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BRIEF RESEARCH REPORT

Examining the dimensionality of vocabulary in English as a second language in Chinese children

Qiuzhi Xie[1] and Susanna Siu-Sze Yeung[2]

[1]Department of Curriculum and Instruction, United Arab Emirates University
[2]Department of Psychology, The Education University of Hong Kong
Corresponding author: Susanna Siu-Sze Yeung; Email: siusze@eduhk.hk

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Abstract

This study compared a unidimensional model of vocabulary and a two-factor model comprising vocabulary breadth and depth in a second language (L2). A total of 167 Chinese Grade 4 and 5 primary school children ($Mean_{age}$ = 9.96 years old) learning English as an L2 participated in this study, and they were tested on four English vocabulary tests. Our results of confirmatory factor analyses indicate that vocabulary breadth and depth were not two distinct dimensions, and the unidimensional model was supported. Theoretical and practical implications were discussed.

Keywords: vocabulary breadth; vocabulary depth; second language; English

Introduction

Vocabulary knowledge is critical for literacy development (e.g., Verhoeven et al., 2019; Xie et al., 2022a; Xie & Yeung, 2022), but the dimensionality of vocabulary is still controversial (Kieffer & Lesaux, 2012; Koh et al., 2020; Tannenbaum et al., 2006). According to Levelt et al.'s (1999) theory of lexical access in speech production, vocabulary storage includes both word phonological forms and semantic representations. This theoretical perspective was validated by the observations of young children that children may store a word form in their lexicon without fully understanding the meaning of that word (Lahey, 1988). This distinction between word forms versus semantic knowledge echoes the instrumental and knowledge hypotheses (Anderson & Freebody, 1981) that contrast vocabulary breadth and depth as two dimensions of word knowledge. Vocabulary breadth refers to the number of words acquired, and it does not indicate how deeply these words are known (Nagy & Herman, 1987). Vocabulary depth denotes how well words are known, and it is an important word knowledge construct that measures the deep understanding of word meanings (Anderson & Freebody, 1981). Henriksen (1999) also include the dimension of partial to precise knowledge as one of the three dimensions of vocabulary. This dimension contrasts the tests that focus on vocabulary size (breadth) versus those that focus on precise comprehension of words (depth). The breadth versus depth dimensions of vocabulary seem to be widely recognized, and a number of researchers separate

vocabulary breadth and depth in their investigation of children's vocabulary knowledge (e.g., M. Li & Kirby, 2015; L. Li et al., 2020; Ouellette, 2006). Vocabulary breadth includes knowing the phonological form and surface meanings of words (M. Li & Kirby, 2015). Vocabulary depth is usually measured via the precision of meanings as well as a word's relations to other words in the lexicon which indicates to what degree lexical networks have been established (e.g., M. Li & Kirby, 2015; Read, 2004).

By contrast, some scholars hypothesized a unidimensional construct of vocabulary (Stewart et al., 2012; Vermeer, 2001), and they argued that vocabulary breadth and depth should be regarded as a continuum of different extent (namely, partial or precise) of word knowledge, rather than different dimensions (e.g., Stewart et al., 2012). In addition, Vermeer (2001) posited that in-depth knowledge of words is usually the consequence of knowing more words and, therefore, the breadth and depth of word knowledge is indistinguishable. For example, children can explain with more detail as to what the word "desk" means if they know such words as "table" and "drawer". Furthermore, some scholars emphasized language environment in vocabulary development (e.g., Sénéchal & LeFevre, 2014) and argued that children immersed in language enriched environments are likely to acquire more new words and more in-depth knowledge of words as they have more opportunities to be exposed to reading and activities that allow for the elaboration of word knowledge; therefore, vocabulary breadth and depth are connectedly developed (Koh et al., 2020). This unidimensional hypothesis of vocabulary is supported by the empirical findings that vocabulary breadth and depth are constantly found to be strongly correlated in both first language (L1) and second language (L2) learners (e.g., Koh et al., 2020; Vermeer, 2001).

Several studies used confirmatory factor analysis (CFA) to examine the dimensionality of vocabulary. A study by Tannenbaum et al. (2006) in Grade 3 English-speaking children showed that a two-factor model identifying vocabulary breadth and depth as two different dimensions fit their data better than a unidimensional model of vocabulary. However, in their study, the correlation between the latent vocabulary breadth and depth factors was very high (r =. 87). By contrast, Lonigan and Milburn's (2017) CFA in English-speaking children from preschool to Grade 5 indicated that a unidimensional model of vocabulary better explained their data than the two-factor model. A study by Koh et al. (2020) in Grade 1 and 2 Chinese-speaking children also favored a unidimensional vocabulary model.

Based on these findings, it remains unclear as to whether vocabulary breadth and depth should be regarded as two different dimensions or under one common dimension. In addition, there is a lack of study exploring vocabulary dimensionality in terms of breadth versus depth in an L2. Compared with an L1, learners' vocabulary knowledge in an L2 is smaller and associative links between words are fewer (Verhoeven, 2000; Vermeer, 2001). Therefore, the findings on L1 vocabulary may or may not be generalizable to L2 vocabulary. Koizumi and In'nami (2020) compared a two-factor model considering vocabulary breadth and depth as distinct dimensions versus a unidimensional model of vocabulary in Japanese adults who learned English as an L2. Although the correlation coefficient (around. 94) between the vocabulary breadth and depth factors in their two-factor model was very high, Koizumi and In'nami (2020) argued that vocabulary breadth and depth were two different dimensions as the two-factor model fit their data better than the unidimensional model. However, such conclusion might be arguable as they compared the model fit via Akaike's information criterion (AIC) that the AIC of the two-factor model was slightly smaller than that of the unidimensional model (4107.574 vs. 4113.674). Given that the unidimensional model was nested in the two-

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factor model in their study and the AIC of the more complicated model is almost always smaller than that of the simpler model in this situation, the comparison of nested models (in their study) should be examined according to whether the difference in χ^2 with the difference in *df* reached significant level (Werner & Schermelleh-Engel, 2011).

In terms of this research background, it remains largely unknown as to whether L2 vocabulary breadth and depth were two different dimensions. This study investigated the dimensionality of vocabulary in an L2. Here is the research question: "Do vocabulary breadth and depth represent two distinct dimensions, or do they represent a similar construct?" We did not have a strong hypothesis for this research question given the inconsistent previous findings on the vocabulary dimensionality (Koh et al., 2020; Lonigan & Milburn, 2017; Tannenbaum et al., 2006).

Methods

Participants

A total of 167 Chinese children (77 girls) aged from 9 to 11 years old (Mean age = 9.96, *SD* =. 60) in a primary school in Hong Kong participated in this study. Among these children, 87 were in Grade 4, and 80 were in Grade 5. Parental education levels of these children ranged from Primary Education to Doctorate Degree with a median of Senior Secondary Education. These children spoke Cantonese as an L1, and they had been learning English as an L2 for at least 6 years. Cantonese was the instructional language in the school, and English was taught as a subject of around 6-8 hours every week. At Grade 4 and 5 of primary school, these children were still at an early stage of learning English.

Measures

Four English vocabulary tests were provided to the participants. Receptive and expressive vocabulary tasks assessed vocabulary breadth. These tasks test participants' knowledge of words in terms of oral forms and basic meanings, and the knowledge regarding precise and multiple meanings of a word is not needed to complete these tasks. Therefore, these tasks are aligned with the operationalization of vocabulary breadth (Nation, 1990). Word definition and synonyms tasks tested vocabulary depth in this study. Word definition task was commonly used to test the precision of word knowledge (e.g., M. Li & Kirby, 2015), and knowledge of synonyms has also often been used to test depth of word knowledge as having a repertoire of words to present a concept indicates an in-depth comprehension of that concept (Koh et al., 2020; Nation, 1990) and a lexical network related to that concept. The Cronbach's α coefficients of these measures are presented in Table 1.

Table 1. Descriptive Statistics

Variables	n	Score Range	Mean	*SD*	Cronbach's α	Skewness
Receptive vocabulary	165	3–22	12.21	4.46	.77	.08
Expressive vocabulary	167	0–28	11.69	6.24	.85	.83
Vocabulary definition	165	0–16	1.98	3.37	.84	2.11
Woodcock synonyms	165	0–10	2.60	2.30	.77	1.04

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Receptive vocabulary

Receptive vocabulary was assessed via the Peabody Picture Vocabulary Test – 4th edition (PPVT-4; Dunn & Dunn, 2007). This test has been used many times in Hong Kong children, and good psychometric properties have been reported (e.g., Xie et al., 2022b; Yeung & Savage, 2020). In this test, a target word was orally presented in English together with four pictures, and children were required to circle one of the pictures corresponding to that word. The audio stimuli used for this task were pre-recorded using a female voice. A total of 24 items from 2 sets (total 17 sets in all) of this test were administrated, and each correct answer was allocated 1 point. The items were selected based on our pilot testing on item difficulty.

Expressive vocabulary

The first 15 items in the Expressive Picture Vocabulary subtest of the Clinical Evaluations of Language Fundamentals – 5th Edition (CELF-5; Wiig et al., 2013) were used. Good reliability and validity of this task have been shown (Coret & McCrimmon, 2015). In this task, the experimenter presented pictures, and children were asked to name the pictures in English. Each item was scored from 0 to 2. For several items, 1 point was given if a child's answer was partially correct (e.g., saying "award" instead of the correct answer "trophy").

Word definition

The Word Definition subset of the CELF-5 (Wiig et al., 2013) that contains 12 testing items and 2 trial items was used to measure the precision of word knowledge. In this test, an experimenter orally presented in English a target word and a sentence with that word (e.g., Neat. Grandma said "You keep your room very neat."). Children were asked to explain that target word in Cantonese. Each answer was scored from 0 to 2 points depending on the precision of the answer according to the marking theme of the CELF-5 (Wiig et al., 2013).

Synonyms

We adapted the first 15 items from Test 17 (Reading Vocabulary) of Woodcock-Johnson III Tests of Achievement (Woodcock et al., 2001) that have good reliability and validity (Bradley-Johnson et al., 2004). In this task, children were orally presented with a word and were asked to say another word with the same or similar meaning (e.g., the synonym of the target word "Speak" can be talk, say, orate, or utter). Each correct answer was scored 1 point.

Procedure

The measures were provided to the participants at several sessions in their school. Before this study was conducted, research ethical approval was obtained from the Education University of Hong Kong, and parental consent was sought.

Results

The descriptive statistics are presented in Table 1. All the measures used in this study were of good internal consistency reliability as indicated by the Cronbach's α values that were.

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Table 2. Zero-order Correlations (above Diagonal) and Partial Correlations Controlling for Grade (below Diagonal)

	1	2	3	4
1. Receptive vocabulary	--	.42	.43	.55
2. Expressive vocabulary	.42	--	.62	.70
3. Word definition	.46	.62	--	.65
4. Woodcock synonyms	.57	.70	.65	--

Note. All the correlations were significant (p <. 001). Asterisks are not presented to make the table neat.

77 or above. Vocabulary definition scores were positive skewed as indicated by the skewness value (2.11). The scores on the other measures were generally normally distributed, indicated by the absolute values of their skewness scores smaller than 2.00 (Gravetter & Wallnau, 2014).

We conducted zero-order correlations among the vocabulary measures (Table 2). The four vocabulary measures were significantly correlated with each other (.42 ≤ r ≤.70, p <. 001). We additionally did partial correlations among these measures controlling for grade (Table 2) and found that the results were very similar to those of the zero-order correlations.

We conducted CFA to investigate the dimensionality of vocabulary by using MPlus 8.1. Maximum likelihood estimates were used. We firstly tested a 2-factor model of vocabulary comprising the breadth and depth factors (Figure 1). Receptive and expressive vocabulary scores were the indicators of the latent vocabulary breadth factor. Vocabulary definition and synonyms scores were the indicators of the latent vocabulary depth factor. The correlation between the two latent factors was considered. The model fit our data well: χ^2 (1) = 1.022 (p >. 05), CFI = 1.000, TLI = 1.000, RMSEA =. 011 (90% CI from. 000 to. 205). All the indicators significantly loaded on the corresponding latent factors. However, the correlation between the two latent vocabulary factors was near 1.00.

We then tested the unidimensional model with receptive vocabulary, expressive vocabulary, vocabulary definition, and synonyms as indicators of the single latent vocabulary factor (Figure 2). The model fit was acceptable: χ^2 (2) = 3.547 (p >. 05), CFI =. 994, TLI =. 983, RMSEA =. 068 (90% CI from. 000 to. 182). All the four indicators

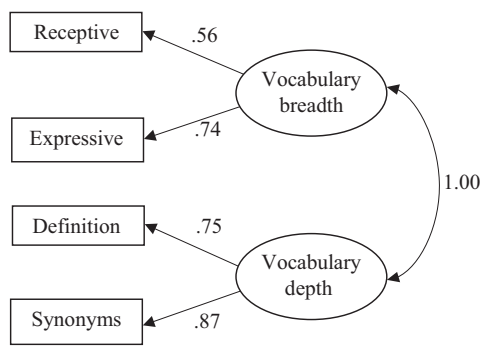

Figure 1. Confirmatory Factor Analysis Testing the Two-factor Model of Vocabulary.
Note. All the path coefficients were significant (p <. 001). Standardized β coefficients are presented.

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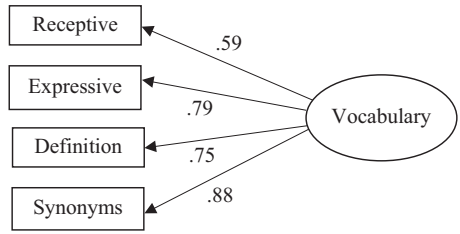

Figure 2. Confirmatory Factor Analysis Testing the Unidimensional Model of Vocabulary.
Note. All the path coefficients were significant (p <. 001). Standardized β coefficients are presented.

significantly loaded on the latent vocabulary factor. Therefore, this unidimensional model of vocabulary was supported. We further compared the two models through the difference in χ^2 with the difference in *df* and found that $\Delta\chi^2(1) = 2.525$ (p >. 05). This suggests that both the models fit our data equally well; thus, the simpler unidimensional model should be recommended (Werner & Schermelleh-Engel, 2011).

Discussion

This study adds to the literature as to whether vocabulary breadth and depth represent a similar construct versus distinct dimensions of vocabulary in an L2. Both of the two-factor and unidimensional models indicate that vocabulary breadth and depth were not two distinct dimensions of vocabulary. Although the two-factor model fit our data well, the correlation between the latent vocabulary breadth and depth factors was around 1.00, suggesting that the two factors were very similar rather than distinct. The close relation between vocabulary breadth and depth has always been shown in empirical studies (e.g., Koh et al., 2020; Vermeer, 2001), even in the studies that favored a two-factor model of vocabulary (Koizumi & In'nami, 2020; Tannenbaum et al., 2006). The comparison between the two models in our study further favored the unidimensional model, and this result is consistent with some previous findings in L1 learners (Koh et al., 2020; Lonigan & Milburn, 2017).

The mean scores of the vocabulary depth tasks were quite low, and the skewness score of vocabulary definition indicated that children's performance on this task was positively skewed. This is probably due to the fact that the English vocabulary depth tasks were generally difficult for the Grade 4 or 5 Chinese children in Hong Kong. These children were at an early stage of learning English as an L2, and their deep understanding of word knowledge (i.e., the precise meanings and having a repertoire of words to present a similar concept) was very limited. Vocabulary depth tests were more difficult for the children than the vocabulary breadth tests as shown by the mean and skewness scores of these tests. To summarize, these results (the CFA and skewness scores) support the argument that vocabulary breadth and depth should be considered as a continuum of word knowledge (Stewart et al., 2012): vocabulary breadth is at the comparatively easy level of this continuum, whereas vocabulary depth, which requires deep understanding of word meanings, is at the more difficult level.

Our findings support the argument that there is no conceptual distinction between vocabulary breadth and depth (e.g., Vermeer, 2001). Perhaps, vocabulary breadth and depth are intertwined, and knowing more words naturally leads to deeper word knowledge (Vermeer, 2001). Also, a large vocabulary size and in-depth vocabulary knowledge

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usually both result from enriched language environments (Koh et al., 2020), and children are able to learn both new words and deep knowledge of words simultaneously. In addition, Elman et al. (1996) argued that interrelated nodes in a network constitute the metal lexicon. A denser network around a word leads to a larger number of words known and deeper knowledge of that word, implying that the development of vocabulary breadth and depth is inter-connected.

On the other hand, our and previous findings (e.g., González-Fernández, 2022; González-Fernández & Schmitt, 2020) have shown a unidimensional model of vocabulary knowledge and, thus, question the popular multidimensional conceptualization of vocabulary knowledge. Dividing vocabulary knowledge into different dimensions in research should be cautious; otherwise, it may lead to problematic and misleading interpretations of research results (González-Fernández, 2022). For instance, if researchers reckon vocabulary breadth and depth as distinct dimensions of vocabulary, they may mis-interpret that the strong relation between these two types of word knowledge shows a predictive effect of one dimension on the other. However, this strong relation may simply due to the fact that both vocabulary breadth and depth are under one construct of vocabulary knowledge (González-Fernández, 2022).

This study has implications for language assessment and instruction. The unidimensional model of vocabulary does not imply that using one vocabulary measurement is sufficient when we want to know the development of children's vocabulary well. Each vocabulary aspect is a critical part of the overall vocabulary construct and, thus, educators and researchers are advised to use several different vocabulary measures to have a comprehensive understanding of children's vocabulary knowledge (González-Fernández, 2022). However, when time is limited, and the research purpose is to have a rough estimation of learners' vocabulary knowledge – for example, to look into the predictive power of vocabulary for other language constructs such as listening and reading comprehension, researchers may select only a few vocabulary measures to roughly represent the vocabulary construct (González-Fernández, 2022). In addition, our study implies that vocabulary breadth and depth could be considered as a continuum of word knowledge and their development is likely to be intertwined. Therefore, we suggest that educators use a variety of instructional methods to improve children's vocabulary knowledge. For example, educators can create a language-enriched environment to provide children with more opportunities to be exposed to the language, as language exposure is crucial for incidentally acquire new words (e.g., Quiroz et al., 2010). Based on the words that children have already acquired, educators can further elaborate the word knowledge to deepen their understanding of the word meaning and multiple usage of the words.

This study is limited by methodological problems that vocabulary breadth and depth were respectively assessed via two measures only and the mean scores of the vocabulary depth tasks were quite low. In addition, we only tested Grade 4 and 5 primary school children; therefore, we were unable to find whether vocabulary dimensionality in an L2 varies as a function of different stages of language development. In addition, the children in our sample were taught English formally at school and they may learn vocabulary mostly via textbooks and teachers' instruction. Compared with the children who acquire English naturally or in a language program without much formal instruction, the children in our sample tended to be less exposed to English outside the classes and, thus, were less likely to acquire new words incidentally and to implicitly deepen their understanding of word meanings via contexts. Therefore, their ways of developing vocabulary may not be the same as those of L1 learners and those who acquire an L2 naturally without much formal instruction. Based on these limitations, future studies with various measures of vocabulary

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and with different groups of learners are needed to replicate our study. In addition, we only considered the breadth and depth of vocabulary in an L2, but scholars also have identified other dimensions such as receptive versus expressive vocabulary dimensions (e.g., Gibson et al., 2014; Henriksen, 1999). Future studies are thus needed to thoroughly test different dimensionality of vocabulary in an L2. Last, our study only focuses on the dimensionality of vocabulary in an L2, and it does not address the relation between L1 and L2 vocabulary knowledge; therefore, this study cannot provide the implication as to whether L1 vocabulary knowledge supports the learning of L2 vocabulary.

Conclusion

This study compared a unidimensional model of vocabulary and a two-factor model that comprised vocabulary breadth and depth. Our results indicate that vocabulary breadth and depth were not two distinct dimensions; rather, the unidimensional model was supported, and vocabulary breadth and depth could be reckoned as a continuum of word knowledge.

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