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What are the contributing cognitive-linguistic skills for early Chinese listening comprehension?☆

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ABSTRACT

Little is known about the cognitive-linguistic skills contributing to early listening comprehension (LC) of Chinese language, an analytic language with abundant compound words. The present study took the initiative to 1) examine whether the established cognitive-linguistic skills of LC in non-Chinese languages, (*i.e.*, working memory, vocabulary skills, grammatical skills, comprehension monitoring), have similar importance in Chinese LC and 2) to identify novel skill (*i.e.*, morphological skills) that could be unique to Chinese LC. A total of 105 Hong Kong-Chinese children at first grade participated in the current study. Results from multiple regression showed that each of the aforementioned skills, except for grammatical skills, had unique contribution to early Chinese LC. Morphological skill was the most prominent unique contributor. Based on path analysis results, we put forward a systematic path model which illustrated the specific roles – both direct and indirect roles – of the cognitive-linguistic skills in the context of each other.

1. Introduction

Listening comprehension (LC) is the ability to extract meaning from a spoken discourse (Snowling & Hulme, 2005). It is a complex process in which a range of cognitive and linguistic skills are involved. LC is especially important for children at school ages, since it affects how well they can communicate and learn from others (Berninger & Abbott, 2010; Byrnes, 1984; Dickinson, Golinkoff, & Hirsh-Pasek, 2010). In particular, a good foundation of LC is a prerequisite for learning to read (the "simple view of reading"; Hoover & Gough, 1990). In view of the significance of early LC in children's learning journey, it is critical to identify the cognitive-linguistic skills fundamental and contributing to the success of LC. The identified skills can provide useful guidance for educators to design effective instructional approach that helps children to master LC early on (Aarnoutse, van den Bos, & Brand-Gruwel, 1998; Carretti, Caldarola, Tencati, & Cornoldi, 2014).

Existing studies has examined the underlying cognitive-linguistic skills of LC (Florit, Roch, & Levorato, 2011; Kim, 2016; Strasser & del Rio, 2014; Tompkins, Guo, & Justice, 2013). These studies were based on children who spoke different languages respectively, such as English, Italian, Spanish, and Korean. According to the construction-integration model (Kintsch, 1988), successful LC is achieved through two phases: a construction phase and an integration phase. The construction phase involves *foundational language skills* (including vocabulary and grammar) to form initial and literal propositions based on the words and phrases of the discourse (Kim, 2016; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012). The integration phase involves a set of *higher-order cognitive skills* to integrate the initial propositions across the discourse to construct a coherent and integrated whole (Kim, 2016; Strasser & del Rio, 2014). Comprehension monitoring, for example, refers to the ability to reflect on and regulate an individual's understanding of incoming information. It is a representation of higher-order cognitive skills, that helps a listener to evaluate whether or not his understanding of the information that just comes in is coherent with those from the preceding part of the discourse, and to make attempt to rectify the problems when necessary. In addition to the aforementioned skills described in the construction-integration model, a third set of skills – *foundational cognitive skills* – defined as the basic cognitive resources for general information processing, was also proposed to be an important contributor to LC (Daneman & Merikle, 1996; Kim, 2016). Well-known examples of *foundational cognitive skills* include attention and working memory (Kim, 2016). In particular, working memory (defined as the capacity needed for storage and manipulation of information in mind) is the key to how efficient a listener can hold and process information in mind. To sum up, LC is conceptualized to involve three levels of processes (from lower to higher level): foundational

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cognitive skills, foundational language skills, and higher-order cognitive skills. The theoretical importance of the three facets of cognitive-linguistic skills for early development of LC had been documented in a number of recent studies based on young children at preschool or first grade who learned to speak in different languages (Kim, 2016; Kim & Phillips, 2014; Strasser & del Rio, 2014).

A few researchers took one step further to examine the structural relationships among the three facets of cognitive-linguistic skills and LC in English-speaking and Korean-speaking children (Kim, 2016; Kim & Phillips, 2014). Kim (2016) proposed four different models that empirically tested plausible paths in a systematic manner. Using structural equation modelling (SEM) method, the researcher identified the best fit model. In this model, the two foundational levels of skills – foundational cognitive skills (*i.e.*, working memory) and foundational language skills (*i.e.*, vocabulary and grammatical skills) – contributed to LC both directly and indirectly *via* higher-order cognitive skills. The other three models, while containing indirect paths *via* higher-order cognitive skills, did not have direct paths from the two facets of foundational skills to LC. These three models were shown to fit less well to the data. Results from this study suggested an empirically-tested model that helps to understand the nature of relationships among the three facets of cognitive-linguistic skills and LC (Kim, 2016).

While the importance of the above cognitive-linguistic skills for LC was demonstrated in several languages, it remains largely unknown in Chinese language. Given some unique linguistic features of Chinese (Chao, 1965; Fung, 2009), it is plausible that Chinese LC may require distinct aspects of linguistic skills in order to extract meanings from words and sentences. In particular, we propose that *morphological skill* – the ability to be aware of and manipulate morphemic meanings within compound words – could be a unique contributor to Chinese LC. Such proposal is mainly based on the uniqueness of Chinese word morphology. In contrast to inflectional languages like English, Italian, and Spanish, in which word formation relies a lot on inflection and derivation morphology, Chinese is often described as an analytic language, and its word formation relies heavily on compounding (Packard, 2000). Over 75% of Chinese words are compound words which are made up of two or three morphemes (Chen, Hao, Geva, Zhu, & Shu, 2009). The lexical meanings of these compound words are often readily predictable from the morphemes comprising of them. For example, the meaning of the three-syllabic word升降機 [sing1-gong3-gei1] (elevator) can be inferred from its constitute morphemes - 升 (up) + 降 (down) + 機 (machine). Similar to the above example, most of the words in Chinese represent meaning at both lexical and morphemic level. It follows that successful LC is likely to involve both lexical meaning processing and morphemic meaning processing, which respectively requires vocabulary skills and morphological skills. Furthermore, previous studies had shown that Chinese children began to develop morphological skills in spoken language as young as at the age of four to five, which continue to grow after school entry (Chung & Hu, 2007; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003; Tong, McBride-Chang, Shu, & Wong, 2009). It appears that Chinese first-graders could already acquire certain morphological skills and make use of the skills for achieving better LC. Taken together, we have reasons to suggest that morphological skills could be a core foundational language skills for Chinese LC among children at early school grades.

In view of the lack of theoretical and empirical basis of cognitive-linguistic skills for early Chinese LC in existing research, the current study took the initiative to propose a range of cognitive-linguistic skills which could be essential contributors to early Chinese LC. Such proposal had been visualized as a path model as shown in Fig. 1. The proposed Chinese model was built upon the existing LC model suggested by Kim (2016), with an addition of an important element of Chinese LC – morphological skills. In all, our proposed model contained three facets of cognitive-linguistic skills: foundational cognitive skills (working memory), foundational language skills (morphological skills, vocabulary, and grammatical skills), and higher-order cognitive skills (comprehension monitoring). Each of them was hypothesized to have its own direct path to LC in the model (see all the direct paths in black solid lines in Fig. 1). The decision to include all those direct paths was based on our alternative models testing results following the procedures described by Kim (2016). Details of the four tested models and results of the model fit comparisons are reported in Supplementary Information. Furthermore, the cognitive-linguistic skills in the model were also hypothesized to have indirect paths, from bottom foundational cognitive skills up to LC (see all the indirect paths as black dash lines in Fig. 1). These indirect paths were hypothesized based on the following assumptions: At the bottom level of the model, working memory is a basic cognitive skill that supports both foundational language skills and higher-order cognitive skills. Children are not likely to perform well in any linguistic tasks or higher-order cognitive tasks if they do not have adequate memory capacity to hold words and sentences in mind while processing their meanings at the same time (Florit, Roch, Altoè, & Levorato, 2009). At the next level of the model, foundational language skills were also shown to support higher-order cognitive skills (Florit et al., 2011; Tompkins et al., 2013). In order to make comprehension monitoring possible, children should first have certain vocabulary and grammatical skills to form initial understanding of the discourse, since otherwise there would be no adequate substance on which comprehension monitoring can operate on (Skarakis-Doyle & Dempsey, 2008).

2. Aim of the present study

All in all, the present study aimed to examine the underlying contribution of a range of cognitive-linguistic skills to early Chinese LC among Hong Kong children in first grade at age 6 to 7. Since Cantonese is the most commonly used Chinese dialect in Hong Kong, from which our sample of children was recruited, the current study was designed based on the Cantonese language. The specific objectives of the present study included:

1) To determine whether each of the three facets of cognitive-linguistic skills has its own unique importance for Chinese LC.
2) To determine whether morphological skills could be viewed as a core component of foundational language skills important for Chinese LC.
3) To establish a path model to clarify the structural relationships among the three facets of cognitive-linguistic skills in relation to Chinese LC. This also helps to shed light on the specific roles – both direct and indirect roles – of the cognitive-linguistic skills in the context of each other.

3. Method

3.1. Participants

The present study was part of a longitudinal study in which we followed a group of Chinese children from preschool to first grade. A total of 120 children were initially recruited from 5 randomly selected mainstream kindergartens in Hong Kong. With 15 children dropped out from our longitudinal study at first grade, 105 first-graders remained for the current LC study. It is noted that while these children originally came from 5 kindergartens, they later went to 38 elementary schools in first grade. In short, the current study included a total of 105 first-graders (57 boys and 48 girls, mean age = 7.15 years, SD = 0.29) from 38 elementary schools in Hong Kong. In short, the current study included a total of 105 first-graders (57 boys and 48 girls, mean age = 7.15 years, SD = 0.29) from 38 elementary schools in Hong Kong. All of the children were native speakers of Cantonese and attending schools with Cantonese as the medium of instruction. They were reported by their teachers and/or parents as normally developing children without any visual, hearing or language impairments. Most

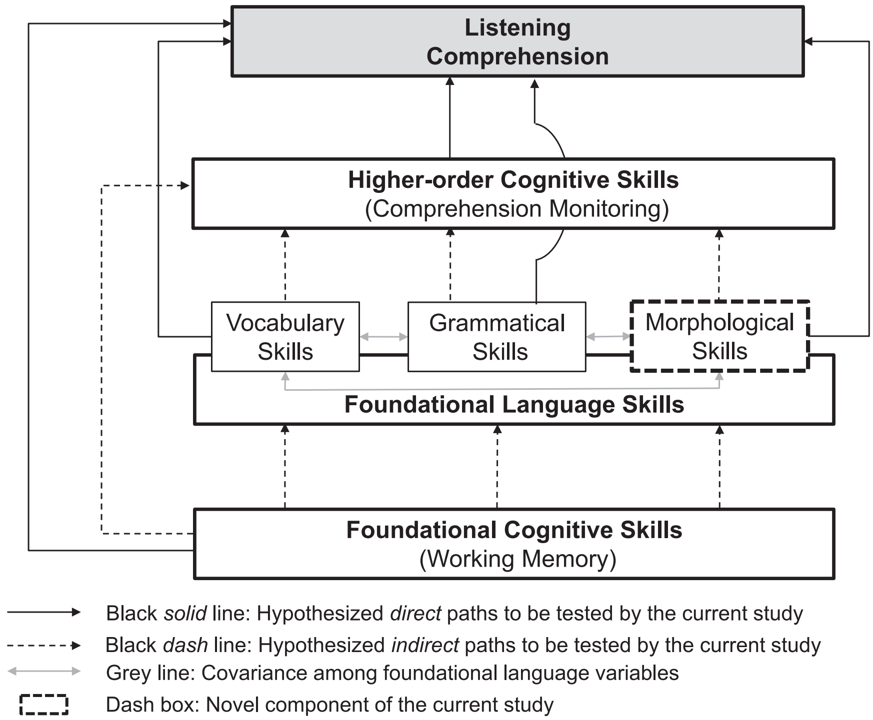

Fig. 1. Proposed model with all the hypothesized paths among the three facets of cognitive-linguistic skills in relation to Chinese LC.

children (90%) lived in middle income households as classified by the standard of government statistics (HKSAR Census and Statistics Department, 2014). As for parental education, 31% of the parents were of junior secondary education level (*i.e.*, Secondary 1 to 3, as equivalent to Grade 7 to 9 in the U.S.) and 44% of them were of senior secondary education level (*i.e.*, Secondary 4 to 7, as equivalent to Grade 10–12 in the U.S.), while 22% of them received tertiary education (*i.e.*, any type of education pursued beyond secondary school-level). The study was approved by the Human Research Ethics Committee for Non-Clinical Faculties, the University of Hong Kong (HRECNCF, HKU) and was conducted in accordance with the Committee's code of ethical conduct in research with human participants.

3.2. Measures

The majority of measures employed in this study were adopted from previously published studies in Chinese school-age children. All of the measures were shown to have reasonable internal reliability (*i.e.*, all Cronbach's αs were 0.70 or above as reported in Table 1). In addition, we computed the inter-rater reliability for all measures for which a check of its scoring objectivity is necessary. In each of these tasks, around 30% of the children's responses were scored independently by two raters who were also the test administrators of the study. The Cohen's Kappa for each measure was 0.77 or above (see Table 1). All measures were conducted orally in Cantonese. Materials and administration procedures of the measures are described in the following paragraphs.

3.2.1. Working memory

Working memory was assessed with a *backward digit span task* based on the Chinese version of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV [HK]; Wechsler, 2010). Our task followed the same format of Wechsler (1991) with modified items. Each item consisted of a string of digits, ranging from two to seven digits long. After listening to each item, children had to reproduce the digits in reverse order. The task consisted of a total of 16 items, with two items for each span length (except for the three- and four- digit span items which had four items each). In order to get one mark, children had to recall all the digits in an item in the correct order. A stopping rule was applied if the child failed two consecutive items at the same span length. The maximum score of the task was 16.

3.2.2. Morphological skills

The present task contained 27 items, which were adapted and modified from the morphological construction task developed by McBride-Chang et al. (2003). The testing procedure of each item, which had been described by Liu and McBride-Chang (2010) and Tong et al. (2009), Tong, McBride-Chang, Shu, Reitsma, and Rispens (2011), is described as below: the examiner first verbally presented a three-sentence scenario to the children, which described a particular object or

Table 1
Means, standard deviations and reliability for all the measures.

	Mean	Range	SD	Reliability (Cronback's α)	Inter-rater reliability (Cohen's Kappa)
Working memory (16)	6.43	2–13	2.65	0.82	–
Morphological skills (27)	16.85	4–25	4.26	0.86	–
Vocabulary skills (30)	18.29	7–30	4.62	0.71	0.78
Grammatical skills (22)	15.00	7–21	3.01	0.71	0.95
Comprehension monitoring (20)	9.40	0–20	5.21	0.82	0.77
LC[a] – retelling (13)	7.46	0–12	2.75	0.78	0.90
LC – question-answering (17)	11.14	2–16	2.33	0.70	0.88

[a] LC = listening comprehension.

concept. Children were then instructed to make use of familiar morphemes to create a new compound word that best represented the specified object. One sample item was that, 'If a kind of oil is made of peanuts, then it is called peanut-oil; if a kind of oil is made of mushroom, then what should it be called?', and the answer was 'mushroom-oil'. There were two practicing items with picture illustration to familiarize children with the task. Children could get one mark for answering correctly in each of the 27 items.

3.2.3. Vocabulary skills

Children's vocabulary skills were measured by a *word definition task*. The task was similar to those used in previous Chinese studies (McBride-Chang et al., 2003; Zhang et al., 2012). The task required children to explain and elaborate the meaning of 15 words which included nouns, verbs, and adjectives. A practice trial was administered before the test words. A marking scheme was developed based on the definitions suggested in Chinese dictionaries. A score of zero, one, or two could be assigned to children's answers in each item. Two marks were given when a child provided reasonable definitions to the target word. For example, a full-mark answer for the definition of the word 誠實 *sing4-sat6* (being honest) was 'telling the truth/not telling lies'. One mark would be given to a loose definition that only explained partial meaning of the word, *e.g.*, "it is a kind of good conduct of a well-behaved child". Zero score was given when the child's definition did not help explain the term at all, *e.g.*, "it means an honest child". The maximum score of the task was 30.

3.2.4. Grammatical skills

Children's understanding of Chinese grammar was tapped by an *oral cloze task* (So & Siegel, 1997). A total of 22 sentences in Cantonese Chinese were recorded in MP3 format and were orally presented to the child. In the recording, each sentence had a word left out, and the missing word was replaced by a bell-like sound 'ding'. The child was asked to figure out the missing word, which could be a noun, a verb, an adjective, a classifier, or a grammatical morpheme, *e.g.*, 是 *si6* (is/am/are). For an instance, the plausible answers for the item我抌咗啲唔要嘅空 *ngo5 dam2 zo2 di1 m4 jiu3 ge3 hung1* (I throw away some empty) could be 樽 *zeon1* (bottles), 盒*hap6* (boxes), 罐*gun3* (cans) and so on. Answers that were grammatically correct but semantically incorrect were also considered acceptable, such as 紙 (paper) and 氣 (air). One point was given to a correct answer in each item. Before the start of the test, one item was conducted with the child as a practice trial.

3.2.5. Comprehension monitoring

An inconsistency detection task was designed to tap children's ability to monitor the textual consistency of listening stories by using procedures similar to that of previous alphabetic studies (*e.g.*, Kim & Phillips, 2014; Schmidt, Schmidt, & Tomalis, 1984). In this task, children needed to listen to 10 short stories through MP3 recordings. Each story contains 3–5 sentences. They were designed to be internally inconsistent, *i.e.* conflicting information were presented across the sentences in each story. For example, one of the stories was about a boy who hated apples, but the story ended up saying that his favorite fruit was apples. The children's task was to identify the parts of the story which did not make sense. In each item, 2 points were given to the child who was able to accomplish two things: firstly, to point out the part that went wrong (*e.g.*, "the story should not tell us that apples was his favorite fruit") and secondly, to explain his/her judgment by indicating the part which was in conflict with the above mistaken part (*e.g.*, "it does not make sense, because at the beginning, the story tells us that the boy always hate apples"). If the child failed to give a full-mark answer, the examiner would prompt him/her verbally to give more explanation, *e.g.*, "why do you think this is wrong?". Only one point was given if the child was able to recognize the problematic statement, but failed to indicate what information in the story was in conflict with that statement (*e.g.*, "the story should not tell us that the boy hated apple (*i.e.*, a correct identification of problematic statement), because apple is good for health (*i.e.*, an incorrect explanation)". Zero mark was given if the child said there was nothing wrong with the story, or if he/she incorrectly identified some other parts of the story to be problematic. The maximum score of the task was 20. A practice trial was used to demonstrate the procedure and check whether the participants understood.

3.2.6. Listening comprehension

The method used to assess listening comprehension was similar to that in previous studies in Spanish and Chinese (Strasser & del Rio, 2014; Yeung et al., 2011). A short story was created for children to listen to, and based on which, they were asked to retell the story and answer some comprehension questions. The story was about a boy taking part in a drawing competition at school. For *story retelling*, initial prompt such as 'what was this story about?' would be given if the child appeared not knowing how to start. Only general prompts such as 'can you tell me more?' or 'what happened next' would be offered when needed during retelling. According to the hierarchal story structure suggested by Stein and Glenn (1979), a total of 13 propositions of different story elements were derived from the narrative, *e.g.*, setting, initiating event, response, attempt, direct consequence, and reaction. One point was given for each proposition provided by the children from their recall. The children's responses were recorded by MP3 for later transcription and scoring. In order to estimate the inter-rater agreement, about 30% of the narrative transcriptions were randomly selected and independently scored by a second rater. The inter-rater reliability of Cohen's kappa was 0.90.

In addition, a total of 13 *comprehension questions* were asked, of which 7 were literal questions, *e.g.*, 'Who asked Lok Lok (the main character) to join the drawing competition?' (this is a literal question because the story directly tells that "One day, the teacher asked Lok Lok to join a drawing competition"), and the other 6 were inference-type questions, *e.g.*, 'Do you think Lok Lok is good at drawing? Why?' (this is an inference-type question, because one needs to infer that Lok Lok is not good at drawing from the storyline: "Lok Lok drew a cat. After looking at the painting, his teacher asked him 'Is it a mouse?' and "At the end, Lok Lok did not win in the competition". Among the 13 questions, 5 were yes/no or multiple choice questions, 4 required a one-word answer, and the other 4 were open-ended questions. One mark was given to each correct answer. For the open-ended questions, 2 of them required an answer that addressed two main key points, and one score was given to each key point answered correctly. The maximum score of the task was 15.

We followed previous researchers (*e.g.*, Keenan, Betjemann, & Olson, 2008) to construct a listening comprehension composite score by averaging the Z score the child obtained in retelling and question-answering. Children's scores attained in the two parts were reasonably correlated with each other ($r = 0.50$, $p \leq 0.001$).

3.3. Procedure

Each child was tested individually, either by the first author or a trained undergraduate student, in a quiet place at the child's school or home over two sessions. Each session lasted around half an hour, and there was a 10-minute break between the two sessions.

3.4. Data analysis

Multiple regression methods were used to address the unique contribution of each cognitive and language skill to listening comprehension. Then a path analysis method was used to determine how well our proposed model (Fig. 1) fit to the current data, as well as to examine the significance of each direct and indirect path in the model. The path analyses were carried out using Mplus Version 7.0 (Muthen & Muthen, 2010). Although this study had a small sample size of 105, it was able to

Table 2
Bivariate correlations among all the measures.

Measures	1	2	3	4	5	6	7
1. Working memory							
2. Morphological skills	0.36***						
3. Vocabulary skills	0.11	0.47***					
4. Grammatical skills	0.22*	0.53***	0.50***				
5. Comprehension monitoring	0.21*	0.43***	0.42***	0.26**			
6. LC[a] – retelling	0.25*	0.54***	0.55***	0.49***	0.46***		
7. LC – questions-answering	0.36**	0.52***	0.37***	0.32**	0.46***	0.51***	
8. LC composite	0.35**	0.61***	0.53***	0.47***	0.53***	0.87***	0.86***

[a] LC = listening comprehension.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

provide 5 participants for each parameter in the saturated model, which fulfill the minimum sample size requirement recommended by Kline (2005).

4. Results

The mean scores and standard deviations of the measures are shown in Table 1. The normality of data was also demonstrated, since the skewness and kurtosis of all variables are within an acceptable range (*i.e.*, between −1 and +1).

4.1. Correlational analyses

Table 2 shows the bivariate correlations among the measures. Each of the three facets of cognitive-linguistic skills (*i.e.,* working memory, morphological skill, vocabulary skill, grammatical skill, and comprehension monitoring) were found to be moderately or strongly associated with the LC composite (*rs* = 0.35–0.61, *ps* < 0.05). It was found that morphological skill was the strongest correlate of LC composite ($r = 0.61$, $p < 0.001$).

4.2. Multiple regression analyses

A simultaneous multiple regression was conducted to determine the unique contribution of each cognitive-linguistic variable to the LC composite. The unstandardized and standardized beta coefficients and standard errors of each variable are reported in Table 3. All of the independent variables, except for grammatical skills, made unique contributions to the LC composite. The relative unique contribution of each variable was evaluated through the interpretation of standardized beta coefficients (Jordan et al., 2013). The variable of morphological skills was shown to be the strongest unique contributor ($\beta = 0.29$, $p < 0.01$). Altogether, the range of cognitive-linguistic measures significantly accounts for 53% of the variance in the LC composite.

Table 3
Multiple regressions explaining listening comprehension composite from each cognitive-linguistic measure (morphological skills, vocabulary skills, grammatical skills, comprehension monitoring, and working memory) with all other controlled.

Measures	Listening comprehension composite			
	B	*SE B*	β	(ΔR^2)[a]
Working memory	0.05	0.02	0.15*	(0.02)
Morphological skills	0.06	0.02	0.29**	(0.05)
Vocabulary skills	0.04	0.02	0.21*	(0.03)
Grammatical skills	0.03	0.03	0.11	(< 0.01)
Comprehension monitoring	0.04	0.01	0.25**	(0.05)

Note. $R = 0.73$, $R^2 = 0.53$ ($p < 0.001$).
[a] R^2 change after all other measures have been entered.
* $p < 0.05$.
** $p < 0.01$.

Another focus was to determine the amount of unique variance in LC explained by each independent variable respectively. This was achieved through conducting a series of hierarchical multiple regressions. In each regression, one of the variables was put into the second step of the regression after all other variables were entered into the first step, so that the unique variance explained by that particular variable could be determined. The results indicated that each of these variables – working memory, morphological skills, vocabulary skills, and comprehension monitoring – significantly explained 2–5% unique variance in the LC composite. The variable of morphological skills uniquely explained 5% variance in LC after accounting for all other variables.

4.3. Path analyses

The resulting model is demonstrated in Fig. 2. All the statistically significant paths and their standardized path coefficients are reported in the model. Our first focus was on the direct path of each of the three facets of cognitive-linguistic skills to LC. Results indicated that the direct paths from working memory, morphological skills, vocabulary skills, and comprehension monitoring to LC were all statistically significant ($p < 0.05$). Our second focus was on the indirect paths of the three facets of cognitive-linguistic skills to LC. The results indicated that foundational cognitive and language skills significantly contributed to LC *via* indirect paths ($p < 0.05$). As shown in Fig. 2, such paths originated from working memory to foundational language skills (morphological skills [path coefficients = 0.36] and grammatical skills [0.22]), and from foundational language skills (morphological skills [0.27] and vocabulary skills [0.30]) to comprehension monitoring, and ultimately led to LC. Table 4 shows direct, indirect, and total effects of the cognitive-linguistic skills on LC. Overall, our model fit adequately to the sample data. The chi-square value of the model was 2.41 (*df* = 3; $p = 0.49$), and the CFI and RMSEA values were 1 and 0 respectively. The NNFI and SMRM values were 1 and 0.04 respectively. It is noted that a CFI value of 0.95 or above, an RMSEA value of 0.05 or below, a NNFI value of 0.95 or above, and a SMRM of 0.05 or below, indicates a good fit (Hu & Bentler, 1999; Kline, 2005).

5. Discussion

The present study identified the cognitive-linguistic skills that contribute to the early success of LC in Chinese children. A wide variety of cognitive and language measures were administered in 105 Cantonese-speaking Chinese children in first grade, including working memory, morphological skills, vocabulary skills, grammatical skills, and comprehension monitoring. Results indicated that all of them (except for grammatical skills) were unique contributors to Chinese LC. The measure of both morphological skills and comprehension monitoring were found to have the largest unique contribution to LC. Results of path analysis further highlight the direct and indirect nature

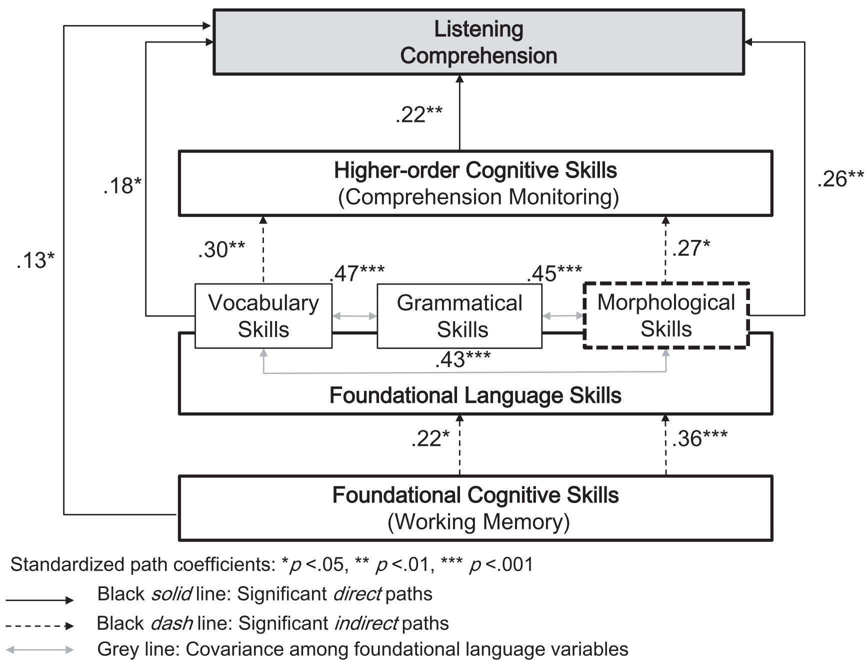

Fig. 2. Resulted model with all the significant paths among the three facets of cognitive-linguistic skills in relation to Chinese LC.

Table 4
Direct, indirect, and total effects of cognitive-linguistic skill on listening comprehension.

Measures	Direct	Indirect	Total
Working memory	0.13	0.25	0.38
Morphological skills	0.26	0.22	0.48
Vocabulary skills	0.18	0.27	0.45
Grammatical skills	–	0.37	0.37
Comprehension monitoring	0.22	–	0.22

of relationships between these skills and Chinese LC. Our proposed path model provided a reasonable conceptualization of the interrelationships among the variables in the study.

The current findings on the direct and indirect contribution of cognitive-linguistic skills could be explained in light of the construction-integration model. Based on this model, the range of cognitive-linguistic skills included in this study were theorized to have unique importance for comprehension: morphological, vocabulary, and grammatical skills are foundational language skills important for a listener to construct initial propositional meaning based on the linguistic inputs (*i.e.*, words and sentences) of the discourse; comprehension monitoring is a higher-order cognitive skill for a listener to build a coherent and integrated situation model across the whole discourse; whereas working memory is a foundational cognitive skill for a listener to hold and retrieve relevant information in mind so that one can execute and coordinate multiple cognitive-linguistic processes all at the same time. Consistent to the construction-integration model, our results showed that foundational cognitive skills, foundational language skills, and higher-order cognitive skills each explained significant and unique variance of LC respectively (2%, 8%, and 5%). Taken the present findings together with those of the previous studies (Kim, 2016; Kim & Phillips, 2014; Strasser & del Rio, 2014), we suggest that successful LC across languages, including English and Chinese, requires children to be competent in all three facets of cognitive-linguistic skills. It follows that such three-facet model of LC is applicable across different linguistic systems. It would be interesting to test the universal applicability of the model to further languages. Furthermore, the three facets of skills were demonstrated to play both direct and indirect roles in Chinese LC as similar to that shown in other languages like English (Kim, 2016; Kim & Phillips, 2014). As expected, our path analysis findings indicated that morphological and vocabulary skills – *i.e. foundational language skills* – not only play a direct role in LC, but they also play a mediated role *via* facilitating higher-order cognitive skills. Working memory – *a foundational cognitive skill* – similarly had both a direct and an indirect role *via* supporting foundational language skills and subsequent higher-order cognitive skills. These findings are consistent with the view that an inability to perform higher-order cognitive skills might be a result of poor linguistic foundational skills or inadequate working memory capacity (Perfetti, Landi, & Oakhill, 2005; Yuill & Oakhill, 1991). Taken together, the current study established a systematic view regarding how the three facets of cognitive-linguistic skills both directly and indirectly contribute to Chinese LC among children. This serves to be an important first step towards building a comprehensive model of Chinese LC.

Morphological skills had been demonstrated, for the first time by the present study, as a strong and unique contributor to Chinese LC. Previous studies had repeatedly demonstrated the importance of vocabulary and grammatical skills in LC (Kim, 2016; Lepola et al., 2012). While the current findings also confirmed the importance of vocabulary skills, morphological skills were shown to significantly explain 5% unique variance in Chinese LC beyond the combined effects of other well-known cognitive-linguistic skills (*i.e.*, vocabulary, grammatical skills, comprehension monitoring, and working memory). The finding suggests that children need to further develop a good sense on how Chinese language represents meanings at morphemic level within compound words. Interestingly, our findings clearly indicated that morphological skills have unique ways to contribute to Chinese LC apart from associating with vocabulary skills. Based on such findings, we suggest that morphemic meanings within compound words may provide additional semantic cues that are not available at lexical level. Using the example of 升降機 (elevator), its component morphemes – 升 (up), 降 (down), and 機 (machine) – directly inform specific features and functions of an elevator (*i.e.*, going up and down). Children with better morphological skills are thus more likely to have a quicker access to the lexicon and be able to extract its meaning more efficiently during listening. Especially when they encounter words which are not in their existing vocabulary knowledge, they may rely on morphological knowledge to make an educated guess about the semantic and syntactic category of the unknown word. For example, if they are able to identify the morpheme機 (machine) in an unknown word 升降機 (elevator), they can at least know that this is a noun word referring to a type of machine. We conclude that morphological skills represent a core component of foundational language skills of Chinese LC.

In contrast to our expectation, grammatical skills were not found to have unique importance for Chinese LC beyond other cognitive-linguistic skills. In existing literature, the notion that grammatical skills are important for early LC is more or less built upon the inflectional and derivation systems of those languages. Under such systems, sentences in inflectional languages are characterized by making intense use of grammatical markers in words to convey important information. For example, information about the timing of an action is conveyed by the grammaticalization of tense in alphabetic English. However, Chinese is a non-inflectional language in which there are no equivalent grammatical markers to indicate tense, number, person, gender, or case. Even though Chinese sentences also convey meaning through word order, the structure of its sentences are nonetheless relatively loose (Fung, 2009), and therefore, word order in Chinese is usually not as reliable as that in English to inform the semantic and syntactic relationships among words in sentences. It is a common view that Chinese sentences convey meaning not so much by rules of grammar *per se*, but more by a shared understanding of the context (Chang, 1992; Li & Thompson, 1981). Given the special characteristics of Chinese grammar, it is reasonable to assume that the relative importance of grammatical skills for Chinese LC could be less prominent than that for LC in inflectional languages. We have to acknowledge that, though, Chinese in fact also makes some use of inflectional and derivational morphemes. However, such aspect of grammatical skills was not adequately represented in the current oral cloze task, since it specifically focused on testing the use of word class in sentences. Taken together, more studies are required to confirm the adequacy of such assumption, using multiple measures of grammatical skills, and studying a larger group of children across a wider age range. Future studies may use a larger sample size, which would increase confidence in the conclusions drawn.

Furthermore, the present findings are among the first to establish the importance of comprehension monitoring, a kind of higher-order cognitive skills, for early Chinese LC. Such findings are consistent with previous claims that successful comprehension in Chinese particularly depends on the mastery of textual coherence (Chik et al., 2012; Yeung, Ho, Chan, Chung, & Wong, 2013). As mentioned above, non-inflectional Chinese does not have grammatical markers in words for tense, person, case, and so on. Such kinds of information thus often have to be inferred from the textual context across sentences. Take this sentence 他和朋友到公園見面 '*He meets/met his friend(s) in the park*' for an instance. Since the noun word 朋友 '*friend*' is not grammatically marked to signify singularity or plurality, information about how many friends are involved in the meeting is unavailable at sentence-level and therefore may need to be drawn from preceding or later sections of the passage. Moreover, the sentence fails to specify whether the meeting is at present or in the past, because the verb word 見面 '*meet*' is not grammatically marked to signify tense like that in English. Again, one has to infer such temporal information from the rest of the discourse. Taken together, we suggest a possibility that LC in non-inflectional Chinese particularly requires children to integrate ideas across sentences, which therefore hinges largely on comprehension monitoring, and potentially other kinds of higher-order cognitive skills, for building a coherent and integrated representation of the discourse. Since the higher-order cognitive skill examined in the current study only limited to comprehension monitoring, future studies in Chinese LC should pay attention to a wider range of higher-order cognitive skills, such as inference-making, theory of mind, counterfactual reasoning, and so on (Guajardo & Cartwright, 2016; Kim, 2016; Strasser & del Rio, 2014).

To sum up, the current study is the first to provide preliminary evidence on a range of cognitive-linguistic skills fundamental to early success in Chinese LC. Practically speaking, the current findings are in favor of teaching multiple cognitive and linguistic skills for nurturing successful LC among Chinese children as young as at first grade. The importance of morphological skills training is particularly highlighted. It appears that children who struggle with LC could possibly experience problems in multiple language and/or cognitive skills, and therefore effective intervention for them may require comprehensive or tailor-made aspects of skills training depending on individual cognitive-linguistic profile. These noted educational implications require future investigations.

6. Conclusion

LC is as a complex process that involves the interplay of multiple cognitive and language skills. The present findings highlight a need to consider both language-general and language-specific factors for understanding the nature of LC across languages. While Chinese LC broadly draws on the three aspect of cognitive-linguistic skills – foundational cognitive skills, foundational language skills, and higher-order cognitive skills – as similar to that in other languages (*e.g.*, English), the specific components constituting each facet of skills could be different from other languages. In light of the drastic amount of compound words in Chinese language, we demonstrated the unique importance of morphological skills for Chinese LC. Future research may further look into other aspect of cognitive-linguistic skills which have potential importance for LC in Chinese or other languages with unique morphological or grammatical features.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.lindif.2017.08.001.

References

Aarnoutse, C. A. J., van den Bos, K. P., & Brand-Gruwel, S. (1998). Effects of listening comprehension training on listening and reading. *The Journal of Special Education, 32*, 115–126.

Berninger, V. W., & Abbott, R. D. (2010). Listening comprehension, oral expression, reading comprehension, and written expression: Related yet unique language systems in Grades 1, 3, 5, and 7. *Journal of Educational Psychology, 102*, 635–651.

Byrnes, H. (1984). The role of listening comprehension: A theoretical base. *Foreign Language Annals, 17*, 317–329.

Carretti, B., Caldarola, N., Tencati, C., & Cornoldi, C. (2014). Improving reading comprehension in reading and listening settings: The effect of two training programmes focusing on metacognition and working memory. *British Journal of Educational Psychology, 84*, 194–210.

Chang, H.-W. (1992). The acquisition of Chinese syntax. In H.-C. Chen, & O. J. L. Tzeng (Eds.). *Language processing in Chinese* (pp. 277–312). Amsterdam: North-Holland.

Chao, Y. R. (1965). *A grammar of spoken Chinese.* University of California Press.

Chen, X., Hao, M., Geva, E., Zhu, J., & Shu, H. (2009). The role of compound awareness in Chinese children's vocabulary acquisition and character reading. *Reading and Writing, 22*, 615–631.

Chik, P. P.-M., Ho, C. S.-H., Yeung, P.-S., Wong, Y.-K., Chan, D. W.-O., Chung, K. K.-H., & Lo, L.-Y. (2012). Contribution of discourse and morphosyntax skills to reading comprehension in Chinese dyslexic and typically developing children. *Annals of Dyslexia, 62*, 1–18.

Chung, W.-L., & Hu, C.-F. (2007). Morphological awareness and learning to read Chinese. *Reading and Writing, 20*, 441–461.

Daneman, M., & Merikle, P. M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic Bulletin & Review, 3*, 422–433.

Dickinson, D., Golinkoff, R. M., & Hirsh-Pasek, K. (2010). Speaking out for language: Why language is central for learning development. *Educational Researcher, 39*, 305–310.

Florit, E., Roch, M., Altoè, G., & Levorato, M. C. (2009). Listening comprehension in preschoolers: The role of memory. *British Journal of Developmental Psychology, 27*, 935–951.

Florit, E., Roch, M., & Levorato, M. C. (2011). Listening text comprehension of explicit and implicit information in preschoolers: The role of verbal and inferential skills. *Discourse Processes, 48*, 119–138.

Fung, R. S.-Y. (2009). Characteristics of Chinese in relation to language disorders. In S.-P. Law, B. S. Weekes, & A. M.-Y. Wong (Eds.). *Language disorders in speakers of Chinese* (pp. 1–18). Clevedon, UK: Multilingual Matters.

Guajardo, N. R., & Cartwright, K. B. (2016). The contribution of theory of mind, counterfactual reasoning, and executive function to pre-readers' language comprehension and later reading awareness and comprehension in elementary school. *Journal of Experimental Child Psychology, 144*, 27–45.

HKSAR Census and Statistics Department (2014). Population and household statistics analyzed by District Council District 2013. Retrieved from http://www.statistics.gov.hk/pub/B11303012013AN13B0100.pdf.

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing, 2*, 127–160.
Hu, L.-T., & Bentler, P. M. (1999). Cutoff criteria for fit indices in covariance structure analysis. Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55.
Jordan, N. C., Hansen, N., Fuchs, L. S., Siegler, R. S., Gersten, R., & Micklos, D. (2013). Developmental predictors of fraction concepts and procedures. *Journal of Experimental Child Psychology, 116*, 45–58.
Keenan, J. M., Betjemann, R. S., & Olson, R. K. (2008). Reading comprehension tests vary in the skills they assess: Differential dependence on decoding and oral comprehension. *Scientific Studies of Reading, 12*, 281–300.
Kim, Y.-S. (2016). Direct and mediated effects of language and cognitive skills on comprehension of oral narrative texts (listening comprehension) for children. *Journal of Experimental Child Psychology, 141*, 101–120.
Kim, Y.-S., & Phillips, B. (2014). Cognitive correlates of listening comprehension. *Reading Research Quarterly, 49*, 269–281.
Kintsch, W. (1988). The use of knowledge in discourse processing: A construction-integration model. *Psychological Review, 95*, 163–182.
Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford Press.
Lepola, J., Lynch, J., Laakkonen, E., Silvén, M., & Niemi, P. (2012). The role of inference making and other language skills in the development of narrative listening comprehension in 4–6-year-old children. *Reading Research Quarterly, 47*, 259–282.
Li, C. N., & Thompson, S. A. (1981). *Mandarin Chinese: A functional reference grammar.* Berkeley: University of California Press.
Liu, P. D., & McBride-Chang, C. (2010). What is morphological awareness? Tapping lexical compounding awareness in Chinese third graders. *Journal of Educational Psychology, 102*, 62–73.
McBride-Chang, C., Shu, H., Zhou, A., Wat, C. P., & Wagner, R. K. (2003). Morphological awareness uniquely predicts young children's Chinese character recognition. *Journal of Educational Psychology, 95*, 743–751.
Muthen, B., & Muthen, L. (2010). *Mplus users' guide* (6th ed.). Los Angeles, CA: Muthen & Muthen.
Packard, J. L. (2000). *The morphology of Chinese: A linguistic and cognitive approach.* Cambridge, UK: Cambridge University Press.
Perfetti, C. A., Landi, N., & Oakhill, J. (2005). The acquisition of reading comprehension skill. In M. J. Snowling, & C. Hulme (Eds.). *The science of reading: A handbook* (pp. 227–247). Malden, MA: Blackwell Publishing.
Schmidt, C. R., Schmidt, S. R., & Tomalis, S. M. (1984). Children's constructive processing and monitoring of stories containing anomalous information. *Child Development, 55*, 2056–2071.
Skarakis-Doyle, E., & Dempsey, L. (2008). The detection and monitoring of comprehension errors by preschool children with and without language impairment. *Journal of Speech, Language, and Hearing Research, 51*, 1227–1243.
Snowling, M. J., & Hulme, C. (2005). *The science of reading: A handbook.* Malden, MA: Blackwell.
So, D., & Siegel, L. S. (1997). Learning to read Chinese: Semantic, syntactic, phonological and working memory skills in normally achieving and poor Chinese readers. *Reading and Writing: An Interdisciplinary Journal, 9*, 1–21.
Stein, N. L., & Glenn, C. G. (1979). An analysis of story comprehension in elementary school children. In R. O. Freedle (Vol. Ed.), *Advances in discourse processes: New directions in discourse processing. Vol. 2. Advances in discourse processes: New directions in discourse processing* (pp. 53–120). Norwood, NJ: Ablex.
Strasser, K., & del Rio, F. (2014). The role of comprehension monitoring, theory of mind, and vocabulary depth in predicting story comprehension and recall of kindergarten children. *Reading Research Quarterly, 49*, 169–187.
Tompkins, V., Guo, Y., & Justice, L. M. (2013). Inference generation, story comprehension, and language in the preschool years. *Reading and Writing, 26*, 403–429.
Tong, X., McBride-Chang, C., Shu, H., Reitsma, P., & Rispens, J. (2011). Longitudinal predictors of very early Chinese literacy acquisition. *Journal of Research in Reading, 34*, 315–332.
Tong, X., McBride-Chang, C., Shu, H., & Wong, A. M.-Y. (2009). Morphological awareness, orthographic knowledge, and spelling errors: Keys to understanding early Chinese literacy acquisition. *Scientific Studies of Reading, 13*, 426–452.
Wechsler, D. (1991). *Wechsler intelligence scale for children* (3rd ed.). San Antonio, TX: Psychological Corporation.
Wechsler, D. (2010). *Wechsler Intelligence Scale for Children*Hong Kong(4th ed.). China: King-May Psychological Assessment.
Yeung, P.-S., Ho, C. S.-H., Chan, D. W.-O., Chung, K. K.-H., & Wong, Y.-K. (2013). A model of reading comprehension in Chinese elementary school children. *Learning and Individual Differences, 25*, 55–66.
Yeung, P.-S., Ho, C. S.-H., Chik, P. P.-M., Lo, L.-Y., Luan, H., Chan, D. W.-O., & Chung, K. K.-H. (2011). Reading and spelling Chinese among beginning readers: What skills make a difference? *Scientific Studies of Reading, 15*, 285–313.
Yuill, N., & Oakhill, J. (1991). *Children's problems in text comprehension: An experimental investigation.* New York: Cambridge University Press.
Zhang, J., McBride-Chang, C., Tong, X., Wong, A. M.-Y., Shu, H., & Fong, C. Y.-C. (2012). Reading with meaning: The contributions of meaning-related variables at the word and subword levels to early Chinese reading comprehension. *Reading and Writing, 25*, 2183–2203.