Working Memory Capacity and the Use of Inference in L2 Reading

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1. INTRODUCTION

1.1. Working memory capacity and reading comprehension

Reading comprehension involves various levels of language process from orthographic knowledge to text integration skills. Research to date suggests that one of the major distinguishing characteristics of skilled readers is the degree of automatization in language processing, especially at the bottom-up level. Skilled readers have automatized bottom-up processes and thus are able to devote their attention to higher-level semantic or inferential processes. Less skilled readers, on the other hand, tend to devote their attention to bottom-up processes at the expense of top-down processes due to capacity limitation.

The focus on individual differences such as relative efficiency in language processing among readers is a growing trend in the study of language processes. This development stems, in a large part, from landmark findings that individual differences in working memory capacity are correlated with reading skills and other types of language processes such as inference generation, vocabulary development, listening comprehension and even verbal intelligence. Furthermore working memory span is a good predictor of reading skills in both L1 and L2 (Berquist, 1997; Daneman & Carpenter, 1980; Harrington & Sawyer, 1992; Osaka & Osaka, 1992).

Working memory capacity represents the ability to store and process information simultaneously in real time (cf. Baddley, 1986). This immediate memory process serves as relative efficiency in processing by which readers can allocate resources to higher order processes. Skilled readers are assumed to have more efficient processing skills thus allowing more capacity to be devoted to the storage of information. Working memory is thus seen as a resource devoted to processing and storage activities. In this way it differs from the traditional conception of short-term memory which has a fixed set of slots where to-be-maintained information is passively stored.

1.2.Working memory capacity and inference skills

Studies comparing L1 comprehension behavior of higher-and lower-capacity participants have yielded useful data that help specify the way working memory constrains specific language processes. One such process that has been shown to depend on working memory resources is inference generation (Singer & Ritchot, 1996; Whitney, Ritche, and Clark, 1991). It was reported that working memory capacity is a very good predictor of text integration skills allowing the reader to maintain coherence within and between sentences in the text in L1 reading (Carpenter & Just, 1989; Daneman & Carpenter, 1983; Masson & Miller, 1983). This is because working memory serves to facilitate local

coherence (sentence to sentence connections) and it aids in the manipulation of information needed for global coherence (the formation of a well-connected overall representation). Since various cognitive processes compete for a limited amount of processing resources, low level processes such as word and sentence level processing will be prioritized and resource consuming at the expense of higher level processes in L2 comprehension. As a result, readers should show less evidence of information integration during L2 text comprehension and there will be detrimental effect on inference generation during L2 text comprehension.

Consistent with the idea that a poor working memory span is a cause of deficient integration abilities, Yuill, Oakhill & Parkin (1989) have shown that readers with low working memory span have more difficulty in resolving anomalies in text when the anomalous and resolving information is separated by intervening sentences. Walczyk and Taylor (1996) also found that readers with less efficient access to information in working memory capacity looked back in the text more frequently.

According to Whitney, et al. (1991), readers who differ in their text integration abilities might differ in their use of inferences because of the trade-off in using working memory for achieving a coherent overall representation of the main idea (global coherence) and using working memory for connecting successive propositions in the text (local coherence). Therefore, the inferences that readers with low span make should be more local to the sentence being processed while readers with larger memory spans should not be faced with the same tradeoff between information needed for local and global coherence (Whiteney et al., 1991: 134−5). In cognitive and educational psychology, local and global coherence is often considered to be attained through 'bridging inferences' and 'elaborative inferences' respectively. Bridging inferences are understood to be necessary for establishing text coherence through pronominal resolution and causal relation identification between sentences. On the other hand, elaborative inferences are considered to help comprehension through the used background knowledge. Whitney, et al. (1991) also found that readers with a high working memory span can be more selective in their use of elaborative inferences by forming thematic inferences at an early stage and forcing the remaining text to fit into the established pattern, repairing incorrect early interpretations as they proceed. On the other hand, readers with low working memory span might concentrate on local coherence and be more specific in their elaborations in order to make the propositions easier to hold in memory, forming only a loosely connected overall representation.

1.3.Working memory and inference skills in L2 reading

If working memory capacity constraints play such a central role in accounting for individual differences in L1 processing, it is not unreasonable to assume that working memory plays an important role in L2 reading too. In L2 reading research, however, only a few attempts have been made so far to explain the relation between working memory and L2 reading or proficiency. It has been suggested that L2 working memory can be a good predictor of L2 proficiency and reading (Berquist, 1997; Harrington & Sawyer, 1992;

Humell ,1998; Osaka & Osaka, 1992). Although the relative importance of L2 working memory on L2 reading has been suggested by these findings, a major question still remains unaddressed: what kind of reading subskills does working memory relate to most? As Harrington and Sawyer (1992: 33) has suggested, it would be of quite interest if the strong relation between working memory and integration skills found in L1 reading applies for L2 reading. The adequacy of working memory capacity as an explanatory construct in L2 reading depends to a large measure on specifying which process is sensitive to working memory capacity differences and how this sensitivity is manifested in the development of reading ability. Although many studies have suggested that an inferential skill for text integration plays an important role in L2 reading (Carrell, 1984; Chicalanga, 1993; Horiba, 1993; Yoshida, 1997, 1998), it has also been pointed out that the cause of problems in inference generation in L2 reading processes cannot simply be attributed to L2 proficiency alone and some other unknown factors are involved (cf. Yoshida, 1998). Ikeno (2002) is one of the few studies which investigated the relationship between working memory capacity and higher-order processes in L2 reading by indicating a working memory effect on text structure prediction. Therefore, a working memory factor may be worth investigating as a new explanatory construct which constraints inferential process in L2 reading. Moreover, it would be also necessary to identify the role of an inevitably intervening effect of L2 reading proficiency on the working memory factor, if you assume that lower level processing such as lexical accesses and syntactic processing will be prioritized over higher level processing such as interactive processing and will be more resource consuming during L2 comprehension than during L1 comprehension as Dufor & Kroll (1995) and Potter, von Eckhardt, & Geldman (1984) showed. Therefore, this study will examine the relation between working memory and inferential processes in L2 reading and also the interaction between L2 reading proficiency and inferential processes.

In addition, the present study will make a claim of causal effect of the working memory on L2 inferential processes. The data in previous studies supporting a strong relation between working memory and L2 reading are almost all correlational and global in nature. Therefore, they are open to multiple causal interpretations. In other words, there has not been enough causal claims made yet, since little experimental data has been provided to date. The present study, therefore, attempts to answer the following research questions by going beyond global correlations:

1. What is relationship between working memory capacity and inference generation in L2 reading?
2. Does working memory capacity affect L2 inference performance ?
3. How is working memory capacity related to how readers use inferences in text comprehension?
4. How is L2 reading proficiency related to how readers use inferences in text comprehension?

I believe that identifying a relation between working memory and inferential processes by testing the hypotheses above, will lead to a clearer understanding of how working memory

contributes to the construction of models of L2 reading.

2.METHOD

2.1.Participants

The participants for this experiment are paid volunteer Japanese University students in their second year. The participants are both male and female, and homogeneous in terms of educational background. They were enrolled in their second-year English course at a university in Japan. They were all English majors; their English proficiency level was considered to range from low-intermediate to high-intermediate levels (approximately 400 to 550 points on TOEFL). They had studied English for six or seven years in instructional settings in Japan. From an original pool of 30 participants, the data from 22 participants was used for this study. Data from eight participants were not included because the rest of the participants misunderstood the instructions for the reading span test or think-aloud method.

2.2.Materials

Materials for the study consisted of a set of memory tests for L2 English and a set of measures indexing L2 reading proficiency. The English reading span test consists of 42 sentences. The sentences are simple, active, and 11－13 words in length. The L2 Reading Span Test (henceforth: RST) used in Osaka and Osaka's (1992) study was used with little modification instead of the more frequently used Daneman and Carpenter (1980) RST because sentences are shorter and the English is easier for low proficiency participants. In this way, possible floor effects in performance due to task difficulty can be avoided. Each sentence ends with one of the test words drawn from the list of pretested words. The sentences were presented in sets of increasing size, starting with two sentences per set and extending up to five sentences per set. A sentence verification task was incorporated in this test to ensure that participants were reading and processing the sentences for meaning.

General English reading ability was measured with the reading section of the Secondary Level English Proficiency Test: Education Testing Service (SLEP), since a test of this level seemed to be the most appropriate measure of English reading ability of the participants of this study.

Two passages used in Horiba (1996) were used for the think-aloud protocol method with two groups (cf. Appendix A). Narrative texts were used instead of expository texts because (1) The effect of background knowledge can be controlled; (2) More inferences and predictions are generally generated (cf. Olson, MacK, and Duffy, 1981); (3) The classification system of inferences for narrative texts is much more developed. These passages are also appropriate, because there is always a twist at the end in the narrative which allows one to check for comprehension.

2.3. Procedure

All participants in the original pool were administered the reading section of SLEP test

(secondary level English test) and the modified version of the reading span test to access L2 reading proficiency and working-memory capacity in L2 reading. The reading section of SLEP test took participants 45 minutes to complete and this test was group-administered.

The reading span test was administered individually. The participants were asked to read a short set of sentences, shown on a card and to remember the last word of each sentence. They saw each sentence for only a short time (about 19 seconds) and they were not allowed to write anything down. After they had seen all the sentences, they answered the last word of each sentence. Participants were also asked to do the sentence verification test. They were told to verify the meaning of the sentence presented on a card for each set, by indicating if a paraphrased version of one of the sentences was true or false. The performance on this verification test was not scored. It was used simply to prevent examinees' from trying to remember the final words without thinking about the meaning of the sentences. After oral instructions were given, a practice section was held. Participants were divided into two groups based on the scores of the RST. The top half of the participants formed the high-span group and the lower half of the participants were considered to represent the low-span group. They were also divided into two groups based on the score of SLEP test, the high L2 reading proficiency group and low L2 reading proficiency group. T-tests were used to show that the differences between groups were statistically significant ($p < .05$).

Table 1 : The mean table of Reading section of SLEP (SD)(max.=75)

	high	low
SLEP score	60.7 (4.4)	38.4 (3.8)

Table 2 : The mean table of READING SPAN Test (SD)(max.=70)

	high	low
RST score	57 (5.83)	41.8 (3.34)

After reading two passages, participants were asked to report their reading processes in Japanese while reading each event from a passage. They were asked to talk about what they thought was happening, including any inferences or predictions they made or connections between the current event and any prior ones. First, they received the think-aloud protocol instruction and then conducted a short practice section. Subjects' responses were recorded on tape so that the content could be scored later.

"Think-aloud" protocols from subjects reading narrative texts were also examined to observe their inference generation patterns in association with individual differences in working memory capacity. Despite many limitations of this method (cf. Akaike, 1995; Matsumoto, 1993), several previous studies have shown that this method can yield a very rich data base concerning the flow of information through working memory and can do so without intruding significantly on the comprehension process itself (cf. Ericsson and Simon, 1984). Thus, it appears that the "think-aloud" method is a useful on-line tool to begin to study the role that working memory constraints may play in influencing readers'

use of inferences in comprehension.

2.4.Analysis

Each think-aloud protocol was analyzed to check for passage comprehension. The comprehension for a passage is scored holistically by three raters with a two-point scale. The inter-rater reliability was high (higher than 95% agreement). Participants who seemed to understand the whole passage including the punch line received a full point while participants who seemed to understand the whole text but did not get the punch line received .5 point and no point was given to participants who seemed to understand only part of the text. Since two passages are used, the maximum score readers can get is 2 points.

The idea units from participants data were analyzed paying special attention to inferences generated by participants based on the following inference categories.

Categories Used for Protocol Idea Unit Classifications

Bridging Inference (local coherence)	***Elaborative inference (global coherence)***
1. Referential	1. Superordinate goals/actions
2. Causal antecedent	2. Causal consequence(prediction)
3. Subordinate goals/actions	3. State
4. Lexical	4. Evaluation, Opinion & Question
	5. Thematic & Author's intent
	6. Global opinion and Evaluation

The categories are based on a modified version of Graesser and Kreuz's (1993) inference classification system. The principal change was to include readers' questions, opinions and evaluations and also to classify all the inference types into two major categories (i.e. bridging and elaborative inferences). Definitions and examples for each type of inference are listed in Appendix B.

3.RESULTS

The tapes from each session were transcribed and divided into idea units representing simple sentences. Each idea unit was classified by three judges as belonging to one of the two major categories (i.e. Bridging/Elaborative inferences). The translation parts where participants were just translating sentences were all omitted from analysis because they were considered to be working on the encoding process without trying to get extra information from the text. The results of the descriptive statistics are presented in Table 3. The data are presented in terms of frequency.

Table 3.
Mean number of think-aloud productions in each category by group (SD)

RST	high Span		low Span	
L2 reading proficiency SLEP	HIGH	LOW	HIGH	LOW
Bridging Inference	8.2 (3.3)	8.5 (1.6)	6.1 (3.2)	6.0 (4.1)
Elaborative Inference	22.5 (15.0)	8.2 (5.8)	9.0 (6.7)	3.2 (4.0)

3.1.Correlations

As is evident in Table 4, the RST had a significant correlation with the total number of inferences generated (r= .66, p <.01) and a weaker but significant correlation with the number of Bridging inferences (r= .46, p <.05) and Elaborative inferences (r= .51, p <.05). In contrast, the correlation with passage comprehension did not reach significance (r= .40, p <.10).

As for the correlation with the reading ability test (SLEP), the RST did not correlate with the SLEP. This is not consistent with previous findings. However, as in the case of the RST, SLEP scores correlated strongly with Elaborative inference (r= .45, p <.05), but the correlation between the SLEP and Bridging inferences was not significant and the correlation with Total inference generation was also lower than the correlation between the RST and Elaborative inferences (r= .40, p <.10). This may suggest that readers with high L2 proficiency can make more elaborative inferences than readers with low L2 proficiency.

Comprehension of the passages had a stronger correlation with the SLEP unlike RST (r= .58, p <.01). It is also noteworthy that passage comprehension strongly correlated with Elaborative inferences (r= .64, p <.01) but not Bridging inferences. This result may suggest that Elaborative inferences are the type of inference which can directly contributes to better understanding of the passages. In other words, readers who comprehended passages better make more elaborative inferences.

Table 4.
Correlations among Inference generation, RST and Reading Scores

	RST	SLEP	Comp	Bridg	Elab	Total
RST	-	-.24	.40^{+}	.46*	.51*	.66**
SLEP		-	.58**	-.15	.45*	.40^{+}
Comprehension			-	.28	.64**	.51*
Bridging				-	-.17	.14
Elaborative					-	.95**
Total						-

** p < .01 * p < .05 + p < .10 N=22.
RST= reading span test, SLEP= reading section of SLEP, Comprehension= comprehension of the passages, Bridging=bridging inferences, Elaborative= Elaborative inferences, Total=total amount of inferences

3.2.The results of ANOVA

According to the correlational data above, it seems that there is a working memory span effect on inference generation. The next step is to decide whether working memory span has an effect on each type of inference generation, and in which inference type the working memory span is most influential. A repeated ANOVA was carried out with three factors (RST, L2 reading proficiency and Inference type). In the overall analysis of variance, the main effect of working memory span factor was significant: high-span group performed better on all the types of inference generation, F (1, 18)=13.2, p <.01. This result may suggest that working memory span influences the amount of inference type regardless of inference type. There was also a significant iteration between inference type effect and SLEP (L2 reading proficiency) effect: F (1, 18)=5.6, p <.05. As is shown in Figure 1, the difference between the higher proficiency group and lower proficiency group is more marked with Elaborative inferences than with Bridging inferences.

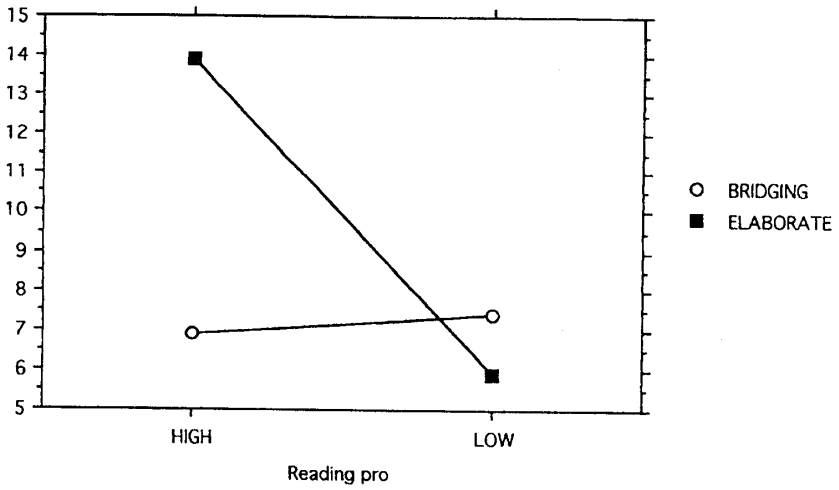

Figure 1. Proficiency (SLEP) × Inference type interaction plot

4. DISCUSSION

Research Question 1)

What is relationship between working memory capacity and inference generation in L2 reading?

High correlation between RST and Elaborative inferences and higher correlations between RST and inference generation of Bridging- and Total- inference than between SLEP and inference generation may suggest that readers with higher reading span can generate more inferences of any type of inference. The Elaborative inferences' high correlations with SLEP or passage comprehension may also suggest that readers who score higher on a L2 reading proficiency test and passage comprehension questions can make more Elaborative inferences.

Research Question 2)

Does working memory capacity affect L2 inference performance ?

As it can be predicted from the correlation analysis which shows the relatively strong correlations between the RST and the number of inferences, the analysis of variance has confirmed the working memory span effect, showing that the total number of inferences, regardless of the type, is also much larger with readers with high working memory spans than with those with low spans. Observation during the think-aloud task suggests that this may be because lower level processing is resource consuming during comprehension and readers with low working memory are often engaged in encoding processing manifested in a greater incidence of paraphrases, a translation process or repeated reading. Accordingly, there are not many cognitive resources left for getting extra information, namely inference processes. This is in the line with the finding in Zwan & Brown (1996) that non-fluent L2 readers are severely constrained by lack of efficient lexical and syntactic processes and these limitations affect their ability to integrate information across sentences.

Research Question3)

How is working memory capacity related to how readers use inferences in text comprehension?

The significant main effect of reading span suggests that working memory span can predict only the amount of inference generation in L2 reading but not the type of inference. This may be because readers with low working memory spans tend to spend their cognitive resources for encoding processes and run out of resources for making inferences. According to observation of think-aloud task, they were either reading aloud repeatedly and translating or paraphrasing when they don't make inferences, since participants were instructed to report something about the text at the end of every clause. Especially the low span group spent much of their time for either translating or repeated reading and made fewer inferences. This may be one of the biggest characteristics which distinguish L2 reading from L1 reading. That is, unlike the case of L1 reading where local coherence can be maintained only by generating Bridging inferences, L2 readers with low working memory spans have to spend most of their cognitive resources for lower level processes to get literal information by reading repeatedly and translating sentence by sentence before Bridging inferences are generated. As a result, there are not enough cognitive resources left to maintain and integrate the fragmentary information even at a local level. Furthermore, high L2 reading proficiency allows much more resources to be left to integrate information at a global level as a high working memory span allows for the allocation of resources for inference generation.

Research Question4)

How is L2 reading proficiency related to how readers use inferences in text comprehension?

The significant interaction between L2 reading proficiency (SLEP) and inference type shows that the difference between readers with higher L2 reading proficiency and readers with lower reading proficiency is much bigger on Elaborative inference than on Bridging inference. This result suggests that readers with high L2 reading proficiency make more

Elaborative inferences than readers with low reading proficiency. In other words, it is L2 reading proficiency which determines inference type while the amount of inference generation is determined by working memory span. Therefore, there is a smaller difference between the two proficiency groups in generation of Bridging inferences than in that of Elaborative inferences. The reason why the high L2 proficiency group generates more Elaborative inferences than the low proficiency group may be that generating Elaborative inferences in L2 requires readers to have good comprehension of the passage which largely depends on the L2 proficiency as suggested by the high correlation between passage comprehension and Elaborative inferences. Bridging inferences, on the other hand, do not necessarily require good comprehension of the whole passage but require only understanding the text locally and this is also supported by a low correlation between passage comprehension and Bridging inferences. In other words, readers who have good L2 comprehension skills and can comprehend the target passages very well are very efficient in generating more inferences which can directly contribute to better text comprehension while readers with low L2 comprehension and poor understanding of the target texts are not efficient in using inferences even though they can make a lot of inferences due to their high working memory capacity. This result is consistent with a finding from L1 study in Gernsbacher et al. (1990) that less skilled comprehenders are less effective in suppressing irrelevant information than skilled comprehenders and a comprehension skill can come into play only when there is an adequate degree of effective lower level processing. This requirement of adequate degree of lower level processing may make a greater impact in L2 reading comprehension than L1 reading, because an insufficient L2 proficiency causes impairment of the storage function of working memory and forgetting the content leads to poor text comprehension as a result, as claimed by Kato (2001).

This study showed that the combination of the working memory span effect and L2 reading proficiency effect can explain more clearly how inferences are generated in L2 reading. As suggested by this study, it is necessary to consider a L2 reading proficiency factor when the role of working memory span in L2 reading is examined, unlike in L1 reading where only the working memory span effect can independently predict inference processes during reading. Therefore, it is important to carry out further studies to find out how much an effect of L2 proficiency has on inference processes during L2 reading or other L2 reading sub skills and how the L2 proficiency relates to working memory span.

5.LIMITATIONS

First of all, the administration procedure of the RST has a problem, since the attitude of the participants during the test varies. Some participants made an effort to remember words while others did not try hard and just report what they happened to remember. Instructions for the test and practice sessions should be more carefully prepared. The content validity of the RST has also been criticized by researchers especially those whose research goal is to identify a working memory system itself rather than the relationship between working memory and reading sub-constructs.

The construct validity of the measurement of a general L2 reading test operationalized as the score of SLEP reading section is also questionable since there is not enough evidence which supports the SLEP as a general L2 reading proficiency measurement. It would have been better to use multiple measures of L2 reading ranging from vocabulary tests to on-line reading tests after carefully operationalizing L2 reading proficiency.

Another limitation of this study is the reliability of think-aloud method with Japanese English learners. Great concerns have been raised about verbal reports as an introspective research method for tapping L2 learners' inner cognitive processes. The argument is that verbal reports lead to an unnatural reading process and does not provide complete reflection of actual internal processing. Using the data from multiple sources such as written protocol may compensate for any existing lack of validity.

6.CONCLUSION

The evidence from this research clearly indicates that constraints of not only working memory but also L2 reading proficiency are associated with tradeoffs in bottom-up strategies and top-down strategies in L2 reading. Therefore, readers with a high working memory span can execute bottom-up processes such as encoding textual information in a routine or automatized manner which allows for more attention to be given to higher order text and message processing while greater incidence of paraphrases and other indices of lower level processing should be found and more attentional processing is required for readers with limited working memory capacity. However, predictions made by working memory capacity are mute on the frequency distribution of the types of inferences that will be generated.

On the other hand, L2 reading proficiency can predict the types of inferences generated during L2 text comprehension. In other words, readers with high L2 reading proficiency generate more elaborative inferences than readers with low L2 reading proficiency while incidence of Bridging inferences is not different between the two groups. This significant effect of L2 proficiency on inference process during L2 reading is perhaps one of the biggest characteristics which distinguish L2 reading from L1 reading. However, it should be noted that the types of inference generation adopted by a particular reader may depend on factors other than working memory capacity and L2 reading proficiency. Thus, future research should investigate how other factors such as text-based factors and the reader's background knowledge interact with working memory and L2 reading proficiency factors. In addition, further investigation into contribution of working memory and L2 reading proficiency to inference generation during L2 reading is needed.

The present study also revealed how sensitive inferential processes in L2 reading are to working memory although much remains unknown about the relation between working memory and L2 reading proficiency. If working memory capacity differences can be shown to be independent of L2 proficiency, it is possible to claim the adequacy of working memory capacity as an explanatory construct in L2 reading processes. Therefore, before the promise of this approach can be fulfilled, such independence should be investigated not only cross-sectionally but also longitudinally by future research.

Despite the limitations above, I believe that the present study can provide insights into models of L2 reading process by associating individual differences in text-processing strategies with differences in working memory span. I also believe that research on L2 working memory deserves further attention as it may have wider applications to models of L2 aptitude.

7.IMPLICATIONS

Much evidence has been provided so far to show important role of working memory in language processing, and the battery of tests available has grown in reliability and sophistication. A clear understating of the role that working memory constraints play in the development of reading skills would contribute to the construction of models of L2 reading and would additionally be of interest to theories of L2 aptitude, as Skehan (1989: 30－31) has suggested.

However, few studies have investigated the modifiability of working memory capacity or efficiency. A central question to the educator is whether it is possible to intervene to accelerate or improve the development of working memory capacity or efficiency in either L1 or L2?; Are there techniques for training and increasing processing capacity?; How and to what degree do reading processes become automatic and can this development be accelerated by outside factors? If working memory constraints on learners' processing ability are taken into consideration, overloading of the processing system in L2 classrooms can be minimized. In this way, more cognitive resources can be allocated to higher order processing skills such as inference generation.

In order to prove the validity of pedagogical methodologies suggested above, extensive longitudinal studies with the goal of stimulating working memory development in L1 and/or L2 are called for. I believe such memory research is important in designing pedagogical materials, producing reading exercises and listening task, and in manipulating whatever linguistic input the teacher gives in the classroom. Considerable future research is necessary to better understand the functioning of L2 working memory in L2 processing and acquisition.

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Appendix A

The passage used for think-aloud

The Baby and The Thief

Once upon a time, a thief sneaked into the attic of a house. When he looked down, he saw a father, a mother, and a baby sleeping. Both the father and the mother were sound asleep. "Good. They're all sound asleep." As the man, feeling relieved, was about to climb down, the baby, which was sleeping between its parents, opened its eyes wide open. "Oh oh." The man hurriedly climbed back into the attic. The baby was looking up towards the man with a face looking ready to cry. "Oh, no. I'll be in big trouble if it cries now." The man stuck out his tongue. Then the baby smiled. "Good baby." The man made a funny face by pursing his lips. The baby, looking at him, smiled again. "What a cute baby!" The man, who became very fond of this baby forgot about what he was supposed to do and was playing with the baby, moving his hands and showing a funny face. Meanwhile, the first rooster crowed, and it had been getting light outside. "Oh oh, the day is breaking." The man, waving his hand toward the baby, ran away without stealing anything.

The Thief Who Answered

When the thief was about to get out of the mansion carrying a big bundle, he was seen by the villagers. "Thief! Thief!" They were all chasing him, holding sticks in their hands. The thief threw the bundle away and started to run. While he was running here and there, he ended up being tracked down in front of a pond. "I'm in trouble." In such a case, there's no place to escape besides jumping into the pond. The thief put a piece of bamboo into his mouth, and then jumped into the pond. Then the villagers came. But the thief was gone. "Strange. He surely came running this way. Search for him carefully" They all searched for him in the grass around the pond, but he wasn't anywhere. "He might have fallen into the pond," somebody said. "That's alarming. Even if he's thief, we cannot let him die" When they all stared all the surface of the water, there was something like a stick standing straight and swaying. Seeing it, a villager said, "Hey, is that the thief? Then the thief, rising to the surface of the water, said, "This is not a thief. It's a stick, a stick." (Horiba, 1996)

Appendix B :
Categories used for coding inferences and Examples from participants think-aloud data

Bridging Inference

(inferences which fill a conceptual gap to establish text coherence and essential for comprehension)

1. Referential: A word or phrase is referentially tied to a previous element or constituent in the text (EX. "The person who said "Good" is the thief")
2. Causal antecedent: The inference is on a causal chain (bridge) between the current explicit action, event, or state and the previous passage context. (EX. "The thief said 'Good' because he thinks he can successfully get the work done")
3. Subordinate goals/actions: The inference is a goal, plan, or action that specifies how an agent's subordinate actions is achieved.(EX. "So the thief ended up with playing with a baby and forgetting to steal")
4. Lexical: The inference is a meaning of unknown word which can infered based on context.(EX. "I wonder what *track down* means. I guess the thief was caught in front of the pond"

Elaborative inference

(inferences which are not required for text coherence but embellish a text representation)

1. Superordinate goals/actions: The inference is a goal, plan, or action that specifies how an agent's super-ordinate actions is achieved.(EX. "So the thief did want to steal something even though he seems to be forgetting his job due to the baby")
2. Causal consequence: (prediction) The inference is on a forecasted causal chain, including physical events and new plans of agents.(EX. "The thief will be caught at the end")
3. State: The inference is on a forecasted causal chain, including physical events and new plans of agents.(EX. "This thief must be used to taking care of babies.")
4. Evaluation, Opinion & Question: The inference is the evaluation and opinion that the reader has when reading a text or the question which helps readers to understand the story better.(EX. "I wonder if villagers finally caught the thief." "This is strange. Nobody noticed thief's trace.")
5. Thematic & Author's intent: This is a main point or moral of the text or the author's attitude or motive in writing a text segment.(EX. "This story is about a stupid thief who forgot to steal anything." "This is a kind of joke.")
6. Global opinion and Evaluation: The inference is the opinion and evaluation about the main point of the story.(EX. "What a fool this thief is!")

(The modified version of Graesser & Kreuz's (1993) classification system)