Modeling the Relationships between Language Skills and Sentence Comprehension among Chinese Junior Elementary Graders

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Abstract

The present study examined the contributions of vocabulary knowledge, syntactic skills, and oral narrative skills to sentence reading comprehension among Chinese junior elementary school children. Various language and reading measures were administered to 85 Chinese normally-achieving children at Grades 2 and 3 in Hong Kong. Results showed that vocabulary knowledge and oral narrative skills contributed significantly to word order skills, an important syntactic skill in Chinese. Vocabulary knowledge contributed to word recognition directly and contributed to sentence comprehension indirectly through word recognition and syntactic skills; and syntactic skills contributed to sentence comprehension directly. These findings suggest that while vocabulary knowledge is important for Chinese word reading, syntactic word order plays a central role in Chinese sentence comprehension. The implications of these findings for our theoretical understanding of the Simple View of Reading, as well as reading instruction, will be discussed.

Introduction

Reading comprehension is a multi-componential task involving many cognitive processes (Oakhill & Cain, 2012; Share & Leiken, 2004). These cognitive processes could roughly fall into two categories. Lower cognitive processes involve translating written codes into meaningful language units (e.g., word recognition and its relevant sub-lexical processes) and higher processes involve combining these language units into a meaningful mental representation (e.g., inference making that enables a reader to connect one part to other parts of the text) (Kendeou, Papadopoulos, & Spanoudis, 2012; Kendeou, van den Broek, White, & Lynch, 2009; Perfetti, 2007; van den Broek, 1997).

According to the multi-component view of reading comprehension, to comprehend a text, a reader must be able to draw on language skills and cognitive processes at the word-, sentence-, and discourse-level to construct a coherent mental representation of the text (Kendeou, Papadopoulos, & Spanoudis, 2012; Oakhill & Cain, 2012; Silva & Cain, 2015; van den Broek, Kendeou, Lousberg, & Visser, 2011; Vellutino, Tunmer, Jaccard, & Chen, 2007). Word-level reading (i.e., word recognition) involves lower cognitive processes and hence efficient word recognition could preserve processing resources for higher level comprehension (Perfetti, 2007). At sentence-level comprehension, to comprehend a sentence, a reader must decode individual words, access the phonological, orthographic, and semantic representations of the words to retrieve meanings, and combine these into clauses and sentences guided by syntactic knowledge (Silva & Cain, 2015). At discourse-level comprehension, a reader must be

able to connect individual idea units and integrate information across different parts of a text. Lower and higher levels of cognitive processes involved in reading comprehension begin to develop before formal reading education starts and they independently predict reading comprehension performance at a later age (Kendeou, van den Broek, White, & Lynch, 2009; Silva & Cain, 2015). It is essential for us to understand how these cognitive processes lead to successful reading comprehension. Such understanding has important implications for educational practice with respect to literacy programmes to foster reading comprehension skills in young children. The present study adds to this line of literature in examining the unique contributions of word recognition, vocabulary knowledge, syntactic, and oral narrative skills in sentence comprehension in Chinese (a logographic language other than English). In doing so, the decoding and linguistic components and their relations with reading comprehension as suggested in the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990) (SVR) are considered.

Understanding Reading Comprehension within the Framework of the Simple View of Reading

According to the SVR framework, reading comprehension is postulated as the product of two interrelated but relatively independent cognitive processes, i.e., decoding (or word recognition) and listening comprehension (or language comprehension). Both processes are necessary cognitive components, and neither of each alone is sufficient for successful reading comprehension (Hoover & Gough, 1990; Tunmer & Hoover, 1992). There is significant support for the central feature of the SVR that reading comprehension is the product of decoding and listening comprehension, namely, significant and sizable variance in reading comprehension explained by measures of these two broad sets of skills across a wide age range (Kendeou, Savage, & van den Broek, 2009; Language and Reading Research Consortium & Chiu, 2018; Oakhill & Cain, 2012; Vellutino, Tunmer, Jaccard, & Chen, 2007). Such finding also provides strong support for the assumption proposed in the SVR that the decoding and linguistic components are of equal importance for successful reading comprehension (Hoover & Gough, 1990).

Although the relationship between decoding and reading comprehension, and also listening and reading comprehension have been empirically substantiated, the nature of the decoding and linguistic components of the SVR remains less clear. The decoding component is defined as the ability to convert graphic stimuli into linguistic referents. The original use of the term decoding in Gough and Tunmer's study (1986) has caused confusion in how to conceptualize this construct. Strictly speaking, decoding may refer to the process of serial grapheme-to-phoneme conversion and hence non-word reading measures should be used to map onto the decoding component specified within the SVR (Kirby & Savage, 2008; Ouellette & Beers, 2010). Yet, the majority of studies conducted on the SVR have used measures of word or non-word reading or both to assess this component. Furthermore, substantial evidence has revealed that word reading measures are more predictive of reading comprehension for readers of more opaque orthographies (e.g., English), while non-word reading measures are more predictive of reading comprehension for readers of more transparent orthographies (e.g., Finnish, German, and Italian) (Florit & Cain, 2011). It seems that the strength of the relationship between decoding and reading comprehension is affected by how the decoding component is conceptualized and measured in the SVR. It can be argued that

the original definition of decoding by Gough and Tunmer (1986) that it refers to the ability to read isolated words quickly, accurately, and silently pertains more to serial decoding as word reading encompasses orthographic learning and recognition (Ehri, 2005; Share, 1995). According to several computational models of word recognition and reading aloud (e.g., the dual-route model), word recognition can be explained by a model of reading aloud that possesses a dual-route architecture from print to speech. The lexical nonsemantic route (i.e., the phonological decoding path) generates the pronunciation of a word and the lexical semantic route (i.e., the orthographic processing path) is responsible for retrieving the meaning of a word from the mental lexicon (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Plaut, McClelland, Seidenberg, & Patterson, 1996). The phonological decoding path may be the primary route in languages with highly transparent orthographies (e.g., Finnish, German, and Italian), while the orthographic processing path is more important in languages where the correspondences between graphemes and phonemes are less predictable (e.g., English) or there is no script-sound correspondences (e.g., Chinese). We use the term word recognition throughout to refer to successful word reading. Therefore, the decoding component of the SVR can be analyzed into phonological decoding and orthographic processes, corresponding to the paths to the dual-route model of reading aloud (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001).

Similarly, the use of the term listening comprehension might complicate the interpretation and evaluation of the SVR. Some researchers have argued that the original choice of listening comprehension as the construct of language skills most relevant to reading comprehension is too vague (Kirby & Savage, 2008; Ouellette & Beers, 2010). The linguistic component is defined as the ability to take word-level lexical information and derive sentence and discourse interpretations of aurally presented texts and thus is also referred to as listening comprehension (Florit & Cain, 2011). For consistency, we use the term language comprehension throughout. Some researchers have pointed out that the construct of language comprehension can encompass all aspects of language knowledge and hence does not fully reflect the important role of specific language skills in reading comprehension (Braze, Tabor, Shankweiler, & Mencl, 2007). For instance, Ouellette and Beers included measures of both language comprehension and oral vocabulary, along with measures of phonological awareness and word recognition to examine their shared and unique contributions to reading comprehension (Ouellette & Beers, 2010). It was found that for more advanced Grade 6 students, oral vocabulary contributed to reading comprehension beyond measures of the two constructs specified in the SVR: word recognition and language comprehension. It is worth to note that in this study, language comprehension would not be a significant predictor of reading comprehension but phonological awareness and oral vocabulary were the significant predictors of reading comprehension when all the variables were entered in the regression model (Ouellette & Beers, 2010). These findings suggest how the construct of language comprehension of the SVR may best be conceptualized and measured. Given that previous research that used measures that control for style, vocabulary, and length to assess oral and written comprehension has reported greater magnitude of correlations between language and reading comprehension (Hoover & Gough, 1990, Vellutino, Tunmer, Jaccard, & Chen, 2007), it may be reasonable to expect a more direct relation between language and reading comprehension both at the discourse-level and subskills specific to text comprehension (e.g., text integration and inferential processing, understanding

of story structure, and comprehension monitoring (Oakhill, Cain, & Bryant, 2003)) contribute to both oral and written comprehension at the discourse-level. For sentence comprehension, word recognition and its subskills (e.g., oral vocabulary and semantic skills) and syntactic skills might be better to represent the decoding and linguistic constructs of the SVR as they account for significant variances in sentence comprehension (Chang, Lieven, & Tomasello, 2008; Kidd, Lieven, & Tomasello, 2006; Nation and Snowling, 2004; Ouellette, 2006).

The other important feature of the SVR is the hypothesized asymmetry in the relative contributions made to reading comprehension by word recognition and language comprehension at different stages of reading development (Gough & Tunmer, 1986; Hoover & Gough, 1990). At the early stage of reading development (i.e., the stage of learning to read), beginner readers are still learning how to decode words and hence word recognition rather than language comprehension should account for more variance in reading comprehension. Language comprehension processes would not fully operate in reading comprehension until word recognition becomes relatively automatic and more resources could be reserved for higher level cognitive processes (e.g., inferences and syntactic repairs) involved in reading comprehension (Florit & Cain, 2011; Vellutino, Tunmer, Jaccard, & Chen, 2007). Support for the hypothesis in the SVR that the influences of these two components will change developmentally came from studies of reading development in children, in which word recognition and phonological decoding skills were found to be better predictors of performance on measures of reading comprehension in children with limited reading skill than in children with more advanced reading skill (Hoover & Gough, 1990; Vellutino, Scanlon, Small, & Tanzman, 1991; Vellutino, Scanlon, & Tanzman, 1994), while language comprehension was found to be a better predictor of performance on measures of reading comprehension in children with more advanced reading skill than in children with limited reading skill (Goff, Pratt, & Ong, 2005; Seigneuric & Ehrlich, 2005).

We had special interests in examining the mechanism of sentence comprehension in this study for two reasons. Firstly, Chinese children at the early stage of learning to read are still developing the automaticity of word recognition and their higher cognitive processes of sentence comprehension becomes less automatic. Only children with efficient word- and sentence-level processing skills would be able to achieve competent passage-level comprehension (Luna, Garver, Urban, Lazar, & Sweeney, 2004). In other words, sentence comprehension is a pre-requisite for passage comprehension. Secondly, despite the widely held view that reading comprehension is a multidimensional construct, the assessment of this construct in the majority of studies examining the relationship among the three components in the SVR favors measures at the discourse-level (Florit & Cain, 2011). However, the strength of the relationship between word recognition and reading comprehension is affected by text genre and test format of reading comprehension (Best, Floyd, & McNamara, 2008; Nation & Snowling, 1997). For example, there are substantial differences have been found in the strength of the association between word recognition and reading comprehension performance measured with materials of different text genres (e.g., narrative and expository) and formats (i.e., single sentences and passages) (Andreassen & Braten, 2010; Best, Floyd, & McNamara, 2008; Francis, Fletcher, Catts, & Tomblin, 2004; Nation & Snowling, 1997). For example, a stronger relationship was found between word recognition and reading comprehension measured with a sentence cloze task than with a task that involves passage reading and open-ended questions (Nation &

Snowling, 1997). This pattern was supported by other work (Andreassen & Braten, 2010). The findings from these studies demonstrate differences in processing demands of sentence- and passage-level comprehension. Both sentence- and passage-level reading comprehension involve lower and higher cognitive processes, but they differ in processing demands of reading comprehension tasks. For lower cognitive processes, word recognition and its relevant sub-lexical processes (e.g., applying knowledge about letter-sound correspondences to sound out a written word) are necessary to convert graphic stimuli into linguistic referents (i.e., words) in reading comprehension tasks involving single sentences or passages. Higher cognitive processes (e.g., integrative processes, inferences and syntactic repairs) involving connecting one element to other elements of a sentence or one part to other parts of a passage are essential to derive sentence and passage interpretations to construct a meaningful mental representation for comprehension. In a sentence cloze task, children need to decode individual words accurately to complete the task, whereas in a passage-reading task, inaccurate decoding of some words may not necessarily be detrimental to correctly responding to questions as children could integrate information across sentences to identify words decoded inaccurately (Garcia & Cain, 2014; Kendeou, Papadopoulos, & Spanoudis, 2012). Given the commonalities and differences in sentence- and passage-level reading comprehension, the exploration of the skills that foster sentence comprehension will enable us to better conceptualize the construct of reading comprehension as specified in the SVR (e.g., the necessity of separating the construct of reading comprehension into sentence- and discourse-level comprehension). Moreover, the literature reviewed earlier is suggestive of a more complicated relationship among word recognition, oral language, and reading comprehension than suggested in the current conceptualization of the SVR. Identifying subskills of sentence comprehension would be helpful to address these issues. For this reason, we evaluated the role of language skills most relevant to word recognition and/or sentence comprehension and their contributions to sentence comprehension. Next, we will discuss the language skills and their relations to various reading skills.

Relations of Vocabulary Knowledge to Word Recognition and Reading Comprehension

Although there is growing recognition of the developmental trajectories of the influences of word recognition and language comprehension on reading comprehension in the SVR, research findings with respect to the relative contribution of oral language skills (one of the important contributors of language comprehension) in early reading comprehension have been contradictory (Catts, Fey, Zhang, & Tomblin, 1999; Paris & Paris, 2003; Speece, Roth, Cooper, & de la Paz, 1999; Vellutino, Tunmer, Jaccard, & Chen, 2007). For example, Muter and colleagues (2004) found that when phonological awareness was taken into consideration, receptive vocabulary measured in school entry predicted passage comprehension rather than word recognition performance measured at Grade 2. Similar findings were also obtained in Catts and colleagues' study (1999) in which oral language skills (measured with receptive vocabulary, oral vocabulary, grammatical understanding, sentence imitation, and grammatical completion) assessed in kindergarten were predictive of reading comprehension assessed at Grade 2 after controlling for phonological skills. However, in a longitudinal study, Storch and Whitehurst (2002) found that oral language skills measured at kindergarten contributed indirectly to reading performance at Grade 2 via the contribution to word reading

performance at Grade 1. On the one hand, results of some studies suggest that oral language skills become fully operative only when word recognition becomes automatic (Speece, Roth, Cooper, & de la Paz, 1999; Vellutino, Tunmer, Jaccard, & Chen, 2007). On the other hand, results of other studies highlight the important role of such skills in early reading development (Catts, Fey, Zhang, & Tomblin, 1999; Paris & Paris, 2003). The lack of consensus in the literature may be due to the age range on which existing studies have focused. Most of the research on assessing the contribution of oral language skills to word recognition and reading comprehension investigated children in kindergarten throughout second grade (see the review by Storch & Whitehurst, 2002). Many oral language skills (e.g., receptive vocabulary), however, develop well among children before kindergarten (Kendeou, Broek, White, & Lynch, 2009) and more advanced oral language skills (e.g., discriminating differences in word meanings) should be the focus of school-aged children.

Another reason for the inconsistent results in previous research concerns the different ways that oral language skills have been conceptualized and measured. Oral language skills have often been measured with oral vocabulary tasks (e.g., receptive and expressive vocabulary) in literature (Kendeou, Broek, White, & Lynch, 2009; Nation & Snowling, 1998b; Nation & Snowling, 2004; Yeung, Ho, Chan, & Chung, 2016). Moreover, oral vocabulary has been conceptualized as the breadth (i.e., how many words are known) and depth (i.e., how well word meanings are known) of vocabulary knowledge. Such distinction comes from models of the mental lexicon. According to Levelt and colleagues (1999), the storage of vocabulary in the mental lexicon involves lexical representations of phonology or sound patterns of word and semantic representations of word meaning. In accordance with this definition, the mental lexicon is regarded as a store of phonological word forms and semantic representations of word meanings and therefore a distinction between the number of lexical entries (i.e., vocabulary breadth) the extent of semantic representation (i.e., depth of vocabulary knowledge) (Coleman, 1998; Levelt, Roelofs, & Meyer, 1999). Ouellette (2006) found that vocabulary breadth predicted decoding skills and word recognition, whereas vocabulary depth contributed to word recognition via vocabulary breadth among Grade 4 children. These findings may reflect that the depth of vocabulary knowledge refines the extent of semantic representations along with the increment of vocabulary size and ultimately benefits word recognition. Given the age range of our participants (i.e., children in Grades 2 and 3), we were particularly interested in testing the direct relationship between oral vocabulary with focus on depth of vocabulary knowledge and word recognition and the indirect relationship between oral vocabulary and sentence comprehension via word recognition.

Apart from oral vocabulary, semantic processing skills is another important aspect of oral language skills. In the framework proposed by Seidenberg and McClelland (1989), single word pronunciation (i.e., word recognition) can be captured by processes that establish mappings between orthographic and phonological representations via a set of hidden units. A phonological process (also phonological pathway), is responsible for mappings between orthographic and phonological representations and a semantic process (also semantic pathway) deals with mappings between semantic, phonological, and orthographic representations (Plaut, McClelland, Seidenberg, & Patterson, 1996). Nation and colleagues have provided substantial evidence for semantic correlates of reading abilities and reading disabilities (Nation, Clarke, Marshall, & Durand, 2004; Nation & Snowling, 1998a, 1998b; Nation &

Snowling, 1999; Nation & Snowling, 2000; Nation & Snowling, 2004). For example, in a longitudinal study by Nation and Snowling (2004), semantic processing skills measured with a semantic fluency test and a synonym judgment task were found to be a concurrent and a longitudinal predictor of both word recognition and reading comprehension after controlling for phonological processing skills. It is worthy to note that as the effect of word recognition was not controlled in this study, it was possible that a considerable proportion of the variance in reading comprehension explained by semantic skills may also be explained by word recognition. Thus, it appears that semantic skills, especially the skill of discriminating subtle differences in word meanings, contribute to word recognition via the semantic pathway in the framework proposed by Seidenberg and McClelland (1989). In other studies, vocabulary knowledge has been shown to be linked to irregular word recognition (Nation & Snowling, 1998b; Ouellette, 2006). The research evidence reviewed here is suggestive of the view that semantic skills exert influence on the semantic pathway (i.e., connecting semantics to orthography), which is consistent with the perspective of computational models of reading (Plaut, McClelland, Seidenberg, & Patterson, 1996) and developmental models of reading (Share, 1995) that highlight the role of semantics in orthographic learning and word learning.

Given the important role of vocabulary knowledge for developing semantic representations and retrieving word meanings in the early stage of reading development, we included measures of oral vocabulary and semantic discrimination to examine their contributions to word recognition and sentence comprehension. We expected a direct role of vocabulary knowledge in predicting word recognition and a less important role in sentence comprehension after controlling for the effect of word recognition. Also, we argued that vocabulary knowledge may have a distinct relation to word recognition and may contribute to sentence comprehension indirectly via the effect on word recognition.

Relations of Syntactic Skills to Word Recognition and Reading Comprehension

In previous research, syntactic skills were demonstrated to contribute significantly to text-level reading comprehension in many studies (Demont & Gombert, 1996; Muter et al., 2004; Plaza, 2001; Plaza & Cohen, 2003; Willows & Ryan, 1986). Moreover, unique contributions of syntactic skills were also found to sentence comprehension (Chang, Lieven, & Tomasello, 2008; Kidd, Lieven, & Tomasello, 2006). These findings suggest that syntactic skills may contribute to reading comprehension indirectly via the effects on sentence comprehension. Among various syntactic skills, there is also substantial evidence in support of the significant role of word order skills in reading comprehension. For example, Tunmer and colleagues (1988) found that word order skills (i.e., processing between-constituent (e.g., VOS, VSO, and SOV) and within-constituent order (e.g., word order for an article and a noun) assessed at Grade 1 predicted word decoding and reading comprehension at Grade 2. As word order provides the information about the basic structure of a sentence, it was reasonable to expect a significant role of word order in sentence comprehension in the present study.

In regard to the relationship between syntactic skills and vocabulary knowledge, the role of oral language skills in syntactic development has been emphasized in research investigating the relationship between metalinguistic awareness and early reading development (Bowey, 2005; Chaney, 1994; Menyuk & Chesnick, 1997; Smith

& Flusberg, 1982). Metalinguistic skills (e.g., phonological awareness, morphological awareness, and syntactic awareness) refer to the ability to reflect on explicitly the structural features of spoken language (e.g., how individual phonemes comprise a word and how constituent words are grouped into an utterance) (Chaney, 1994; Tunmer, Herriman, & Nesdale, 1988). Metalinguistic skills develop separately from and later than basic oral language skills (e.g., speaking and listening a spoken language) before formal schooling (Tunmer, Herriman, & Nesdale, 1988). Evidence in support of this view comes from studies which showed that oral language skills were a powerful predictor of metalinguistic awareness in preschoolers (Chaney, 1994). Chaney (1994) identified factors most crucial in early literacy development and found that 3-year-old children's oral language skills (i.e., oral receptive and expressive language) predicted their metalinguistic awareness (i.e., phonological, morphological, and syntactic awareness) which was associated with emergent literacy (i.e., knowledge about print concepts). It appears that syntactic awareness of preschoolers enables them to develop more sophisticated syntactic skills (e.g., manipulating sentence structures and detecting syntactic errors in sentence comprehension) during formal reading instruction. Smith and Flusberg (1982) reported that the skill of manipulating grammatical morphemic variation was related to vocabulary knowledge and the skill of manipulating word order for imperative sentences was related to both vocabulary knowledge and listening comprehension. This set of findings suggest that children develop the grammatical concept of word class with the expansion of vocabulary knowledge, which helps to acquire grammatical structures that are important for the acquisition of word order rules which in turn contribute to sentence comprehension. Given that vocabulary knowledge is fundamental for the acquisition of syntactic skills, we expected a mediation effect of syntactic skills on the relationship between vocabulary knowledge (and also other language skills such as oral narrative skills) and sentence comprehension in the present study.

Relations of Oral Narrative Skills to Reading Comprehension

Narrative text (e.g., short stories and traditional tales) is the form of reading materials that may be exposed to children most frequently. Evidence for the important role of narrative knowledge for comprehending the meanings of a text came from the research investigating children's ability to produce stories. Children with better knowledge about the conventional features of stories (e.g., beginning, body, and ending of a story) were found to produce more coherent stories and perform better in reading comprehension tasks (Paris & Jacobs, 1984), whilst children with inadequate knowledge about text structures and genres suffered from failure in reading comprehension (Perfetti, 1994). Moreover, children with normal decoding skills but impaired comprehension skills were shown to have impairments in constructing stories due to their impoverished knowledge about the structural features of a story (Cain, 2003; Cain & Oakhill, 1996). The relationship between oral narrative skills and reading comprehension found in these studies suggests that knowledge about the features of narrative texts provides a useful discourse context for text comprehension rather than sentence comprehension. In the present study, we expected that oral narrative skills contributed to sentence comprehension indirectly via the effects on syntactic skills as from a developmental point of view, the acquisition of syntactic skills, particularly the acquisition of advanced syntactic word order skills, is influenced by the development of oral narrative skills (Gombert, 1992; Menyuk & Chesnick, 1997; Miao & Zhu, 1992).

Next, we will introduce the characteristics of the Chinese orthography and review studies investigating the relationship between these language skills and reading comprehension.

Relations of Language Skills to Word Recognition and Reading Comprehension in Chinese

The Chinese writing system contrasts with the alphabetic writing systems primarily on the mapping principle. There is no direct script-sound relation in Chinese at the sub-lexical level. Research has demonstrated a less important role of phonological processing skills in Chinese word reading and reading comprehension. In a longitudinal study, Tong, McBride-Chang, Shu, and Wong (2009) found that orthographic and morphological skills predicted Chinese word reading and reading comprehension concurrently and longitudinally, whereas phonological awareness at kindergarten failed to explain unique variances in word reading and reading comprehension at Grade 1. It appears that the lack of reliable script-sound relation in Chinese results in readers that rely on a semantic pathway (i.e., mappings between orthography, semantics, and phonology) rather than phonological pathway (i.e., mappings between orthography and phonology) for word recognition.

Chinese orthography is also described as a morpho-syllabic writing system (DeFrancis, 1989; Mattingly, 1984). The majority of Chinese words are bisyllabic or multisyllabic (Taylor & Taylor, 1995) and many words share a same morpheme. For example, 飯桌 /faan6 zoek3/ "dining table" and 木桌 /muk6 zoek3/ "woody table" share the morpheme 桌 /zoek3/ "table" and hence they are semantically related. Given the characteristics of semantic compounding in Chinese word formation, vocabulary knowledge, especially semantic discrimination is important for understanding word meanings. This has been demonstrated in So and Siegel's study (1997) in which semantic processing skills (judging meanings of similar words and sentences) predicted word recognition among Chinese students from Grades 1 to 4.

Chinese is also described as a noninflected language as it neither inflects nouns for case, gender, and number, nor inflects verbs for tense and subject-verb agreement (Li & Thompson, 1981; Tsang & Stokes, 2001). Word order is the most significant single syntactic device for Chinese sentence interpretation (Chang, 1992). However, the semantic-driven nature of Chinese may partly determine a rather loose word order system in Chinese as compared to English. The canonical word order for Chinese sentences is Subject-Verb-Object (SVO). An example of SVO order is given as 我打破了花瓶 "I hit break PERF (perfective aspect) vase". SOV and OSV order are allowed in Chinese sentences. SOV and OSV order usually appear in Ba and Bei sentences, respectively (Matthews & Yip, 1994). For example, the SVO sentence 我打破了花瓶 "I hit break PERF (perfective aspect) vase" can be converted to a Ba sentence 我把花瓶打破了 "I ba vase hit break PERF (perfective aspect)" or a Bei sentence 花瓶被我打破了 "Vase bei I hit break PERF (perfective aspect)". Apart from the between-constituent order (i.e., SVO, SOV, and OSV), within-constituent order (i.e., word order in multi-attribute and multiadverbial) reflects the relations between head noun/verb and modifiers and was examined here for the reason that different attributes and adverbials are important in substantiating the main construct of syntactic process in Chinese sentence reading. In Chinese, the placement of adverbs is often in the pre-predicate position after the topic and before the verb in the sentence (Li & Thompson, 1981).

This arrangement is in some contra-distinction to English where some verbs are preverbal and some post-verbal. For example, "He very much likes football" (Chinese version) as compared with "He likes football very much" (English equivalent). Then relative clauses in Chinese are pre-modifying and are realized with the nominalizer (e.g., "dik1") (Li & Thompson, 1981; Mathews & Yip, 1994).

The relationship between syntactic skills and reading comprehension has been established in some correlational studies. Yeung and colleagues (2011) reported that syntactic word order skills accounted for unique variance in both sentence and passage reading comprehension after controlling for the effects of word reading and other cognitive-linguistic skills. Chik, Ho, Yeung, and Chan et al. (2012) reported that syntactic skills of processing word order, connectives, and morphosyntactic structures measured at Grade 1 significantly predicted sentence comprehension measured at Grade 2 after controlling for the effects of phonological, orthographic, and morphological skills. However, word order no longer predicted sentence comprehension when morphosyntax and connective usage were considered. As suggested by the authors, this may be due to the overlap in tasks of word order and connective usage. In the present study, syntactic word order skills were postulated to contribute to sentence comprehension directly but not to word recognition. Research on oral narrative skills in Chinese children is scarce and therefore one of the aims of this study was to examine the role of oral narrative skills in sentence comprehension and its relevance to other language skills.

Despite the important role of language skills in word recognition and reading comprehension being upheld in recent Chinese studies, findings may not be conclusive. For example, Chik, Ho, Yeung, and Wong et al. (2012) found that oral vocabulary and word semantics made significant contributions to reading comprehension after controlling for word reading among children from Grades 1 to 3, but the contributions became non-significant with word reading controlled among children from Grades 4 to 5. Moreover, discourse skills contributed to reading comprehension consistently from Grades 1 to 5 even after controlling for word reading, whereas word order made no significant contribution to reading comprehension with the effect of word reading controlled across the grades. Given that reading comprehension was measured with sentence and passage comprehension scores combined in their study and therefore effects of the language skills failed to be separated from text comprehension to sentence comprehension (e.g., word order may play a more significant role in sentence reading than in passage reading). The present study was also to address this important issue.

In summary, in the present study we have included word recognition and various language skills that have previously been considered as important components of reading comprehension skill to investigate their relations with sentence comprehension.

Aims of the Present Study

The primary aim of the present study is to assess the relative contributions of the various language skills we have known to be related to word recognition and/or sentence comprehension skill in Chinese primary-age children. To address this aim, we used structural equation modelling (SEM) to examine the relationship among word recognition, language skills (i.e., vocabulary knowledge, syntactic skills, and oral narrative skills), and sentence reading comprehension in a sample of Chinese children in Grades 2 and 3. With reference to the SVR, we conceptualized sentence comprehension as determined by word recognition and syntactic skills. We have

focused on syntactic skills rather than language comprehension as suggested in the SVR due to the reason that language comprehension cannot fully reflect the importance of specific language skills such as oral vocabulary (Braze, Tabor, Shankweiler, & Mencl, 2007) and perhaps also syntactic skills. In addition, there may be less distributional variance in the construct of language comprehension to secure it to be a meaningful predictor of reading comprehension skill (Ouellette & Beers, 2010).

In the SEM model (see Appenxix 5: Figure 1), vocabulary knowledge was hypothesized to make direct contribution to word recognition. Syntactic skills were postulated to contribute to sentence comprehension directly but not to word recognition. Vocabulary knowledge and oral narrative skills were hypothesized as two correlated constructs given that they were usually regarded as important aspects of oral language skills in previous studies (Chik, Ho, Yeung, & Wong et al., 2012; Yeung, Ho, Chan, Chung, & Wong, 2013) and we tested the indirect effects of these constructs on sentence comprehension via syntactic skills. Oral narrative skills were often conceptualized as passage-level comprehension related skills in previous research (Cain, 2003; Cain & Oakhill, 1996) and thus no direct relations between oral narrative skills and sentence comprehension were hypothesized here. We focused on the indirect effects of oral narrative skills on sentence comprehension via the effects of syntactic skills. Testing both the direct and indirect role of vocabulary knowledge and oral narrative skills in sentence comprehension is a unique feature of this study as this has been less examined in previous studies. A second SEM model in which the same paths were hypothesized except for that from vocabulary knowledge to sentence comprehension was also specified to test its direct contribution to sentence comprehension (see Figure 2) given that vocabulary knowledge was found to be a strong correlate of discourse-level reading comprehension (Carroll, 1993).

Method

Participants

Junior elementary graders (i.e., Grades 2 and 3 children) were included in this study for the reason that they are in the early elementary stage of "learning to read" during which the recognition of Chinese characters and comprehension of sentences make up of most of their reading experience, both of which prepare them to move to the stage of "reading to learn" (starting at Grade 4). Eighty-five Grade 2 and 3 children, aged from 7; 6 years to 9; 7 years (Mage = 8; 7 years, MIQ = 116), were recruited from local primary schools to take part in the current study. All of the participants had at least average word reading performance as defined by having achieved a scaled score of at least 9 or above on the standardized Chinese Word Reading, a subtest of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD, scaled score mean of the test = 10, 1 *SD* = 3) (Ho, Chan, Tsang, & Lee, 2000). The HKT-SpLD is a standardized assessment tool developed to identify Hong Kong primary school students with dyslexia by assessing their literacy and cognitive functioning.

Measures

A number of language and reading measures were administered to the participants. The nonverbal intelligence test, syntactic word order, synonym judgment, and Chinese sentence comprehension were administered in groups. Word definition, oral sentence construction, story production, and Chinese word reading were

administered individually.

General reasoning ability. The Raven's Standard Progressive Matrices was used to measure the children's nonverbal intelligence. It is a standardized test which contains five sets of 12 items each. Each item comprises one target visual matrix with a missing part. The children were asked to select the most appropriate piece from six to eight alternatives to fill in the missing part. Scoring criterion was based on the local norm established by the former Hong Kong Education Department in 1986.

Vocabulary knowledge. Vocabulary knowledge was measured with a word definition and a synonym judgment task.

Word definition. An oral word definition task was used to measure children's expressive vocabulary. The validity of the task has been tested across languages in previous research (Ouellette, 2006; Wise, Sevcik, Morris, Lovett, & Wolf, 2007; Xiao & Ho, 2014; Yeung, Ho, Chan, & Chung, 2016). Following the procedures in Ouellette's study (2006), we focused on the depth of oral vocabulary among Chinese children by examining their understanding of the semantic category and unique characteristics of a word. There were seven items in the task. In each item, the child was orally presented a word and then required to explain its meaning orally. All the words were frequently encountered by primary school children in their daily life (e.g., 禮物 "gift" and 游泳 "swim"). One practice trial and feedback were given to the child before the testing trials. Three points were given for responses suggesting the semantic category and unique characteristics of a word. Two points were given for responses suggesting either the semantic category or unique characteristics of a word. One point was given for responses explaining relevant rather than unique characteristics of a word. For example, the response 禮物係送俾人嘅物品 "Gifts are objects being presented to others" was given three points as it explained the unique characteristics (i.e., the "present") and semantic category (i.e., the "object") of the concept "gift". The response 禮物係送俾妳慶祝妳生日嘅 "Gifts are presented to you for birthday celebration" was given two points as only the unique characteristic (i.e., the "present") of the "gift" was mentioned. The response 禮物係包喺好靚嘅包裝入便嘅 "Gifts are wrapped in a beautiful package" was given one point as only the relevant characteristics (i.e., the "wrapped in a beautiful package") were mentioned. The children's responses were marked by two well-trained undergraduate students with psychological background. Discrepancies between the two scorers were settled by discussion until 100% agreement was obtained.

Synonym judgment. Following Nation and Snowling's studies (1998b, 2004) and, a synonym judgment task modeled after the task assessing word semantics in the study by Chik, Ho, Yeung, and Wong et al. (2012) and used in our previous study (Xiao & Ho, 2014) was used here to measure children's semantic processing skills (i.e., the skill of discriminating subtle differences among semantically similar words). There were 12 items in the task. In each item, there were one target word and three words of the same word class (i.e., nouns, verbs, or adjectives). All the words were selected from Chinese textbooks for Grades 1, 2, and 3 students in Hong Kong. Among the three words in each item, only one shared one morpheme and had similar meaning with the target word and the other two shared one morpheme but had different meanings with the target

word. For example, the word 旅客 “traveler” had similar meaning with the target word 遊客 “tourist”, while 遊戲 “game” and 乘客 “passenger” shared one morpheme with the target word respectively but they were semantically different from the target word. One practice item and feedback were given to the children before the testing items. All items were presented orally to the children. In order to reduce children’s memory load, printed test items were also provided to the participants. The children were asked to circle the word semantically similar to the target word in each item. One point was given for a correct response.

Syntactic Skills

A syntactic word order test was used to assess children’s understanding of some rules of basic sentence structures. This test was the same as that used in our previous study (Xiao & Ho, 2014) and similar to the syntactic measures used in other studies on reading development among Chinese children (Chik, Ho, Yeung, and Chan et al., 2012; Ho et al., 2012; Yeung, Ho, Chan, & Chung, 2016).

Simple declarative sentence structure subtest. The subtest was developed to measure the skill of processing the canonical SVO word order. There were six sentences in the subtest. Each sentence was comprised of three to six words and/or phrases with an incorrect word order. For example, the scrambled sentence 熱愛-爸爸-運動 “likes Dad sports” should be reorganized to 爸爸熱愛運動 “Dad likes sports”. The children were asked to reorganize the words and/or phrases to form a meaningful sentence in each item. One practice item and feedback were given to the children before the testing items. Partial scoring was applied in the subtest. Every two consecutive phrases being arranged in a correct order were given one point, yielding a maximum score of 21 for the subtest (i.e., one item consisting of three phrases with two embedded consecutive phrases, two items consisting of four phrases with three embedded consecutive phrases, two items consisting of five phrases with four embedded consecutive phrases, and one item consisting of six phrases with five embedded consecutive phrases).

BaBei sentence structure subtest. The subtest was developed to measure the skill of processing the noncanonical SOV and OSV word order. There were ten simple declarative sentences in the subtest. For example, the sentence 妹妹弄壞了洋娃娃 “Sister has damaged the doll” should be transformed to the Ba sentence 妹妹把洋娃娃弄壞了 “Sister ba doll damage break PERF (perfective aspect)”. The children were asked to transform five sentences into Ba sentences and the other five into Bei sentences. Two points were given for correct writing of ba or bei construction and no omission errors in a sentence. One point was given for correct writing of ba or bei construction with omission errors in a sentence.

Multiple modifiers subtest. The subtest was developed to measure the skill of processing the multiattributive and multiadverbial order. There were 24 incomplete sentences (11 for multiattributive and 13 for multiadverbial filling, respectively) in the subtest. In each item, three to five words and/or phrases were provided to fill in the missing attributives or adverbials. For example, the incomplete sentence 開幕儀式在_____禮堂裡舉行 “The opening ceremony was held in _____hall” was missing with three attributives. 我們學校 “our school”, 能容納很多人的 “could

contain many people", and 漂亮的 "beautiful" were provided to fill in the blanks. The reorganized sentence should be 開幕儀式在我們學校能容納很多人的漂亮的禮堂裡舉行 "The opening ceremony was held in the beautiful hall which could contain many people in our school" according to the relatively fixed multiattributive order in Chinese: possessive phrase + classifier phrase + relative clause + adjective/noun/verb + head noun, (Yip & Rimmington, 2004). The children were asked to reorganize the given words and phrases and then use them to complete the sentence in each item. One practice item and feedback were given to the children before the testing items. Similar partial-scoring procedure used in the subtest of simple declarative sentence structure was applied here. Two consecutive phrases being arranged in a correct order were given one point, yielding a maximum score of 60 for this subtest. Specifically, the maximum score for the 11 multiattributive items was 28 (six items with three consecutive phrases, four items with four consecutive phrases, and one item with five consecutive phrases) and the maximum score for the 13 multiadverbial items was 32 (eight items with three consecutive phrases, four items with four consecutive phrases, and one with five consecutive phrases).

All words of the items were chosen from Chinese textbooks for Grades 1, 2, and 3 students in Hong Kong and only simple sentences were constructed for the three subtests. All items in the three subtests were presented orally to the participants. In order to reduce children's memory load, printed test items were also provided to them. The children were asked to write down the number sequence denoting the correct word order of a sentence in each item in the simple declarative sentence structure and multiple modifiers subtests and write down the Ba and Bei sentences in the BaBei sentence structure subtest.

Oral Narrative Skills

Oral narrative skills were measured with an oral sentence construction and a story production task.

Oral sentence construction. This task was adapted from the oral sentence construction task in the study by Yeung, Ho, Chan, and Chung (2016) and it was designed to assess children's ability to use connectives to construct complex sentences. There were eight items in the task. In each item, a picture and a pair of conjunctions were presented to the children. The child was asked to use the pair of conjunctions (e.g., 如果 "if" and 就 "then") to orally construct a compound sentence to describe the picture. In order to reduce children's memory load, the pair of conjunctions was printed on the upper right corner of the picture. The general idea of the picture (e.g., "the picture is describing the relationship between raining and wet ground") was also provided to the children as a prompt. One practice item and feedback were given to the children before the testing items. Two points were given for responses using the given conjunctions to connect the two clauses in a compound sentence logically and describing the picture appropriately. One point was given for responses connecting the two clauses in a compound sentence logically but describing the given picture inappropriately. The children's responses were marked by two well-trained undergraduate students with psychological background. Discrepancies between the two scorers were settled by discussion until 100% agreement was obtained.

Story production. The story production task used in our previous study (Xiao &

Ho, 2014) was adopted to assess children's ability to construct a story. In this task, the child was asked to tell a story about a family picnic based on a given picture. The experimenter introduced the task by saying, "I want you to tell me a story based on this picture. You are encouraged to tell the story in detail". Whenever the child stopped to give no response, the experimenter encouraged him/her to say something more and asked the question "Have you finished?" until the child answered "Yes". A maximum of two points were given to sentences describing the preparation and purposes of the picnic or trip. A maximum of two points was given to sentences describing the scene (e.g., the view and the food) and a maximum of seven points were given to describing the behaviors of persons. Another maximum of seven points were given to sentences describing possible events taking place in the picnic. Finally, a maximum of two points were given to sentences describing the ending of the story. The children's responses were marked by two well-trained undergraduate students with psychological background. Discrepancies between the two scorers were settled by discussion until 100% agreement was obtained.

Chinese word reading. Word recognition was measured with a standardized word reading test in the present study. The Chinese Word Reading subtest of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD) (Ho et al., 2000) was used to measure children's word reading skills. The HKT-SpLD was a standardized test with local norms on reading and reading-related cognitive skills. In this test, the child was asked to read aloud 150 Chinese two-character words arranged in ascending order of difficulty. The test was discontinued when a child failed to read 15 words consecutively. One point was given for correctly reading both characters in a word.

Chinese sentence comprehension. The cloze format assesses discourse-level comprehension across adjunct sentences based on word associations (Shanahan, Kamil, & Tobin, 1982) and has been shown to be related to accurate and efficient word recognition (Paris, Carpenter, Paris, & Hamilton, 2005; Stahl & Hiebert, 2006) and skills of constructing a mental representation of a text (Tolar, Barth, Francis, Fletcher, Stuebing, & Vaughn, 2011). Therefore, sentence comprehension was measured with a cloze task which required children to select the best fitting word in light of context among three options. In this task, children needed to decode individual words accurately and then select the option most appropriate for the missing part of a sentence with reference to the sentential context. Following the procedures of the cloze sentence task in previous studies (Chik, Ho, Yeung, and Chan et al., 2012; Yeung, Ho, Chan, & Chung, 2016), the Chinese sentence comprehension task used in the study by Xiao and Ho (2014) was adopted to measure children's sentence comprehension skill. It was a cloze task with 21 items. In each item, there was a sentence with a missing word. The children were asked to read the sentence on their own and select an appropriate word from three choices to complete the sentence. One point was given for correctly completing a sentence.

An example item:

我們要懂得_____對錯。

We need to _____ what is right from what is wrong.

①差別[difference] ②區別[differentiate] ③特別[special]

In Chinese, the meanings of 差別[difference] and 區別[differentiate] are similar.

Participants may not be able to select the right word to fill in the blank if they didn't know the syntactic knowledge that 區別[differentiate] should be followed by a noun and 差別[difference] should be followed by a verb. Therefore, the cloze task tapped the cognitive processes involved in sentence comprehension, namely, word recognition in which many sub-lexical cognitive processes are involved (e.g., decode phonological, orthographic, and semantic representations) and syntactic processing (i.e., combine the decoded individual words into clauses and sentences guided by syntactic knowledge) (Silva & Cain, 2015).

Results

Descriptive Statistics

Table 1 (Appendix 1) presents descriptive statistics for the measures used here. The internal reliabilities of most of the measures were satisfactory with reliability coefficients ranging from .69 to .90, except for the synonym judgment task with a coefficient of 0.51.

Interrelationships among Various Measures

Table 2 (Appendix 2) presents the matrix of partial correlation coefficients between various measures after controlling for the effects of age and IQ. For vocabulary knowledge, the word definition and synonym judgment tasks both correlated significantly with Chinese word reading (r = .22, p < .05 and r = .35, p < .01), whereas only the synonym judgment task correlated significantly with Chinese sentence comprehension (r = .33, p < .01). They also correlated significantly with some of the syntactic and oral narrative measures (.22 ≤ *all rs* ≤ .41, p < .05). For syntactic skills, the three syntactic subtests correlated significantly with one and another (.24 ≤ *all rs* ≤ .29, p < .05). Moreover, simple declarative sentence structure correlated significantly with Chinese word reading and Chinese sentence comprehension (r = .26, p < .05 and r = .36, p < .01). Multiple modifiers correlated significantly with Chinese word reading (r = .30, p < .01). For oral narrative skills, the oral sentence construction task correlated marginally with the story production task (r = .21, p = .06). Results of the correlation analyses reveal a moderate association of vocabulary knowledge and syntactic word order skills with reading abilities, and a weak link between oral narrative skills and reading performance.

Unique Contributions of Word Recognition and Language Skills to Sentence Comprehension

Multiple regression analyses were performed to examine the unique contributions made by word recognition and language skills to sentence comprehension. Results show that age and IQ accounted for 23% of the variance in sentence comprehension when entered in the first step as control of background variables (ΔR^2 = .23, p < .001), and Chinese word reading along with other language skills accounted for additional 21% of the variance when entered in the second step (ΔR^2 = .21, p < .01). Given the unique contributions to sentence comprehension made by word recognition and language skills, SEM was conducted to further examine the interrelationships among these variables.

Principal component analysis. Principal component analysis (PCA) was performed to validate whether the seven language measures (i.e., word definition, synonym judgment, simple declarative sentence structure, BaBei sentence structure, multiple modifiers, oral sentence construction, and story production) fell into the proposed language domains (i.e., vocabulary knowledge, syntactic skills, and oral narrative skills). Table 3 (Appendix 3) presents the results of PCA with three factors. Results show that the measures fell into their respective domains with two exceptions. The word definition task loaded primarily on the factor of oral narrative skills and slightly on the factor of vocabulary knowledge.

Structural equation modeling. The three language constructs validated in the PCA were used to explore their relations to word recognition and sentence comprehension in SEM models. As multiple measures were used for language skills in this study, a two-step approach was used to perform structural equation modeling (Anderson & Gerbing, 1988). The first step was to test the measurement model for language skills using confirmatory factor analysis (CFA) with the aim to test the construct validity of the language measures. In Model 1 (Appendix 5), vocabulary knowledge was measured with the word definition and synonym judgment tasks; syntactic skills were measured with the simple declarative sentence structure, BaBei sentence structure, and multiple modifiers subtests; and oral narrative skills were measured with the oral sentence construction and story production tasks (Figure 1: Appendix 5). As results of PCA shows that the word definition task loaded primarily on the factor of oral narrative skills, an alternative CFA model was proposed with this task being conceptualized as a measure of oral narrative skills rather than vocabulary knowledge (see Model 2 in Figure 2: Appendix 6). The second step was to examine the structural model in which the three language constructs (i.e., vocabulary knowledge, syntactic skills, and oral narrative skills) were connected to word recognition or sentence comprehension. Specifically, vocabulary knowledge or synonym judgment was postulated to have a significant effect on word recognition which in turn contributed to sentence comprehension; syntactic skills were postulated to have significant effects on sentence comprehension; and both vocabulary knowledge or synonym judgment as well as oral narrative skills were postulated to contribute to syntactic skills directly (Figures 1 & 2: Appendix 5 & 6).

To evaluate the goodness of fit of each model to the data, we reported the model chi-square statistic associated with the *p* value, the non-normed fit index (NNFI), the comparative fit index (CFI), the root-mean-square error of approximation (RMSEA), and the Akaike's information criterion (AIC). The model chi-square test provides an estimate of the overall good fit of a model (a nonsignificant value of the chi-square statistic indicates a good fit) and it is sensitive to sample size (a value below 2 resulting from dividing a chi-square value by its degrees of freedom indicates a good model fit (Maruyama, 1998)). NNFI and CFI indices equal to or above .95 indicate a good fit (Bentler & Bonnet, 1980; Hu & Bentler, 1999). RMSEA values below .05 indicate a good fit (Cudeck & Browne, 1992). AIC values indicate a better fit when it is smaller (Browne & Cudeck, 1992). Results of CFA show an overall good fit of the measurement model in Models 1 (Appendix 5) and 2 (Appendix 6), respectively, namely, χ^2 (11, N =

85) = 12.05, p = .36 (χ^2/df = 1.10), NNFI = .97, CFI = .98, RMSEA = .03, and AIC = 46.05 for Model 1 (Figure 1: Appendix 5), as well as χ^2 (8, N = 85) = 5.65, p = .69 (χ^2/df = .71), NNFI = 1.07, CFI = 1, RMSEA = 0, and AIC = 31.65 for Model 2 (Figure 2: Appendix 6). All of the factor loadings of the indicator variables on their respective latent factors were significant. Table 4 (Appendix 4) presents the fit indexes of the structural models tested in Models and 2. Model 1 shows an overall good fit to the data, χ^2 (4, N = 85) = 4.37, p = .36 (χ^2/df = 1.09), NNFI = .99, CFI = 1, RMSEA = .03, and AIC = 26.37. All standardized path coefficients were significant. Indirect effects tested in Model 1 were also significant, including the significant indirect effects of vocabulary knowledge on sentence comprehension via word recognition and syntactic skills (standardized coefficient for the indirect effects = .52 × .35 + .37 × .3 = .29) and the significant indirect effect of oral narrative skills on sentence comprehension via syntactic skills (standardized coefficient for the indirect effect = .3 × .3 = .09). Model 2 shows a poor fit to the data, χ^2 (4, N = 85) = 18.06, p = .0012 (χ^2/df = 4.52), NNFI = .71, CFI = .88, RMSEA = .21, and AIC = 40.06. All standardized path coefficients were significant except for that between synonym judgment and oral narrative skills. Indirect effects tested in Model 2 were also significant, including the significant indirect effects of synonym judgment on sentence comprehension via word recognition and syntactic skills (standardized coefficient for the indirect effects = .46 × .37 + .22 × .29 = .23) and the significant indirect effect of oral narrative skills on sentence comprehension via syntactic skills (standardized coefficient for the indirect effect = .46 × .29 = .13). As the overall fit of Model 1 was better than that of Model 2, Model 1 was used for further analysis.

In order to test whether vocabulary knowledge made directly contribution to sentence comprehension, an alternative structural model was proposed with the same hypothesized paths and an added path from vocabulary knowledge to sentence comprehension (Figure 3). Model 3 (Appendix 7) shows an overall good fit to the data, χ^2 (4, N = 85) = 4.07, p = .25 (χ^2/df = 1.36), NNFI = .98, CFI = .99, RMSEA = .07, and Akaike's information criterion (AIC) = 28.07. All standardized path coefficients were significant except for that from vocabulary knowledge to sentence comprehension. As the overall fit of Model 3 was as good as that of Model 1, $\Delta\chi^2$ (1, N = 85) = .3, $p > .05$, Model 1 was the preferred parsimonious model (the AIC value for the first model was smaller than that of the alternative model) to conceptualize the interrelationships among language skills, word recognition, and sentence comprehension in this study.

Discussion

Previous studies conducted in alphabetic languages tend to suggest a conclusion that phonological skills play a dominant role over language skills in reading development especially at the early stage. However, the role of phonological skills may have been overemphasized in early reading development (Bishop, 1991; Storch & Whitehurst, 2002), especially in a nonalphabetic language such as Chinese. The present findings confirm our expectation that word recognition and syntactic skills are two core skills to develop and contribute to sentence comprehension among Chinese children in early elementary school, with each making a sizable contribution. Our findings indicate that successful sentence comprehension in a nonalphabetic language (i.e., Chinese) depends on word recognition and syntactic skills which are affected by vocabulary knowledge and oral narrative skills, respectively. Both sets of language skills begin to develop early in Chinese children's lives and combine to support reading

comprehension in the early elementary grades. Thus, instead of the dominant role of phonological processing skills during the course of learning alphabetic languages, the importance of language skills in Chinese learning is upheld in the present study.

Unique Role of Vocabulary Knowledge in Chinese Word Recognition

The large body of research has demonstrated that children of alphabetic languages typically use phonologically analytic strategies to decode words and therefore phonological processing skills are important for reading development and reading impairment (Byrne & Fielding-Barnsley, 1995; Foorman, Francis, Shaywitz, Shaywitz, & Fletcher, 1997; Vukovic & Siegel, 2006). The distinct role of vocabulary knowledge in word recognition among Chinese children found in this study reiterates the importance of the linguistic component in the SVR model (Gough & Tunmer, 1986; Hoover & Gough, 1990). For the particular purpose of examining the role of vocabulary depth, the word definition task was designed to measure the knowledge about the semantic category and unique characteristics of a word. Moreover, vocabulary knowledge did not contribute to sentence comprehension beyond measures of word recognition and syntactic skills as tested in Model 3 (Appendix 7). This is consistent with Ouellette and Beers' study (2010) that oral vocabulary measured with vocabulary breadth and depth was found to make no significant contribution to reading comprehension beyond the contributions of phonological awareness, decoding, irregular word recognition, and listening comprehension in Grade 1 children. However, in the same study, oral vocabulary was reported to predict reading comprehension even when all these variables were taken into consideration in Grade 6 children and this pattern of results have been demonstrated in other previous studies (Ouellette, 2006; Ricketts, Nation, & Bishop, 2007; Tannenbaum, Torgesen, & Wagner, 2006). The different patterns of results obtained between children of lower grades and upper grades reflects an increased importance of vocabulary knowledge in explaining reading comprehension as children become more proficient readers.

Another finding that requires further discussion is the lack of a correlation between the assessments of vocabulary knowledge. We used two different measures (i.e., word definition and synonym judgment) to test children's understanding of vocabulary knowledge. It seems that the two forms of assessments are tapping into different aspects of vocabulary knowledge. This possibility may be supported by the finding that both word definition and synonym judgment loaded on a same factor (see Table 3: Appendix 3). However, apart from the small but substantial factor loadings on vocabulary knowledge, the word definition task also loaded on oral narrative skills. This is not surprising given that in the word definition task the children were required to explain words' meanings which relies heavily on oral expression skills (e.g., using precise phrases and sentences to define a word). In contrast with the semantic fluency task in which children were required to generate as many examples as possible for a given category (Nation & Snowling, 1998b), the synonym judgment task appears to tap children's understanding of subtle meaning differences among words. On top of knowing the pronunciation of individual words, understanding word meaning differences is essential for getting at the exact meaning of a word which in turn facilitates the understanding of a sentence. This is especially important for children at higher grades when they have acquired a bigger pool of vocabularies with more semantically similar words. Children may first learn the meaning of a word, then they gradually learn more about the form (e.g., pronunciation and spelling) and function of

the word. In this developmental sequence, both vocabulary breadth and vocabulary depth are acquired by children (Miao & Zhu, 1992; Nation & Webb, 2011). Therefore, oral vocabulary and semantic discrimination might be two distinctly different components of vocabulary knowledge.

Unique Role of Syntactic Skills in Chinese Sentence Comprehension

Consistent with previous findings (Chik, Ho, Yeung, & Chan et al., 2012; Yeung, Ho, Chung, & Chan, 2012), sentence comprehension was predicted by word recognition and syntactic skills in this study. This finding confirms and extends the SVR that reading comprehension at the sentence level is determined by two broad components of word recognition and language processing (i.e., syntactic processing in this study) in a nonalphabetic language and how language skills are involved in these two processes. When reading a sentence, the semantic clarity of individual words and syntactic complexity of the sentence both influence the comprehension. Vocabulary or syntactic knowledge alone is not sufficient for successful comprehension. Instead, syntactic processing interacts with semantic processing during the course of sentence reading. Thus, the access of meanings from single printed words (i.e., word recognition) and the organization of sentence constituents are always important for sentence comprehension. Taken together, our data and findings from previous studies tend to suggest that the automatization of the lower level process of word recognition leaves more mental resources available for higher level processes in sentence comprehension such as syntactic processing (Perfetti & Hart, 2002).

Results of CFA show that the canonical SVO order for simple declarative sentences, the noncanonical SOV and OSV order for Ba and Bei sentences, and word order for multiple modifiers are important components of word order skills in Chinese. Among the three types of word order skills, only the canonical SVO order was correlated with sentence comprehension, and the noncanonical SOV and OSV order was correlated with neither word recognition nor sentence comprehension (see Table 2: Appendix 2). Given that only simple sentences were included in the Chinese sentence comprehension test, these results reveal that SVO order has a distinct relation with the understanding of simple sentences, whereas SOV and OSV order are more related to the understanding of noncanonical sentence types (e.g., Ba and Bei sentences and complex sentences with relative clauses). As compared to the between-constituent order (i.e., SVO, SOV, and OSV), the within-constituent order for multiple modifiers may be difficult to acquire. In one of our studies, Chinese dyslexic children were found to perform less well in processing multiple modifiers than SVO, SOV, and OSV sentences (Xiao & Ho, 2014). The non-significant correlation between multiple modifiers and sentence comprehension suggests that the participants in this study may also have similar difficulties in processing such complicated word order at the early stage of reading development. In addition, the significant correlations between multiple modifiers and word recognition may be caused by considerable shared variance between these two measures given that they both tapped morphological knowledge.

In line with our expectation, vocabulary knowledge was shown to contribute to syntactic word order skills directly and to sentence comprehension indirectly via syntactic word order skills. The acquisition of syntactic knowledge is a crucial component of early language development (Simms & Crump, 1983). Li and colleagues (Li, Bate, Liu, & MacWhinney, 1992) found that Chinese children as young as 28 to 44 months old are able to use both word order and animacy strategies to identify the agent

of a sentence. Miao and Zhu (1992) found that children as early as one year old are able to babble words denoting people, objects, and actions; and children from one and a half years to two years old begin to produce modifier-free and complete simple sentences with SV, VO, and SVO order. The awareness of word order at early stage provides a foundation for acquiring advanced word order skills. The word learning experience in formal schooling consolidates the word order skills, which in turn contribute to sentence comprehension.

Role of Oral Narrative Skills in Chinese Sentence Reading Comprehension

Consistent with our expectation, oral narrative skills measured with the oral sentence construction and story production tasks contributed to sentence comprehension via the effects on syntactic skills in this study. The oral sentence construction and story production tasks tapped some aspects of discourse skills (i.e., knowledge about the structures of compound sentences and narrative texts). The knowledge about story structure is important for understanding a text as it helps to build a mental model of the situation represented in the text (Cain & Oakhill, 1996; Oakhill, Cain, & Bryant, 2003). Yeung and colleagues found that syntactic word order and discourse skills (i.e., processing sentence order) contributed significantly to text comprehension (Yeung, Ho, Chan, Chung, & Wong, 2013). However, given that sentence comprehension was not examined in their study, the unique contribution of discourse skills to sentence comprehension remained untested. Nevertheless, our findings along with Yeung et al.'s (Yeung, Ho, Chan, Chung, & Wong, 2013) suggest that discourse skills may have a distinct role in text comprehension rather than in sentence comprehension.

In addition, our findings also suggest that oral language skills (i.e., vocabulary knowledge and oral narrative skills) contribute directly to linguistic capacities (i.e., syntactic word order skills) and ultimately facilitate sentence processing. This finding supports the view that oral language skills exert an influence over the development of reading comprehension via influencing the development of metalinguistic skills (e.g., syntactic awareness) (Tunmer & Herriman, 1984; Tunmer, Herriman, & Nesdale, 1988) and linguistic skills (e.g., advanced syntactic word order skills). Oral narrative tasks (i.e., oral sentence construction and story production) in the present study tapped primarily the knowledge about basic grammatical structures and sentence types in Chinese and such knowledge plays a role in the normal course of syntactic development especially the acquisition of syntactic word order skills (depending on the understanding of the relationship among grammatical structures and sentential components). It appears that the relationships among oral language, linguistic skills, and reading comprehension are more complex than previously postulated. More studies are needed to include measures of both sentence and text comprehension to address this issue.

Theoretical and Educational Implications of the Present Study

Several implications for theoretical considerations and education stem from our findings. With respect to theoretical considerations, our results are consistent with those in the literature in showing that reading comprehension at the sentence- and discourse-level is determined by the two constructs (i.e., the decoding and linguistic constructs) in the SVR. In particular, our finding that word recognition was a significant predictor of sentence comprehension in Chinese Grade 2 and 3 children who had received formal

literacy instruction for 2 or 3 years is consistent with previous evidence showing that the influence of word recognition on reading comprehension is affected by the transparency of the orthography of the language that has to be acquired (Florit & Cain, 2011). For readers of Chinese, the development of word recognition skill in reading comprehension progresses at a slower rate and takes a more prolonged time as Chinese is a more opaque orthography (Joshi, Tao, Aaron, & Quiroz, 2012). Our results also have implications for better conceptualizing the components of language and reading comprehension in the SVR. As pointed out by Ouellette and Beers (2010), the all-encompassing nature of language comprehension obscures the identification of the most relevant aspects of oral language in reading. The present finding that syntactic skills predicted significant sentence comprehension, along with previous evidence that greater correlations were found between measures of language and discourse-level reading comprehension that control for style, vocabulary, length, etc. (Hoover & Gough, 1990; Vellutino, Tunmer, Jaccard, & Chen, 2007) may suggest that syntactic skills might be more relevant to sentence comprehension, while text comprehension might be more reliant on comprehension monitoring skill, text integration skill, and story structure knowledge (Cain, & Oakhill, 1996; Oakhill, Cain, & Bryant, 2003). Although the validity of the SVR in Chinese has been tested by Yeung and colleagues in a 3-year longitudinal study conducted in Chinese children from Grade 1 to Grade 3 (Yeung, Ho, Chan, & Chung, 2016), the complex relations between syntactic skills and sentence comprehension as well as oral narrative skills and text comprehension across development were not tested in their study. Further studies are needed to investigate the shared and additional variance accounted for by syntactic skills (and other language skills) and language comprehension in reading comprehension at both sentence and discourse level by incorporating measures of various language skills and measures of sentence and text comprehension across languages that differ in orthographies. In addition, our finding that word recognition was predicted by vocabulary knowledge also suggests an inclusion of a semantic contribution to word recognition rather than to reading comprehension in the SVR, which is not consistent with what the SVR is usually conceptualized as. Semantic area is normally seen as part of language comprehension. Therefore, it may be important to not see word recognition and language comprehension as entirely independent components of the SVR.

From a practical point of view, our findings have implications for assessment and instruction. Firstly, it is important to note that our data may suggest the sensitivity of sentence comprehension tests in the assessment of comprehension skills at early elementary grades which have been focusing on children's text-level reading skills (Kendeou, Papadopoulos, & Spanoudis, 2012). Secondly, the main educational implication of our findings is to enable teachers to understand what they need to teach about reading comprehension within a broad curriculum at the early stage of learning to read Chinese. The language skills examined here could usefully be taught to children to foster their development of comprehension skills. Specifically, knowledge about basic word order rules (e.g., canonical SVO order and non-canonical OSV and SOV order) can be taught at early grades. Advanced word order skills (e.g., processing word order for multiple modifiers) are not suggested to be taught until students are able to process basic word order effectively. To improve syntactic word order skills, knowledge about vocabulary and narrative structures is a must and thus particular attention should be paid to it given the findings that semantic and oral narrative skills contributed to syntactic word order skills directly. Whether these skills should be taught

independently or as part of an integrated training of reading skills, require further research.

One major limitation of the present study was the small sample size for the SEM analyses (Kline, 2016; Wolf, Harrington, Clark, & Miller, 2013). The present findings are needed to be replicated in future studies of large sample size.

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Prof. Connie Suk-han Ho is the Eugene Chuang Professor in Developmental and Educational Psychology and the Director of two Doctoral Educational Psychology programmes at the University of Hong Kong. Her research focuses mainly on the cognitive and genetic aspects of literacy learning and developmental dyslexia. She has been the founder and active researcher of the Hong Kong Specific Learning Difficulties Research Team since 1998. Prof. Ho's team has developed several sets of standardized assessment instruments for all professional psychologists and teachers in Hong Kong to identify students with dyslexia from preschool to tertiary levels. Her team has also developed the first evidence-based Chinese tiered intervention model for literacy instruction.

Appendix 1

Table 1

Reliabilities, Possible Maximum Scores, Means, Standard Deviations, and Ranges for Various Measures

Characteristics/ Measure	Reliability	Possible maximum score	*M*	*SD*	Range
Age (in months)	/	/	102.69	6.83	25
IQ (Raven's Progressive Matrices)	.88	/	116.12	11.58	45
Vocabulary knowledge					
Word definition	.86	21	17.20	2.65	11
Synonym judgment	.51	12	9.65	1.61	7
Syntactic skills					
Simple declarative sentence structure	.72	21	16.48	3.03	13
BaBei sentence structure	.90	20	18.78	1.76	10
Multiple modifiers	.69	60	39.92	4.96	23
Oral narrative skills					
Oral sentence construction	.83	16	14.64	1.33	5
Story production	.82	20	6.18	2.61	13
Chinese word reading	.70	150	118.79	14.06	58
Chinese sentence comprehension	.73	21	14.98	2.61	13

Note. Test-retest and split-half reliabilities were computed for the standardized measures of IQ and Chinese word reading. Interrater reliabilities were computed as Pearson's correlation coefficients for word definition, oral sentence construction, and story production. Cronbach alpha coefficients were computed for synonym judgment, the three subtests of syntactic skills (i.e., simple declarative sentence structure, BaBei sentence structure, and multiple modifiers), and Chinese sentence comprehension.

Appendix 2

Table 2

Matrix of Partial Correlation Coefficients between Various Measures after Controlling for the Effects of Age and IQ (n = 85)

	1	2	3	4	5	6	7	8	9
1. Word definition	-								
2. Synonym judgment	-.01	-							
3. Simple declarative sentence structure	.10	.28*	-						
4. BaBei sentence structure	.19	.02	.27*	-					
5. Multiple modifiers	.25*	.20	.29**	.24*	-				
6. Oral sentence construction	.22*	.05	.15	.17	.19	-			
7. Story production	.41** *	.09	.01	.03	.14	.21[a]	-		
8. Chinese word reading	.22*	.35**	.26*	.17	.3**	.14	.19	-	
9. Chinese sentence comprehension	.11	.33**	.36**	.17	.18	.12	.14	.42***	-

*$p < .05$; **$p < .01$; ***$p < .001$; [#a]$p = .06$.

Appendix 3

Table 3

Results of the Principal Component Analysis with Varimax Rotation for 7 Language Measures (n = 85)

Measure	Factor			Communality
	1 (Vocabulary knowledge)	2 (Syntactic skills)	3 (Oral narrative skills)	
Word definition	.17		.80	.67
Synonym judgment	.88		.13	.81
Simple declarative sentence structure	.66	.47		.66
BaBei sentence structure	.06	.87		.76
Multiple modifiers	.45	.46		.50
Oral sentence construction		.34	.53	.41
Story production	.13		.84	.74

Note. Loadings ≥ .30

Appendix 4

Table 4

Model Fit Indexes

	χ^2	*df*	*p value*	χ^2/df	NNFI	CFI	RMSEA	AIC
Acceptable fit			> .05	< 2	≥ .95	≥ .95	< .05	
Model 1	4.37	4	.36	1.09	.99	1	.03	26.37
Model 2	18.06	4	.0012	-	.71	.88	.21	40.06
Model 3	4.07	4	.25	1.36	.98	.99	.07	28.07
Model 1 and 3 comparison	$\Delta\chi^2$ (1, N = 85) = .3, p > .05							

Appendix 5

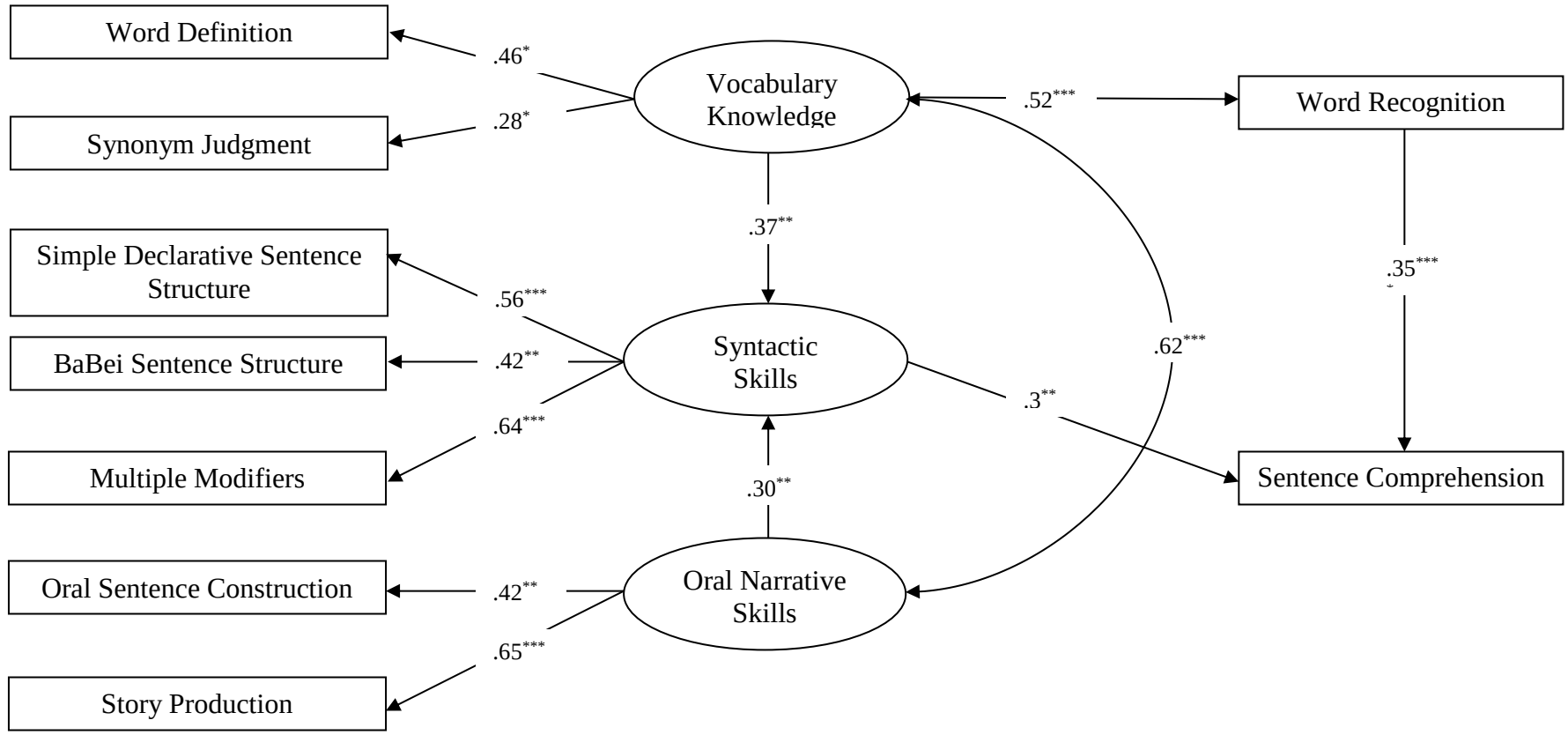

Figure 1: Model 1 of Language Skills and Sentence Comprehension in Chinese
* $p < .05$; ** $p < .01$; *** $p < .001$

Appendix 6

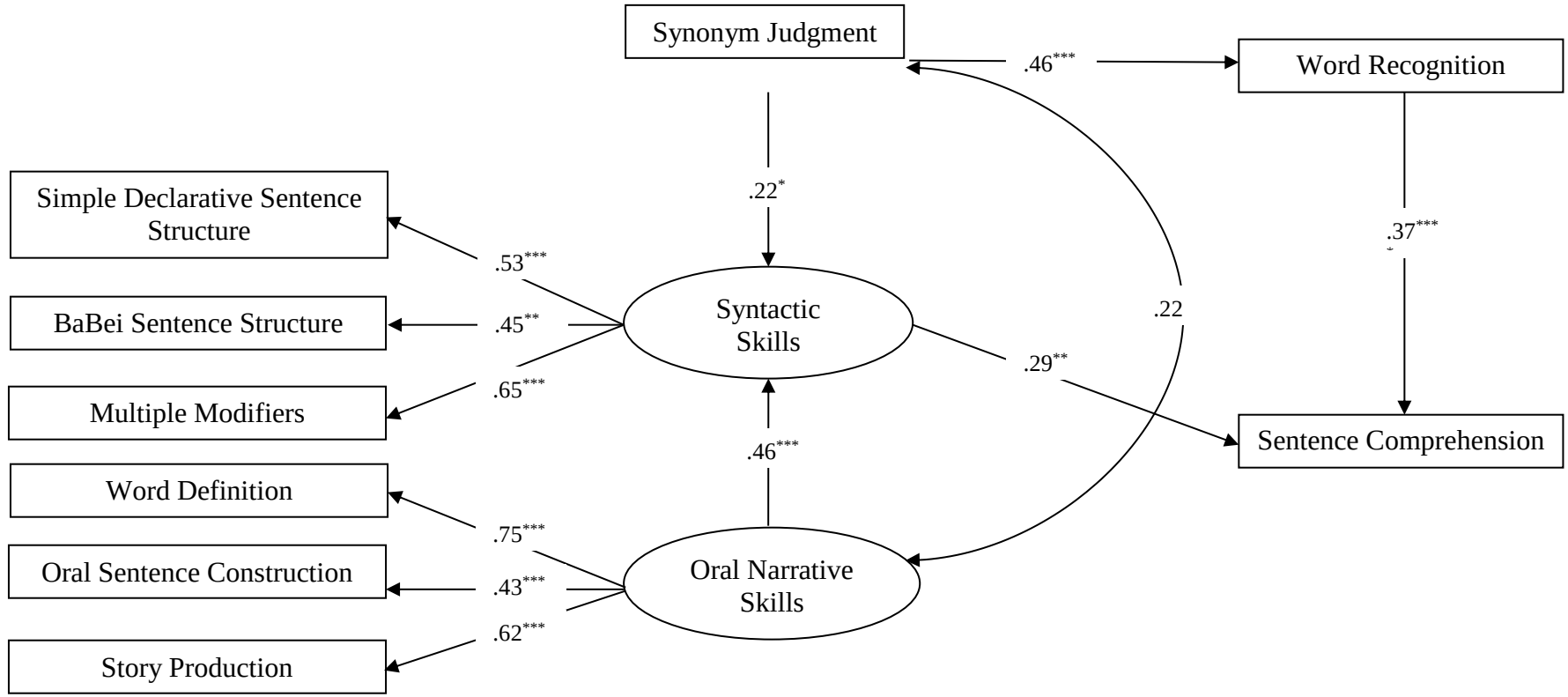

Figure 2: Model 2 of Language Skills and Sentence Comprehension in Chinese
* $p < .05$; ** $p < .01$; *** $p < .001$

Appendix 7

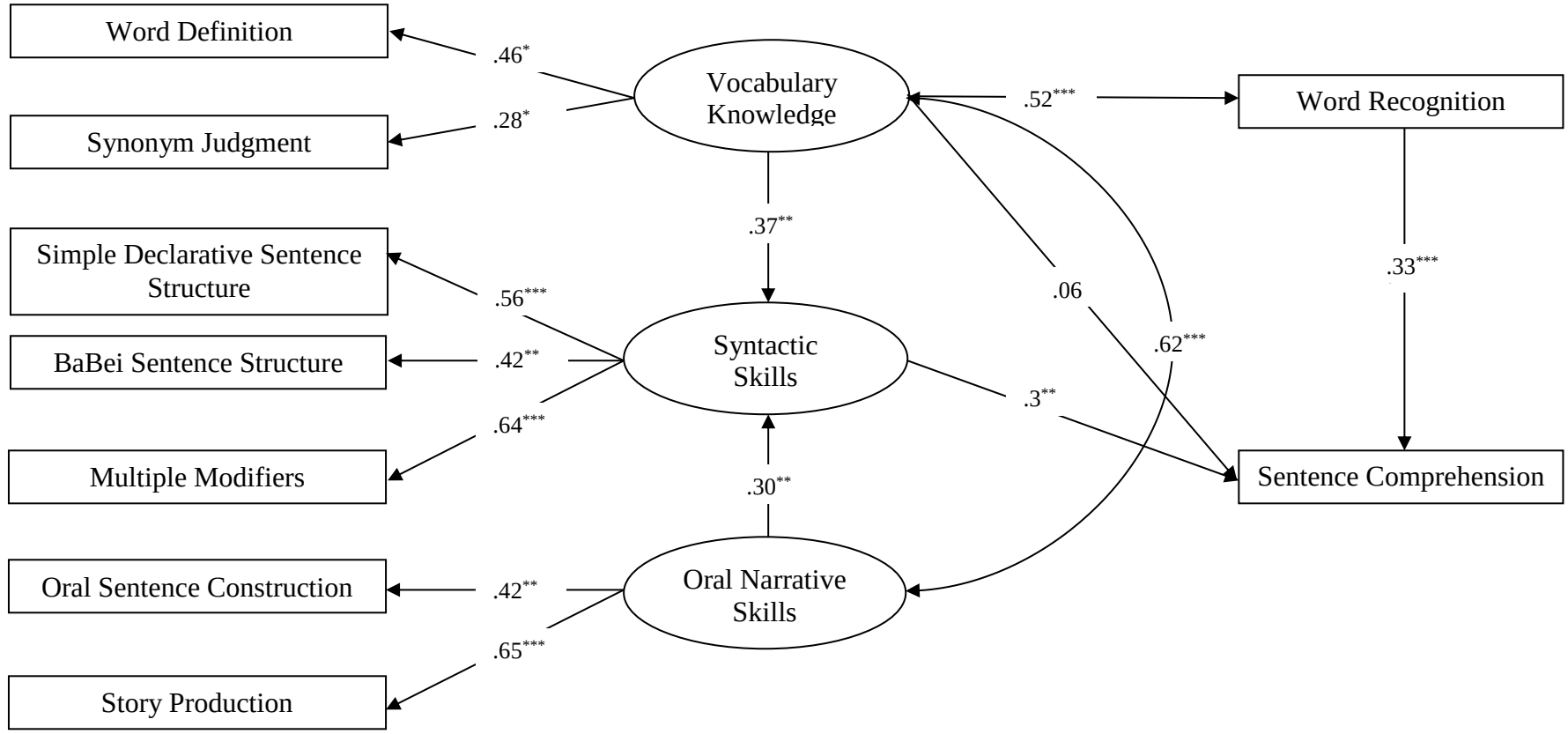

Figure 3: Model 3 of Language Skills and Sentence Comprehension in Chinese
*p<.05; **p<.01; ***p<.001