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# Relations of emergent literacy skill development with conventional literacy skill development in Korean

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# Relations of growth trajectories of emergent literacy skills with development of conventional literacy skills in Korean

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Abstract

The present study investigated relative contributions of initial status and growth rates of emergent literacy skills (i.e., phonological awareness, letter-name knowledge, vocabulary, and rapid serial naming) to initial status and growth rates of conventional literacy skills (i.e., word reading, pseudoword reading, and spelling) for young Korean children. A total of 215 four-year-old children were followed for approximately 15 months. Results showed (1) consistent effects of letter-name knowledge, phonological awareness, and rapid serial naming on conventional literacy skills, and (2) the importance of children's initial level in the emergent literacy skills for achieving conventional literacy skills. These results are discussed in light of characteristics of the Korean language and writing system.

Word count: 110

Key words: Relative contributions, Emergent literacy skills, Longitudinal, Korean, Pseudoword reading, Spelling, Word reading

The last three decades of research have identified several emergent literacy skills that are critical for early literacy acquisition in languages that have alphabetic writing systems, such as phonological awareness, alphabet knowledge, and rapid serial naming (Adams, 1990; Amtmann, Abbott, & Berninger, 2007; Snow, Burns, & Griffin, 1998; Wolf & Bowers, 1999). However, less clear from these previous studies is relative contributions of these emergent literacy skills to conventional literacy skills achievement, particularly in languages other than English. Furthermore, there is a paucity of research on how the development of important emergent literacy skills are related to development of conventional early literacy skills (e.g., decoding and spelling). In other words, it is not clear whether and, if so, to what extent individual differences in growth rates of emergent literacy skills matter for growth of conventional literacy skills. In the present study, we address these gaps in the literature by examining how initial status and growth rates of phonological awareness, letter-name knowledge, vocabulary, and rapid serial naming are related to initial status and growth rates of word reading, pseudoword reading, and spelling skills for young Korean children.

The Korean language has an alphasyllabary writing system, called Hangul. That is, phonology and orthography are mapped in multiple units in Korean, both at the syllable and phoneme levels. Thus, in principle phonemes are encoded into graphemes, but the syllable is also saliently represented in orthography. As an example, the four phonemes of a two syllable word, tree /na.mu/ is organized into two syllable blocks of two phonemes in each syllable, 나무, rather than a linear horizontal string of four letters, ㄴ ㅏ ㅁ ㅜ. This nonlinear composition of letters into syllables lends visual saliency to the syllable. Given this orthographic characteristic, children's understanding of sound structures (i.e., phonological awareness) at the syllable and phoneme level might be particularly relevant to children's early literacy acquisition. Indeed, previous cross-sectional studies have shown that syllable awareness and phoneme awareness (Cho & McBride-Chang, 2005; Cho et al., 2008; Kim, in press$_a$) contribute to literacy skills. In the present study, syllable awareness and phoneme awareness were included to investigate their relative contributions to early literacy acquisition such as word reading, peudoword reading, and spelling in Korean.

Alphabet knowledge is another important skill in early literacy acquisition in Korean (Kim, 2009; in press$_a$; in press$_b$). It was speculated that letter-name knowledge may have a particularly large impact on literacy acquisition in Korean (Kim, 2009) because of consistent phonological patterning of Korean letter names and consistent and systematic cues for sounds that the letter names offer. The vast majority of the Korean letter names have a CVVC pattern, and the consonant in the CV syllable contains the sound value of a consonant when in the onset position whereas the consonant in the VC syllable contains the sound values of a consonant when in the coda position. These systematic and explicit cues for sound values for consonants in different positions are critical because 19 consonant sounds in the onset position become reduced to seven sounds in the coda position, resulting in different sounds for many consonants when in the onset vs. coda (e.g., ㅅ represents /s/ in the onset but /-t̚/ in the coda) (Kim, 2009). Furthermore, Korean letter names have an invariant one-to-one relation with letter sounds, which may facilitate induction of letter sounds from letter names. Notably, vowel letter names represent sounds.

Rapid serial naming of alphanumeric symbols has shown to be related to word reading for typically developing readers as well as those with reading disabilities in English (see for reviews Scarborough, 1998; Wolf & Bowers, 1999) although it is not clear what a rapid serial naming task captures that are critical for word reading, e.g., phonologically based information argued by Torgesen, Wagner, Rashotte, Burgess, & Hecht (1997) or processing speed and integration of lower level visual processes with higher level cognitive and linguistic processes argued by Wolf & Bowers (1999). The unique role of rapid serial naming in literacy acquisition appears to be somewhat inconsistent in Korean. In Cho and McBride-Chang's (2005) study, rapid serial naming was not related to word reading for kindergartners and second grade children once phonological awareness and vocabulary were taken into consideration. In contrast, for four- and five-year-old children, rapid serial naming was related to word reading even after accounting for vocabulary, phonological awareness, visual skills, and morphological awareness (Cho et al., 2008).

Vocabulary is another skill that has received recent attention for its potential, direct contribution to early literacy acquisition. The connectionist models of reading (e.g., Bishop & Snowling, 2004; Plaut, McClelland, Seidenberg, & Patterson, 1996) hypothesize that semantic knowledge interacts with orthography and phonology and is directly related to word reading, particularly for exception word reading. In fact, recent studies provide initial evidence for this hypothesis (Nation & Snowling, 2004; Ricketts, Nation, & Bishop, 2007). Vocabulary is also hypothesized to have an indirect relation with word reading via phonological awareness. According to the lexical restructuring model (Metsala & Walley, 1998; Walley, Metsala, & Garlock, 2003), vocabulary is the primary force for development of phonological representations, which, in turn, is critical for word reading development. Positive correlations between vocabulary and phonological awareness have been reported in Korean (Cho et al., 2008; Kim, in press$_b$) as well as in English (e.g., Bowey & Francis, 1991; Burgess & Lonigan, 1998; Chaney, 1992; Lonigan, 2006; Rvachew, 2006).

In the present study, we examined relative effects of emergent literacy skills on conventional literacy skills in Korean, using longitudinal data from young Korean children. Specifically, we investigated whether and, if so, to what extent initial status and growth in emergent literacy skills (i.e., phonological awareness, letter-name knowledge, receptive vocabulary, and rapid serial naming of digits) are related to growth trajectories (i.e., initial status and growth rate) of conventional literacy skills such as word reading, pseudoword reading, and spelling in Korean. The findings will reveal important information about how language and orthography characteristics (e.g., differences in phonological structures, letter naming systems, and transparency of orthography) influence magnitudes of relations between emergent and conventional literacy skills across languages.

## Method

### Recruitment of Sample

The present study used longitudinal data reported elsewhere (Kim, 2008; 2009). A total of 215 four- and five-year-old children were attending five preschools in two metropolitan cities in South Korea. These children were from low to low-average socioeconomic family backgrounds. Among the 215 children, 128 children participated in the study from the first wave of data collection and 87 children joined in the second wave.

Teachers at each site reported no hearing or visual difficulties for the sampled children. Table 1 shows the sample children's average age and gender distribution at each wave. At first wave, children were approximately 56 months old (ranging from 50 to 64 months), on average, and 53% were boys. The overall attrition rate was 34%. This high attrition rate was primarily due to change of academic year and school transfers that occurred between the third and fourth wave of data collection. Analyses showed that children who left the study were not different from children who remained in the study in language and literacy skills measured in the presents study, and thus, attrition appear to be random (see below; also see Kim, 2009 for details)

<Insert Table 1 here>

Instructional context

The vast majority of children in Korea receive literacy instruction and have developed fundamental literacy skills prior to formal schooling in grade one (Korean Association of Child Studies & Hansol Education Research Center, 2002). Preschools, called children's house, typically provide early literacy instruction in Korean. A whole word approach (i.e., the word is the unit of instruction) has been a predominant instructional method in early literacy instruction in Korea since the 90s (Cho et al., 2008; Kim, 2007). Informal observations indicated that the teachers at the participating preschools predominantly employed a whole word approach without systematic and explicit instruction on the phoneme-grapheme correspondences in Korean. Much emphasis was placed on recognizing words as a whole by using flash cards and numerous copying of words.

Procedures

Data were collected four times, each in the beginning, middle, end of the first year of preschool (typically four-year-olds), and three months into the second year of preschool (i.e., five-year-olds). Because identical instruments were administered for emergent literacy and conventional literacy skills in all the four waves of data collection, the order of items and the order of options within items were randomized on each occasion of measurement to minimize practice effects (the exceptions were in the vocabulary and spelling measures). The assessment battery was individually administered to each child in a quiet room in two sessions, each taking approximately 30-35 minutes. The spelling task was group-administered (i.e., three to four students).

## Measures

Because there were no standardized instruments that measure language and literacy skills in Korean, instruments were developed and piloted with children of similar background and age. The internal-consistency reliability for each measure was estimated by Cronbach's alpha except serial digit naming for which test-retest reliability was estimated. Table 1 displays descriptive statistics and reliability estimates for each measure in the study.

## Outcomes

Word reading. This task measured children's ability to read real words in Korean. The measure included 60 high frequency real words of increasing difficulty with two practice items. The words increased in difficulty by including longer words (i.e., starting with monosyllabic words and progressively including two, three, and four syllable words) and complex vowels, double consonants, and phonologically opaque words. Phonologically opaque words have mismatches between phonological realizations and orthographic representations due to applications of phonological rules (see Kim, in $press_b$). The child was asked to read aloud each of the words and testing was discontinued after three consecutive incorrect items. Each item was scored dichotomously to provide a total maximum score of 60.

Pseudoword reading. This task measured children's decoding skills. Fifty pseudowords of increasing difficulty were created based on Korean phonotactic rules (rules of allowable sound sequences). Similar to the word reading task, the difficulty of items increased by including progressively longer words (from monosyllabic words to five syllable words) and complex vowels, and adding coda[1] and phonologically opaque words. Children were told that the words in this task were not real and asked to read aloud each word as best as they could. Testing was discontinued after three consecutive incorrect items. It had two practice items. Each item was scored dichotomously to provide a total maximum score of 50.

Spelling. This was a dictation task assessing child's ability to spell words (encode sounds graphically). It included 16 real words and four pseudowords. The spelling words were composed of one to four syllable words which were phonologically transparent (12 items) and opaque (8 items). Each item was scored dichotomously to provide a total maximum score of 20. As expected, spelling was difficult for children of this age such that there was a floor effect, particularly at first wave ($M = 1.09$, $SD = 2.21$). Sixty-three percent of the children ($n = 69$) scored zero at first wave.

Primary Question Predictors

[1] Reading words with coda is more challenging in Korean due to coda neutralization, i.e., many consonants have different sound values when in onset vs. coda (see Kim, 2007).

Syllable awareness. An oddity task was used to measure children's syllable awareness. In this task, children were asked to select odd words (words that have different sounds) from among three words. For example, the child was asked to select one word that has a different sound among three words (e.g., /moca/, /hutʃu/, /morɛ/; see Kim 2008 for the items). All the words were of two syllables with varying syllable structures (CV.CV, CV.CVC, CV.VC, CVC.CV, and CVC.CVC). In order to reduce memory burden, corresponding pictures were presented with each word. All the words were common Korean words that students encounter in everyday interactions. Directions were presented orally. Children were asked to repeat each stimulus word to ensure their correct perception of items. There were two practice items and 15 test items. The students received feedback and explanations on their responses for the practice items. For the first two test items, correct answers were provided without feedback. Testing was discontinued after four consecutive incorrect items. Each item was scored dichotomously to provide a total maximum score of 15.

Phoneme awareness. An oddity task was used to assess children's phoneme awareness. For example, a child was asked to identify a word with the odd word out from among three words that differed in the onset (e.g., /kal/, /koŋ/, & /tul/; see Kim 2008 for the items included in the phoneme oddity task). There were three practice items with 15 experimental items. The first five items had monosyllabic words with a CV structure; the next five items monosyllabic words with a CVC structure; and the last five words two syllable words with a CV structure (i.e., CV.CV). Testing was discontinued after four consecutive incorrect items.

An oddity task is believed to tap into "implicit" phonological awareness, and previous studies with English-speaking children have reported inconsistent results for the reliability of an oddity task, some finding reasonable reliability (Muter, Hulme, Snowling, & Stevenson, 1994) and others low reliability (Hulme et al., 2002; Schatschneider, Francis, Foorman, Fletcher & Mehta, 1999). The oddity task requires children to select a correct answer from a set of options, and inherently has a possibility for a chance level performance as does any task with a multiple choice format. In the present study, the percentages of children performing above chance level (i.e., scoring 6 or above) in the syllable oddity task were 41, 63, 64, and 79 for time one to four, respectively. In the phoneme awareness task, the percentages were 22, 16, 22, and 17 for time one to four, respectively. The low rate in the phoneme oddity task reflects that children in the sample had a difficulty with the phoneme awareness task. However, if children performed at chance in these tasks, it would have been reflected in the reliability estimate (i.e., Cronbach's alpha). Because internal consistency measured by Cronbach's alpha is influenced by both the number of items in a test as well as intercorrelations among the items, students who were merely guessing would have a low probability of getting the items correct solely on chance. For example, the probability for a child to get two items correct solely by chance is 17%, and this chance rate decreases exponentially for multiple items. Therefore, if children had performed at chance, the intercorrelations among the items would be low and consequently Cronbach's alpha estimates would be low as well. However, as seen in Table 1, the Cronbach's alpha estimates for syllable awareness and phoneme awareness tasks were reasonably high (.90 and .87, respectively; also see in Kim, 2008 about a pilot study result).

Receptive vocabulary. The receptive vocabulary measure, the Peabody Picture Vocabulary Test-Revised (PPVT-R, Dunn & Dunn, 1981), was modified to suit the Korean context based on pilot work. The instrument contained 66 vocabulary words of increasing difficulty. The test administration was discontinued after five consecutive incorrect items. As Table 1 shows, children's average vocabulary increased over time steadily from 34 words in the first wave to 48 words in the last wave.

Letter-name knowledge. Letter-name measure included 40 Korean letters (10 simple and 11 complex vowels, and 19 consonants) that were arranged in a random order. Children were asked to say the name of each letter. Each item was scored dichotomously to provide a total maximum score of 40.

Rapid serial naming. The Numbers subtest of the Rapid Automatized Naming and Rapid Alternating Stimulus Tests (Wolf & Denckla, 2005) was used. This task presents five different digits repeated randomly 10 times in five rows, requiring children to name all the stimuli presented as rapidly as possible. In the analysis, the latency score was used, not accuracy, because as expected, there were few errors in accuracy. Specifically, the mean scores for waves one to four were 47.47 (SD = 7.06), 49.21 (SD = 3.30), 49.51 (SD = 3.99), and 49.71 (SD = 1.04), respectively, out of a possible total score of 50.

## Data Analytic Strategies

### Multilevel Growth Modeling

A combination of multilevel modeling and dominance analysis were the primary analytic procedures in the present study. Multilevel growth modeling was used in order to estimate students' average level of performance at the beginning of the study (i.e., initial status) as well as the average rate of change for each of the predictors (e.g., letter-name knowledge and RAN-numbers) and outcomes (e.g., spelling). Since participants were assessed on measures multiple times during 15 month span, growth over time can be viewed as being nested within each individual (thus multilevel). The estimates obtained from the growth models of emergent literacy (i.e., individual variation around the average initial status and growth rate) were then used in a dominance analysis as predictors of growth trajectories of conventional literacy skills. The dominance analysis revealed which predictor(s) made significant contributions to explaining variation in conventional literacy outcomes.

In order to select the most valid model to describe growth across tasks, a series of models that contained a combination of fixed and random parameters were estimated. Fixed parameters were the mean predicted initial status scores and growth rate across the students, while random parameters were the estimation of variability around the mean (i.e., variance components). The two models that were examined included a linear growth model with a random intercept and a fixed slope and a linear growth model with a random intercept and a random slope.

Each of the models was estimated using Hierarchical Linear Modeling 6.06 (Raudenbush, Bryk, Cheong, & Congdon, 2004), and the individual Empirical Bayes rates for each student were retained. The individual student slope from the linear model was the amount of growth per month students made for the given task the model estimated. As previously described, individual students' initial status and growth rates from these models were estimated and subsequently used in a dominance analysis to predict word reading, pseudoword reading, and spelling.

Dominance Analysis

Many studies that examined the concurrent or predictive utility of emergent reading skill measures have used stepwise or hierarchical regression techniques in order to evaluate the unique contribution of a predictor in a model that includes other correlated variables. Because variables in the social sciences are often correlated, these methods are sensitive to order of entry in the regression equations. Hierarchical multiple regressions assume that the order of entry for each predictor has been theoretically justified a priori to analysis; thus, the order with which each is added to the model affects the estimate of the unique variance component. More limiting than the hierarchical regression is the use of a stepwise regression, which is widely denigrated as an inefficient and often inappropriate method to estimate unique variances since it relies on statistical software-based decisions, rather than using empirical evidence to guide the analysis (Thompson, 1995). Budescu (1993) developed a method of multiple regression, called dominance analysis, that addresses the nature of correlated predictors. Dominance involves the pairwise comparisons of all predictors as they relate to a criterion (Budescu, 1993). Predictor A (e.g., initial status of letter-name knowledge) is considered more important, or dominant, over Predictor B (e.g., initial status of phonological awareness) in predicting the criterion (e.g., spelling slope) if the unique variance contribution to the criterion of Predictor A is greater than Predictor B when both are simultaneously in the model with and without other predictors. This method is superior to hierarchical regression in many circumstances because it provides a more intuitive result for comparing the relative importance of a predictor to an outcome. A particular limitation of interpreting coefficients from a hierarchical regression is that both the regression coefficient (i.e., $\beta$) and the unique variance estimate (i.e., $R^2$) are contextualized according to the order of entry that the researcher uses for the particular predictor variable. Thus, the amount of unique variance that an independent variable contributes will change if it is the first or the last variable entered into the hierarchical regression. Azen and Budescu (2003) noted that dominance analysis describes the relative importance of an independent variable as a function of the degree to which it contributes more to the prediction of a criterion variable than does another independent variable across subset models. As such, the unique variance of each independent variable is estimated in a series of nested and non-nested regression models to ultimately summarize its relative importance in predicting a criterion.

The procedure examines all possible model combinations of predictors to determine an order of importance. Using $2^p$-1 model, where p is the number of predictors based on the number of variables one wishes to include in the analysis, it is possible to calculate the total number of subset models for the dominance analysis. In the present study, a total of eight possible predictors were used, which resulted in maximum of 255 total subset models. The subset models are comprised of a series of multiple regressions where pairwise comparisons of predictors are entered. Thus, in the example of six predictors, there are eight subset models with only one predictor, 28 subset models with a combination of two predictors, 56 subset models with a combination of three predictors, 70 subset models with four predictors, 56 subset models with five predictors, 28 subset models with six predictors, eight subset models with seven predictors, and one subset model with all eight predictors.

## Results

### Preliminary analysis

Frequency analyses of the selected variables revealed that between 9% and 40% of the data were missing for a given time point. Since multiple imputation (MI) represents a common way to handle missing data in both cross-sectional and longitudinal applications, this procedure was utilized for the present study. A critical assumption for multiple imputation is that the data are missing at random, thus, we used Little's (1988) chi-square test of missing completely at random. Results from the analysis indicated that the data were missing completely at random ($\chi^2$ (816) = 790.46, p = 0.733), and that a multiple imputation was warranted. PROC MI in SAS 9.2 was conducted with 10 imputations using Markov Chain Monte Carlo estimation (Yuan, 2005). Table 1 displays both the original and imputed means for each literacy skill by wave. A strong correspondence was observed between the original raw score values and the imputed scores.

Multilevel Growth Modeling

Although average initial status and growth rates of the emergent and conventional literacy skills obtained from the growth modeling are not directly germane to the research questions, it is useful to present the fixed and random effects from the model to illustrate the general trends of scores across emergent and conventional literacy skills. The maximum likelihood mean coefficients, along with empirical bayes means are reported in Appendix A-1. The bayes residuals from the multilevel models were used as the predictors in the dominance analysis. Research has demonstrated the superiority of empirical bayes estimation of parameters as being less influenced by estimation error than are ordinary least squares residuals (Raudenbush & Bryk, 2001; Weiping & Laisheng, 2008). The fixed effect results demonstrated that a close correspondence was observed between the maximum likelihood coefficients and the empirical bayes means. Moreover, the slopes for the four predictors (i.e., letter-name knowledge, phonological awareness, vocabulary, and RAN- numbers) and three outcomes (i.e., word identification, pseudoword reading, and spelling) were all statistically significant at $p < 0.001$. In addition to the mean initial status and growth for each variable, the amount of variability between students in the fixed effects was explored. Significant variability indicated that students' beginning of year or monthly growth scores were statistically different. The variance components reported in Appendix A-2 demonstrated that growth rates in syllable awareness, phoneme awareness, and vocabulary did not significantly vary across students. As such, these estimates of slopes were fixed and not included for the dominance analysis because the values would be constant for all participants. Using the empirical bayes residuals and fixed effect results from the multilevel level analysis, individual bayes estimates were created and used in the subsequent analyses.

Correlations among the individual bayes initial status and growth rates for the predictor and criterion variables are reported in Appendix A-3. A small negative correlation was observed between initial status and growth on word reading ($r = -.29$), and a small positive correlation was estimated between initial status and growth on pseudoword reading ($r = .37$). A moderate positive correlation was observed for letter knowledge initial status and growth ($r = .54$), and a large positive correlation existed for spelling initial status and growth ($r = .92$). Conversely, a large negative correlation between initial status and growth was estimated for the RAN numbers task ($r = -.79$). Rogosa (1995) has demonstrated that positive correlations between initial status, when centered at the first occasion of measurement, and change are indicative of fan-spread growth. That is, students who began the year at a higher level of performance tended to grow faster than other students. Alternatively, the negative correlation is a description of trends where the variances between the initial and final assessments shrink. Because the metric for RAN numbers was time (i.e., seconds), the negative trend indicated that students who spent more time at the beginning of the year on the task had a tendency to decrease their time more quickly than other students.

Dominance Analysis

A series of six dominance analyses were conducted in order to examine the relative dominance of the predictors to the following criterion variables: 1) word reading initial status; 2) word reading growth; 3) pseudoword reading initial status; 4) pseudoword reading growth; 5) spelling initial status; and 6) spelling growth. A summary of the dominance analyses are reported in Tables 2-4. Each table reports three pieces of information pertaining to explained variance: 1) the average amount of unique $R^2$ the individual predictors contribute to the criterion across all models (i.e., Average); 2) the unique bivariate coefficient of determination (i.e., no predictors in the model; p = 0); and 3) the average amount of unique $R^2$ each individual predictor contributes to the criterion given a set number of additional predictors in the model (e.g., 2 additional predictors; p = 2). Thus, in Table 2, when examining the unique contribution of letter-name knowledge to initial status of word reading, across all $2^p$-1 regression models with five predictors for initial status (i.e., 31 models) an average 38% of the variance was explained. In the basic bivariate condition, 64% of the variance is explained, and as the number of additional predictors in the model increased from one to five, the amount of average unique variance decreased from 42% to 23%. The amount of average unique variance in word reading initial status explained by RAN-numbers was 10%, followed by syllable awareness (10%), vocabulary (6%), and phoneme awareness (5%). Variability in word reading slopes was predominantly captured by students' word reading initial status (19%), followed by letter name- knowledge (8%) and RAN-numbers (7%). Minimal amounts were explained by the others (e.g., RAN-numbers and letter-name knowledge growth, and vocabulary and phonological awareness initial status). A summary of the word reading dominance analysis results are reported in Table 2.

<Insert Table 2 about here.>

For the pseudoword dominance analyses (Table 3), letter-name knowledge contributed the most unique variance in the prediction of initial status (31%) compared with RAN-numbers, syllable awareness, and phoneme awareness (6% each), and vocabulary (4%). Letter-name knowledge also contributed the most unique variance in explaining pseudoword reading slopes (24%), followed by RAN-numbers (6%), pseudoword initial status (4%), growth in letter-name knowledge (3%), RAN-numbers, syllable awareness, and phoneme awareness (2% each), and vocabulary (1%).

<Insert Table 3 about here.>

Results for the spelling analyses (Table 4) reflected a similar rank order to pseudoword reading in initial status. Letter-name knowledge had the highest unique variance contribution (29%), followed by syllable awareness (10%), RAN-numbers (9%), phonemes (6%), and vocabulary (5%). When examining the prediction of spelling slopes, initial status in spelling skills accounted for the most average unique variance (47%), and letter-name knowledge explained an average 16% of the unique variance in spelling slopes. Syllable awareness and RAN-numbers accounted for 6%, respectively; 3% was explained by phoneme awareness, growth in letter-name knowledge, and growth in RAN-numbers; and 2% of variance in spelling was explained by vocabulary.

<Insert Table 4 about here.>

While these data represented the estimation of the average unique and total variance components from the models, an additional set of analyses were used to test whether the average differences in the unique $R^2$ were statistically different from each other. Since the $R^2$ was estimated within the same sample, a formula provided by Alf and Graf (1999) was used to calculate the asymptotic standard error for each comparison. Using $\Delta R^2$ and the standard error, 95% confidence intervals were constructed to evaluate if the differences were statistically significant. Intervals not containing zero were statistically significant at the 0.05 level. Of particular interest to compare were the differences in unique variance contributions between letter-name knowledge and phonological awareness, and between syllable awareness and phoneme awareness in predicting the initial status and slopes of the three literacy outcomes. The former (i.e., letter-name knowledge vs. syllable and phoneme awareness) was statistically significant for all the outcomes and thus not shown in Table 5. For the latter, growth rates in pseudoword reading was not used in this analysis because the unique $R^2$ explained was identical (i.e., 2%, Table 3). As evidenced by the 95% confidence intervals, the data from these analyses (Table 5) indicated that the differences in $R^2$ between the selected predictors were statistically significant only when predicting initial status in word reading and growth in spelling. Such findings suggested that when predicting initial status in word reading and growth in spelling, and all other predictors were added to the model, initial status in syllable awareness contributed more unique variance than did phoneme awareness.

<Insert Table 5 about here.>

## Discussion

The present study investigated relative contributions of growth trajectories of emergent literacy skills to growth trajectories of conventional literacy skills for young Korean-speaking children. Overall, the present study revealed that (1) where children begin (i.e., initial status) in emergent literacy skills played larger roles in conventional literacy skill acquisition than did growth rates of emergent literacy skills; (2) letter-name knowledge, initial status in particular, had a large impact on word reading, pseudoword reading, and spelling in Korean; (3) phonological awareness and rapid serial naming were consistently related to initial status and growth rates of various literacy skills, but their effect sizes were smaller than those of letter-name knowledge; and (4) vocabulary tended to minimally contribute to literacy outcomes.

One of the key interests in this study was examining the roles of initial status and growth rate of emergent literacy skills in growth trajectories of conventional literacy skills. In particular, we were interested in whether growth of emergent literacy skills would make a unique contribution to growth of conventional literacy skills. In contrast to children's initial status, individual differences in growth of emergent literacy skills were much less prominent in explaining variation in conventional literacy outcomes. Interestingly, there was little variation in growth rates of oral language skills (i.e., phonological awareness and vocabulary). Thus, only letter-name knowledge and rapid serial naming of numbers were included to examine how growth rates of these skills are related to conventional literacy achievement. Approximately two to three percent of variance in the literacy outcomes was uniquely explained by the growth rates of letter-name knowledge and rapid serial naming whereas initial status had a large impact on literacy achievement (e.g., letter-name knowledge explained 24% of variance in pseudoword reading growth). These results suggest a stable nature of development of emergent literacy skills, and the importance of children's initial level of knowledge and skills. This, however, should not discourage efforts to create differential growth rates, particularly for children who start at a low level. It should be noted that the results of the present study were obtained in the absence of systematic and explicit instruction on the emergent literacy skills examined in the present study. Thus, if systematic and explicit instruction on these emergent literacy skills is provided, children with lower initial level in emergent literacy skills may achieve faster growth rates in those skills, which then may amplify the contribution of growth rates of emergent literacy skills to achievement in conventional literacy skills.

The longitudinal nature of the present study also allowed us to explore a potential bidirectional relation between emergent and conventional literacy skills. Although the role of emergent literacy skills in conventional literacy acquisition is of primary interest to researchers and educators, literacy acquisition may also invoke development of emergent literacy skills, causing a reciprocal facilitation of development (e.g., Perfetti, Beck, Bell, & Hughes, 1987; Whitehurst & Lonigan, 1998). A bidirectional relation would be supported if growth in conventional literacy skills is related to growth in emergent literacy skills. The results from the present study suggest that such relations exist but the magnitudes were weak. For instance, bivariate correlation coefficients

(Appendix A-3) tended to be small – the strongest relation was between growth of letter-name knowledge and growth of spelling ($r = .35$). Our further analysis showed that after partialing out initial status of literacy skills, growth of letter-name knowledge was significantly and positively related to growth rates of literacy skills, albeit small in magnitudes ($.15 \leq rs \geq .27$; results not shown). Growth of rapid serial naming was not related to growth of literacy skills once initial status of literacy skills were taken into consideration. Despite overall weaknesses of magnitudes in the relations, these results are in line with the suggestion that conventional literacy acquisition may facilitate emergent literacy skill acquisition (Perfetti, Beck, Bell, & Hughes, 1987; Compton, 2003).

Children's letter-name knowledge at the beginning of the study was the strongest predictor of children's initial status and growth rates in word reading, pseudoword reading, and spelling, above and beyond phonological awareness (both syllable and phoneme awareness), rapid serial naming of numbers, and vocabulary. Letter-name knowledge initial status explained approximately 8 to 38% of variance in initial status and growth rates of literacy skills. It should be noted that for growth rates of literacy skills, children's literacy skills at the beginning of the study were taken into account. Furthermore, letter-name knowledge initial status had a greater effect on literacy outcomes than did phonological awareness (i.e., both syllable awareness and phoneme awareness), which is consistent with a previous cross-sectional study (Kim, 2009). However, this result (i.e., Table 5) requires caution because the relative effect sizes may depend on how phonological awareness is measured. As noted earlier, oddity tasks used in the present study measure children's implicit phonological awareness. However, it was suggested that explicit phonological awareness tasks (e.g., sound deletion, blending, and segmenting tasks) may be more strongly related to literacy skills than implicit phonological awareness tasks for English-speaking children (e.g., oddity task and matching task) (Schatschneider, Francis, Foorman, Fletcher, & Mehta, 1999). A recent cross-sectional study suggests a similar trend in Korean as well (Kim, in press$_a$).

Phonological awareness was important to conventional literacy acquisition in Korean. However, there was little individual variation in growth rate of phonological awareness (both syllable and phoneme awareness), and initial status of phonological awareness determined rate of growth. Thus, only initial status was included as a predictor of literacy outcomes in the dominance analysis. While, the unique contributions of syllable and phoneme awareness to the literacy outcomes tended to be consistent (with an exception for word reading growth), syllable awareness explained greater amount of variance than phoneme awareness in word reading initial status and growth rates in spelling. These findings contrast with those in English, which showed the large impact of phoneme awareness compared to phonological awareness of a larger unit (i.e., rime awareness; Hulme et al., 2002; Muter et al., 2004). These differences may be due to the orthographic characteristics of Korean and English – in Korean the syllable as well as the phoneme is saliently represented in writing whereas in English the phoneme is the basic unit. However, a future replication of these findings is needed, given the floor effect in the phoneme awareness task in the present study.

Rapid serial naming also appears to play a role in literacy skills in Korean. Although the effect sizes of rapid serial naming on various literacy outcomes were smaller than those of letter-name knowledge (5 to 10% of unique variance explained), it is notable that its effect was consistent across literacy outcomes. These findings in the present study support that children's automaticity in serial naming is uniquely related to growth trajectories of literacy skills in Korean even after accounting for other emergent literacy skills such as phonological awareness, letter-name knowledge, and vocabulary.

Vocabulary was also examined for its potential, direct role in conventional literacy skill acquisition in Korean. Growth rates of vocabulary did not vary among children, similar to a finding for English-speaking children (Snow, Porche, Tabors, & Harris, 2007). Overall, its impact of initial status was small, ranging from one to six percent of variance in literacy outcomes. These results confirm findings from previous cross-sectional studies in Korean (Cho & McBride-Chang, 2005; Cho et al., 2008; Kim, in press$_a$), and suggest that although vocabulary knowledge is positively related to conventional literacy skill acquisition (bivariate correlation coefficients ranging up to .45), its effect on conventional literacy skill acquisition in Korean may be largely indirect, for example, via phonological awareness (Walley et al., 2003), perhaps due to the fairly transparent orthography in Korean. In other words, because the letter-sound correspondences are highly consistent in Korean, phonological coding related skills (i.e., phonological awareness and letter-name knowledge) might be sufficient for word reading and spelling such that children's knowledge of word meaning may not add a unique contribution (but see Cho et al., 2008).

As noted above, the included emergent literacy skills did not explain much variance in the growth rates of word reading outcome while initial status in word reading was the strongest predictor. This finding is somewhat surprising and contrasts with other literacy outcomes in the study. This suggests that other factors not assessed in the present study should be considered such as home literacy environment. Furthermore, the generally small effects of emergent literacy skills on growth rates of word reading might be partly due to instructional approaches to early literacy acquisition. Given the emphasis on visual aspects of word reading in the current early literacy instruction in Korea (e.g., look up and say), it would be interesting to closely examine how visual skills (e.g., visual discrimination and visual spatial relation; see Cho et al., 2008) may be related to children's word reading achievement, and to investigate classroom literacy instructional practices and their effects on children's literacy acquisition.

Overall, the findings of the present study corroborate and extend previous studies with Korean-speaking children, suggesting the importance of a systematic approach to language and print-related skills in order to promote conventional literacy acquisition. However, a few limitations should be noted. First, only one type of phonological awareness task (i.e., implicit phonological awareness using an oddity task) was used in the present study. It would be illuminating for a future study to examine potentially differential relations of implicit and explicit phonological awareness tasks with conventional literacy skills. Another limitation of the present study was floor effects in the phoneme and spelling tasks. Thus, the effects of phoneme awareness on literacy skills may have been underestimated in the present study. Similarly, the effects of predictors on spelling, initial status in particular, may not have been fully captured due to reduced variance in spelling. Although young children typically have difficulty with phoneme manipulation and spelling, future studies are needed to replicate these findings with assessments that capture sufficient variation in these tasks.

Appendix A-1

Fixed Effect Results and Empirical Bayes Means

| Variable | Parameter | Coefficient | EB Means | S.E. | t-ratio | df | p |
|---|---|---|---|---|---|---|---|
| Syllable awareness | Initial Status | 5.55 | 5.52 | 0.30 | 18.40 | 214 | <0.001 |
| | Slope | 1.42 | 1.43 | 0.13 | 10.65 | 80 | <0.001 |
| Phoneme awareness | Initial Status | 2.43 | 2.42 | 0.21 | 11.67 | 214 | <0.001 |
| | Slope | 0.15 | 0.14 | 0.10 | 1.48 | 84 | 0.141 |
| Letter-name knowledge | Initial Status | 12.01 | 11.08 | 0.78 | 15.37 | 214 | <0.001 |
| | Slope | 0.88 | 0.94 | 0.07 | 13.46 | 80 | <0.001 |
| RAN - Numbers | Initial Status | 63.66 | 63.33 | 1.81 | 35.36 | 146 | <0.001 |
| | Slope | -1.70 | -1.66 | 0.17 | 10.09 | 44 | <0.001 |
| Vocabulary | Initial Status | 34.02 | 34.09 | 0.61 | 55.96 | 214 | <0.001 |
| | Slope | 1.15 | 1.10 | 0.05 | 22.67 | 85 | <0.001 |
| Word reading | Initial Status | 12.52 | 12.83 | 1.44 | 8.67 | 214 | <0.001 |
| | Slope | 2.45 | 2.42 | 0.13 | 19.32 | 97 | <0.001 |
| Pseudoword reading | Initial Status | 4.42 | 4.28 | 0.95 | 4.65 | 214 | <0.001 |
| | Slope | 1.60 | 1.63 | 0.11 | 14.17 | 138 | <0.001 |
| Spelling | Initial Status | 0.82 | 0.76 | 0.19 | 4.37 | 93 | <0.001 |
| | Slope | 0.43 | 0.43 | 0.02 | 17.20 | 86 | <0.001 |

EB represents Empirical Bayes.

Appendix A-2

Random Effects (i.e., Variance Components) for Growth Models

| Variable | Parameter | Variance | S.D. | df | $\chi^2$ | p |
|---|---|---|---|---|---|---|
| Syllable awareness | Initial Status | 7.59 | 2.76 | 214 | 304.54 | <0.001 |
| | Slope | 0.09 | 0.30 | 214 | 198.63 | 0.375 |
| Phoneme awareness | Initial Status | 2.36 | 1.54 | 214 | 265.16 | <0.001 |
| | Slope | 0.02 | 0.12 | 214 | 195.84 | 0.430 |
| Letter-name knowledge | Initial Status | 83.80 | 9.15 | 214 | 933.96 | <0.001 |
| | Slope | 0.50 | 0.25 | 214 | 360.4 | <0.001 |
| RAN - Numbers | Initial Status | 412.39 | 20.31 | 214 | 999.37 | <0.001 |
| | Slope | 1.69 | 1.30 | 214 | 434.79 | <0.001 |
| Vocabulary | Initial Status | 42.72 | 6.54 | 214 | 1291.58 | <0.001 |
| | Slope | 0.04 | 0.20 | 214 | 234.42 | 0.161 |
| Word reading | Initial Status | 318.87 | 17.86 | 214 | 1346.52 | <0.001 |
| | Slope | 1.52 | 1.23 | 214 | 583.32 | <0.001 |
| Pseudoword reading | Initial Status | 103.17 | 10.16 | 214 | 597.44 | <0.001 |
| | Slope | 1.20 | 1.10 | 214 | 520.43 | <0.001 |
| Spelling | Initial Status | 2.58 | 1.60 | 214 | 426.64 | <0.001 |
| | Slope | 0.05 | 0.23 | 214 | 512.48 | <0.001 |

Appendix A-3

Correlations among Empirical Bayes Estimates

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Syllable awareness initial status | 1.00 | | | | | | | | | | | |
| 2. Phoneme awareness initial status | 0.44 | 1.00 | | | | | | | | | | |
| 3. Vocabulary initial status | 0.54 | 0.36 | 1.00 | | | | | | | | | |
| 4. Letter-name knowledge initial status | 0.49 | 0.35 | 0.43 | 1.00 | | | | | | | | |
| 5. Letter-name knowledge -Growth | 0.26 | 0.14 | 0.23 | 0.54 | 1.00 | | | | | | | |
| 6. RAN-Numbers initial status | -0.37 | -0.21 | -0.36 | -0.55 | -0.35 | 1.00 | | | | | | |
| 7. RAN-Numbers - Growth | 0.25 | 0.13 | 0.28 | 0.42 | 0.20 | -0.79 | 1.00 | | | | | |
| 8. Word reading initial status | 0.53 | 0.40 | 0.45 | 0.80 | 0.26 | -0.52 | 0.49 | 1.00 | | | | |
| 9. Word reading - Growth | -0.03 | -0.09 | -0.12 | 0.07 | 0.17 | -0.16 | -0.05 | -0.29 | 1.00 | | | |
| 10. Pseudoword reading initial status | 0.45 | 0.39 | 0.37 | 0.71 | 0.22 | -0.43 | 0.38 | 0.87 | -0.29 | 1.00 | | |
| 11. Pseudoword reading - Growth | 0.29 | 0.25 | 0.21 | 0.62 | 0.27 | -0.40 | 0.24 | 0.50 | 0.49 | 0.37 | 1.00 | |
| 12. Spelling initial status | 0.54 | 0.41 | 0.43 | 0.72 | 0.32 | -0.49 | 0.39 | 0.79 | -0.03 | 0.74 | 0.48 | 1.00 |
| 13. Spelling Growth | 0.51 | 0.37 | 0.36 | 0.71 | 0.35 | -0.49 | 0.35 | 0.71 | 0.17 | 0.64 | 0.60 | 0.92 |

Coefficients greater than .10 are statistically significant at .05 level.

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Table 1

Descriptive Statistics for the Original and Imputed Data at Each Time Point (i.e., waves 1, 2, 3, & 4)

| Variable (maximum score) | | Wave 1 (N = 128; 68 boys) | | Wave 2 (N = 206; 104 boys) | | Wave 3 (N = 178; 87 boys) | | Wave 4 (N = 141; 73 boys) | |
|---|---|---|---|---|---|---|---|---|---|
| | α | Original | Imputed | Original | Imputed | Original | Imputed | Original | Imputed |
| Children's age | | 56.49 (3.63) | - | 61.73 (3.59) | - | 65.64 (3.59) | - | 69.60 (3.65) | - |
| Emergent literacy skills | | | | | | | | | |
| Syllable awareness (15) | .90 | 5.48 (4.19) | 5.48 (3.21) | 7.41 (4.66) | 7.42 (4.56) | 8.32 (4.78) | 8.32 (4.32) | 9.78 (4.30) | 9.78 (3.47) |
| Phoneme awareness (15) | .87 | 2.51 (3.24) | 2.52 (2.50) | 2.46 (2.88) | 2.46 (2.81) | 2.80 (3.23) | 2.80 (2.93) | 2.81 (3.23) | 2.81 (2.38) |
| Vocabulary (66) | .90 | 33.81 (7.67) | 33.04 (8.03) | 41.31 (8.99) | 41.18 (9.02) | 44.29 (8.47) | 44.30 (8.55) | 47.75 (8.20) | 47.83 (8.70) |
| Letter-name knowledge (40) | .96 | 11.83 (9.79) | 12.93 (9.93) | 15.54 (11.54) | 15.41 (11.56) | 17.84 (10.92) | 18.39 (10.96) | 24.66 (10.75) | 24.66 (10.82) |
| Rapid serial naming – numbers | .85* | 65.97 (26.14) | 65.21 (25.99) | 53.45 (19.32) | 53.50 (19.36) | 46.11 (15.67) | 46.09 (15.57) | 43.77 (17.40) | 43.53 (17.73) |
| Literacy skills | | | | | | | | | |
| Word reading (60) | .98 | 11.67 (17.53) | 11.99 (18.16) | 25.07 (21.79) | 24.84 (21.85) | 35.83 (22.08) | 36.77 (22.29) | 42.84 (19.28) | 43.33 (19.45) |
| Pseudoword reading (50) | .98 | 5.16 (11.12) | 5.36 (11.70) | 10.80 (16.09) | 10.73 (16.12) | 18.20 (18.60) | 18.90 (18.70) | 25.55 (19.60) | 25.84 (19.74) |
| Spelling (20) | .73 | 1.09 (2.21) | 0.98 (2.29) | 2.72 (3.13) | 2.72 (3.12) | 4.65 (4.23) | 4.66 (4.23) | 6.37 (4.39) | 6.53 (4.48) |

* Test-retest reliability approximately 10 days apart

Table 2

Dominance Analysis Results –Initial Status and Slope of Word Reading

| Parameter | Predictor | Average | p=0 | p=1 | p=2 | p=3 | p=4 | p=5 | p=6 | p=7 |
|---|---|---|---|---|---|---|---|---|---|---|
| Status | Letter-name knowledge | 0.38 | 0.64 | 0.42 | 0.33 | 0.27 | 0.23 | - | - | - |
| | RAN-Numbers | 0.10 | 0.27 | 0.12 | 0.06 | 0.03 | 0.01 | - | - | - |
| | Syllable awareness | 0.10 | 0.29 | 0.11 | 0.05 | 0.02 | 0.01 | - | - | - |
| | Vocabulary | 0.06 | 0.21 | 0.06 | 0.02 | 0.01 | <0.01 | - | - | - |
| | Phoneme awareness | 0.05 | 0.16 | 0.05 | 0.02 | 0.01 | 0.01 | - | - | - |
| Slope | Word reading initial status | 0.19 | 0.08 | 0.13 | 0.17 | 0.20 | 0.22 | 0.24 | 0.25 | 0.25 |
| | Letter-name knowledge | 0.08 | 0.01 | 0.04 | 0.07 | 0.08 | 0.10 | 0.11 | 0.12 | 0.13 |
| | RAN-Numbers | 0.07 | 0.03 | 0.05 | 0.07 | 0.08 | 0.09 | 0.09 | 0.08 | 0.08 |
| | RAN-Numbers Growth | 0.02 | <0.01 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 | 0.03 | 0.02 |
| | Letter-name knowledge Growth | 0.02 | 0.03 | 0.04 | 0.03 | 0.03 | 0.02 | 0.01 | 0.01 | <0.01 |
| | Vocabulary | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| | Syllable awareness | 0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | Phoneme awareness | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

Note: Unless otherwise noted, the predictor is initial status (e.g., RAN-Numbers represents RAN-Numbers initial status).

Table 3

Dominance Analysis Results –Initial Status and Slope of Pseudoword Reading

| Parameter | Predictor | Average | p=0 | p=1 | p=2 | p=3 | p=4 | p=5 | p=6 | p=7 |
|---|---|---|---|---|---|---|---|---|---|---|
| Status | Letter-name knowledge | 0.31 | 0.50 | 0.34 | 0.27 | 0.23 | 0.21 | - | - | - |
| | RAN-Numbers | 0.06 | 0.19 | 0.08 | 0.04 | 0.02 | <0.01 | - | - | - |
| | Syllable awareness | 0.06 | 0.20 | 0.07 | 0.03 | 0.01 | <0.01 | - | - | - |
| | Phoneme awareness | 0.06 | 0.16 | 0.06 | 0.03 | 0.02 | 0.02 | - | - | - |
| | Vocabulary | 0.04 | 0.14 | 0.04 | 0.01 | <0.01 | <0.01 | - | - | - |
| Slope | Letter-name knowledge | 0.24 | 0.38 | 0.30 | 0.25 | 0.23 | 0.21 | 0.20 | 0.19 | 0.18 |
| | RAN-Numbers | 0.06 | 0.16 | 0.09 | 0.06 | 0.05 | 0.04 | 0.03 | 0.03 | 0.02 |
| | Pseudoword reading initial status | 0.04 | 0.14 | 0.07 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 |
| | Letter-name knowledge growth | 0.03 | 0.07 | 0.04 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| | RAN-Numbers growth | 0.02 | 0.06 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | <0.01 | <0.01 |
| | Syllable awareness | 0.02 | 0.08 | 0.03 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | Phoneme awareness | 0.02 | 0.06 | 0.03 | 0.01 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 |
| | Vocabulary | 0.01 | 0.04 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

Note: Unless otherwise noted, the predictor is initial status (e.g., RAN-Numbers represents RAN-Numbers initial status).

Table 4

Dominance Analysis Results –Initial Status and Slope of Spelling

| Parameter | Predictor | Average | p=0 | p=1 | p=2 | p=3 | p=4 | p=5 | p=6 | p=7 |
|---|---|---|---|---|---|---|---|---|---|---|
| Status | Letter-name knowledge | 0.29 | 0.52 | 0.32 | 0.24 | .019 | 0.16 | - | - | - |
| | Syllable awareness | 0.10 | 0.29 | 0.12 | 0.06 | 0.03 | 0.02 | - | - | - |
| | RAN-Numbers | 0.09 | 0.24 | 0.10 | 0.05 | 0.03 | 0.01 | - | - | - |
| | Phoneme awareness | 0.06 | 0.17 | 0.06 | 0.03 | 0.02 | 0.01 | - | - | - |
| | Vocabulary | 0.05 | 0.19 | 0.05 | 0.02 | <0.01 | <0.01 | - | - | - |
| Slope | Spelling initial status | 0.47 | 0.84 | 0.62 | 0.51 | 0.44 | 0.39 | 0.35 | 0.32 | 0.30 |
| | Letter-name knowledge | 0.16 | 0.50 | 0.30 | 0.19 | 0.12 | 0.09 | 0.05 | 0.02 | <0.01 |
| | Syllable awareness | 0.06 | 0.26 | 0.12 | 0.06 | 0.03 | 0.02 | 0.01 | <0.01 | <0.01 |
| | RAN-Numbers | 0.06 | 0.24 | 0.11 | 0.05 | 0.02 | 0.01 | 0.01 | 0.01 | <0.01 |
| | Phoneme awareness | 0.03 | 0.14 | 0.06 | 0.03 | 0.01 | 0.01 | 0.01 | <0.01 | <0.01 |
| | Letter-name knowledge growth | 0.03 | 0.12 | 0.05 | 0.02 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 |
| | RAN-Numbers growth | 0.03 | 0.12 | 0.04 | 0.02 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | Vocabulary | 0.02 | 0.13 | 0.04 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

Note: Unless otherwise noted, the predictor is initial status (e.g., RAN-Numbers represents RAN-Numbers initial status).

Table 5

95% Confidence Intervals for Selected Pair-wise Differences between Syllable Awareness and Phoneme Awareness

| | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|
| Parameter | Outcome | $\Delta R^2$ | SE | Lower | Upper |
| Initial Status | Word reading | 0.05 | 0.007 | 0.002 | 0.013 |
| | Pseudoword reading | 0.02 | 0.004 | -0.0001 | 0.004 |
| | Spelling | 0.01 | 0.003 | -0.0008 | 0.003 |
| Growth | Word Reading | <0.01 | 0.001 | -0.001 | 0.0002 |
| | Spelling | 0.03 | 0.004 | 0.0002 | 0.005 |