The Developmental Trajectory of Oral Vocabulary Knowledge in Elementary School Children and Its Prediction of Reading Ability

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Abstract

A longitudinal study tracking oral vocabulary knowledge was conducted with 149 Chinese-speaking first-grade primary school children over 6 years with 8 assessments. Using latent growth modeling, we explored the developmental trajectory of oral vocabulary knowledge in primary school children and, after controlling for relevant variables, examined the predictive effects of the initial level and growth rate of oral vocabulary knowledge on reading abilities in sixth grade. The results revealed: (1) Oral vocabulary knowledge in primary school children exhibited continuous nonlinear growth, with third and fifth grades being periods of rapid growth in children's oral vocabulary knowledge development, and individual differences among children exhibited a stable differential developmental pattern; (2) After controlling for general cognitive abilities and relevant reading cognitive skills, both the initial level and growth rate of oral vocabulary knowledge significantly predicted sixth-grade reading accuracy, reading fluency, and reading comprehension, with stronger predictions for reading accuracy and reading comprehension than for reading fluency; compared to the initial level, the growth rate of oral vocabulary knowledge demonstrated a stronger predictive effect on reading abilities.

Full Text

The Developmental Trajectory of Oral Vocabulary Knowledge and Its Predictive Effects on Reading Abilities in Primary School Children: A Latent Growth Model Study

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Abstract

This study tracked 149 Chinese first-grade children over six years with eight waves of testing to examine the developmental trajectory of oral vocabulary knowledge using latent growth modeling. After controlling for relevant variables, we investigated how the initial level and growth rate of oral vocabulary knowledge predicted reading abilities in sixth grade. Results revealed: (1) Children's oral vocabulary knowledge exhibited continuous nonlinear growth throughout primary school, with third and fifth grades identified as periods of accelerated development. Individual differences among children showed a stable-differences developmental pattern. (2) After controlling for general cognitive abilities and reading-related cognitive skills, both the initial level and growth rate of oral vocabulary knowledge significantly predicted sixth-grade reading accuracy, reading fluency, and reading comprehension, with stronger predictions for reading accuracy and comprehension than for fluency. Moreover, the growth rate demonstrated stronger predictive power than the initial level.

Keywords: oral vocabulary knowledge, reading accuracy, reading fluency, reading comprehension, latent growth modeling

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In daily interactive activities, children acquire oral language experience and initially establish sound-meaning connections. As children begin learning to read, their primary task is to master decoding, which in Chinese literacy manifests as character and word recognition. This process gradually establishes form-sound connections between written text and oral language, leveraging existing sound-meaning connections from oral experience to create form-sound-meaning connections, thereby enabling reading acquisition. As decoding skills develop, the importance of children's knowledge about sound-meaning connections—namely, oral vocabulary knowledge (Ouellette, 2006)—begins to increase (Yan et al., 2020). Research has found that the breadth of vocabulary knowledge plays an increasingly important role in children's reading (Yan et al., 2021). Studies on the relationship between oral vocabulary knowledge and reading have shown that oral vocabulary knowledge is a crucial factor influencing children's reading development (Ouellette, 2006; Song et al., 2015), and that the richness and depth of children's oral vocabulary knowledge can predict their reading abilities (Wright & Cervetti, 2017). Thus, previous research has focused primarily on how early oral vocabulary knowledge predicts later reading abilities (Verhoeven & van Leeuwe, 2008).

However, children's oral vocabulary knowledge develops rapidly during the primary school years, with substantial variation in growth rates (Cheng et al., 2018; Rowe et al., 2012). This phenomenon suggests that beyond examining oral vocabulary knowledge at a single time point, investigating its developmental trajectory is essential for capturing the dynamic changes in children's vocabulary acquisition (Lei et al., 2011; Parrila et al., 2005; Salaschek et al., 2014). Therefore, exploring the developmental trajectory of oral vocabulary knowledge and its predictive effects on subsequent reading development holds significant theoretical and practical importance. The present study aims to examine the developmental trajectory of oral vocabulary knowledge and its predictive effects on reading abilities in sixth grade among Chinese first-grade children.

Oral vocabulary can generally be assessed along two dimensions: breadth and depth. Breadth refers to the quantity of vocabulary—specifically, the number of words stored in an individual's lexicon—and is typically measured using picture-naming tasks. Depth refers to the quality of vocabulary—namely, the extent to which an individual understands word meanings and their application in text—and is typically measured using vocabulary definition tasks (Ouellette, 2006). For Chinese school-age children, successful reading requires not only mastering a word's pronunciation but also grasping its meaning and connotations. In terms of mental lexicon storage, vocabulary breadth corresponds to phonological representations, while vocabulary depth corresponds to semantic representations (Ouellette, 2006). Research has found that vocabulary depth is more closely related to reading comprehension than vocabulary breadth (Cain & Oakhill, 2014; Proctor et al., 2012), possibly because reading comprehension is associated with vocabulary quality (Perfetti, 2007). To investigate the relationship between oral vocabulary development and reading abilities from a developmental perspective, the present study focuses on the developmental trajectory of oral vocabulary depth and its predictive effects on reading abilities.

Studies on Chinese children have found that oral vocabulary knowledge increases significantly with age during both the preschool period (Li et al., 2011) and early school years (Cheng et al., 2017). One study testing children in grades 1, 3, and 5 at two time points one year apart found significant growth in oral vocabulary knowledge across all three grade levels over the one-year period (Zhao et al., 2016). However, short-term tracking with only two time points cannot adequately describe developmental trajectories. Examining developmental trajectories requires at least three time points and involves describing four aspects: direction, continuity, shape, and pattern (Grimm et al., 2011; Pfost et al., 2014). The intercept describes individuals' initial status at the beginning of tracking, while the growth rate describes the speed of change during the tracking period (Liu & Zhang, 2005). Direction refers to whether a particular ability increases or decreases during a specific period; in this study, this is indexed by whether children's oral vocabulary knowledge increases or decreases across eight testing waves. Continuity refers to whether developmental changes persist consistently; here, this is indexed by whether pairwise comparisons of oral vocabulary knowledge across eight testing waves are significant. Shape refers to whether developmental change is linear (equal change across time intervals) or nonlinear (varying change speeds across periods); in this study, this is determined by examining the factor loadings of the slope across time intervals. Pattern refers to how individual differences change during development—specifically, whether gaps between individuals remain constant, increase, or decrease; this is indexed by the linear correlation between initial level and growth rate.

In the present study, a significant positive correlation between the intercept and slope of oral vocabulary knowledge would indicate that individual differences in children's oral vocabulary knowledge increase over time (a Matthew effect). A significant negative correlation would indicate that individual differences decrease over time (a compensatory pattern). No significant correlation would indicate that individual differences remain relatively stable (a stable-differences pattern).

One study tracking 177 first-grade children over one year with three waves found that oral vocabulary knowledge showed significant linear growth, with relatively stable individual differences (Hui et al., 2018). However, statistically speaking, three time points can only be modeled as linear growth. Another study tracking first-grade children's oral vocabulary knowledge over three years with five waves found nonlinear growth between grades 1 and 3, with faster development in grade 3 and relatively stable individual differences across the three years (Cheng et al., 2018). Nevertheless, oral vocabulary knowledge is a low-constraint skill that continues to develop throughout an individual's life (Paris, 2005). For primary school children, there remains substantial room for growth in oral vocabulary knowledge. From an educational practice perspective, assessing the growth rate of oral vocabulary knowledge helps identify children with slower development and enables timely, targeted instructional intervention. For assessment purposes, while initial and final levels are important, growth rate is also a critical indicator (Fuchs & Deshler, 2007). If only initial or final levels are assessed, children with low initial or final levels but rapid growth might be identified as developmentally delayed, when in fact these children are responsive to instruction. Assessing growth rate can thus help identify children at risk early and provide appropriate guidance. Therefore, the first objective of this study was to conduct an 8-wave, six-year tracking of first-grade children to precisely characterize the developmental trajectory of oral vocabulary knowledge throughout primary school in terms of direction, continuity, shape, and pattern.

Mapping oral language experience onto written words forms the foundation of reading development. Research has found that oral vocabulary knowledge, as an important component of oral language experience, is closely related to children's reading abilities (Cain & Oakhill, 2011). Reading ability is typically assessed through three indicators: reading accuracy, reading fluency, and reading comprehension. Reading accuracy examines the ability to correctly identify words; reading fluency examines the ability to read accurately, quickly, and with prosody; and reading comprehension examines the ability to extract explicit information, make inferences, and integrate different perspectives. According to the Reading Triangle Theory (Perfetti, 2009), oral vocabulary knowledge influences reading accuracy (word recognition). Understanding a word's meaning helps children establish a specific representation of that word, and recognizing a word with familiar meaning strengthens the form-meaning connection. When identifying words, children rely not only on phonological pathways but also on semantic pathways to activate word meaning and retrieve the word from memory (Zhou & Marslen-Wilson, 2000). Therefore, understanding word meaning can facilitate the semantic pathway of word recognition. A five-year longitudinal study of 300 two-year-old British children found that oral vocabulary knowledge was a significant predictor of reading accuracy (Duff et al., 2015). The Reading Triangle Theory also posits that children's text comprehension depends on their understanding of word meanings in the text; children with rich oral vocabulary knowledge recognize more words while reading, which helps them better understand the text (Perfetti, 2009). The Lexical Quality Hypothesis (Perfetti, 2017) further proposes that high-quality words are those from which phonological and semantic information can be rapidly retrieved and maintained for a sufficient duration to support subsequent reading. Words known only by name without understanding their meaning, or words whose meaning is known but not their referents, are considered low-quality words. Lexical quality affects reading comprehension through semantic identification; children with high-quality lexical representations can extract precise word meanings during reading, form meaning units, and integrate them to construct textual meaning. Therefore, children's oral vocabulary knowledge has an important influence on reading comprehension. Research has found that oral vocabulary knowledge at age 6 can predict reading comprehension in grade 2 (Muter et al., 2004). Another one-year short-term longitudinal study of lower, middle, and upper elementary grades using a cross-lagged model found that oral vocabulary knowledge in middle grades significantly predicted reading comprehension (Chen et al., 2019). Although few studies have examined the effect of oral vocabulary knowledge on reading fluency, the Reading Triangle Theory (Perfetti, 2009) and Lexical Quality Hypothesis (Perfetti, 2017) suggest that children with high-quality lexical representations can quickly identify words, freeing up cognitive resources for meaning processing and enabling more fluent reading. A further question is whether oral vocabulary knowledge predicts different reading abilities equally—specifically, whether its predictive effects on reading accuracy, comprehension, and fluency differ.

However, previous research on the relationship between oral vocabulary knowledge and reading abilities has been limited to discrete time points. Although oral vocabulary knowledge at a particular time point can predict later reading abilities, examining the developmental trajectory, particularly the relationship between growth rate and reading abilities, provides a dynamic understanding of language and reading development. Specifically, would children with similar initial levels of oral vocabulary knowledge but different growth rates have similar reading abilities later? If two first-grade children have the same initial level of oral vocabulary knowledge, but one child's knowledge grows faster than the other's from grades 1 to 6, their reading abilities in grade 6 might differ substantially. The growth rate of oral vocabulary knowledge contains critical information about children's potential for vocabulary development. Thus, examining the relationship between oral vocabulary knowledge and reading abilities should include both static measurement at specific time points and dynamic measurement of developmental potential. Therefore, the second objective of this study was to simultaneously examine the predictive effects of both the initial level and growth rate of oral vocabulary knowledge on reading abilities, thereby testing whether the growth rate of oral vocabulary knowledge has unique predictive power for reading abilities. If the growth rate does have unique predictive effects, do these differ from those of the initial level?

In summary, this study conducted eight waves of tracking over six years beginning with first-grade children to first examine the developmental trajectory of oral vocabulary knowledge throughout primary school in terms of direction, continuity, shape, and pattern. Second, we investigated how the initial level in grade 1 and the growth rate from grades 1 to 6 predicted reading abilities in grade 6, comparing the magnitude of predictions across different reading abilities and between initial level and growth rate. Since previous research has found that general cognitive abilities and reading-related cognitive skills such as phonological awareness, morphological awareness, orthographic awareness, and rapid naming are closely related to reading abilities, this study statistically controlled for these variables to examine the unique contributions of the initial level and growth rate of oral vocabulary knowledge to reading abilities.

2.1 Participants

The study recruited 149 first-grade children (69 girls) from two primary schools in Linfen City, Shanxi Province. Eight waves of testing were conducted. Time 1 (T1) occurred in the fall semester of grade 1, with a mean age of 75.92 ± 4.09 months. The subsequent four waves were administered at 6-month intervals: spring semester of grade 1 (T2), fall semester of grade 2 (T3), spring semester of grade 2 (T4), and fall semester of grade 3 (T5). The final three waves were administered at 12-month intervals: fall semester of grade 4 (T6), fall semester of grade 5 (T7), and fall semester of grade 6 (T8). Attrition occurred at T2 (3 children), T3 (19 children), T4 (1 child returned), T5 (3 children), T6 (3 children), and T7 (5 children), with no attrition at T8. A total of 32 children were lost to attrition.

2.2 Measures

2.2.1 Predictor Variable: Oral Vocabulary Knowledge

Oral vocabulary knowledge was assessed using a vocabulary definition task that measured expressive vocabulary (Shu et al., 2006). The test consisted of one practice item and 32 test items arranged from easy to difficult based on word concepts and frequency. The procedure was as follows: The examiner orally presented a two-character word and asked the child to verbally explain its meaning. Children's oral responses were recorded and independently scored by two raters on a 0-2 scale (2 = complete understanding, 1 = partial understanding, 0 = no understanding). Testing was discontinued after five consecutive zero scores. Cronbach's α coefficients for the eight waves were 0.74, 0.78, 0.87, 0.76, 0.82, 0.80, 0.77, and 0.77, respectively.

2.2.2 Outcome Variables

Reading Accuracy was assessed using a character recognition task (Li et al., 2012). The test material consisted of 150 Chinese characters arranged from easy to difficult. Children were asked to read the characters aloud sequentially. Testing was discontinued after 15 consecutive errors or failures. Each correctly read character received 1 point, with a total possible score of 150. Cronbach's α was 0.99.

Reading Fluency was assessed using a three-minute reading task (Lei et al., 2011). The test consisted of three practice sentences and 100 test sentences arranged by length from short to long. Children were required to silently read each sentence and judge whether its meaning was correct within a three-minute time limit. For example: "Children who watch TV for too long are prone to myopia, so they should rest their eyes" (√); "Cars can float around in the ocean like boats" (×). The scoring rule was the total number of characters in correctly answered sentences minus the total number of characters in incorrectly answered sentences. Cronbach's α was 0.89.

Reading Comprehension was assessed using a passage reading task that measured children's ability to extract information, make basic inferences, integrate content, and evaluate texts after reading. The task included four passages (Wen, 2005; Mullis et al., 2007): "Fleas Have High Jumping Skills," "Tails Are Animals' Swimming Organs," "In the Vegetable Garden," and "Space Walk," comprising two narrative texts and two expository texts. After reading each passage, children answered 61 questions (1 point each), with a total possible score of 61. Cronbach's α was 0.75.

2.2.3 Control Variables

General Cognitive Ability was assessed using Raven's Progressive Matrices (Zhang & Wang, 1989). The procedure was as follows: Children were visually presented with a figure missing a part and asked to select the missing portion from 6-8 options through nonverbal reasoning. The test consisted of 60 items (1 point each). Cronbach's α was 0.90.

Phonological Awareness was assessed using a phoneme deletion task (Shu et al., 2006) that measured children's ability to recognize and manipulate phonemes in syllables. The test consisted of six practice items and 12 test items. The examiner orally presented a syllable, asked the child to repeat it correctly, and then to say what remained after deleting a specified phoneme (e.g., "/xiang3/ without /ang3/ is what?" Correct answer: xi3). Cronbach's α was 0.84.

Rapid Automatized Naming was assessed using a digit naming task (Shu et al., 2006) that measured the speed of phonological access to familiar symbols. The material was a 5$×$5 matrix of five common digits (1, 3, 4, 5, 8), each appearing five times. Children were asked to read the digits as quickly and accurately as possible, with two trials administered. The score was the average time across the two trials. The correlation between the two trials was 0.91.

Morphological Awareness was assessed using a compound word production task that measured children's ability to recognize and manipulate morphemes and morpheme relationships in compound words (Cheng et al., 2017). The test consisted of eight practice items and 20 test items (12 two-morpheme items and eight three-morpheme items). The examiner orally presented a sentence describing a novel object, and the child was asked to produce the best word to name it, with simpler words preferred (e.g., "What do you call a fruit shaped like an ear?" Correct answer: "ear-fruit"). Two raters independently scored responses on a 0-3 scale. Inter-rater reliability was 0.98, and Cronbach's α was 0.85.

Orthographic Awareness was assessed using a pseudoword judgment task that measured children's understanding of Chinese character structure (Cheng et al., 2015), including precise processing of sub-character units (components and radicals) and knowledge of component positions. The test consisted of 90 items involving four types: pseudowords (correct components in correct positions), position errors (correct components in wrong positions), component errors (wrong components in correct positions), and stroke errors (random stroke combinations). The 45 pseudowords served as filler items and were not scored; the remaining three types each contained 15 items (1 point each), for a total possible score of 45. Children were asked to mark "√" for real characters and "×" for non-characters. Cronbach's α was 0.93.

2.3 Procedure

Oral vocabulary knowledge was assessed from T1 to T8. Reading accuracy, fluency, and comprehension at T8 served as outcome variables. General cognitive ability, phonological awareness, rapid naming, morphological awareness, and orthographic awareness at T1 served as control variables. Trained examiners administered all tests. Reading fluency, reading comprehension, general cognitive ability, and orthographic awareness were administered in classroom group sessions, completed in two sessions. All other tests were administered individually in quiet rooms provided by the schools. Each testing session lasted no more than 45 minutes, with all tests completed within one week.

2.4 Data Analysis

This study used Mplus 7.11 to conduct latent growth modeling on the eight waves of data to obtain the intercept (initial level in grade 1) and slope (growth rate from grades 1-6) of oral vocabulary knowledge. These were then included as predictor variables in a structural equation model to predict reading abilities in grade 6. Model fit was evaluated using the chi-square to degrees of freedom ratio (^{2}/df), comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Good model fit was defined as ^{2}/df < 3, CFI > 0.95, TLI > 0.90, and RMSEA and SRMR < 0.08 (Wang et al., 2011). The Mplus syntax is provided in the Appendix.

The study spanned six years with an attrition rate of 21.48%. Chi-square and t-tests comparing children who completed all waves (n = 117) with those who dropped out (n = 32) revealed no significant differences in age [t(144) = 0.54, p = 0.59], gender ratio [^{2}(df = 1) = 1.27, p = 0.26], or T1 general cognitive ability [t(143) = 1.06, p = 0.29], phonological awareness [t(147) = 0.44, p = 0.66], rapid naming [t(147) = 0.27, p = 0.79], or orthographic awareness [t(147) = 0.35, p = 0.73]. However, significant differences emerged for T1 morphological awareness [t(147) = 3.22, p = 0.003] and oral vocabulary knowledge [t(147) = 2.21, p = 0.029]. This attrition analysis suggests that the relatively high attrition rate may limit the generalizability of our findings, necessitating caution in interpretation. Subsequent analyses used maximum likelihood estimation to accommodate missing data.

3.1 Descriptive Statistics

Table 1 presents the means, standard deviations, and correlation matrix for all variables across eight waves. Oral vocabulary knowledge showed consistent growth from T1 to T8. A repeated measures ANOVA with testing wave as the independent variable and oral vocabulary knowledge scores as the dependent variable revealed a significant main effect of time, Wilks' $\lambda = 0.05$, $F(7, 109) = 289.68$, $p < 0.001$, $^2 = 0.95$. Post-hoc pairwise comparisons (LSD) showed significant differences between all eight waves (ps ≤ 0.007), indicating an upward developmental direction and continuity in children's oral vocabulary knowledge across the eight testing waves. The eight waves showed moderate significant positive correlations, with coefficients ranging from 0.45 to 0.72. Reading accuracy, fluency, and comprehension showed moderate significant positive correlations with the eight waves of oral vocabulary knowledge, with coefficients ranging from 0.41 to 0.60, 0.35 to 0.46, and 0.41 to 0.62, respectively. Among control variables, general cognitive ability and morphological awareness showed significant positive correlations with all eight waves of oral vocabulary knowledge, with coefficients ranging from 0.27 to 0.40 and 0.33 to 0.47, respectively. Phonological awareness showed low-to-moderate significant positive correlations with oral vocabulary knowledge, except at T7, with coefficients ranging from 0.19 to 0.32. Rapid naming showed low-to-moderate significant negative correlations with oral vocabulary knowledge, except at T1, with coefficients ranging from -0.18 to -0.27. Orthographic awareness showed low-to-moderate significant positive correlations with oral vocabulary knowledge, except at T3, with coefficients ranging from 0.18 to 0.25.

3.2 Developmental Trajectory of Oral Vocabulary Knowledge in Primary School

We first constructed a linear latent growth model for children's oral vocabulary knowledge to examine its developmental trajectory, estimating intercept and slope parameters. The first five testing waves were spaced 6 months apart, while the last three waves were spaced 12 months apart. To define the intercept as the initial level of oral vocabulary knowledge, factor loadings were set to 0, 1, 2, 3, 4, 6, 8, and 10. Results showed $^2(31) = 91.56$, $p < 0.001$, $^2/df = 2.95$, CFI = 0.91, TLI = 0.92, RMSEA = 0.12 (90% CI [0.09, 0.14]), SRMR = 0.09. These fit indices indicated that the linear growth model did not fit the data well, suggesting that a linear model was inappropriate for the eight-wave developmental trajectory.

A quadratic nonlinear growth model was then constructed with slope loadings of 0, 1, 4, 9, 16, 36, 64, and 100. Fit indices were $^2(27) = 63.26$, $p < 0.001$, $^2/df = 2.34$, CFI = 0.94, TLI = 0.94, RMSEA = 0.10 (90% CI [0.07, 0.13]), SRMR = 0.07. These indices also indicated inadequate fit, suggesting that a quadratic nonlinear model was inappropriate.

A freed-loading curve model was estimated, constraining the first two time points to 0 and 1 while freely estimating the remaining six loadings. Fit indices were $^2(25) = 51.97$, $p = 0.001$, $^2/df = 2.08$, CFI = 0.96, TLI = 0.95, RMSEA = 0.08 (90% CI [0.05, 0.12]), SRMR = 0.08, indicating acceptable fit. The estimated slope factor loadings were 0, 1, 2.57, 3.19, 5.73, 7.66, 10.63, and 12.23.

To create a psychologically meaningful model, we constrained the eight slope loadings to 0, 1, 2.5, 3, 5.5, 7.5, 10.5, and 12.5. This constrained model showed $^2(31) = 57.48$, $p = 0.003$, $^2/df = 1.85$, CFI = 0.96, TLI = 0.96, RMSEA = 0.08 (90% CI [0.04, 0.11]), SRMR = 0.08, indicating good fit. A nested model comparison between the constrained and freed-loading models showed $\Delta ^2(6) = 5.514$, $p = 0.480$, indicating that constraining the loadings did not worsen model fit. Therefore, the constrained model was retained as the final model.

Results showed that the intercept—representing children's oral vocabulary knowledge at school entry—was 8.75, significantly greater than 0 ($p < 0.001$).

Oral vocabulary knowledge increased significantly across the eight waves (M = 1.98, SE = 0.05, $p < 0.001$). Combined with the descriptive statistics showing significant differences between all waves, these results indicate continuous growth in both direction and continuity throughout primary school, confirming that oral vocabulary knowledge is a low-constraint skill. The slope factor loadings (0, 1, 2.5, 3, 5.5, 7.5, 10.5, 12.5) revealed a nonlinear shape, with accelerated increases at the fifth time point (grade 3) and seventh time point (grade 5), indicating that oral vocabulary knowledge developed at an accelerating pace as grade level increased. Specifically, grades 3 and 5 were periods of accelerated growth. Both intercept variance ($\sigma^2 = 20.85$, $p < 0.001$) and slope variance ($\sigma^2 = 0.16$, $p < 0.001$) were significantly greater than 0, indicating significant individual differences in both initial level and growth rate. The correlation between intercept and slope was not significant (r = -0.01, p = 0.93), and the scatterplot (see Appendix) showed no discernible pattern, indicating no significant association between initial level and growth rate—a stable-differences pattern.

To more rigorously test this pattern, we grouped children using $±$1 SD from the mean and examined differences in subsequent growth rates. Based on T1 oral vocabulary knowledge (M = 8.62, SD = 5.14), we identified a high-scoring group (> M + 1 SD, i.e., > 13.76, n = 30), a medium-scoring group (M $\pm$ 1 SD, i.e., 3.48 to 13.76, n = 94), and a low-scoring group (< M - 1 SD, i.e., < 3.48, n = 25). Growth rates did not differ significantly among the three groups (high: 1.93 $\pm$ 0.23; medium: 1.99 $\pm$ 0.30; low: 2.00 $\pm$ 0.35), $F(2, 146) = 0.57$, $p = 0.569$, ^{2}p = 0.008. Additionally, growth mixture modeling (GMM) of oral vocabulary knowledge across eight time points identified two subgroups with different initial levels (low = 5.69; high = 13.05) but similar growth rates (low = 1.95; high = 2.02). These analyses collectively demonstrate a stable-differences pattern in oral vocabulary knowledge development during primary school.

3.3 Predictive Effects of Oral Vocabulary Knowledge Initial Level and Growth Rate on Reading Accuracy, Fluency, and Comprehension

We examined the predictive effects of children's oral vocabulary knowledge initial level and growth rate on their grade 6 reading abilities, controlling for general cognitive ability and early reading-related cognitive skills (phonological awareness, rapid naming, morphological awareness, and orthographic awareness). Results are shown in Figure 1 [Figure 1: see original paper]. For clarity, correlations among control variables are not displayed but were estimated in the model. Fit indices were ^{2}(79) = 85.35, p = 0.293, ^{2}/df = 1.08, CFI = 0.99, TLI = 0.99, RMSEA = 0.02 (90% CI [0.00, 0.05]), SRMR = 0.05, indicating good model fit. Results showed that both the initial level and growth rate of oral vocabulary knowledge significantly and positively predicted reading accuracy (B = 0.35, $p < 0.001$; B = 0.40, $p < 0.001$), reading fluency (B = 0.23, p = 0.037; B = 0.27, p = 0.003), and reading comprehension (B = 0.39, $p < 0.001$;

$B = 0.48$, $p < 0.001$). Among control variables, phonological awareness and rapid naming significantly predicted reading accuracy ($B = 0.20$, $p = 0.004$; $B = -0.22$, $p = 0.010$).

To compare the magnitude of predictions across reading abilities, we used model comparison with equality constraints on prediction coefficients. First, comparing intercept contributions across outcomes, the intercept's contribution to reading comprehension did not differ significantly from its contribution to reading accuracy ($\Delta\ ^2(1) = 0.32$, $p = 0.575$), but its contribution to reading fluency was significantly lower than to both reading accuracy ($\Delta\ ^2(1) = 3.91$, $p = 0.048$) and reading comprehension ($\Delta\ ^2(1) = 3.97$, $p = 0.046$). Second, comparing slope contributions, the slope's contribution to reading comprehension did not differ significantly from its contribution to reading accuracy ($\Delta\ ^2(1) = 0.10$, $p = 0.747$), but its contribution to reading fluency was significantly lower than to both reading accuracy ($\Delta\ ^2(1) = 7.44$, $p = 0.006$) and reading comprehension ($\Delta\ ^2(1) = 7.50$, $p = 0.006$). These results indicate that the initial level and growth rate of oral vocabulary knowledge predicted reading accuracy and comprehension more strongly than reading fluency.

To compare the contributions of initial level versus growth rate to each reading ability, we again used equality constraints. Results showed that the slope contributed more than the intercept to reading comprehension ($\Delta\ ^2(1) = 24.084$, $p < 0.001$), reading accuracy ($\Delta\ ^2(1) = 17.662$, $p < 0.001$), and reading fluency ($\Delta\ ^2(1) = 6.756$, $p = 0.009$). These findings indicate that, compared to children's oral vocabulary knowledge at school entry, their growth potential in oral vocabulary knowledge during primary school was a stronger predictor of all reading abilities in grade 6.

4.1 Developmental Trajectory of Oral Vocabulary Knowledge in Primary School

The extended tracking period in this study allowed us to observe developmental changes in children's oral vocabulary knowledge throughout primary school in detail. Significant positive growth was observed between each adjacent time point, indicating an overall upward developmental direction with relatively continuous growth—no plateau or decline occurred. These results demonstrate that, in terms of direction and continuity, children's oral vocabulary knowledge shows sustained growth during primary school, confirming that oral vocabulary knowledge is a low-constraint skill (Paris, 2005) with substantial developmental space for primary school children. Future research should continue investigating oral vocabulary knowledge development during middle school.

Regarding developmental shape, oral vocabulary knowledge showed nonlinear growth during primary school. The slope factor loadings (0, 1, 2.5, 3, 5.5, 7.5, 10.5, 12.5) indicate accelerated growth in grade 3 and again in grade 5. The nonlinear growth model shows that grades 3 and 5 were periods of rapid vocabulary development, with accelerated growth occurring during the transitions from lower to middle grades (grade 3) and from middle to upper grades (grade 5). This phenomenon can be explained within the framework of Chall's (1983) stages of reading development. First, lower-grade children are in the "learning to read" stage. After systematic character and word instruction, children receive explicit guidance on word meanings and their usage in reading, allowing them to integrate vocabulary learned through oral communication with meanings learned in the classroom, resulting in accelerated oral vocabulary development during the transition from lower to middle grades. Second, as children become proficient readers, middle-grade children transition to "reading to learn." They encounter diverse reading materials covering broad topics, and extensive reading increases their understanding of unfamiliar words. Increased reading volume also leads to more meaningful conversations with adults and peers about reading content, enabling children to use more sophisticated and complex vocabulary in oral communication and to more precisely grasp word meanings across different contexts and relationships between words. This facilitates accelerated oral vocabulary development during the transition from middle to upper grades.

Using three analytical approaches, this study found that oral vocabulary knowledge development during primary school exhibited a stable-differences pattern, showing neither Matthew effects nor compensatory patterns. One possible explanation is that early-acquired oral vocabulary knowledge remains at a relatively shallow level of basic semantics (Zhou & Marslen-Wilson, 2000) and does not yet involve deep semantic understanding. Subsequent development of oral vocabulary knowledge may be more related to semantic pathway development in middle and upper grades. Consequently, children's initial oral vocabulary level is not significantly associated with their subsequent growth rate, resulting in similar growth rates among children with different starting levels and stable individual differences over time.

4.2 Predictive Effects of Oral Vocabulary Knowledge Initial Level on Reading Accuracy, Fluency, and Comprehension

This study also examined how children's oral vocabulary knowledge initial level and growth rate predicted their grade 6 reading abilities. Regarding the predictive effect of initial level, first-grade oral vocabulary knowledge significantly predicted grade 6 reading accuracy, fluency, and comprehension. These findings align with Pan et al. (2022), who found stable predictive effects of oral vocabulary knowledge on reading accuracy from grades 1 to 3, and with research showing that first-grade oral vocabulary knowledge significantly predicts grade 2 reading fluency and comprehension (Li & Wu, 2020). The unique contribution of this study is extending these predictive effects over a much longer tracking period.

Our results provide supportive evidence for the Reading Triangle Theory (Perfetti, 2009) from a non-alphabetic language. First, understanding word meaning affects word recognition: representations of phonology and semantics in oral vocabulary facilitate children's character recognition abilities. The more deeply children understand word meaning, the tighter the sound-meaning connection, which promotes the semantic pathway of word recognition. Second, deeper understanding of oral vocabulary indicates higher-quality lexical representations (Perfetti, 2017), enabling children to rapidly access word meanings during text reading and allocate freed cognitive resources to meaning processing. This facilitates smoother information extraction, faster semantic inference, and more efficient text meaning construction, resulting in more fluent reading. Finally, oral vocabulary knowledge corresponds to semantic representations in the mental lexicon. High-quality semantic representations enable children to more comprehensively and precisely distinguish near-synonyms and grasp subtle meaning differences across contexts. This allows them to extract more precise word meanings during reading, activate other words in the same domain, form richer lexical network connections, create meaning units with other text content, and ultimately construct text meaning to promote deeper reading comprehension.

In summary, this study provides empirical support for the Reading Triangle Theory from Chinese children, demonstrating that oral vocabulary knowledge not only facilitates reading accuracy and comprehension but also promotes reading fluency development. These results underscore the important role of meaning-related language skills in Chinese reading.

4.3 Predictive Effects of Oral Vocabulary Knowledge Growth Rate on Reading Accuracy, Fluency, and Comprehension

Previous research has rarely examined the contribution of oral vocabulary knowledge growth rate to subsequent reading abilities. A key finding of this study is that the growth rate of oral vocabulary knowledge from grades 1 to 6 significantly and independently predicted grade 6 reading accuracy, fluency, and comprehension. This finding aligns with Song et al. (2015), who found that oral vocabulary knowledge growth from ages 4.4 to 10.4 predicted reading abilities at age 11.4. Together, these findings emphasize the importance of oral vocabulary knowledge growth rate for reading ability development during primary school. Moreover, our results show that the predictive effect of oral vocabulary knowledge growth rate on reading abilities is independent of general cognitive ability, initial oral vocabulary knowledge level in grade 1, and reading-related cognitive skills including phonological awareness, rapid naming, morphological awareness, and orthographic awareness. Thus, growth rate in oral vocabulary knowledge explains variance in reading abilities not accounted for by these previously established reading-related skills, demonstrating its independent contribution.

Furthermore, we found that the initial level and growth rate of oral vocabulary knowledge predicted reading accuracy and comprehension more strongly than reading fluency. This suggests that oral vocabulary knowledge more strongly promotes reading decoding and text comprehension than decoding speed and fluent reading. One possible explanation is that when cognitive resources are limited, reading decoding receives priority allocation, as basic decoding must be completed before transitioning to overall text comprehension and fluent reading. During reading, the facilitative effect of oral vocabulary knowledge first manifests at the word level, then contributes to overall text comprehension. Only after decoding accuracy and meaning comprehension reach certain levels can the facilitative effect extend to fluent reading. Therefore, oral vocabulary knowledge shows stronger predictive effects on reading accuracy and comprehension than on fluency.

Finally, we found that children's oral vocabulary knowledge growth rate during primary school was a stronger predictor of their grade 6 reading abilities than their initial level at school entry. Compared to initial level, growth rate contains critical information about children's plasticity and potential in oral vocabulary knowledge development. According to the skill learning theory of cognitive development (Klingberg, 2014), behavioral development serves as an indicator of cognitive skill plasticity, reflecting neural plasticity. Skill learning theory emphasizes the importance of distinguishing between learning and ability, positing that learning plays a crucial role in brain plasticity and cognitive development. Theoretically, learning and developmental potential are strong predictors of children's academic achievement. From this perspective, our findings provide empirical support for skill learning theory and highlight that monitoring children's oral vocabulary knowledge growth can provide important information for identifying at-risk children and guiding instruction.

4.4 Limitations and Future Directions

This study has several limitations that should be addressed in future research. First, the relatively high attrition rate and small sample size limit the generalizability of our findings and preclude more detailed analysis of individual differences in oral vocabulary knowledge development. Since we found significant individual differences in both initial level and growth rate, future research should expand the sample size and implement better retention strategies to more thoroughly investigate individual differences. Second, although this longitudinal study used latent growth modeling to examine the predictive effects of initial level and growth rate, causal inferences cannot be drawn. Our conclusions require testing through experimental or intervention studies. Finally, constrained by the research design, this study primarily examined the direct predictive effects of oral vocabulary knowledge on reading abilities. Future research should explore more complex relationships, such as the underlying mechanisms of these predictive effects, boundary conditions, and bidirectional relationships between oral vocabulary knowledge and reading abilities.

4.5 Theoretical and Practical Implications

Despite these limitations, this study has important theoretical value. Through eight waves of testing over six years, we systematically examined the developmental trajectory of oral vocabulary knowledge during primary school in terms of direction, continuity, shape, and pattern. We found sustained growth in oral vocabulary knowledge and identified the significant independent predictive effect of growth rate on reading abilities. These findings highlight the importance of understanding developmental trajectories for predicting children's reading abilities several years later.

This study also has practical implications for Chinese language education in primary schools. Given the important predictive role of oral vocabulary knowledge growth rate, assessment should not focus solely on initial or final levels but should incorporate learning progress. Teachers can conduct tracking assessments of children's oral vocabulary knowledge development—for example, using developmental progress charts—to identify children with slower growth and provide appropriate guidance. Instructional activities such as word explanation, synonym substitution, and polysemy discrimination can be organized for children at different developmental levels to enhance learning and understanding of high-frequency words. Encouraging parents to provide rich vocabulary environments through parent-child reading and conversation can help children deeply understand word meanings, relationships between words, and word usage in sentences, ultimately improving reading abilities through vocabulary instruction.

Key Findings:
(1) Children's oral vocabulary knowledge showed continuous nonlinear growth during primary school, with accelerated development in grades 3 and 5, and individual differences exhibited a stable-differences pattern.
(2) After controlling for general cognitive ability and reading-related cognitive skills, both the initial level and growth rate of oral vocabulary knowledge significantly predicted grade 6 reading accuracy, fluency, and comprehension, with stronger predictions for accuracy and comprehension than for fluency. The growth rate was a stronger predictor than the initial level.

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Appendix: Mplus Syntax

Variable names: vdt1~vdt8 = oral vocabulary knowledge at T1-T8; rct8 = reading comprehension; crt8 = reading accuracy; rft8 = reading fluency; iq = general cognitive ability; pdt1 = phonological awareness; rant1 = rapid naming; cwpt1 = morphological awareness; oat1 = orthographic awareness

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vdl vds | vdt1@0 vdt2@1 vdt3@2.5 vdt4@3 vdt5@5.5 vdt6@7.5 vdt7@10.5 vdt8@12.5; ! Constructi
vdl with vds;! Correlation between intercept and slope of oral vocabulary knowledge developm
rct8 crt8 rft8 on vdl vds;! Prediction of reading comprehension, reading accuracy, and readi
rct8 crt8 rft8 on iq pdt1 rant1 cwpt1 oat1; ! Prediction of reading comprehension, reading a
iq with pdt1 rant1 cwpt1 oat1 vdl vds;! Correlations among control variables and with inter
pdt1 with rant1 cwpt1 oat1 vdl vds;
rant1 with cwpt1 oat1 vdl vds;
cwpt1 with oat1 vdl vds;
oat1 with vdl vds;
rct8 with crt8 rft8;! Correlation between reading comprehension and reading accuracy/fluency
crt8 with rft8;! Correlation between reading accuracy and reading fluency
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Scatterplot of the correlation between intercept and slope of children's oral vocabulary knowledge:

[FIGURE: Scatterplot of the correlation between intercept and slope of children's oral vocabulary knowledge]

Note: Figure translations are in progress. See original paper for figures.

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