THE ROLE OF VISUO-SPATIAL AND VERBAL WORKING MEMORY IN L2 JAPANESE READING PROFICIENCY

AURORA M. TSAI

University of Hawai'i at Mānoa

ABSTRACT

Verbal working memory is recognized as a strong predictor of L2 reading development in the area of learning new vocabulary, reading comprehension, and overall L2 proficiency in alphabetic languages such as English. However, few studies have addressed if the same is true in logographic languages such as Japanese. Previous literature has indicated that phonology plays a weaker role in reading Japanese than alphabetic languages and that visual information is often processed for semantic rather than phonetic information. Based on these findings, it was hypothesized that visuo-spatial working memory would display a stronger relationship with Japanese reading proficiency than verbal working memory. This study investigated the relationship between (a) visuo-spatial working memory and Japanese reading proficiency and (b) verbal working memory and Japanese reading proficiency. Thirty learners of Japanese as a foreign language had their visuo-spatial working memory assessed using a spatial span task and a dual 3-back task. Their verbal working memory was assessed using an automated reading span task. Participants also took a Japanese cloze test and proficiency self-rating questionnaire to indicate their reading proficiency. Correlations were not found between the visuo-spatial working memory tasks and the Japanese cloze test, but a weak correlation was found between the verbal working memory task and the Japanese cloze test. Since the reading assessment used in this study had questionable validity, the hypothesis and research questions for this study could not be fully addressed. Suggestions are made for refining assessment tools and using other techniques to help us better understand of the relationship between working memory measures and Japanese reading proficiency.

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INTRODUCTION

Working memory has been demonstrated as an important component of language aptitude, individual differences, and reading ability in second language acquisition. When language learners receive oral or text-based input written in their second language, they must pay attention to its overall meaning in order to form a logical response or reaction. At the same time, however, learners may simultaneously store words or grammatical structures they are exposed to while listening or reading in order to recall them later. This ability to store new information while processing other material at the same time is termed “Working memory capacity” (WMC). A large body of research has shown correlations between individual working memory capacity and language performance (Juffs & Harrington, 2011), such as increased ability to learn new words (Service & Kohonen,1995; Baddeley, Gathercole, & Papagno, 1998) and learning L2 grammar (Speciale et al., 2004). This suggests that learners with higher WMC have advantages in learning a second language.

Baddely and Hitch’s (1974) working memory model has been revised several times over the past few decades to include several key components (Baddeley, 1981, 2000, 2003). A fundamental component of this model that has been highly researched in second language acquisition is the *phonological loop*, which is responsible for storing and processing verbal and acoustic information. Baddeley’s model also includes the *central executive, episodic buffer,* and the *visuo-spatial sketchpad*. The *central executive* is responsible for attentional control and the *episodic buffer* is responsible for turning novel, short-term memory into long-term memory. The *visuo-spatial sketchpad*, often referred to as “visuo-spatial memory,” integrates spatial, visual, and possibly kinesthetic information into a unified representation for temporary storage and manipulation (Baddeley, 2003).

Most working memory studies on second language acquisition have focused on verbal working memory, including investigations of learners’ ability to process and store lexical, semantic, phonological, and/or syntactic information. Over time, verbal working memory has become accepted as the system responsible for the processing and storage of both familiar and novel phonological information in language learning (Juffs & Harrington, 2011). Verbal working memory has also been shown to play a central role in reading development, learning new vocabulary words and overall L2 proficiency in alphabetic languages, particularly English

(Harrington & Sawyer, 1992; Service & Kohonen, 1995). Harrington and Sawyer (1992) found correlations between Japanese ESL readers' performance on a verbal working memory task and their reading comprehension scores. Service and Kohonen (1995) observed Finnish school children and found a strong relationship between their performance on a nonword repetition test, a classic measure of phonological memory, and their learning of English vocabulary. Studies on verbal working memory often cite Baddeley and Hitch's (1974) well-known model of working memory.

Baddeley mentions that the *visuo-spatial sketchpad's* relevance to language use is less clear than the *phonological loop*, although he states that the system is likely to be involved in everyday reading tasks, such as facilitating accurate eye movements from the end of one line of text to the beginning of the next (Baddeley, 2003, p. 200). However, both Baddeley's (2003) and Baddeley and Gathercole's (1998) reviews of working memory research are mainly concerned with alphabetic languages, where the association with phonological memory has been clearly established. However, less is known about the role of the *phonological loop* in languages with non-alphabetic scripts, and what role the *visuo-spatial sketchpad* may play in language abilities in these languages.

The purpose of this study is to investigate the role of verbal (phonological) and visuo-spatial working memory in L2 Japanese reading proficiency of native English speakers, as measured by a Japanese cloze test. Since research has not yet determined if phonological memory, also known as verbal memory, is important for L2 readers of logographic scripts such as Japanese, this study attempts to address this gap in knowledge. In addition, this study also investigates the role of visuo-spatial working memory for L2 readers of Japanese, since research has suggested the importance of visuo-spatial skills in remembering Japanese characters. Based on evidence from prior literature, it was hypothesized that visuo-spatial working memory would display a stronger relationship with Japanese reading comprehension than verbal working memory.

In the next sections, I will first introduce some background on different Japanese writing systems and their specialized functions within text. Then I will review the literature that has investigated relationships between (a) phonological memory, also known as *verbal working memory* and (b) visuo-spatial memory in the processing of languages with logographic scripts.

Logographic Scripts

Japanese uses a logographic script consisting of Chinese characters referred to as “kanji”. These characters are pictographic symbols that were originally created to represent word meanings rather than phonetic sounds. Examples include “山” (mountain) and “言” (say). Many *kanji* can be broken down further into subcomponents called “radicals,” in which several *kanji* are paired together to create a related meaning. For example, “言” (say) and “舌” (tongue) are individual *kanji* characters, but are called *radicals* when they are combined with other elements to create a different kanji character. For example, in the characters “話” (talk, conversation) and “語” (tale, language), the half-sized “言” symbol is the *radical* on the left side of the character and is related to the word’s meaning. Radicals can appear in various locations of a kanji character and help readers identify the word meaning. Therefore, it is important for Japanese learners to see the visual, pictographic image of the *kanji*, quickly identify the spatial location of each radical, and transform the written script into a specific meaning, which are all steps involved in lower-level reading processes. Important lower-level reading processes include automatic word recognition, letter identification and text decoding.

While Chinese text consists completely of Chinese characters, Japanese text is comprised of a combination of both *kanji* characters as well as phonetic letters known as “hiragana” and “katakana.” *Hiragana* and *Katakana* are two syllabaries that consist of 46 basic symbols each, both representing the same set of sounds. For example, in *hiragana* あ, か, and さ represents [a], [ka], and [sa], but in *katakana*, ア, カ, and サ are used to represent [a], [ka], and [sa]. *Hiragana* is the first script that is usually taught to both native Japanese and second language Japanese speakers, and is used mainly for function words such as case-marking particles and for morphemic inflections. *Katakana* is usually taught to Japanese speakers after *hiragana*, and is mainly used for words borrowed from other languages (Everson, 2011). Together, these two phonetic alphabets in Japanese are referred to as “kana.” Japanese can also be written in the Roman Alphabet, called “romaji,” which is often used for road signs, as well as introducing foreign language learners to Japanese vocabulary before *kana* scripts (Everson, 2011). For example, a road sign with town names on it like 池袋 or あさぎり町 would have *ikebukuro* and *asagiricho* written under each name respectively. Japanese speakers must read a combination of *kanji*, *hiragana*, *katakana*, and *romaji* in their everyday lives, although in different proportions.

According to Ellington (2009) a typical Japanese newspaper will contain 50 percent *kanji*, 40 percent *hiragana*, and 10 percent *katakana* and *romaji*. Japanese people are taught approximately 2,000 kanji by the time they graduate high school, but approximately 4,000 kanji are commonly used in Japanese novels, newspapers, official documents, and the names of Japanese people (Ellington, 2009).

According to Nara and Noda (2003), in the majority of Japanese foreign language (JFL) classes, learners are introduced to kana on the first day of instruction or kana replaces all Romanization of Japanese after several lessons. However, most learners begin to struggle with reading the further they advance in their Japanese studies. This is due to the large number of *kanji* characters students must memorize in order to comprehend texts. On average, 145, 387, and 806 kanji are introduced to JFL learners in the first, second, and third years of instruction respectively (Nara and Noda, 2003). In addition, each *kanji* character has several phonetic readings associated with it depending on its linguistic environment. For example, the *kanji* character "生" can be read [iki] in "生きる" ([ikiru] "to live"), but can also be read [uma] in "生まれる" ([umareru] "to be born"). The 生 character has more than 8 phonetic readings associated with it, but all words with this character have semantic meanings related to "life," "genuine," or "birth." As one would guess, JFL learners often struggle to memorize all of the necessary phonetic readings associated with each *kanji* character. Without memorizing the phonological information associated with each kanji, learners cannot attain the ability to read sentences fluently out loud. However, research has yet to determine if access to these phonological readings is a necessary requirement for learners to comprehend Japanese texts, since quicker access to the meaning of *kanji* characters from visual cues may compensate for these phonological gaps.

Phonological Working Memory in Logographic Languages

Studies on Chinese and Japanese speakers have provided some evidence that phonological memory plays a weaker role in the reading of logographic compared to alphabetic texts. This is evident from ESL and JFL (Japanese as a Foreign Language) studies. Hamada and Koda (2010) showed that learners with alphabetic L1 backgrounds have better phonologic decoding ability than those of logographic L1 backgrounds. They compared college level ESL learners with alphabetic (Turkish and Korean) and logographic (Japanese and Chinese) L1 backgrounds by testing their speed and accuracy in naming out loud real and pseudowords in English. In addition, participants also read three passages with pseudowords and inferred their meanings. Results showed that ESL learners of alphabetic L1 backgrounds had better phonologic decoding ability than those of L1 logographic backgrounds and that alphabetic groups showed a stronger relationship between decoding efficiency and ability to infer word-meanings. Hamada and Koda offer two explanations of their findings: (a) ESL learners with logographic L1 background may rely less on phonology in L2 reading comprehension and word-meaning inference than their alphabetic counterparts, and (b) L1 logographic ESL learners may extract phonological information differently from L1 alphabetic readers. It is possible that both of these together may influence readers' decoding abilities.

Studies on Japanese reading have also shown that for Japanese speakers reading kanji, phonological decoding of kanji words is not required for access to semantic information, indicating that another mechanism is at work besides phonological memory. For example, Chen, Yamauchi, Tamaoka, and Vaid (2007) tested the universal phonology principle (Frost, 1992)**,** which states that access to meaning of a written word requires activation of phonological information first. Native Japanese speakers did two lexical decision tasks where they were shown two kanji character compounds and had to distinguish real words from nonwords. Before being shown the kanji compounds, participants were primed with homophones, semantically related, and unrelated words written in kanji. Chen et al. found that the use of semantically related primes had a significant effect on kanji target recognition, but homophonic kanji primes did not. This provides strong evidence that access to phonological information is not a prerequisite to accessing meaning when reading kanji compounds.

Yamada (1998) had adult Japanese speakers do a word naming task and then an English translation task of Japanese words written in *kana*, the Japanese phonetic script, and *kanji*. Yamada found that Japanese adults were able to name Japanese words faster when written in kana, but translate the words into English faster when written in kanji. Yamada demonstrated that semantic access takes place earlier in kanji than in kana words. However, if semantic access to kanji words occurs earlier than phonological access, what type of memory facilitates this process?

More recent research has pointed out the importance of visuo-spatial working memory in logographic languages such as Chinese and Japanese (Hatta, Kawakami, & Tamaoka, 1998; Tong and McBride-Chang 2010). If participants can easily remember visual images and spatial locations of textual items, they may have a higher visuo-spatial working memory and an easier time reading logographic texts. There are still only a few studies that have examined the relation between visuo-spatial memory and reading proficiency in logographic languages, but some evidence for the role of visuo-spatial memory has arisen from studies on both L1 and L2 reading and writing processes. I review these studies briefly.

Visuo-Spatial Working Memory in Logographic Languages

Over the past two decades, Baddeley's (1981) *visuospatial sketchpad* has been further subdivided into spatial, verbal, and possibly motor or orthographic working memory (Baddeley, 2003). Several studies have demonstrated strong evidence for the influence of visual and orthographic memory on the ability to recognize words quickly and understand meaning in Chinese and Japanese texts (Sakuma et al., 1998; Tong & McBride-Chang, 2010; Yamada, 1998). For example, Tong and McBride-Chang (2010) examined visual-orthographic skills, phonological awareness, and morphological awareness in Chinese second-graders and fifth-graders learning English as a second language, looking at reading skills in both Chinese and English. They measured visuo-orthographic skills through a task in which children had to decide if Chinese *radicals* and "*nonradicals*" were real or not. Phonological awareness was measured using a syllable deletion task in Chinese. For reading in Chinese, they found that for both grade levels, visual-orthographic skills and morphological awareness were associated with Chinese character recognition. However, phonological awareness was not associated with character recognition. The authors attribute the importance of visual-orthographic skills in reading Chinese to the need for children to correctly discriminate slightly different graphic patterns for accurate character recognition.

Chikamatsu (2006) observed word recognition in L1 English readers of L2 Japanese. She had two proficiency groups of Japanese learners participate: the first proficiency group was enrolled in Japanese 102 (second semester Japanese) and the second group was in Japanese 202 (fourth semester Japanese). They completed a lexical judgement task, which involved judging whether words were "familiar," "unfamiliar," or nonwords. Japanese words that were written in hiragana script (e.g., でんわ, [denwa] "phone") and foreign loan words (e.g., テレビ, [terebi] "television") that were written in katakana were considered "familiar," because this is how they are normally written in Japanese. However, Japanese words written in katakana (e.g., デンワ, [denwa]) or foreign loan words written in hiragana (e.g., てれび, [terebi]) were considered "unfamiliar," because these words are not usually written using those syllabaries. Chikamatsu found that the more advanced Japanese learners had larger differences in their reaction times to familiar versus unfamiliar words than the lower proficiency students. This was in line with Chikamatsu's hypothesis, that higher-proficiency group would show more visual reliance, moving away from heavy reliance on phonological information used in their L1. These findings are interesting because they provide some evidence that Japanese learners are starting to rely on visual cues even before they start learning kanji characters. However, more research on how visual versus phonological information is used in recognizing not only *kana*, but *kanji* as well would shed more light on these reading processes.

Hatta et al. (1998) performed a study on English-speaking learners of Japanese and the types of writing errors they made in comparison to a group of Japanese counterparts. For Japanese L1 speakers, phonological *kanji* writing errors were most frequent, in the form of misused homonym kanji characters. For example, L1 Japanese students would write 社回 (nonword) instead of 社会 (*shakai, "*society"), where 回 and 会 have the same phonological reading, "kai". However, for English speaking L2 Japanese learners, orthographic errors were most frequent, where students wrote non-existent kanji, such as 陪屋 (non-existent) instead of 部屋 (*heya*, "room"). These results imply that phonology might play a larger role in writing for Japanese L1 speakers, but that orthographic memory plays a larger role for Japanese L2 learners.

Orthographic memory has been hypothesized as an individual processing component within visuo-spatial memory, but has not been empirically established as a separate construct from other memory components such as verbal or visual working memory (Baddeley, 2003). Unfortunately, no working memory tasks have been developed to measure orthographic working memory, probably because the majority of working memory research has investigated alphabetic languages, where orthographic memory is not perceived significant to the development of reading and writing skills. However, other components of visuo-spatial memory have been explored, such as "spatial working memory" and "speeded visuo-spatial working memory." Shah and Miyake (1996) identified spatial working memory as a separable processing component in their research and operationalized a span task to measure this type of visuo-spatial working memory. In addition, Jackson (forthcoming) was able to observe learners' "speeded recognition of visuo-spatial information" by devising another type of working memory task called a dual 3-back task. Since both of these working memory tasks are measures of complex visuo-spatial working memory, I chose to use them in this study in order to investigate the role of visuo-spatial working memory in Japanese reading proficiency.

Purpose

The purpose of this study is to explore possible relationships between two constructs of working memory capacity and Japanese learner's reading proficiency levels. More specifically, I would like to address the following research questions:

1. Is there a relationship between **visuo-spatial** working memory and L2 Japanese reading proficiency in L1 English speakers?
2. Is there a relationship between **verbal working** memory (measured in the L1) and L2 Japanese reading proficiency in L1 English speakers?

I explore these relationships by examining the Japanese reading proficiency of L1 English L2 Japanese learners using a Japanese cloze test (Douglas, 1994) and by examining their working memory capacities using three different computer-facilitated tasks: a spatial span task and dual 3-back task to measure visuo-spatial working memory, and a reading span task to measure verbal working memory.

Hypothesis

Since prior literature has suggested visuo-spatial memory's importance to reading in logographic languages, I hypothesize that visuo-spatial working memory ability will correlate positively with Japanese reading proficiency, as measured by a Japanese cloze test. The role of phonological or verbal memory in reading logographic texts is less clear, as *kanji* characters represent semantic rather than phonological information. Thus, I also hypothesize that Japanese learners' verbal working memory will not exhibit as strong a correlation with L2 Japanese reading proficiency as visuo-spatial working memory.

METHOD

Participants

A total of 38 students from the University of Hawai‘i at Mānoa participated in this study. Four participants were excluded because they were later found to be heritage learners of Japanese. Another four participants were excluded because they had spent 1-4 years living in Japan and their data produced outliers in the areas of classroom learning experience and self-ratings of language abilities. As a result, a total of 30 participants were kept in the study. Participant ages range from 18 to 32 years, with a mean age of 21 (*SD* = 3.72). All participants had 1 to 7 years of Japanese instruction during their undergraduate education and/or during high school except one, who had no years of classroom instruction, but had intensively studied Japanese for 1.5 years. All participants were native speakers of English, who had started learning Japanese in high school or at university. Many of the participants had L2 knowledge of other languages, including Vietnamese, Urdu, Russian, and French, but none had knowledge of other logographic languages (i.e., Chinese). Because it was important to have JFL learners who were advanced enough to read and understand a simple Japanese passage, all participants were recruited from second year Japanese courses and higher.

Language Learning Background

Data on participants' Japanese proficiency and years of instruction were collected using questions adapted from the Language Proficiency and Experience Questionnaire (LEAP-Q; Marian, Blumenfeld, & Kaushanskaya, 2007; Appendix A). The LEAP-Q is a self-report of language background and was demonstrated by Marian et al. (2007) to be a valid method for predicting participants' L2 proficiency. Of particular importance were the questions that asked about the number of years students had learned Japanese in a classroom environment and their self-rated proficiencies in speaking, understanding, and reading Japanese. It was assumed that the number of years participants had learned Japanese in a classroom would have the largest influence on their language proficiency. Self-ratings of speaking, understanding and reading Japanese were collected to check the reliability of Japanese cloze test scores as a measure of Japanese proficiency.

Japanese Proficiency

A Japanese cloze test was used to determine Japanese reading proficiency because cloze tests have been widely recognized as a good measure of written L2 ability and assess not only morphosyntactic knowledge, but also lexical, semantic, and grammatical knowledge (Tremblay et al., 2011). Only a few studies have explored cloze tests for L2 Japanese (Yamashita, 1997; Douglas, 1994). Of the few that are available, Douglas (1994) was able to develop a morpheme-based Japanese cloze test, which showed strong correlations with students' proficiency. Fourteen students were split into two groups, one of which took the phrase-version cloze test while the other took the morpheme-version version of the cloze test. The morpheme-version cloze test had higher correlations with students' Japanese proficiency, as measured by seven quizzes (r (7) = 0.881, $p < 0.01$), and two midterm exams (r (7) = .944, $p < 0.01$). These correlations are positive and significant, but the sample size was small and it is possible the correlations were produced by chance. Since no information was available for the reliability or validity of Yamashita's cloze test, the Douglas's test was used. The test contains a total of 306 morphemes with every seventh item deleted and 22 fill-in-the-blank areas (Appendix B). All aspects of the cloze test were kept the same except for the name of the institution used to indicate participants' university and additional instructions provided at the top of the test (Appendix B). Although Douglas did not mention a time limit given to the participants in her study, participants were given a time limit of 13 minutes to finish the test. Because of this time limit, it was believed that cloze test scores also would be influenced by participants' reading fluency. However, most participants were able to complete the test well within 13 minutes, so it is likely that the time limit was too generous and that reading fluency was not an influence on participants' ability to answer test questions.

Since Douglas (1994) does not provide an answer key to her cloze test, an alternative scoring method was used. Two native speakers of Japanese scored each test; they were asked to mark any answer that was grammatically and contextually acceptable as a correct answer, even if it did not match the exact answer from the original text. Answers that did not make sense grammatically or semantically were marked as incorrect. When the two scorers disagreed on the acceptability of an answer, a third native speaker was consulted for a final decision. To keep consistency in scoring, all acceptable and unacceptable answers were recorded and used as reference for the scoring of subsequent tests (Appendix C). The highest test score possible was 22.

The Spatial Span Task

As a test of visuo-spatial working memory, Shah and Miyake's (1996) spatial span task was used as one measure to find the relationship between visuo-spatial working memory and L2 reading comprehension of Japanese.

The spatial span task is partially L1 dependent because the instructions are in English and it involves making decisions about alphabetic letters. Partially for this reason, only native English speakers were used in this experiment. Combined with the reading span task (RST) conducted in English, it was important for participants to be "English dominant," or individuals who have used English as their main form of communication throughout their life. This was also important because Shah and Miyake (1996) used fifty-four native English speakers in their study, who determined the reliability of their spatial span task scores by comparing it with participants' composite scores on five different spatial tasks (r (51) = .5, $p < .01$). Since this spatial span task only had a moderate correlation with participants' spatial skills, it may limit the reliability of the spatial span task as a true measure of spatial memory. However, since this was one of the only published visuo-spatial working memory tasks available, I decided to use this instrument as one measure of visuo-spatial memory.

I adapted the spatial span task from Shah and Miyake's (1996) study according to their procedures using Psyscope software. The program was designed to follow Shah and Miyake's task as closely as possible, but I added additional instructions and practice sessions for the participant to read before beginning the scored section of the task. During the first step of the task, called "the decision task," the participant must decide within 2200 milliseconds whether a rotated Roman alphabetic letter is "mirror-imaged" or "normal" (Figure 1). After pressing the "n" or "m" key to indicate their answer, the letter disappears and another letter appears on the screen, this time in a different orientation (45, 90, 135, 180, 225, 270, or 315 degree angle).

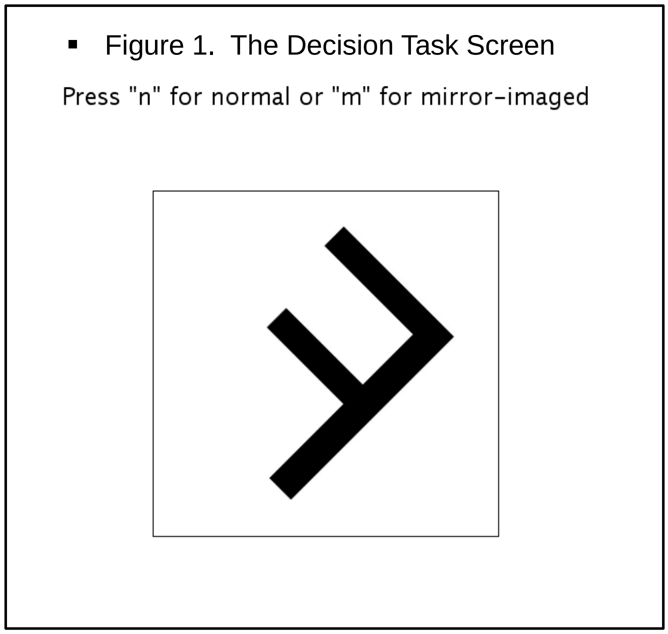

Figure 1. The Decision Task Screen
Directions: When this screen appears during the spatial span task, the participant must decide whether or not the image is normal or mirror-imaged by pressing the “n” or “m” key respectively.

When the second rotated letter appears, participants must make the same decision about whether it is “mirror-imaged” or “normal”. Five vertically and horizontally nonsymmetrical alphabetic letters were chosen for the task (F, J, L, P, R) because they are symbols that all participants are familiar with.

After deciding whether a set of 2-5 letters are “mirror-imaged” or “normal,” participants have to recall which angle each letter was rotated on the recall screen. At the recall screen, numerals 1-8 are positioned in a box at 45 degree intervals, such that 1 = 0, 2 = 45, 3 = 90, 4 = 135, 5 = 180, 6 = 225, 7 = 270, and 8 = 315 degrees (Figure 2).

Participants are instructed to press the number that corresponds to where they see the top of the first, second, and other succeeding letters in the order that they are presented. For example, if participants see the first letter of a set rotated at 45 degrees and the second letter rotated at 270 degrees, they would press “2” and then “7” as the correct recall sequence (Figure 2).

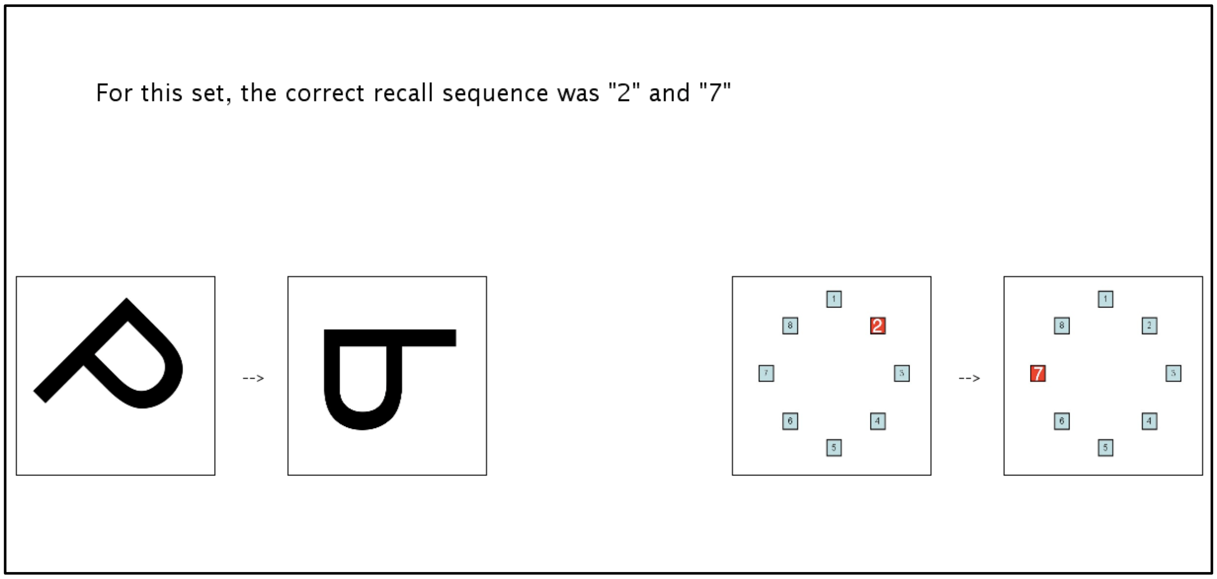

Figure 2. Instructions for Recalling Letters from the Spatial Span Task

Sets of two, three, four, and five letters are shown five times each, progressing from the smallest sets to the largest sets. The rotation of each letter is random, but no letters are displayed with the same rotation twice in a row.

A partial credit scoring system was adapted for this task since this has been found to be more reliable than absolute scoring systems (Conway et al., 2005). In Shah and Miyake's (1996) absolute scoring system, a participant's spatial span score was "defined as the highest set size for which all the spatial orientations of the letters were recalled in the correct sequence, for at least three of five sets" (p. 9). The highest maximum score is 5 in this scoring system. However, for partial scoring systems, participants are given a point for each correct recall, with a highest maximum score of 70 (2x5 + 3x5 + 4x5 + 5x5). Some participants' accuracy rates on the decision task were very low, but in accordance with Miyake and Shah (1996), this was not taken into consideration when scoring the task. Miyake and Shah did not consider accuracy levels in their scoring because those who had low decision task accuracy also tended to do poorer on the recall task, indicating that participants were not strategically ignoring the decision task in order to perform the recall task more accurately.

The Reading Span Task

In order to test participants' verbal working memory an English version of the Automated Reading Span Task (RST) was used. This task was developed by the Georgia Institute of Technology Attention and Working Memory Lab (Unsworth et al., 2005), based on the original Reading Span Task developed by Daneman and Carpenter (1980). I decided to use a computer-adapted version of the RST because it has been recognized as a more reliable indicator of the processing components of WMC over other tasks, such as the operation span task or digit span task (Conway et al., 2005), has been well-developed over the past few decades, and was demonstrated to be a reliable test for assessing L2 learners' verbal working memory by Harrington and Sawyer (1992). Unlike Harrington and Sawyer's study, however, the RST was given to participants in their L1 because in a Japanese RST, the JFL students' proficiency in Japanese would probably be the largest influence on their RST scores.

The computer-facilitated version of the RST runs on E-Prime computer software and provides all instructions to participants on the screen. At the beginning of the RST, participants are given instructions and practice sessions before starting the span task. In this automated version of the RST, the decision task is to decide whether or not a sentence semantically makes sense or not. Once clicking a "yes" or "no" button, participants are shown a single capital letter, which they must recall later. Then another sentence appears, where they again decide if it makes sense or not, and then another letter appears at random. The number of sentences that appear can range from three to seven sentences. If the "set" is only three sentences, the participant will have to recall the letters they were shown in the correct order after completing the decision task on three sentences. If the set contains five sentences, they complete the decision task on five sentences before coming to a screen where they are asked to recall letters in the correct order. The size of the sets are produced in random order, but set sizes of 3, 4, 5, 6, and 7 are presented three times each during the RST for a total of 75 sentence decision tasks and 75 letters.

The RST was scored by giving a point for each letter in a set that was recalled in the correct order. For example, if a participant recalled two letters in a set size of 3, three letters in a set size of 3, and four letters in a set size of 4, their score would be 7 (0+3+4). The total score possible for the RST was 75 because participants were given sets of three to seven letters three times each.

The Dual 3-back Task

The dual 3-back task was used as an additional measure of visuo-spatial memory, although it is also considered an indicator of fluid intelligence and attentional capacity (Jaeggi et al., 2011). This task was used in Jackson's (forthcoming) research and I received permission from the author to use it for this study. As with the spatial span task, this task was also administered using Psyscope software. After participants read the instructions, they see a computer screen divided into four quadrants. One-by-one, "non-verbalizable" shapes randomly appear in one of these quadrants for 200ms at a time. Participants are told to press the space bar whenever they see the same shape in the same location as three screens before (Figure 3).

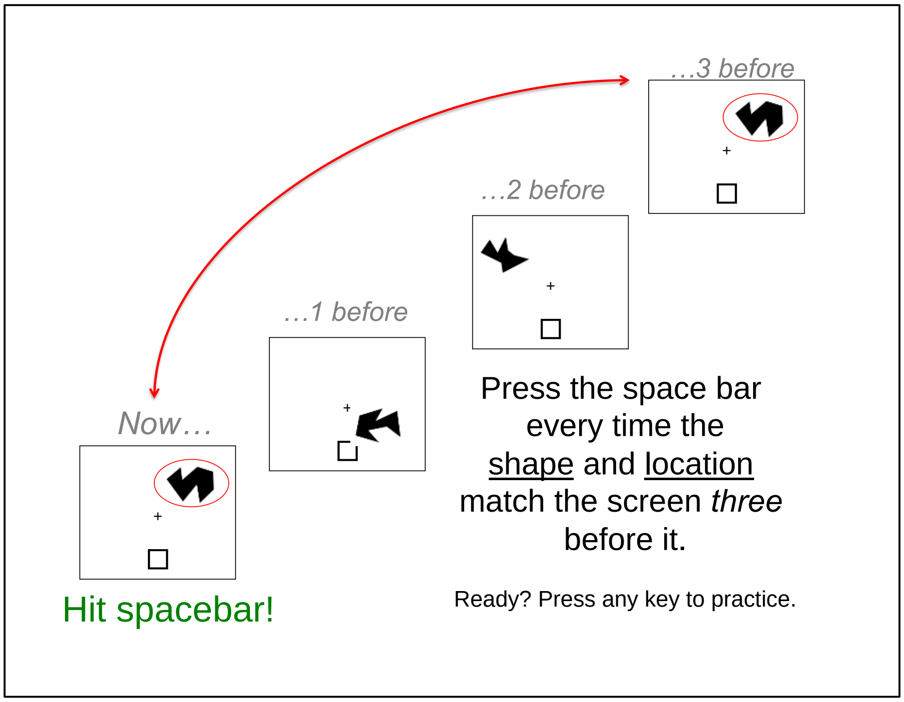

Figure 3. Instructions for the Dual 3-back Task

The experiment runs for a total of two minutes, in which participants are shown a total of 60 shapes. Eighteen of these shapes are "target" items that match the same shape and same location as the shape three screens earlier. Four of the shapes presented are "lure shapes" that match the same shape as three screens earlier, but are in a different location. Two of the items are "lure locations" that match the location of the shape three screens earlier, but are a different shape. In order to score this task, the scoring procedure described by Haatveit et al. (2010) was followed.

The *d* prime score of each participant was computed by subtracting z-scores for the proportion of incorrect responses (false alarms) from the *z*-scores for the proportion of correct responses (hits), using the following equation: *Z*(hits) – *Z*(FA).

Procedure

The LEAP-Q questionnaire was sent out to all participants by e-mail and the participants were asked to fill it out and send an electronic copy back to the researcher before participating in the project. The experiment took place in a university computer lab, where participants were asked to take the Japanese cloze test (15 minutes), spatial span task (15 min), 3-back task (5 min) and reading span task (20 min) in that order. The researcher gave the same instructions to each participant about what tests they were going to take and the approximate amount of time it required. After completing the cloze test, spatial span task, and 3-back task, participants were given the option to take a rest before moving on, however, all participants opted to move on to the reading span task without break. Once completed, participants were compensated $10 for their time.

RESULTS

The Japanese Cloze Test and LEAP-Q Survey Results

The participants' cloze test scores (JCT) exhibited a normal distribution with an average score of 10.73 out of 22 points (Table 1). The JCT's Cronbach's alpha was calculated to be 0.815, indicating that participants tended to get the same answers correct and incorrect with fairly high reliability. All data collected from the LEAP-Q questionnaire also exhibited normal distributions, including participants' years of Japanese classroom instruction (Class) and self-ratings for their speaking (SR-S), understanding (SR-U), and reading (SR-R) abilities in Japanese. Participants had an average 3.8 years of classroom instruction. All self-rating scores were on a scale from 1 to 10. Speaking had the lowest average score of 4.27, while understanding and reading both had average scores of 4.88. Standard deviations and total possible points (K values) of all scores are displayed in Table 1.

Table 1

Mean, standard deviation, and total possible score (K) on the JCT, Class, LEAP-Q, SR-S, SR-U, and SR-R.

	JCT	Class	SR-S	SR-U	SR-R
Mean	10.73	3.8	4.27	4.88	4.88
SD	4.56	1.72	1.60	1.84	1.86
K	22	NA	10	10	10

Relationship Between the Cloze Test and Self-ratings of Proficiency

As discussed in the methods section, participants' self-ratings of their Japanese abilities were used as a second instrument to measure participants' Japanese proficiency to compare with Japanese cloze test scores. Correlations between the cloze test and self-ratings from the LEAP-Q survey were determined using Pearson's product moment correlation. Participants' abilities to "speak" (r (28) = 0.27, p = 0.16), "read" (r (28) = 0.26, p = 0.18) and "understand" Japanese (r (28) = 0.25, p = 0.17) all showed weak positive correlations with the JCT, but all values were small and none reached significance (Table 2).

Table 2

Summary of Intercorrelations for JCT, Class, SR-S, SR-U, and SR-R

Measure	1	2	3	4	5
1. JCT	1.000	0.302	0.266	0.258	0.249
2. Class	-	1.000	*0.444	0.336	0.219
3. SR-S	-	-	1.000	*0.758	*0.583
4. SR-U	-	-	-	1.000	*0.653
5. SR-R	-	-	-	-	1.000

Note: * $p < 0.05$. All scores were calculated using Pearson's product-moment correlation.

The LEAP-Q was designed by Marian et al. (2007), who found L2 self-ratings of speaking ability to have high correlations with learners' L2 reading skills, including reading fluency (r = 0.64, $p < .01$), passage comprehension ($r = .74$, $p < .01$), and grammaticality judgments ($r = .667$, $p < .01$). Since Marion et al. found much stronger correlations between self-ratings and these reading skills, we should question the validity of the JCT as a reliable indicator of learners' Japanese reading proficiency. In addition, the JCT did not focus on testing specific reading skills (e.g. reading fluency, comprehension), but rather general reading skills; it is possible that this also created inconsistency in the scores. Taking the questionable validity of the JCT into consideration, we should be cautious when interpreting the results, especially since the JCT was used as the primary means to assess learners' Japanese reading proficiencies.

Participants' self-rating of their ability to speak, understand, and read Japanese also contained inherent limitations as an accurate indicator of Japanese proficiency. Although the correlation between self-ratings and cloze test scores may have become significant with a larger number of participants (n = 30), it is unlikely that the r-values would become larger for several reasons. Learners' self-ratings of their Japanese language abilities were inconsistent because the adapted version of Marian et al.'s (2007) questionnaire contained no guidelines for number selection on the 1-10 self-scoring scale. As a result, overall confidence levels of each individual were likely to influence self-rating scores. In addition, the self-rated speaking scores had a significant positive correlation with years of classroom instruction ($r(28) = 0.44$, $p = 0.014$), indicating that these self-reports may be influenced by participants' reflections on the length of their language learning experience rather than actual language ability. The original version of Marian et al.'s questionnaire contained brief one to four-word guidelines for each self-rating score (e.g. 1 – very low, 4 – slightly less than adequate, 8 – very good, 10 – perfect), which may have allowed participants to answer more consistently; this difference may help explain why Marian et al. found stronger correlations between self-rating scores and reading skills in their study. Marian et al. also found that learners tended to rate their reading skills higher than they actually performed on the reading tasks, so it is clear that providing descriptive guidelines for the self-rating questionnaire is important for collecting reliable data.

Japanese Cloze Test Scores and Classroom Instruction

As mentioned in the methods section, it was hypothesized that participants' years of Japanese classroom instruction would be the strongest predictor of their Japanese reading proficiency. It was therefore expected that Japanese cloze test scores would display a strong correlation with years of classroom instruction. However, results show that the correlation was weak and did not reach statistical significance (r (28) = 0.30, p = 0.11; Figure 4). A larger number of participants may have generated a significant correlation, but probably not a stronger effect size, as all participants had different classroom instruction experiences. Even if learners had the same number of years of classroom instruction, differences in curriculum intensity, amount of homework, kanji characters studied and teacher expectations will naturally result in differences among learner proficiencies.

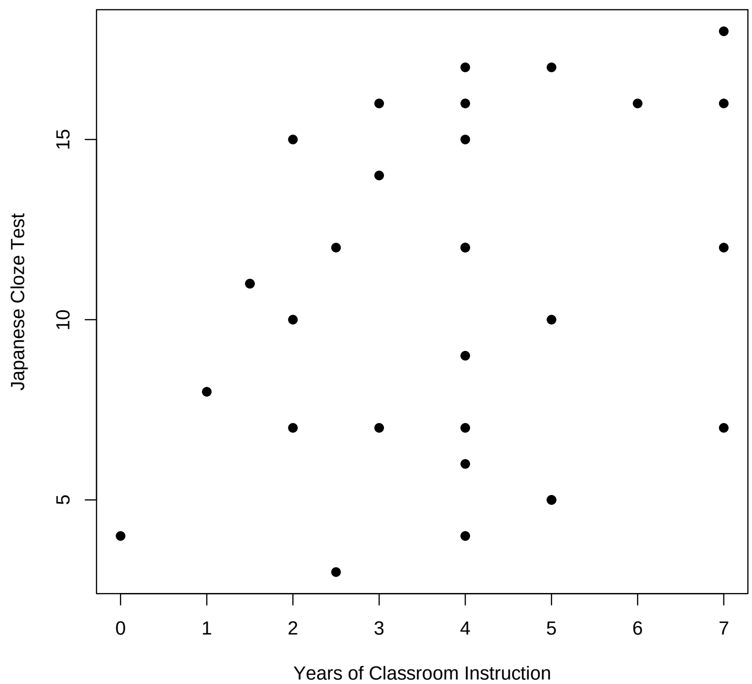

Figure 4. Scatterplot of Japanese Cloze Test Scores and Years of Japanese Classroom Instruction

Working Memory Tasks

While participants' scores on the spatial span task (SST) and dual 3-back (3-Back) task displayed normal distributions, scores from the reading span task (RST) were moderately negatively skewed (Figure 5).

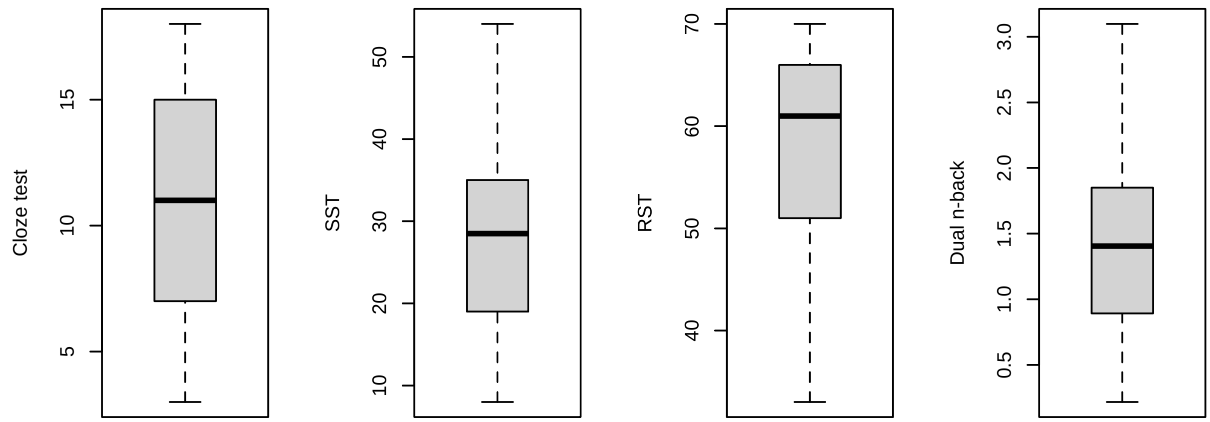

Figure 5. Box Plots of the JCT, SST, RST, and 3-back. The RST had a Negative Skew of -0.81, Calculated with a D'Agostino Test of Skewness

Participants scored an average of 27 out of 70 on the spatial span task (SST), with a standard deviation of 11.87 (Table 3). The SST itself had relatively high internal consistency (α = 0.81), but most participants commented that this task was "really hard," which indicates why the average spatial span task score is quite low. On the dual 3-back task, participants scored an average of 1.398 with a standard deviation of 0.66 (Table 3). This task also had high internal consistency (α = 0.78) and scores were well distributed. Since the *d* prime scoring method for the dual 3-back test produces values similar to a z-score, there was no maximum score attainable (*K* value). Among participants, the maximum score achieved was 3.097 and the minimum was 0.218. Since everyone scored above zero, it indicates that all participants chose more correct than incorrect answers. On the reading span task (RST), participants scored an average of 58.5 out of 75, with a standard deviation of 8.64 (Table 3). Since this task was borrowed from Unsworth et al. (2005), the data was automatically scored and data from this study was not available to calculate the reliability. However, the creators of this task were able to show a high level of internal consistency (α = 0.78) and test-retest reliability (α = 0.76; Redick et al., 2012).

Table 3

Mean, standard deviation (SD) and total possible score (K) for the SST, RST, and 3-Back

	SST	RST	3-Back
Mean	27	58.5	1.398
SD	11.87	8.64	0.66
Alpha	0.81	(0.78)	0.78
K	70	75	NA

Note: The dual 3-back task was scored using *d* prime values, and therefore did not have a maximum score. Data for calculating the Cronbach's alpha for the RST was not available for this study, but shown in previous research (Redick et al., 2012).

Correlations among Working Memory Tasks

None of the working memory task scores exhibited significant intercorrelations with each other (Table 4). We would have expected at least a weak correlation between two or more of these tasks if they were measuring the same or similar working memory domains. For example, since the spatial span task and the dual 3-back task were both testing areas of visuo-spatial working memory, we might expect these two datasets to have a moderate correlation. However, since the data does not display a correlation between these two tasks, it suggests that the spatial span and dual 3-back tasks measure different psychometric properties of working memory.

Jaeggi et al. (2011) reported that only very weak correlations have been observed between visuo-spatial dual *N*-back tasks and reading span tasks (between r = 0.10 and r = 0.24); therefore, it is not surprising that this study did not observe a correlation between these two tasks. Jaeggi et al. (2011) also reported that dual *N*-back tasks appear to test short-term memory rather than the complex memory required for working memory tasks and that dual N-back scores exhibit higher correlations with measures of fluid intelligence. Jaeggi et al.'s (2011) findings and results from this study suggest that the dual *N*-back task measures different psychometric properties than the span tasks. However, since the spatial span task and reading span task scores also did not display a relationship, it supports Baddeley's (2000) model and the idea that visuo-spatial and verbal working memory are domain-specific constructs, with separable subsystems for each type of working memory.

Table 4

Intercorrelations for JCT, Class, SST, RST, and 3-Back

Measure	1	2	3	4	5
1. JCT	1.000	0.302	0.333	-0.152	0.046
2. Class	-	1.000	-0.046	0.233	0.061
3. RST	-	-	1.000	0.167	0.015
4. SST	-	-	-	1.000	0.056
5. 3-back	-	-	-	-	1.000

Note: Correlations were calculated using Pearson moment product correlation and no correlations were significant.

Visuo-spatial Working Memory and Japanese Reading Proficiency

It was hypothesized that Japanese learners' visuo-spatial working memory would exhibit a stronger correlation with L2 Japanese reading proficiency than verbal working memory. However, the results did not support this hypothesis. Correlational analyses did not show a relationship between either of the visuo-spatial working memory tasks and L2 Japanese reading proficiency as measured by a Japanese cloze test (Table 4). The correlation between the spatial span task (SST) and the Japanese cloze test (JCT) was r (28) = -0.152 (p =0.423) using Pearson's product-moment correlation. The dual 3-back task also did not exhibit a correlation with Japanese cloze test scores (r (28) = 0.046, p = 0.81). These results do not support the hypothesis that visuo-spatial working memory is related to Japanese reading proficiency.

Verbal Working Memory and Japanese Reading Proficiency

In contrast with the visuo-spatial working memory tasks, scores for the reading span task had a weak, but non-significant correlation with cloze test scores (r (28) = 0.33, p = 0.07). Because the data for the reading span task was moderately skewed, however, the correlation appears stronger than it would be under a normal distribution, illustrated in Figure 6.

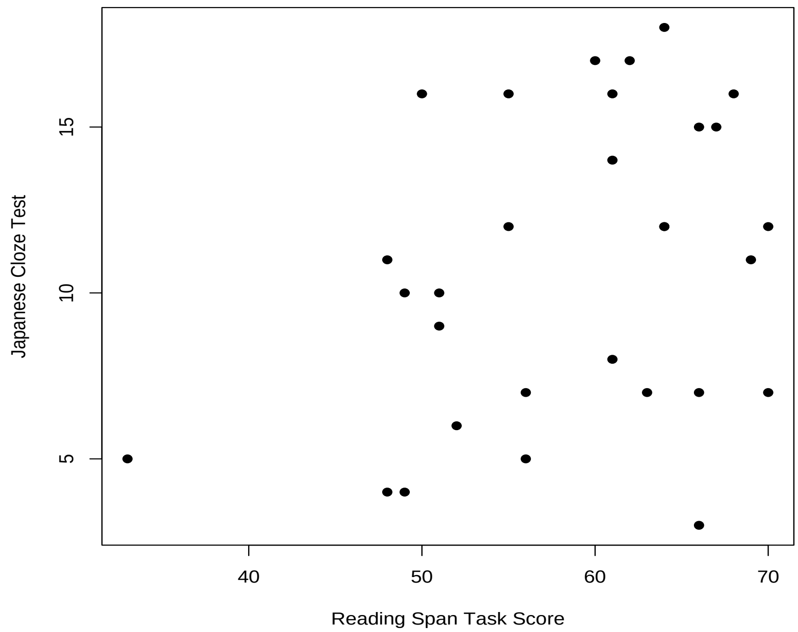

Figure 6. Scatterplot of Japanese Cloze Test and Reading Span Task scores. *K*=22 for the Japanese Cloze Test and *K* = 75 for the Reading Span Task. RST Data are Negatively Skewed.

A Model for Predicting Japanese Reading Proficiency

The aim of this study was to investigate the role of working memory in the Japanese reading proficiency of Japanese as a foreign language learners. Since other studies have found verbal working memory to be a good predictor of L1 and L2 reading ability in alphabetic languages, it was hypothesized that verbal and visuo-spatial working memory would also be a good predictor of Japanese reading ability. Therefore, it was originally planned for a multiple linear regression model to be run using years of classroom instruction, spatial span scores, dual 3-back scores, and reading span scores to predict Japanese cloze test scores. However, because visuo-spatial scores did not have bivariate correlations with the JCT (Table 4), only years of classroom instruction (Class) and reading span scores (RST) were included in the model. In order to control for participants' years of Japanese instruction and focus on individual differences, years of classroom instruction was entered into the model first and reading span scores were entered in second (Table 5).

Table 5

Multiple Linear Regression of JCT scores with Class, RST, and SST as predictor variables

Predictor	Coefficient	*SD*	*t*-value	*p*
Constant	-2.949	5.635	-0.523	0.6050
Class	0.780	0.420	1.856	0.0743*
RST	0.183	0.090	2.031	0.0522*

* $p < 0.10$

Analysis of Variance

Source	*df*	Multiple *R*-squared	Adjusted *R*-squared	*F*	*p*
Regression	27	0.211	0.153	3.62	0.040
Residual	4.193				

Results of the linear regression model show that years of classroom instruction predict Japanese cloze test scores with moderate significance ($\beta = 0.78$, $t\,(27) = 1.86$, $p = 0.074$; Table 5) and reading span scores also has some predictive power of cloze test scores, also with moderate significance ($\beta = 0.18$, $t\,(27) = 2.03$, $p = 0.05$; Table 5). However, both of these predictors only account for a small proportion of the variance ($R^2 = 0.153$, $F = 3.62$, $p = 0.04$; Table 5). In addition, this linear regression model is limited in power, as number of participants in this study was quite small; in conservative models, there should be at least 30 participants per predictor variable. For these reasons, the multiple linear regression model should be interpreted with considerable caution.

DISCUSSION

The aim of this study was to determine if a relationship exists between (a) visuo-spatial working memory and Japanese reading proficiency and (b) verbal working memory and Japanese reading proficiency, as measured by a Japanese cloze test. It was hypothesized that visuo-spatial working memory would have a stronger relationship with Japanese reading proficiency than verbal working memory, but the results did not support this study did not support the hypothesis; no correlations were found between either visuo-spatial working memory task and Japanese reading proficiency. A small correlation was found between the verbal working memory task and Japanese reading proficiency, but it was not significant and the data was not reliable because reading span task scores were negatively skewed.

Visuo-spatial Working Memory and Japanese Reading Proficiency

There are several possible explanations for why the two visuo-spatial working memory tasks did not exhibit a relationship with Japanese cloze test scores. One is that the type of skills needed to complete the cloze test were not visuo-spatial in nature; since participants were not required to read quickly or produce kanji characters in writing, the type of reading skills needed for this assessment may not have required strong visuo-spatial memory. While we would expect automatic character recognition or orthographic memory to be associated with visuo-spatial working memory, the cloze test appeared to measure learners' grammatical and lexical knowledge instead. These skills do not require a strong memory of kanji characters since they can be developed through oral practice and could be written on the test using the phonetic *kana* alphabet.

Another possible reason for why the two visuo-spatial working memory tasks did not have a relationship with Japanese cloze test scores is that visuo-spatial working memory plays little to no role in learners' Japanese reading proficiency. To further explore this relationship, a deeper and more detailed investigation would be needed. A more accurate understanding of visuo-spatial working memory and Japanese reading proficiency can be accomplished if we focus on assessing the specific reading sub-skills that require a larger demand of visual working memory. For example, researchers may test learners' automatic *kanji* recognition skills by giving them a lexical decision task, in which they decide whether a kanji character is a real word or nonword. This type of task would rely heavily on learner's visual memory of kanji characters and provide some indication of their reading fluency. In addition, eye-tracking experiments would also provide valuable data, as these devices can measure learners' word recognition and reading fluency at the same time learners are reading. Reading comprehension can also be tested at the same time if learners are instructed to answer comprehension questions after reading the text. A final suggestion is to substitute the Japanese cloze test with a gap-filling test to investigate the extent to which visual working memory plays a role in kanji automatic word recognition and comprehension. As a gap-filling test, the test writer would carefully select important kanji characters or multiple-character words for omission, so that learners' would require comprehension of these key kanji characters in order to fill in the gaps and obtain a higher score. This test should also omit the use of *furigana*, which refers to the small *hiragana* characters that can be put on top of kanji characters as a phonetic guide.

Verbal Working Memory and Japanese Reading Proficiency

The reading span task scores were negatively skewed and its correlation with the Japanese cloze test was not strong or significant, so it could not be determined if verbal working memory plays a role in Japanese reading proficiency. However, the possibility of this relationship still remains. We can still hypothesize that verbal working memory and specifically phonological memory is helpful for the interpretation and learning of words written in the phonetic *hiragana* and *katakana* scripts, since studies have shown this to be true for learning to read in languages with purely phonetic alphabets such as Spanish and English (Speciale et al. 2004; Kormos & Sáfár, 2008).

In addition, since *hiragana* characters are used to represent the majority of function words and morphemic inflections in Japanese, we might also predict that verbal working memory plays a role in the accurate understanding of Japanese grammar. This also provides a possible explanation for the weak correlation found between the reading span task and Japanese cloze test scores (r (28) = 0.33, p = 0.07), since the majority of cloze test items required grammatical judgment skills. Therefore, if future studies are conducted on verbal working memory and Japanese reading proficiency, the researchers may obtain more informative results if they use reading assessments that focus on grammar comprehension skills. These assessments could be designed as gap-filling tests similar to the cloze test used for this study, but with gaps placed only where grammar-based knowledge is essential for providing an accurate answer.

CONCLUSION

This study was unable to find relationships between any of the working memory tasks and Japanese reading proficiency, which may be largely attributed to the choice of using the cloze test as the main instrument for assessing reading proficiency. The cloze test was chosen because it was one of the few Japanese assessments available that had been tested for validity as a measure of Japanese proficiency among 14 students (Douglas, 1996). However, it was not clear if this test was an accurate indicator of L2 reading proficiency since cloze test scores did not correlate with learners' self-ratings of Japanese proficiency in speaking, understanding, or reading. In addition, it could not provide information about specific reading skills, such as automatic word recognition, reading fluency, and inter-sentential reading comprehension, lower level reading skills that are more likely to display a relationship with visuo-spatial working memory. In contrast, an assessment that specifically assesses grammar comprehension while reading may be more likely to exhibit a relationship with verbal working memory. For future studies in this area, it would be helpful to develop Japanese reading tasks and assessments that can separately measure these reading sub-skills. Developing these types of assessments is important because reading researchers are now recognizing reading as "a constellation of closely related mental operations," which when studied separately, can help us find possible relationships between corresponding skills in L1 and L2 languages (Koda, 2005). By using skill-focused assessments to pinpoint and measure learners' reading subskills, we can also obtain a richer understanding of the relationship between these different types of working memory and Japanese reading proficiency.

Implications

Since developing Japanese reading tests and recruiting a large number of participants for this type of study is time-consuming, it is helpful to reexamine the value of finding relationships between working memory and reading proficiency.

In alphabetic languages, verbal working memory has been found to aid the learning of new words (Baddeley et al., 1998; Service & Kohonen, 1995) and grammar (Speciale et al. 2004) in a second language. If the same is true for Japanese, then it is possible that verbal working memory tasks can be used to measure one's aptitude for learning to read in Japanese as well. If visuo-spatial working memory is also found to be a predictor of L2 reading ability in Japanese, it might indicate that the type of working memory skills needed to read in a second language are language-specific; in other words, a language's script may have a large influence on the working memory skills needed to excel at reading in the language. Van den Noort et al. (2006) have already provided some evidence that verbal working memory tasks produce scores that are language-specific in their study of Dutch, German, and Norwegian speakers. Additionally, if learners have higher working memory skills in one area (verbal or visuo-spatial) over another, teachers may be able to use this knowledge to their advantage when they select teaching materials and activities. These implications provide some grounds for further investigations of working memory and Japanese reading proficiency.

Another important research question to investigate is the extent to which working memory capacity is fixed over time. There is some evidence that working memory can increase with intensive working memory training sessions. In Shiran and Breznitz's (2010) study, they found that both dyslexic and normal readers could improve their verbal and visuo-spatial working memory skills with working memory test training, which also led to increases in their reading rate, comprehension scores, and decoding abilities. If such training can help learners develop better language skills, it may be another technique we can use to help learners with initially low working memory skills.

However, we should also explore the possibility that the act of studying language itself may increase one's working memory. Few studies have addressed this topic, but French and O'Brien (2008) found evidence that phonological working memory can improve with L2 language training, although it is language-dependent. In their study, speakers of French studied English over five months and showed improvements in their English phonological working memory, but not in Arabic phonological working memory. More research should be conducted to confirm French and O'Brien's finding that phonological working memory can improve based on the language being studied. If it is true that phonological working memory can improve with language study, then we should re-evaluate past research that assumes working memory is a causal factor in L2 language proficiency, specifically the studies have used verbal working memory tasks in the same language as the language being studied by participants (e.g., Harrington & Sawyer, 1992; Service & Kohonen, 1995). We may also want to shift our attention to using and developing nonlanguage-based tasks, such as the operation span or a nonword repetition task that is not language specific.

As we learn more about individual differences, working memory, and L2 language development, we may be able to devise better language teaching methods based on the strengths and weaknesses of learners' working memory. In addition, we should be able to predict learner's learning potential in specific areas of language learning. To help us reach these goals, we should continue research on what types of training might improve working memory and the relationships that exist between specific types of working memory and specific second language reading subskills.

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APPENDIX A

Language Experience and Proficiency Questionnaire

Last Name		First Name		ID #	
Age		Date of Birth		Male □	Female □

(1) Please list all the languages you know in order of proficiency (most fluent to least fluent)

1	2	3	4	5

(2) Please list all the language you know **in order of acquisition** (your native language first)

1	2	3	4	5

(3) Please list what percentage of the time you are currently and on average exposed to each language.
(Your percentages should add up to 100%):

Language:	English	Japanese	Other:	Other:
Percentage:				

(4) At what age . . .

Were you first exposed to Japanese?		Did you start studying Japanese in a formal setting?	

(5) Please write the number of years you have studied Japanese . . .

In a classroom	*Independently*	*With a private teacher*

(6) Please list the institutions where you have studied Japanese if applicable:

____

____

a. What textbook did you use?

____

(7) Please describe the main types of study techniques or materials you used during independent study:

____

____

(8) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where Japanese is spoken		
A family where Japanese is spoken		
A school and/or working environment where Japanese is spoken		

(9) On a scale from zero to ten, please select your level of proficiency in speaking, understanding, and reading Japanese

Speaking		Understand spoken language		Reading	

(10) Have you ever had a vision problem □, hearing impairment □, language disability □, or learning disability □? (Check all applicable). If yes, please explain (including any corrections):

APPENDIX B

Japanese Cloze Test

This is a test of Japanese reading and writing proficiency. **Please fill in the parenthesis with the appropriate Japanese words or particles**. Some instances have more than one correct answer.
Also, please do your best to write kanji when appropriate. If you cannot remember the kanji character(s), then please give your best guess and write hiragana next to it. If you cannot remember the kanji character at all, you can write the hiragana only. If you cannot come up with an answer for a particular fill-in-the-blank spot, you may skip it.

私は、今UH という大学で日本語を勉強しています。UH は、ホノルルにある大学 (　　　)、フットボールで有名な大学です。(　　　) は、去年の秋学期に始めました (　　　) 、もうそろそろ一年になります。日本語 (　　　)クラスは、月曜日から金曜日まで毎日一時間あります。このクラスでは、(　　　)のように宿題があります (　　　)、毎週金曜日には、テストが (　　　)。漢字もどんどん出てきて、かなり (　　　)です。私は、毎日二時間ぐらい、(　　　)をしたり、ラボに行って (　　　) を聞いたりしていますが、 (　　　)これでもじゅうぶんでは (　　　) ように思うこともあります。(　　　)は、日本語を専攻にする (　　　) ですから、日本語では、A (　　　) とりたいと思っています。

UH (　　　) 日本語を二年ぐらい勉強してから、(　　　)へ行って、日本の大学で (　　　) ぐらい勉強してくるつもりです。日本 (　　　)生活は、とても楽しいそうです。(　　　) へ行って帰って来た人は、
「(　　　)はとても親切で日本の (　　　) はとても楽しかった。」と言っています。

(以下省略)

Appendix C

Japanese Cloze Test Scoring Chart

	Exact Answer	Acceptable Answers	NOT acceptable
1	で		に, が
2	日本語	私、UH、実	
3	から	ので,	が
4	の		
5	毎日	山、高校	ので、毎、これ、いつも、
6	?	し	から、が、けど
7	あります	ある、あります	
8	大変	むずかしい	ない
9	宿題	勉強	
10	テープ	シーディー、こうぎ、レクチャー、話	先生、コンサート、来て、文法
11	ときどき	まだ、やっぱり	宿題、X
12	ない		たりない
13	？	私	
14	つもり		いる、ため,こと
15	を	以上、	点、と、が、しか
16	で		は, に
17	日本		りゅうがく、図書館
18	一年	二年	かよう
19	？	の	
20	日本	東京、大学	
21	日本人	人、みんな、	UH,日本
22	生活	文化、大学、寺、クラス、留学	