direct and/or indirect relationships with reading comprehension. Secondly, how we assessed the learners might have had an influence on what we have found about the predictive relationships. For example, to reduce time constraints of data collection, we selected a limited number of sets of words in the PPVT-IV and group-administered the same words to all children rather than testing them individually following a procedure of identifying unique basal and ceiling sets for each one of them. While some variance in learners' vocabulary knowledge was established by the task (with no ceiling or floor effects at both times) to allow for subsequent covariance structural modeling, it might have been better and more adequately represented should a standard procedure of administration had been followed.

CONCLUSIONS

Through SEM and model-based bootstrapping analyses, we examined the concurrent as well as longitudinal effects of morphological awareness on ESL reading comprehension. With a focus on young Chinese-speaking learners, we found that derivational awareness directly and significantly predicted ESL reading comprehension over and above the influence of learners' lexical skills; it also indirectly contributed to ESL reading comprehension primarily via learners' vocabulary knowledge; and the contribution also became strengthened over time.

The significant effects of derivational awareness on vocabulary knowledge and reading comprehension highlight a need of focused instruction on English derivational morphology. Previous studies on English-speaking students have provided converging evidence for the effect of direct teaching of morphology on vocabulary and reading development (see a recent meta-analysis by Bowers et al. 2010). While the focus of the present study was on young English learners in a multilingual society with an L1 typologically distant from English (i.e., Chinese), the pedagogical implication is certainly boarder for reading development among diverse groups of English learners. The contexts of English learning and learners' L1 backgrounds may vary; an inherent property of English print, however, remains that there is a prevalence of morphologically complex words, particularly derivational words (Nagy and Anderson 1984). To promote the development of insights into English morphology, activities that involve analysis of isolated English words, such as segmenting affixes from derived words and identifying base morphemes and categorizing derived words with affixes that have different meanings and grammatical functions (e.g., *-ful*, *-ize*, and *-ment*), can be helpful. Learners' L1, such as cognates and other morphological processes, can also be a good instructional resource, given the recent research finding that L1 morphological awareness is often a unique and significant correlate of L2 vocabulary and word decoding (or cross-linguistic transfer of morphological awareness) (e.g., Cheung et al. 2010). On the other hand, it seems more desirable that morphology is taught with activities contextualized in reading practice (e.g., practicing "morphological problem solving" and using grammatical information of derivational suffixes during textual reading) so that morphological teaching does not stop at the lexical level (e.g., expanding the vocabulary repertoire) and learners could be more strategic users of their morphological insights in dealing with issues in textual comprehension.

NOTE

1. Given that the children were L2 learners of English in a non-English-monolingual setting, Set 7 (Start Age 8) rather than Set 8 (Start Age 9) was chosen to measure their oral, receptive vocabulary knowledge when they were about 9.48 years old and first tested at the end of Grade 3. Five sets of 60 words were chosen to balance a capacity to capture adequate variance of vocabulary knowledge in the participants for covariance structure modeling and time constraints of data collection.

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Table 1: Performance on all tasks at Time 1 and Time 2

	Time 1		Time 2	
	Mean	*SD*	*Mean*	*SD*
Morphological Relatedness	22.20	5.00	25.06	4.59
Affix Choice (real)	8.38	3.20	10.02	3.59
Affix Choice (pseudo)	6.77	3.12	8.19	3.64
Word Reading Fluency	14.31	7.70	23.30	11.28
Vocabulary Knowledge	36.80	9.93	44.92	10.04
Reading Comprehension	5.08	2.52	6.51	2.72

Table 2: Bivariate correlations between morphological awareness and reading at Time 1 (T1) and Time 2 (T2)

	1	2	3	4	5	6	7	8	9	10	11	12
T1 Morphological Relatedness	—											
T1 Affix Choice (real)	.445	—										
T1 Affix Choice (pseudo)	.241	.528	—									
T1 Word Reading Fluency	.432	.640	.424	—								
T1 Vocabulary Knowledge	.419	.576	.332	.659	—							
T1 Reading Comprehension	.331	.486	.344	.462	.537	—						
T2 Morphological Relatedness	.524	.513	.340	.564	.505	.350	—					
T2 Affix Choice (real)	.494	.718	.492	.651	.595	.343	.571	—				
T2 Affix Choice (pseudo)	.372	.617	.633	.585	.473	.348	.505	.732	—			
T2 Word Reading Fluency	.392	.610	.384	.818	.644	.430	.583	.699	.583	—		
T2 Vocabulary Knowledge	.462	.654	.363	.663	.861	.538	.535	.636	.478	.653	—	
T2 Reading Comprehension	.485	.616	.403	.629	.701	.552	.497	.635	.539	.585	.647	—

Note. All correlations were significant at $p < .001$ except $p < .05$ for $r = .241$.

Table 3: Parameter estimates of the model testing the concurrent relationship of morphological awareness to reading comprehension at Time 1

	Predictor	Direct Effect		Indirect Effect	Total Effect
		β	R^2	*β*	*β*
	Factor Loadings of the Measurement Model				
MorRel1	← MA1	.531***	.282	–	–
AffChoR1	← MA1	.864***	.746	–	–
AffChoP1	← MA1	.581***	.337	–	–
	Parameter Estimates of the Structural Model (Baseline)				
WorFlu1	← MA1	.774***	.599	–	.774***
Vocab1	← MA1	.365*	.576	.341*	.706***
	← WorFlu1	.440**		–	.440**
ReaCom1	← MA1	.473	.610	.249	.722***
	← Vocab1	.444*		–	.444*
	← WorFlu1	-.083		.195	.112
	Parameter Estimates of the Structural Model (Modified)				
WorFlu1	← MA1	.768***	.590	–	.768***
Vocab1	← EMA1	.363*	.575	.340**	.703***
	← WorFlu1	.443**		–	.443**
ReaCom1	← MA1	.414*	.598	.298*	.712***
	← Vocab1	.424*		–	.424*
	← WorFlu1	–		.188	.188

Note. MorRel1 = Time 1 Morphological Relatedness; AffChoR1 = Time 1 Affix Choice (real); AffChoP1 = Time 1 Affix Choice (pseudo); MA1 = latent variable of Morphological Awareness at Time 1; WorFlu1 = latent variable of Time 1 Word Reading Fluency; Vocab1 = latent variable of Time 1 Vocabulary Knowledge; ReaCom1 = latent variable of Time 1 Reading Comprehension.

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 4: Parameter estimates of the model testing the concurrent relationship of morphological awareness to reading comprehension at Time 2

	Predictor	Direct Effect		Indirect Effect	Total Effect
		β	R^2	β	β
	Factor Loadings of the Measurement Model				
MorRel2	← MA2	.665***	.442	–	–
AffChoR2	← MA2	.907***	.823	–	–
AffChoP2	← MA2	.782***	.612	–	–
	Parameter Estimates of the Structural Model (Baseli)				
WorFlu2	← MA2	.790***	.624	–	.790***
Vocab2	← MA2	.480**	.565	.247*	.727***
	← WorFlu2	.313*		–	.313*
ReaCom2	← MA2	.519**	.771	.310	.830***
	← Vocab2	.417**		–	.417**
	← WorFlu2	.009		.130	.139
	Parameter Estimates of the Structural Model (Modified)				
WorFlu2	← MA2	.790***	.625	–	.790***
Vocab2	← MA2	.480**	.565	.247*	.727***
	← WorFlu2	.312*		–	.312*
ReaCom2	← MA2	.526***	.772	.304**	.831***
	← Vocab2	.418**		–	.418**
	← WorFlu2	–		.131	.131

Note. MorRel2 = Time 2 Morphological Relatedness; AffChoR2 = Time 2 Affix Choice (real); AffChoP2 = Time 2 Affix Choice (pseudo); MA2 = latent variable of Morphological Awareness at Time 1; WorFlu2 = latent variable of Time 2 Word Reading Fluency; Vocab2 = latent variable of Time 2 Vocabulary Knowledge; ReaCom2 = latent variable of Time 2 Reading Comprehension.

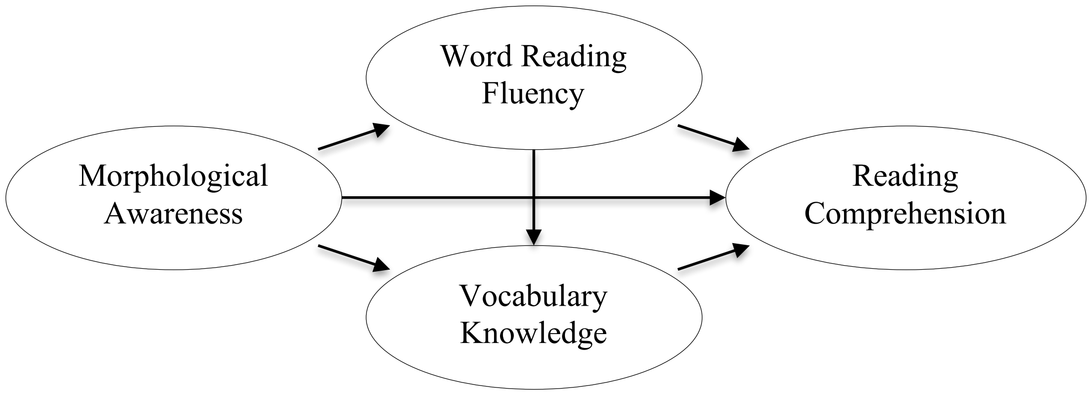
* $p < .05$ ** $p < .01$ *** $p < .001$

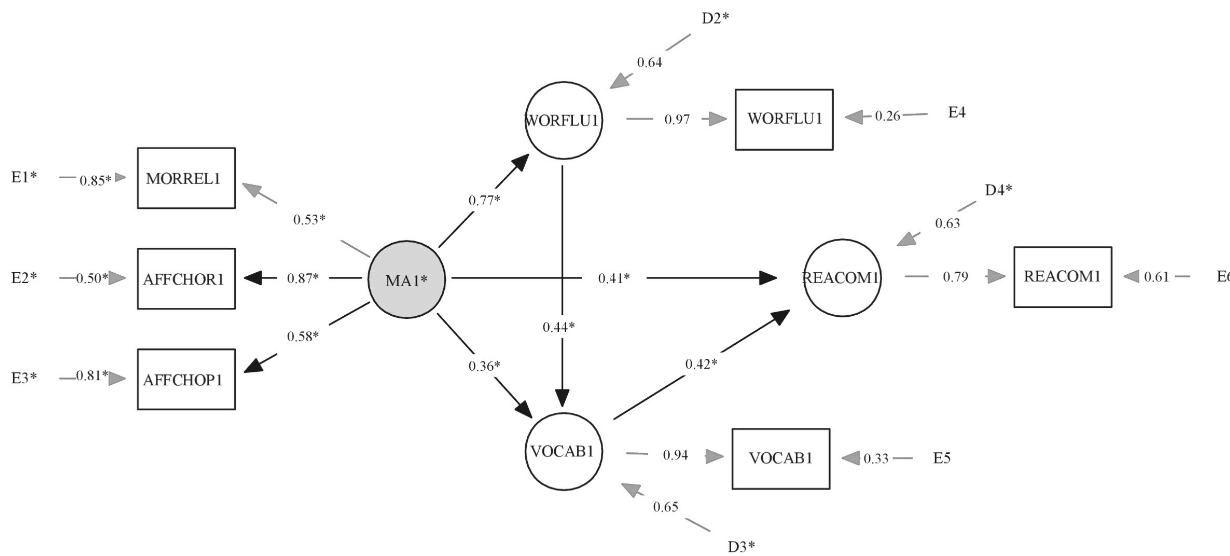
Table 5: Parameter estimates of the model testing the longitudinal effect of morphological awareness on reading comprehension

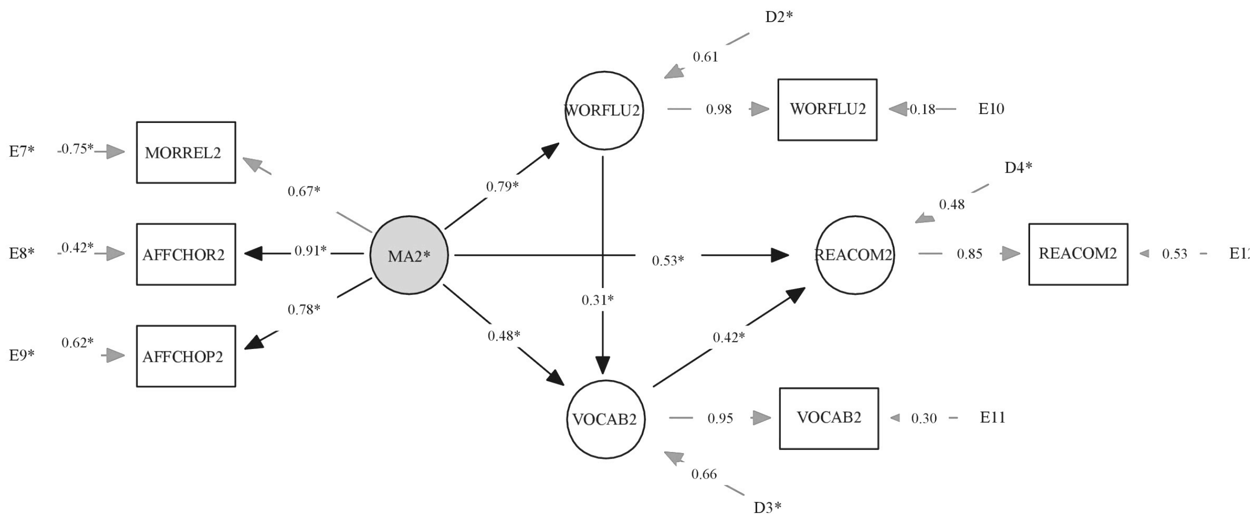
	Predictor	Direct Effect		Indirect Effect	Total Effect
		β	R^2	*β*	*β*
Parameter Estimates of the Baseline Model					
ReaCom1	← MA1	.743***	.553	–	.743***
WorFlu1	← MA1	.813***	.661	–	.813***
Vocab1	← MA1	.528*	.604	.232	.759***
	← WorFlu1	.285		–	.285
ReaCom2	← ReaCom1	.279	.924	–	.279
	← Vocab1	.438**		–	.438**
	← WorFlu1	-.014		.125	.110
	← MA1	.371		.528	.899***
Parameter Estimates of the Modified Model					
ReaCom1	← MA1	.793***	.629	–	.793***
WorFlu1	← MA1	.809***	.655	–	.809***
Vocab1	← MA1	.513*	.609	.232	.759***
	← WorFlu1	.305		–	.305
ReaCom2	← ReaCom1	.524***	.941	–	.524***
	← Vocab1	.560***		–	.560***
	← WorFlu1	–		.171	.171
	← MA1	–		.841***	.841***

Note. MA1 = latent variable of Morphological Awareness at Time 1; WorFlu1 = latent variable of Time 1 Word Reading Fluency; Vocab1 = latent variable of Time 1 Vocabulary Knowledge; ReaCom1 = latent variable of Time 1 Reading Comprehension; ReaCom2 = latent variable of Time 2 Reading Comprehension.

* $p < .05$ *** $p < .001$


Word Reading Fluency
Morphological Awareness
Reading Comprehension
Vocabulary Knowledge


D2*
0.64
WORFLU1
0.97
WORFLU1
0.26
E4
E1*
0.85*
MORREL1
0.53*
0.77*
D4*
0.63
E2*
0.50*
AFFCHOR1
0.87*
MA1*
0.41*
REACOM1
0.79
REACOM1
0.61
E6
0.44*
0.58*
E3*
0.81*
AFFCHOP1
0.36*
0.42*
VOCAB1
0.94
VOCAB1
0.33
E5
0.65
D3*


D2*
0.61
WORFLU2
0.98
WORFLU2
0.18
E10
E7*
0.75*
MORREL2
0.67*
0.79*
D4*
0.48
E8*
0.42*
AFFCHOR2
0.91*
MA2*
0.53*
REACOM2
0.85
REACOM2
0.53
0.31*
0.78*
0.48*
0.42*
E9*
0.62*
AFFCHOP2
VOCAB2
0.95
VOCAB2
0.30
E11
0.66
D3*

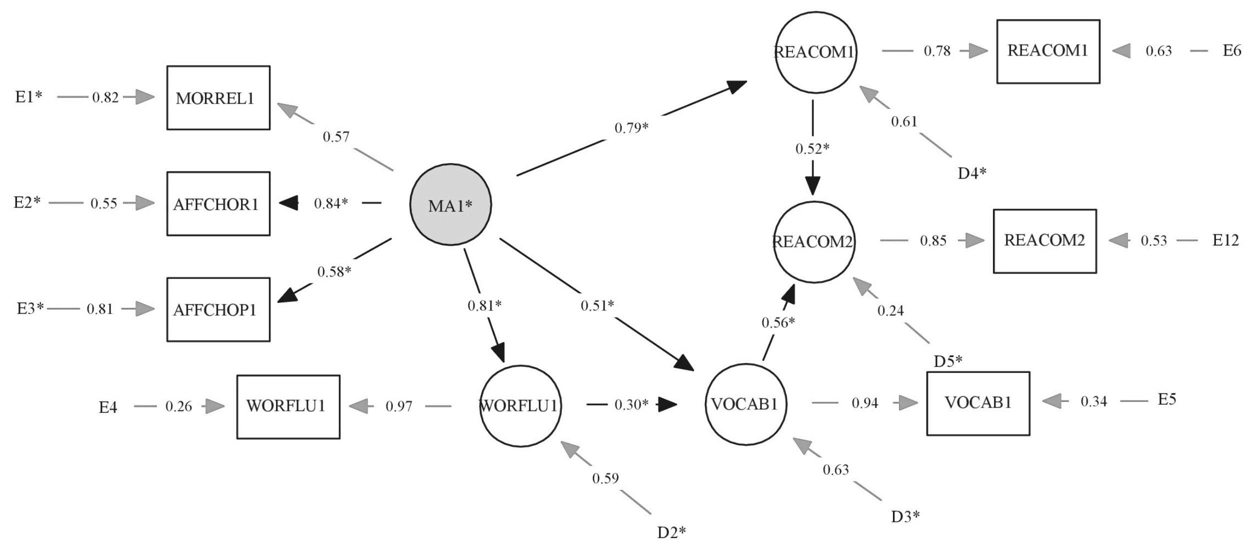

E1*
0.82
MORREL1
0.57
E2*
0.55
AFFCHOR1
0.84*
MA1*
E3*
0.81
AFFCHOP1
0.58*
E4
0.26
WORFLU1
0.97
WORFLU1
0.81*
0.51*
0.30*
VOCAB1
0.94
VOCAB1
0.34
E5
0.59
D2*
0.63
D3*
0.79*
REACOM1
0.78
REACOM1
0.63
E6
0.61
D4*
0.52*
REACOM2
0.85
REACOM2
0.53
E12
0.56*
0.24
D5*

Figure 1. Baseline model showing the structural relationships between morphological awareness, word reading fluency, vocabulary knowledge, and reading comprehension.

Figure 2. Final model of the concurrent relationship of morphological awareness to reading comprehension at Time 1

MORREL1 = Time 1 Morphological Relatedness; AFFCHOR1 = Time 1 Affix Choice (real); AFFChOP1 = Time 1 Affix Choice (pseudo); MA1 = latent variable of Morphological Awareness at Time 1; WORFLU1 = latent variable of Time 1 Word Reading Fluency; VOCAB1 = latent variable of Time 1 Vocabulary Knowledge; REACOM1 = latent variable of Time 1 Reading Comprehension.

Figure 3. Final model of the concurrent relationship of morphological awareness to reading comprehension at Time 2

MORREL2 = Time 2 Morphological Relatedness; AFFCHOR2 = Time 2 Affix Choice (real); AFFChOP2 = Time 2 Affix Choice (pseudo); MA2 = latent variable of Morphological Awareness at Time 2; WORFLU2 = latent variable of Time 2 Word Reading Fluency; VOCAB2 = latent variable of Time 2 Vocabulary Knowledge; REACOM2 = latent variable of Time 2 Reading Comprehension.

Figure 4. Final model of the longitudinal relationship of Time 1 morphological awareness to Time 2 reading comprehension

MORREL1 = Time 1 Morphological Relatedness; AFFCHOR1 = Time 1 Affix Choice (real); AFFChOP1 = Time 1 Affix Choice (pseudo); MA1 = latent variable of Morphological Awareness at Time 1; WORFLU1 = latent variable of Time 1 Word Reading Fluency; VOCAB1 = latent variable of Time 1 Vocabulary Knowledge; REACOM1 = latent variable of Time 1 Reading Comprehension; REACOM2 = latent variable of Time 2 Reading Comprehension.