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Is Functional Working Memory Related to Performance in Vocabulary Definition and Sentence Comprehension in a Standardized Language Test for Preschool Cantonese-Speaking Children?

Tam On Yee

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Abstract

This study investigated whether functional working memory (FWM) is related to preschool children’s performance in sentence comprehension and vocabulary definition in a standardized language test. Thirty-one children aged between 4 and 6 years old participated in the study. FWM was measured using the Cantonese version of the Competing Language Processing Task (CLPT). Pearson product-moment correlations were computed to investigate the relationship between (1) CLPT and overall sentence comprehension, (2) CLPT and vocabulary definition, (3) CLPT and simple sentence comprehension, (4) CLPT and complex sentence comprehension. The correlation coefficient for (2) and (3) was not statistically significant, and that for (1) was approaching statistical significance. The correlation coefficient for (4) was positive and statistically significant with a large effect size. The implications of FWM in language assessment and the measurement of FWM in preschool children are discussed.
Sentence comprehension is one of the tasks we often use to assess children’s language abilities. However, this task often tests more than what children actually know about language. Sentences used in this task sometimes have to be quite long and complex, which can be demanding for children’s memory. As they try to process and comprehend the sentence as it is being spoken to them, they have to store the incoming words and the pieces of the message being constructed. Poor performance in sentence comprehension could therefore be a result of inadequate linguistic knowledge, a deficit in information processing and storage in working memory, or a combination of these deficits (Lahey & Bloom, 1994).

In standardized language tests, different tasks are used to examine how much children know about language, and it is likely that these tasks pose different demands on children’s working memory. In this study, we will examine whether functional working memory is related to two tasks in the Reynell Developmental Language Scales (RDLS-C, Reynell & Huntley, 1987), a general standardized language test for preschool children in Hong Kong.

There are two major theories of working memory, the functional working memory (FWM) (e.g. Daneman & Carpenter, 1983; Just & Carpenter, 1992) and the phonological working memory (PWM) (Baddeley, 1986). Montgomery (2000) refers to both of these as verbal working memory. The FWM proposed by Carpenter and associates (e.g. Daneman & Carpenter, 1983; Just & Carpenter, 1992) suggests that working memory is a single component system with cognitive resources shared between processing and temporary
storage. Processing refers to the generation of the representations of the language operation, whereas storage is the temporary retention of the information that has just been processed. As cognitive resources for FWM is limited, if the demands required for processing, or storage, exceed the amount of resources available in the working memory, a trade-off will be resulted. During comprehension, trade-off can take place if a large proportion of the cognitive resources are allocated to comprehension for meaning. This results in inadequate resources for holding onto the information that has been processed previously, leading to a loss of information. On the other hand, if a large proportion of the resources are allocated to the storage of information, there will not be enough resources available for processing and thus leading to slowing in the processing of information (Miyake, Carpenter & Just, 1994). In this study, we will adopt Carpenter and associates’ model of FWM in our examination of the relationship between verbal working memory and language.

Research findings have suggested that there is an association between working memory capacity and language abilities in typically developing children. Some of these studies used a listening span task (e.g., Daneman & Blennerhassett, 1984), while others used the Competing Language Processing Task (CLPT) (Gaulin & Campbell, 1994) to assess FWM. The correlation between FWM and auditory comprehension was reported to be positive and with a large effect size according to Cohen’s effect size scales (1988) (correlation, $r = .5$ or higher is determined as large effect size) in preschool children (Daneman & Blennerhassett, 1984)
and in late preschool to school-aged children between 5 and 9 years old (Ellis Weismer, Evans, & Hesketh, 1999). In addition, a positive and a large effect size was also found between FWM and receptive vocabulary in typical children between 6 and 12 years of age (Gaulin & Campbell, 1994). Montgomery’s (2002) interpretation of the relationship between FWM and word knowledge is that learning a new word requires the child to infer the meaning of the word from the context, and at the same time, phonological information of the word is stored during the process of inferring of the lexical meaning. Hence, processing and storage are both involved in word learning, and they share and compete for processing resources. A child who is weak in FWM can be a poor word learner, and more limited in vocabulary knowledge as revealed in his/her lower receptive vocabulary test score.

Apart from the above evidence on typically developing children, the relationship between FWM and language abilities have also been reported in children with specific language impairment (SLI). Montgomery (2002) presented evidence suggesting that children with deficits in verbal working memory (both FWM and PWM) may have difficulties in language learning and/or language comprehension as they have difficulties in holding onto the information long enough and/or process the information for the message quick enough before it fades away. In another study, Montgomery (2000) investigated the relationship between sentence comprehension and FWM on children with SLI. Redundant and non-redundant sentences were used as stimuli. Both the redundant and non-redundant
sentences conveyed the same meaning and with the same structure. However, extra words or unnecessary syntactic markings were included in the redundant sentences and therefore they were of longer length. Children with SLI comprehended non-redundant sentences as well as the typical receptive vocabulary-matched children. However, they performed worse on the comprehension of redundant sentences than the vocabulary and the age controls. Based on the theory of FWM, Montgomery (2000) interpreted that the poorer performance in comprehending redundant sentences was due to the trade-off between processing and storage. Since cognitive resources for FWM are limited, a trade-off between storing and processing of information occurs when the demand of either one of the tasks exceeds the amount of resources available. In another study that compared the FWM of children with SLI with their typically developing age-matched peers, Ellis Weismer et al. (1999) found that children with SLI had a reduced FWM span than their age peers. These studies point to the fact that children with SLI have difficulties in information processing.

Standardized language tests are commonly used as tools to assess children’s language knowledge. In many of these tests, children are tested via the use of a sentence comprehension task or a vocabulary definition task among others. Children performance is often analyzed in such a way so as to find out the areas of language they are weak in. However, how the nature of the tasks that might influence the child’s performance is often not considered (Lahey & Bloom, 1994). Reviews on standardized language tests had only
briefly mentioned that the children’s performance in sentence comprehension tasks could be impaired by the lengthy commands (Edwards, Garman, Hughes, Letts, & Sinka, 1999; Spekman & Roth, 1984).

From an information processing point of view, these tasks used in standardized language tests pose different demands on children’s FWM. In sentence comprehension, children are sometimes asked to perform an action in response to a command given. An example from RDLS-C is “攞晒其他動物同埋個農夫入農場裡面” (Put all the other animals and the farmer into the field). The children have to locate the word boundaries, recognize the words, assess their meanings and identify their grammatical roles. These all take place as children process the sentence structure for the interpretation of its meaning, which is stored in FWM as it evolves. According to Carpenter and associates’ model of FWM, FWM is essential in retaining the information that has been processed for further processing.

In the constraint-based model of sentence parsing (MacDonald, Pearlmutter, & Seidenberg, 1994), the use of previously stored information for comprehension is also emphasized. Hence, sentence comprehension relies heavily on the simultaneous storage and processing of information. By contrast, in word definition, children are asked to provide what they know about the word, in response to short and simple commands involving “what” and “why” questions. Examples from RDLS-C are: “乜嘢係書?” (What is a book?), “凍點解?”(What does cold mean?). These questions are generally the same for all items. The demand on
simultaneous storage and processing of information appears relatively low for word
definition. Therefore, it is hypothesized that FWM will have a significant and positive
relationship with the sentence comprehension, and no significant relationship with the
vocabulary definition task in RDLS-C.

Moreover, the demand on FWM would increase with sentence complexity. Complexity
in this context is defined as the amount of information to be comprehended in a sentence.
Comparing a more complex sentence, such as, “擺晒其他動物同埋個農夫入農場裡面” (Put
all the other animals and the farmer into the field) with a less complex sentence, such as, “邊
隻馬食緊草?” (Which horse is eating the grass?), the pieces of information to be stored and
processed are more in the former than the latter. According to the model of FWM, the
demand on the resources of FWM increases when the pieces of information to be processed
increase, and hence it can be hypothesized that FWM relates more strongly with the
comprehension of complex than simple sentences.

Since different tasks have different demands on FWM, it is plausible that poor
performance on a task does not necessary indicate poor language abilities. Poor performance
can also provide an alternative explanation. For example, since sentence comprehension is
demanding on FWM, poor performance on this task can be due to poor language ability or
poor information processing ability alone, or the combined effect of poor language ability and
poor information processing ability. Information on sentence comprehension performance
alone cannot fully inform us on children’s underlying deficits. Thus, the aim of this study was to investigate the relationship of FWM in two tasks of a standardized language test, namely sentence comprehension and vocabulary definition. The results would give insights on whether to include FWM in clinical assessments of language ability in preschool children.

The following research questions were posed:

1. Is there a positive and significant relationship between CLPT and vocabulary definition?

2. Is there a positive and significant relationship between CLPT and sentence comprehension?

3. If the answer for question 2 is positive, is the positive and significant relationship only for complex but not for simple sentences?

Method

Participants

Thirty-three 4 to 6-year-old children from two kindergartens were randomly selected and invited to participate in the study. Two of the children were excluded from the study as one of them fell outside the age range and the other one was reported by the parents to have received prior speech and language intervention. Eventually 31 children, with a mean age of 4.9 years were included in the study. They were all native speakers of Cantonese and had no apparent learning and language problem as reported by their teachers.
During casual conversations before the study tasks, two of the children were observed to have some articulation errors which involved deaspiration, frication and stopping. However, the target words that the children needed to recall for the CLPT task did not involve any of these phonemes.

Procedure

Tasks

Each of subjects participated in three tasks, the Cantonese version of the Competing Language Processing Task (CLPT; Wong, Strokes & Yung, 2005), sentence comprehension (subtests 8 and 9) and vocabulary definition tasks of the Reynell Development Language Scales-Cantonese version (RDLS-C; Reynell & Huntley, 1987). The order of conducting of the three tasks was counterbalanced and randomized so as to control for any order or practice effects. The tasks were conducted in a quiet room in the kindergartens where the children attend.

Competing Language Processing Task (CLPT). The Competing Language Processing Task (Cantonese version) designed by Wong, Strokes and Yung (2005) was used to assess FWM. There are two Cantonese versions of the CLPT. Both versions share the same sentence stimuli, and they differ only in the administration procedure. The one for older school-aged children uses the same elicitation procedure as in Gaulin and Campbell (1994). The other version for younger preschool involves the use of puppets in the delivery of the stimuli.
sentences and their last words. The purpose of this adaptation is to highlight the last words to be recalled and to reduce the demand for syllable segmentation for the children. The CLPT consists of four practice trials and 30 sentences grouped in five levels. In each level, there are one to five sentences, and the task starts with the lowest level with just one sentence in the set. The children in this study were asked to judge on the truthfulness of each sentence in the set after it was presented, and to recall the last word in each sentence after the whole set of sentences had been presented. For example, at level one, there is one sentence, “風扇會開花” (Fans produce flowers). The children were asked to judge the truthfulness of the sentences immediately after the sentence was presented to them. After the set of sentences at each level was presented and judged for truthfulness, the children were asked to recall the last words in each sentence. In this example, the word to be recalled is “花” (flowers). For the Truth/False component of the task one mark was given to the correct judgment of truthfulness of an item, and the total was 30 marks. For the word recall component, one mark was given to any correct recall of last word of the sentences in the set (irrespective of order of production). There were 30 marks for the word recall component as well. Responses involving errors in the articulation of the initial consonants and acceptable variants of the lexical tones for the target word, “奶” (which can be pronounced as /nai⁵/ and /nai¹/) were all accepted.

*Vocabulary definition.* In this task, children were asked to give definitions to a list of nouns, verbs and adjectives. With reference to the RDLS-C scoring guidelines, one mark was
given for the correct definition given for each item. There were a total of 10 marks in this task. In order to demonstrate the requirements of the task, children were asked what a pencil was, “乜嘢係鉛筆?” . After the children had provided their definition, the clinician would then recast their answer, and provided other relevant responses such as, “鉛筆用木造嘅, 像長嘅, 用來寫字嘅” (Pencils are made of wood. It is long and is used for writing) to ensure that children would provide as much information as they had on the word.

Sentence comprehension. Two subtests in the RDLS-C were used to assess the children’s comprehension of sentences. The task on sentence comprehension required the children to manipulate sets of props upon commands and questions given by the clinician. These subtests were chosen as they involved a number of different concepts and attributes in addition to being lengthier and more complex than stimuli used in other subtests. These tasks were therefore appropriate for the examination of the correlation of FWM and sentence comprehension. Other comprehension subtests in the RDLS-C were considered but not chosen. One reason was that some of the items in these tasks require utilization of world knowledge which adds a potential confounding factor to the relationship we aimed to examine in this study. For example, world knowledge of knowing that children, but not adults and infants, usually have to go to school is tapped in the following questions, “邊個同小明一齊返學呢?” (Who goes to school with Bobby?), “邊個舊時要返學，而家唔駛呢?” (Who used to go to school but doesn’t now?), “邊個而家唔駛返學, 第二時至要返呢?” (Who will
go to school later but doesn’t yet?). One mark was given to the correct completion of one item. There were 24 items in total in this task.

Classification of sentence complexity. Each of the sentences in the comprehension task was classified as being complex or simple according to the number of contrastive elements presented in each sentence. Elements are concepts of the objects and their quantities, adjectives, locatives and the way that the actions are performed (Dryer, 2005). Contrastive elements are the elements that the children have to make correct choices upon the given set of objects for successful completion of the entire instruction, hence indicating adequate comprehension. The criteria in determining contrastive elements are presented in Appendix A. Simple sentences are ones that include three of fewer contrastive elements and complex sentences are ones that include four or more contrastive elements. There were 11 simple and 13 complex sentences. The classification of complexity of stimuli in the sentence comprehension tasks is resented in Appendix B.

Reliability

Inter-rater reliability of the contrastive elements judgment. Five independent raters who were in their final year in the Bachelor of Science in Speech and Hearing Sciences program were asked to determine the number of contrastive elements in the sentences used in the comprehension task. Instructions for how to determine the contrastive elements were provided to the raters. Inter-rater reliability was calculated to determine the degree the trained
raters agreed on their analysis of contrastive elements. The mean inter-rater reliability was 87.7%.

*Inter-observer reliability of sentence comprehension, vocabulary definition and CLPT.* A second rater who was also studying in the Bachelor of Science in Speech and Hearing Sciences program was asked to record and score 10% of the data of the tasks of sentence comprehension, vocabulary definition and the CLPT. Instructions on how to record and score the responses were provided. The inter-observer reliability for all the three tasks was 100%.

*Test-retest reliability of sentence comprehension, vocabulary definition and CLPT.* One month after the first administration, 10 randomly selected children received a re-administered of the tasks of sentence comprehension, vocabulary definitions and CLPT. The test-retest reliability for the tasks of sentence comprehension, vocabulary definitions, the Truth/False component of CLPT and the word-recall component of CLPT were 83.4%, 81.2%, 95.9% and 80% respectively.

Results

*Overall Task Performance*

All raw scores of each of the tasks were converted into percentages for statistical analysis. Table 1 presents the mean percentages, standard deviations and range (in percentage) of the children’s sentence comprehension, vocabulary definition and CLPT scores. As
expected, the children received a higher mean score in simple sentence comprehension ($M = 85, SD = 13$) than complex sentence comprehension ($M = 59, SD = 15$). Results from a $t$-test confirmed that this difference was statistically significant ($t(30) = 7.76, p < 0.001$). In addition, the score of the Truth/False judgment of CLPT ($M = 97, SD = 36$) was much higher than that of the word recall component of CLPT ($M = 41, SD = 14$). Results from a $t$-test also confirmed that this difference was statistically significant ($t(30) = 24.29, p < 0.001$).

Table 1

*Mean Percentage, Standard Deviations and Range (in Percentage) of Scores by Tasks.*

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<tr>
<th>Task</th>
<th>Mean (SD)</th>
<th>Range of Score</th>
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<tbody>
<tr>
<td>Overall Sentence Comprehension</td>
<td>71 (11)</td>
<td>50-92</td>
</tr>
<tr>
<td>Complex Sentence Comprehension</td>
<td>59 (15)</td>
<td>27-85</td>
</tr>
<tr>
<td>Simple Sentence Comprehension</td>
<td>85 (13)</td>
<td>55-100</td>
</tr>
<tr>
<td>Vocabulary Definition</td>
<td>66 (24)</td>
<td>0-100</td>
</tr>
<tr>
<td>CLPT-Truth/False Component</td>
<td>97 (36)</td>
<td>87-100</td>
</tr>
<tr>
<td>CLPT-Word Recall Component</td>
<td>41 (14)</td>
<td>13-63</td>
</tr>
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</table>

Scatter plots were drawn. They show a linear and positive relationship between CLPT and overall sentence comprehension, between CLPT and complex sentence comprehension. To answer the question answer whether there was a positive and significant relationship between CLPT and vocabulary definition and between CLPT and overall
sentence comprehension; Pearson product-moment correlations were computed. According to Cohen’s (1988) effect size scale, correlations equal to or higher than .5 is regarded as large, correlation equal to or higher than .3 and below .5 are regarded as medium and correlation equal to or higher than .1 and below .3 is regarded as small. The results indicated that there is no statistical significant relationship between CLPT and vocabulary definition ($r = .28$, $p = .12$) and a positive relationship which approach statistical significance between CLPT and overall sentence comprehension ($r = .35$, $p = .05$, medium effect size). Since the overall score of sentence comprehension included both the scores of complex and simple sentence comprehension, the fact that only a near significant correlation was found between the CLPT and the overall sentence comprehension could be attributed to the insignificant and negative correlation obtained between CLPT and the simple sentence comprehension ($r = -0.07$, $p = .70$). A statistically significant and positive relationship between CLPT and overall sentence comprehension is likely to be obtained with a larger sample size.

For the correlation between CLPT and complex sentence comprehension, as expected, only a positive and significant relationship was obtained in the correlation between CLPT and complex sentence comprehension ($r = .51$, $p < .001$, large effect size). No statistical significant relationship between CLPT and simple sentence comprehension ($r = -0.07$, $p = .70$).

*Recall Responses of the CLPT*
There are five levels in the CLPT. The greatest number of words that a child could recall at each level was recorded. Figure 1 presents the number of correct words recalled by the number of children at each level. As indicated by Figure 1, a majority of the children recalled one to two words throughout the five levels. The greatest number recalled at Level 1, Level 2, Level 3, Level 4 and Level 5 were one, two, three, three and four respectively. Only three out of the thirty one children successfully recalled all the target words in Level 3. No children recalled all target words, and only six recalled three of the four target words at Level 4. Similarly, no children recalled all target words in and only one child successfully recalled four out of five words in Level 5.

![Figure 1. The number of correct words recalled by the number of children at each level of the CLPT](image)

**Figure 1.** The number of correct words recalled by the number of children at each level of the CLPT

*Responses in the CLPT: Follow up analyses*
In the CLPT, the children were asked to recall the last word of each sentence presented to them. However, 24 out of 31 children produced more than the target words at least once in their recall responses. Among these 24 children, 15 of them included the superfluous words in 50% or more in their recalled responses. It was found that the seven children who produced only the target words as required were older \((M = 5.35\text{ years}, SD = 0.61)\) than children who produced the superfluous words \((M = 4.78\text{ years}, SD = 0.62)\). Result of an unpaired \(t\)-test shows that the ages of the children who showed the two different recall response patterns were statistically different \((t(29) = 2.13, p <0.05)\).

CLPT also involves asking the children to verify the truthfulness of the sentences. Half of the items in the test are sensible sentences while the other half are nonsense sentences. It was found a greater number of target words were recalled from the sensible sentences \((M = 57.95, SD = 10.2)\) than the nonsense sentences \((M = 41.89, SD = 10.25)\). A paired \(t\)-test was conducted to compare whether the children recalled more target words in sensible as opposed to nonsense sentences. The result of the \(t\)-test confirmed this observation \((t(30) = 4.38, p < .01)\). Among the words not recalled, a higher mean was found from the nonsense sentences \((M = 56.54, SD = 5.97)\) than from the sensible sentences \((M = 43.92, SD = 5.56)\). Similarly, another paired \(t\)-test was run to examine which contexts of sentences that the target words from were recalled less by the children. The result of the \(t\)-test confirmed that more target words from the nonsense sentences were not recalled than target words from the sensible
sentences ($t(30) = 6.25, p < .01$). These findings indicated that words from the sensible sentences were recalled in a higher proportion than from nonsense sentences.

**Discussion**

*FWM and Language Assessment*

The aim of this study was to examine whether the relationship between FWM and sentence comprehension and between FWM and vocabulary definition differ due to the different demands on these tasks as administered in a standardized language test. As expected, the children’s performance in word definition did not relate to their FWM. A relationship between FWM and their overall sentence comprehension appeared likely with the correlation coefficient approaching significance. When the children’s performances on complex sentences were examined, there was a positive and statistically significance correlation with large effect size between their FWM and sentence comprehension. The implication of these findings will be discussed in terms of the role of FWM in language assessment tasks common in standardized tests.

Differences in the correlation findings for simple and complex sentences suggest that FWM is involved in sentence comprehension. While FWM is not related to the comprehension of simple sentences, there is a large effect size in the relationship between FWM and comprehension task involved complex sentences. This finding was explained by the theory of FWM which says that demands on FWM increases with the stimuli complexity.
for simultaneous processing and storing. Compared to simple sentence comprehension, the pieces of information to be stored and processed simultaneously in the complex sentence comprehension were more. Similar results were reported in Montgomery’s (2000) study. In his study, tasks that were used to measure FWM and comprehension of redundant and non-redundant sentences were correlated. A nearly significant correlation was only found between the task used for tapping FWM and redundant sentences comprehension in the younger six-year-old typical control subjects. Though the participants and the tasks for sentence comprehension and FWM were different in our study, the result of Montgomery’s and our study indicated that the demand on simultaneous storing and processing of information increased with longer or more complex sentences. If the children could not coordinate well between the simultaneous storage of information that had been processed earlier and the processing of the new information by integrating the new information with the old, sentence comprehension would suffer (Montgomery, 2000).

The lack of a significant correlation between FWM and vocabulary definition indicated that some of the tasks in a standardized language test did not require active storage and processing of information, and hence their demand on the capacity-limited FWM was less. In the vocabulary definition task, the demand for simultaneous storage and processing of information was low, and not likely to exceed the FWM resources limits. The children only
had to focus on producing the semantic equivalent (Benelli, Belacchi, Gini & Lucangeli, 2006) for the words to be defined.

Tasks in standardized language tests were intended to assess children’s language ability. This study showed that FWM was involved in some of these tasks and yet it was not included as part of the assessment protocol. Poor performance in sentence comprehension could be a result of the child’s inadequate linguistic knowledge, deficit in FWM or the combined effect of these deficits (Lahey & Bloom, 1994). The linguistic ability was judged not to be reliably determined by the sentence comprehension without controlling the factor of the demand of FWM in the task. A few critiques on how the task could have influenced the child’s performance on standardized language tests were raised (Edwards, Garman, Hughes, Letts, & Sinka, 1999; Spekman & Roth, 1984). However, the reasons on how the FWM could have influenced the children’s performance in standard tests were not widely investigated and emphasized enough. Hence, treatment planning based on the linguistic performance revealed in a standardized language test would not reliably address the possible underlying deficits of FWM that could have impeded the child’s language development. The results of the present study certainly support the consideration of the possible contribution of FWM in language assessment.

*Recall Responses of the CLPT*
The performance pattern of the children on the Truth/False component and word recall component of CLPT was consistent with the results obtained in studies conducted by Gaulin and Campbell (1994) and Ellis Weismer et al. (1999). A higher accuracy of Truth/False component and a lower accuracy of word recall component were obtained. However, some interesting findings on the recall responses in the CLPT were observed in this study but not reported in the previous studies. It was found that 24 out of 31 children in the present study included more than the target word for at least once in their recall responses. In addition, more target words were recalled from the sensible than nonsense sentences. Difference in the age of the participants and the adapted version of CLPT between the present study and their studies might account for these differences. These word recall responses will be discussed in terms of the cueing strategies, the metalinguistic ability and the effect of the context on target word retrieval of preschool children.

Children in the present study were more successful in recalling the target words in sensible sentences than nonsense sentences. This result was consistent with the findings of Craik and Tulving’s (1975) research. In their study, the participants read words of common nouns in a tachistoscope. After that, they were asked whether the words they had seen were compatible to the sentences (e.g., “He met a _______ in the street”) they had just heard. Half of the words were compatible to the sentences, while the other half were not. After verifying the compatibility of words with the sentences, they were asked to recall the words they have
seen. However, they were not informed about the recalling of words prior to the experiment.

The results found that the participants recalled larger proportion of words that were compatible to the sentences than those incompatible ones. Criak and Tulving had interpreted this finding in term of the extent of elaboration in encoding and retrieval of target words in the compatible sentences. They interpreted that semantic knowledge would facilitate encoding of words. When a word was compatible to a sentence, there would be more contextual support for elaboration of the information during the encoding of the target word. The enhanced encoding of words in the compatible sentences would enhance the readiness for target word recall. In addition, as the target word was encoded with the compatible sentence as an integrated unit, the sentence itself would become a cue to facilitate the retrieval of the target word. These facilitation effects were not likely for words presented in incompatible sentences. These interpretations could also be used to explain the findings in this study that a greater proportion of words from the sensible sentences were recalled than those from nonsense sentences in our study. The sensible items which were more familiar to the children were judged to provide a contextual support for encoding and retrieval of the target words.

Another recall pattern was that the children included more than the target word for at least once in their recall responses. Twenty-four out of 31 children produced more than the target word at least once in their recall responses. Among these 24 children, 15 of them
included the superfluous words in 50% or more in their recalled responses. This word recall pattern could be attributed to the retrieval strategies used by the children. Retrieval strategies are strategies used for obtaining information stored in the long-term memory (Bjorklund & Douglas, 1997). In these responses, it was plausible that the children encoded a portion of the sentence stimuli together with the target word for later recall. This might facilitate later retrieval since the target word is more elaborated in meaning (Craik & Tulving, 1975).

There is an alternative interpretation of the children’s inclusion of words other than the target. The persistence of including more than the target words in the recall responses was also reported in Daneman and Blennerhassett’s (1984) study. Two pieces of evidence provide support to this suggestion. Findings from studies on word consciousness and word boundaries (Ehri, 1975; Holden & MacGinitie, 1972) suggest that preschool children did not consider words as a salient unit. Given the younger age of the children in this study, an adapted version of CLPT was used in which the last word to be recalled was highlighted with the use of puppets. Such an adaptation was meant to facilitate the segmentation of the last word from the sentence for the children. It is plausible however that these preschool children still had difficulties isolating the target word from the sentence due to the poor metalinguistic ability. McBride-Chang and Ho (2005) investigated the syllable deletion ability in Cantonese-speaking children and reported that older children scored higher than younger children. In fact, the older children (mean age = 5.33 years) in our study were more likely to
produce only the target words as their recall responses, while younger children (mean age = 4.75 years) were more likely to include more than the target word in their recall responses. This indicated that younger subjects were less efficient in controlling and manipulating the target syllables, and hence affecting their performance in the CLPT task.

Regardless how the children’s recall responses were interpreted, such responses would lead to possible inaccuracy in measuring the FWM capacity. FWM span was measured according to the numbers of target words recalled. When the preschool children included more than the target words in their responses due to poor encoding or poor syllable segmentation ability, the non-target words would take up some of the limited resources of FWM. As a result, resources that could be used to stored more target words would be taken up by the non-target words. The numbers of target words stored and recalled would therefore be fewer in these children. The recall response patterns observed in this study therefore question the appropriateness of using the CLPT in preschool population for measuring their FWM.

Implication and Future Study

The present study reported on the role of FWM in two tasks commonly used in a standardized language test for assessing preschool children’s language. Different language tasks pose different demands on FWM, and this need to be considered when evaluating children’s performance (Lahey & Bloom, 1994). Poorer performance in comprehension of
complex sentences than the shorter sentences would suggest possible information processing
deficits, in addition to difficulties with comprehending the concepts or structures involved in
the sentences. Assessment of FWM is then warranted to determine the information
processing deficits.

Regarding the assessment tool used for assessing FWM, digits backward subtest
from the Wechsler Intelligence Scale for Children (Wechsler, 1991) and CLPT (Gaulin &
Campbell, 1994) are tools that were recommended to assess FWM (Montgomery, 2002). In
addition, assessing language functioning in academic activities (Wiig, 1995) can help
determine the influence of FWM on a child’s learning. However, these assessments are all for
school-age population. For preschool population, the adapted version of CLPT used in this
study could be used as an assessment tool for FWM. However, further investigation on the
appropriateness in using the CLPT for the preschool population is needed as the preliminary
data obtained in this study suggested the performance in CLPT could be affected by the
metalinguistic limitation of the preschool population. Modification of the task or devising
other appropriate tests for assessing FWM for preschool children is needed.

Correlation between FWM and sentence comprehension and vocabulary definition was
investigated only in this study. Much remains unknown about the interaction between FWM
ability and other tasks used in standardized language tests. Hence, investigation of the
interaction between FWM and other language assessment tasks is warranted. Development of
appropriate language assessments with the confounding variable of FWM controlled is also of great importance into making accurate diagnosis and planning appropriate treatment for the children.

Acknowledgement

I would like to express my sincere gratitude to Dr. Anita Wong for her guidance and stimulating comments. I would like to thank all the teaching staff and clinical supervisors for their guidance and support in these four years of study.

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Last but not least, I would like to thank my classmates for their help in reliability checking and my family for their enduring encouragement.
References


Appendix A

Criteria on Determining Number of Contrastive Elements in Sentence Comprehension Task

Elements refer to concepts of objects, descriptions of their quantity, physical characteristics and positions, as well as concepts of actions and the way they are performed (Dryer, 2005). These concepts are explicitly encoded in words of different syntactic categories (e.g., aspect markers, zo2, ceoi4 zo2) in the instructions for these two comprehension tasks in the RDLS-C. Contrastive elements are the elements which correct choices have to be made with reference to the relevant set of objects for successful completion of the entire instruction. In other words, to successfully carry out the task in the RDLS-C, the child has to comprehend all elements that are contrastive.

Contrastive Elements: Decision Rules

a. Contrastive Elements about Objects

1. Contrastive elements have to be contrasted within the given object set

   Example:
   Present object set: 紅色叉 (a red fork), 藍色叉 (a blue fork), 紅色刀 (a red knife), 藍色刀 (a blue knife)
   Command: “俾隻紅色叉我” (Give me a red fork)
   “紅色” (red) is a contrastive element because there are other colored objects to contrast with. “叉” (fork) is another contrastive elements as there is a red knife and a red fork in the current object set to contrast with. Hence, the child has to make the right choice of the colors and the objects in order to comprehend this item successfully.

   Example:
   Present object set: 2 綠色叉 (two green forks), 1 綠色刀 (a green knife), 1 紅色叉 (a red fork), 1 藍色杯 (a blue cup), 1 紅色碗 (a red bowl)
   Command: “擺哂啲綠色叉喺碗前便” (put all the green forks in front of the bowl)
   There are 4 contrastive elements:
   “哂”(particle): As there are more than one forks in the current object set, the child has to decide whether to manipulate all or just some forks
“綠色” (adjective) is counted as another contrastive elements as there are other colored objects, such as the red knife and other color utensils to choose from.

“碗” (object) is counted as another contrastive element as there is another distracter, the cup to contrast with.

“前便” (locative) is counted as a contrastive element as there are other locations, such as “上/下/執/前/後/裡便” for the child to make choices.

2. When determining contrastive elements, the current object set and the current location of objects have to be considered.

   Example:
   Current object set: four forks in a cup and no forks in the bowl
   Command: “喺杯度拎三隻叉” (Take three forks from the cup)
   Since there are no other objects in the cup to distract the child to consider what to take out. Thus, the concept, “fork”, is not considered as a contrastive element as well. Thus, contrastive element of this command are “杯” (cup) and “三” (numeral) only.

3. Classifiers, such as “粒, 枝” provide clues to properties of objects. If the child could comprehend the classifier, the child could complete the task without comprehending the objects that the classifiers describe (particularly in the current object set which only consists of a limited number of objects described by different classifiers—“粒鈕”, “枝筆”, “個盒”, “隻杯”). Thus, the classifiers together with and the objects they describe are considered as one contrastive element, e.g. “隻杯”, “隻叉” are considered as one contrastive element.

   b. Contrastive Elements that Involve Actions or the Way that the Actions being Performed

   The default action for these two comprehension tasks is manipulation of objects without involving the examiner. Therefore, any actions that involve the examiner, such as showing or giving objects to him/her are considered contrastive.

   For example, compare the commands “擺哂啲綠色叉喺碗前便” (put all the green forks in front of the bowl) and “搵隻紅色叉俾我” (give me the red fork), “俾我” (give me) in the second command is a contrastive element in which the action involved the examiner. However, “擺” (put) in the first command is the default action, i.e. not considered a contrastive element.

   Thus, there are three contrastive elements in second command, “搵隻紅色叉俾我” (give me the red fork), “紅色” (red), “叉” (fork) and “俾我” (give me), while in the first command, “擺哂啲綠色叉喺碗前便”, there are only 4 contrastive elements only, “哂” (particle, all), “綠色” (green), “碗” (bowl), “前便” (locative, in front of).
Classification of the Complexity of the Stimuli of the Task of Sentence Comprehension

<table>
<thead>
<tr>
<th>Stimuli used in sentence comprehension task</th>
<th>No of contrastive elements</th>
<th>Classification of complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subtest 8</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 撲枝 黃色 筆 比我</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td>2 俾 鋪 最細 暗 黃 我</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td>3 撲枝 最長 暗 紅色 筆 若</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td>4 撲 三枝白色 鈕 椰杯 裡便</td>
<td>4</td>
<td>complex</td>
</tr>
<tr>
<td>5 撲粒黑色鈕 椰 杯 下便</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td>6 撲三枝短 暗 筆 椰 盒 裡便</td>
<td>5</td>
<td>complex</td>
</tr>
<tr>
<td>7 俾耐鈕 椰椰 杯 裡便?</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td>8 椰杯啱拎 兩粒鈕 出 嘛</td>
<td>2</td>
<td>simple</td>
</tr>
<tr>
<td>9 俾耐筆 擺埋啱呢?</td>
<td>2</td>
<td>simple</td>
</tr>
<tr>
<td>10 俾枝 紅色 筆 無 無埋 到?</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td><strong>Subtest 9</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 邊只馬 食緊草?</td>
<td>2</td>
<td>simple</td>
</tr>
<tr>
<td>2 擇一 隻 豬啱個 人 後便</td>
<td>4</td>
<td>complex</td>
</tr>
<tr>
<td>3 俾一隻細 豬啱 黑 豬 隻邊</td>
<td>5</td>
<td>complex</td>
</tr>
<tr>
<td>4 擇起 最大隻白 豬 俾佢 對眼我睇</td>
<td>5</td>
<td>complex</td>
</tr>
<tr>
<td>5 擇個農夫 同埋 一隻 豬啱農場 裡便</td>
<td>5</td>
<td>complex</td>
</tr>
<tr>
<td>6 擇啱 所有的猪 看隻 咖啡色馬 後便</td>
<td>4</td>
<td>complex</td>
</tr>
<tr>
<td>7 將 隻 五 俾埋 一齊</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td>8 擇啱 白 豬去 翻住 細場 裡外便</td>
<td>5</td>
<td>complex</td>
</tr>
<tr>
<td>9 擇啱 其他 動物 同埋 個 豬啱人 豬場 裡面</td>
<td>6</td>
<td>complex</td>
</tr>
<tr>
<td>10 隴 隻 豬 必啱 細場 外便?</td>
<td>4</td>
<td>complex</td>
</tr>
<tr>
<td>11 擇 隴一隻細 豬啱個 豬啱農場 隻邊</td>
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<td>complex</td>
</tr>
<tr>
<td>12 隴 隴細 豬 無埋到人 豬場度?</td>
<td>4</td>
<td>complex</td>
</tr>
<tr>
<td>13 隴啱 猪 擺埋 個農夫 隴遠?</td>
<td>3</td>
<td>simple</td>
</tr>
<tr>
<td>14 擇啱 隴 紅色 粗豬之外, 擇啱啱 其他 動物 個盒 裡便</td>
<td>7</td>
<td>complex</td>
</tr>
</tbody>
</table>

Remarks: 1. Elements that were circled or highlighted in the same color are considered as one contrastive element. 2. Sentences with three of fewer contrastive elements were assigned to be simple sentences. Sentences with four or more contrastive elements were assigned to be complex sentences. There were 11 simple and 13 complex sentences in the tasks of sentence comprehension.