THE ROLE OF PHONOLOGICAL MEMORY IN ADULT L2 LEXICAL DEVELOPMENT

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This paper explores the role of phonological memory (PM) in the vocabulary acquisition of adult second language learners to uncover whether these learners' PM capacities could explain vocabulary and proficiency gains over an academic semester. Intermediate learners of Korean were tested at both the start and end of a semester on non-word repetition (NWR) tasks in Korean and English as a longitudinal measure of their PM capacities in the two languages. Vocabulary and C-test performances were used to gauge participants' lexical knowledge and proficiency respectively at the two time points. Results indicated that there was a significant interaction of PM capacity and time such that high PM capacities were associated with an increase in vocabulary breadth and proficiency in Korean. In addition, a significant positive correlation between the Korean and English NWR tasks was found, suggesting PM may be language-independent.

INTRODUCTION

Vocabulary development is an important component in learning a second or foreign language (L2). It has been suggested that there is a strong link between learners' vocabulary size and overall comprehension in the L2 (Nation 1993; Read 1997). As a result, the value of vocabulary in both L2 pedagogy and research has been reemphasized in recent years (see Blachowicz, Fisher, Ogle, & Watts-Taffe 2006; Schmitt 2010). In this context, a number of researchers have been exploring working memory models in relationship to vocabulary learning to better examine the role working memory plays in the acquisition of new words. Scholars have discovered that a significant predictor of L2 vocabulary gains is phonological short-term memory (PM), a part of the working memory model introduced by Baddeley (1986). Baddeley, Gathercole, and Papagno (1998) stated that PM, which works to process and store unfamiliar sound patterns to long-term memory, is directly related to learning novel words in the L2.

In terms of L2 learning, there is a continuum of learners ranging from those who are learning the target language for the first time to those who have previous experience. Foreign language learners are those who learn a second language formally in a classroom context. Heritage language learners, on the other hand, are defined as language students who are "...raised in a home where a non-English language is spoken...speak or at least understand the language, and to some degree are bilingual in that language and in English" (Valdes 2001, p. 38). Compared to foreign language learners, HLLs are said to have a "better" grasp of phonology, grammar, vocabulary, and sociolinguistic rules upon entering a foreign language classroom due to their experience with the language outside of school (Campbell & Rosenthal 2000).

However, heritage language experience is often difficult to quantify. Qualitative measures such as age of acquisition and years of exposure are controversial and potentially problematic since inherent differences of the quality and quantity of language input exist at the individual level for HLLs (Montrul 2008). While differences between a heritage and traditional language learner in a foreign language classroom are acknowledged due to earlier exposure and

experience with the language at home, systematic explanations for this phenomenon are less than clear.

This study aimed to better understand and explain the differences between these two learners. Due to early language input, HLLs might have comparatively higher PM capacities than foreign language learners, enabling them to learn the language quicker in a formal classroom setting. Based on this presumptive hypothesis, HLLs' PM capacities along with their vocabulary gains within a school semester were compared with those of the traditional, foreign language learner to investigate whether PM contributed to the HLLs' distinct learning trajectories and/or learning rates (Polinsky & Kagan 2007). Accordingly, the focus of this study was to explore whether HLLs' phonological memory capacities, honed informally from an early age at home, may help them explicitly learn the language at the intermediate level, since PM has been repeatedly linked to the learning of new words at the beginning stages of learning (Baddeley et al. 1998). The results of vocabulary tests, proficiency tests, and non-word repetition tasks at the beginning and end of the academic semester for both heritage and non-heritage learners in Korean and English will be described and compared. Qualitative survey data (e.g., age, instruction, amount of exposure) will also be incorporated in the discussion of results.

Furthermore, to explore the effects of PM, language learners with high- and low-PM capacities in the L2 were separated and analyzed in regards to their vocabulary size at Time 1 and 2 to see whether there were differences in the vocabulary sizes of language learners of varying PM capacities. While the original motivation of this study had been geared toward HLLs, there is the likelihood that despite home language background, PM capacities are not reflective of prior experience. Thus, it is important to take a step back and test whether PM capacity itself may be responsible for vocabulary gains in these participants.

LITERATURE REVIEW

The concept of PM is derived from Baddeley's (2002) working memory model, which holds that working memory is comprised of three specialized systems. The phonological loop, mainly responsible for processing phonologically based information, is one system. The visuospatial sketchpad is another system accountable for the processing of nonlinguistic visual and spatial information. The third and final is the episodic buffer that works to integrate information from a variety of sources. All of these operate under the central executive that coordinates the three systems and activates representations in long-term memory (Figure 1). For the present study, the focus is on the phonological loop.
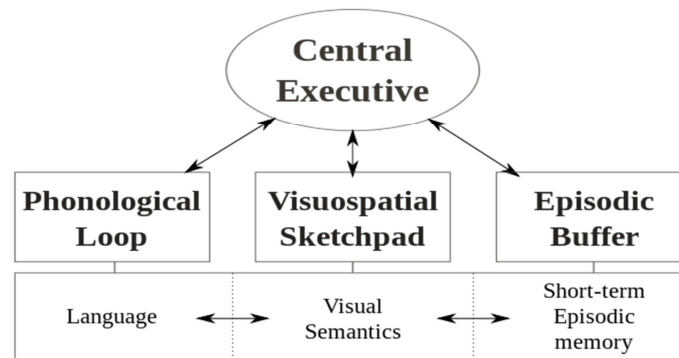

Figure 1. Baddeley's 1986 model of working memory

As mentioned above, the processing of sounds and other phonologically based (i.e. verbal) information is handled predominantly by the phonological loop. There are two specific subsystems within the phonological loop: the phonological store and rehearsal process. The input of phonological information is first stored, and subvocal ("inner speech") rehearsal helps retain the processed phonological information. Thus, the phonological loop is seen as a necessary system in the acquisition of new words for both the L1 and L2. Phonological short-term memory (PM) is, therefore, the ability to retain verbal information temporarily and depends entirely on the function of the phonological loop. (Kaushanskaya & Yoo 2012)

Consequently, it is not surprising that the phonological loop and phonological short-term memory have become particular areas of research interest for both first and second language learning and use (Juffs & Harrington 2011). The non-word repetition (NWR) task, which is most often used to measure PM, assesses one's ability to recall and repeat nonsense words after they are presented. The level of accuracy on the NWR task is believed to reflect an individual's phonological memory skills and capacity (Kroll & de Groot 2005), and performance on the NWR task is dependent on "the ability to perceive, store, recall, and reproduce phonological sequences, which are all important elements in word learning" (Juffs & Harrington 2011, p. 141). NWR tasks involve language-specific phonotactic patterns and must follow a language's sound combinations. Therefore, NWR tasks differ depending on the language.

Ortega (2009) also explains that, "[d]ifferential memory capacities are thought to play a central part in creating differential likelihoods of success when learning a foreign language. Memory alone is thought to help predict how well people will learn new vocabulary, [and] what levels of comprehension they will achieve in listening or reading" (p. 165) further validating the importance of exploring memory in second language acquisition.

In regards to first language, Gathercole, Willis, Emslie, and Baddeley (1992) presented empirical evidence on how the ability to recall non-words as measured by the NWR task can predict L1 vocabulary development in early childhood. In the field of second language studies, PM is also considered crucial to L2 vocabulary learning in children. Service and Kohonen (1995) found that Finnish elementary schoolchildren who performed well on the English non-word repetition lists ended up learning more L2 English vocabulary. Masoura and Gathercole (2005) also discovered similar results, namely that the ability to repeat non-words in L1 Greek and L2 English corresponded to children's Greek and English vocabulary knowledge. In addition, Cheung (1996) reported parallel findings among Hong Kong children learning English as a foreign language. Collectively, these studies support the theory presented by Baddeley et al. (1998) that the phonological loop is a "language-learning device" in young children.

PM is also vital and relevant for L2 vocabulary learning in adults. In Chun and Payne's (2004) study, L2 German college students with low short-term memory capacities in their L1 English had difficulty remembering new words in German. Researchers in that study found that students who performed poorly on the NWR task looked up vocabulary significantly more often than those with high memory span scores. Similar results were observed in another study by O'Brien, Segalowitz, Collentine, and Freed (2006) that found higher PM was associated with greater gains in lexical areas of the L2. Martin and Ellis's (2012) study also confirmed a significant relationship between PM and vocabulary knowledge in learning an artificial language.

While Kaushanskaya and Yoo (2012) have looked at adult bilinguals' phonological short-term and working memory in both their native and second languages, as well as in the cross-linguistic relationships between the two languages, no study thus far has compared the PM of

adult language learners with and without prior exposure to a language (e.g., HLLs) and examined their learning patterns over time.

Therefore, the main goal of this research project was to investigate whether adult HLLs have, in fact, a PM capacity that equips them with the instruments to formally learn the language of their heritage at a quicker rate than foreign language learners in the university setting. Pedagogically, this study may contribute to the current debate on whether heritage and non-heritage language learners should be learning in the same classroom or not. The findings from the present study will also contribute more generally to the field of PM in L2 acquisition by exploring PM with respect to L2 vocabulary and proficiency in a longitudinal manner, and interesting findings relevant to understanding working memory may be uncovered over time with this specific population.

RESEARCH QUESTIONS

The research questions for the current study are as follows:

1. How do HLLs compare to foreign language learners on the vocabulary, C-test, and NWR task measures? Can heritage language background account for high PM capacity and any vocabulary gains from Time 1 to 2?

2. How do high PM learners compare to low PM learners in every measure? Can L2 PM capacity explain any vocabulary gains from Time 1 to Time 2?

3. What is the relationship between Korean and English NWR task performance?

METHOD

Participants

The participants consisted of current students and recent graduates who had taken or placed at the KOR 201-202 level at the University of Hawai'i at Mānoa. All had attained at least an elementary level of proficiency in the Korean language. Participants were recruited from the intermediate Korean classes at the beginning of Fall 2012 and by word-of-mouth. Student participants were compensated at both Time 1 and 2 for their time and effort.

Twenty-six individuals participated at Time 1, and twenty-two came back for Time 2. Out of the 26 participants, 13 were HLLs, and the other 13 were traditional foreign language learners. Learners were categorized based on the information provided in the "Language history" section of the background questionnaire. The ages of the participants ranged from 18 to 31 (SD = 3.03), and the mean age was 22.27 years. All (100%) reported that English was their more dominant and proficient language. At Time 1, all participants were tested within a three-week time-frame from August 27 to September 14, 2012. For Time 2, participants were tested within a two and a half-week frame from November 22 to December 6. No participants were excluded from the data analysis.

The background questionnaires revealed that HLLs learned the language significantly earlier, $t(24) = -7.49$, $p < .001$. The HLLs also had more previous instruction in Korean, $t(14.11) = 2.29$, $p < .05$, which was attributed to supplementary church and community classes prior to university coursework. Predictably, HLLs also had more exposure to the Korean

language at home, t (13.50) = 2.13, p = .05. Age of onset, previous instruction in Korean, and home language in Korean are all characteristics that are associated with HLLs. Table 1 contains more detailed information on participants' Korean language background.

	Heritage (n=13)			Non-heritage (n=13)			Overall (n=26)		
	Min/ Max	Mean	SD	Min/ Max	Mean	SD	Min/ Max	Mean	SD
Age (years)									
Age*	18-25	20.77*	2.35	19-31	23.77*	2.95	18-31	22.27	3.03
Age of onset***	0-19	4.77***	7.56	18-27	21.33***	2.39	0-27	13.00	1.98
Language experience (months)									
Prior instruction*	0-96	31.23*	28.81	0-27	12.15*	8.57	0-96	21.69	22.99
Study abroad	0-4	.54	1.33	0-6	.77	1.74	0-6	.65	1.52
Living abroad	0-12	1.85	3.67	0-39	4.31	11.21	0-39	3.08	3.08
Exposure to language (hrs per wk)									
Korean class	0-5	1.65	1.89	0-5	2.88	1.65	0-5	2.24	1.85
Home*	0-28	5.62*	7.51	0-6	1.04*	1.81	0-28	3.42	5.93
Work	0-10	.92	2.78	0-3	.25	.87	0-10	.60	2.08
School	0-4	.35	1.11	0-4	.92	1.38	0-4	.62	1.25
Social situations	0-6	1.23	1.88	0-10	1.63	2.76	0-10	1.42	2.30
Watching TV	0-7	1.54	2.47	0-15	3.85	5.41	0-15	2.65	4.23
Listening music	0-30	3.77	8.11	0-35	5.58	10.27	0-35	4.64	9.06

*p < .05, ** p < .01, *** < .001

Table 1. Participants' self-reported Korean language background

In terms of proficiency, HLLs reported higher self-ratings for understanding, t (24) = 3.56, p < .05, speaking, t (24) = 2.48, p < .05, and overall proficiency, t (24) = 2.80, p < .05. The significant differences between heritage and non-heritage language learners in these areas suggest that HLLs might not only be superior in these areas, but also may have more one-on-one interaction with Korean. However, the fact that self-rated reading and writing were not significantly different for heritage and non-heritage language learners suggests that in terms of academic Korean, their proficiencies are similar. Descriptive statistics on participants' proficiency self-ratings can be found in Table 2.

	Heritage (n=13)			Non-heritage (n=13)			Overall (n=26)		
	Min/ Max	Mean	SD	Min/ Max	Mean	SD	Min/ Max	Mean	SD
Self-proficiency ratings (1-10)									
Reading	1-8	4.77	1.70	0-7	3.62	2.10	0-8	4.19	1.96
Writing	0-7	4.00	2.04	1-6	3.23	1.69	0-7	3.62	1.88
Understanding**	0-9	6.46**	2.47	0-6	3.38**	1.89	0-9	4.92	2.67
Speaking*	0-9	5.08*	2.40*	0-6	3.08*	1.66	0-9	4.07	2.26
Overall proficiency*	1-8	5.31*	1.93*	1-5	3.38*	1.56	1-8	4.35	1.98

*p < .05, ** p < .01, *** < .001

Table 2. Participants' self-ratings in Korean

There was an unanticipated main effect of age, t (24) = -2.90, p < .05, which may be attributed to a) the HLLs who took the placement test and began taking Korean upon entering university and b) the wider range of ages in the foreign language learner group. However, despite the statistically significant difference in mean, the average ages for HLLs and foreign language learners were 20.77 and 23.77, respectively. Working memory and age is an interesting topic in the field of second language studies, but due to the mild three-year gap between the two learners' mean ages, this particular attribute will not be discussed further.

While significant differences are apparent in areas such as age of onset, previous instruction, exposure to Korean at home, self-ratings in speaking, understanding, and overall proficiency, the two learner groups are for the most part comparable in other categories, such as time spent in Korea, current instruction in Korean, Korean use and exposure outside the home, exposure to media, and self-rated reading/writing.

Materials

The background data and proficiency self-rating questionnaire was adapted from the LEAP-Q: Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya 2007). The questionnaire was an electronic PDF file that participants could fill in as a form (see Appendix A). The background data and questionnaire included extensive questions regarding participants' parents' history and their exposure to Korean in particular domains (e.g. at home, work, school, etc.). The questionnaire was entirely in English.

The non-word repetition (NWR) task was used to measure each participant's phonological memory (PM) capacity in Korean and English. Participants were instructed to repeat non-words of increasing length (in two-, four-, six-syllable blocks). PsyScope, a software program designed for psycholinguistic experiments (Cohen, MacWhinney, Flatt, & Provost 1993), and the experimental stimuli from Kaushanskaya and Yoo (2012) were utilized. Both non-word repetition tasks featured three levels of syllable length (two-, four-, and six-). Kaushanskaya and Yoo (2012) emphasize that the Korean and English databases (Gupta, Lipinski, Abbs, Lin, Aktunc, & Ludden 2004; Lee 2006) created their non-words using similar procedures, and that the non-word stimuli across the two languages were matched for acoustic duration (for examples, see Appendix B and C). The English and Korean non-word repetition tasks would effectively measure and compare the PM capacities of all participants in their respective languages and any changes that arose from the start to the end of the school semester.

The vocabulary tests covered words that appeared in eight different textbooks from beginning to advanced level KLEAR (Korean Language Education and Research). The 50 test items elicited English-to-Korean (k = 25) and Korean-to-English (k = 25) word translations with four unmarked sections: Beginning (k = 10), Intermediate (k = 20), Intermediate Advanced, (k =10) and Advanced (k = 10). The words were compiled from the "New Words" lists in every chapter and randomly chosen per section. Examples included 영화 (*yenghwa,* "movie") for Beginning, 문제 (*mwuncey,* "problem") for Intermediate, 감정 (*kamceng,* "feeling") for Intermediate Advanced, and 독립 (*toklip,* "independence") for Advanced. A native speaker evaluated the appropriateness and difficulty of each word on the test beforehand and suggested certain word omissions and substitutions. See Appendix D for the actual test.

A Korean C-test was also administered to assess general Korean language proficiency and supplement the vocabulary test. This C-test developed by Lee-Ellis (2009) had been tested for its reliability and concurrent validity. This proficiency measure, similar to a cloze test, has selected passages from real and educational sources. The passages contain deleted parts of some

words to test a wide range of proficiency levels. As recommended by Lee-Ellis (2009), only four of the five passages were used, due to the estimated target proficiency level of the participants. There was a total of 155 items for the C-test, and the exact passages and blanks of the C-test can be found in Appendix D.

Written tests for the vocabulary and proficiency measure were used to prevent potential biases since HLLs reported higher self-ratings for speaking and understanding on the background questionnaire. Students at this level also tend to be accustomed to and familiar with written proficiency and vocabulary tests.

Procedures

Participants received a background data and proficiency self-rating questionnaire by email and completed it prior to the actual experiment. In a short personal interview at Time 1, students confirmed details from the questionnaire and their reported language ability with the experimenter.

The non-word repetition tasks for both English and Korean were conducted at the start (Time 1) and end (Time 2) of the semester in counter-balanced order between participants. For both non-word tasks, the non-words of different syllable lengths were prerecorded and presented as blocks with each participant tested on all two-syllable non-words first (k = 32), followed by four-syllable non-words next (k = 32), and six-syllable non-words (k = 32) for a total of 96 words for each language. Participants were instructed to repeat the auditory non-word as accurately as possible as soon as an auditory beep was heard 4000 ms after the offset of a non-word. Responses were audio-recorded for each participant. Participants were instructed prior to the experiment to press a space bar when proceeding to the next non-word. All participants' responses were audio-recorded.

The paper vocabulary tests and C-tests were given to all participants either before or after the NWR task in counter-balanced order. An equal number of participants completed the paper tests before and after the non-word repetition tasks. Half of the participants worked on the vocabulary and C-tests before the NWR, while the other half did so afterwards. Participants were explicitly told to fill out as much as they could on the tests. However, as expected, participants from both heritage and non-heritage groups were generally able to complete the first two (Beginning and Intermediate) of the four sections, while often leaving the Intermediate-Advanced and Advanced portions incomplete.

Scoring and coding

For the vocabulary and C-test, spelling conventions were not considered important. A partial credit system was implemented for both tests. Half-credit was given for vocabulary items where the translations were correct but incomplete. For example, for the item "wedding invitation", half-credit would be awarded to an answer that had either "wedding" or "invitation." For the C-test, a point was given to every correct word or particle.

A bilingual speaker of Korean and English listened to and coded all the participants' recorded NWR responses using auditory judgment and a partial coding system in which each syllable was counted as either accurate or inaccurate. Coding was adjusted to include the proportion of correctly produced syllables out of the total number per non-word. Given that the total number of words for each language was 96, the total possible syllables correct for both Korean and English was 32 for the 2-syllable words (k=16), 62 for the 4-syllable words (k=16), and 96 for the 6-syllable words, which amounts to a total possible raw score of 192 for both Korean and English.

To ensure the reliability of the coded data, a native speaker of Korean coded the Korean non-words for three randomly chosen participants. The inter-rater reliability was calculated using Pearson Correlation (r). There was a significant correlation between the two raters' coding, r = .87, n = 3, p = .01, one-tailed, suggesting a positive relationship between the coding of the two raters. As for the English non-words, a native speaker of English coded the English NWR task accuracy of the three participants. Using the same statistical test, a significant correlation was also found between the two raters' coding, r = .97, n = 3, p = .01, one-tailed, which suggests that the coding for all experimental participants was done in a consistent, reliable manner.

PREDICTIONS

Research Question 1 – learner groups

The HLL group is expected to perform more accurately on the Korean NWR task than the foreign language learner group at both Time 1 and 2 due to their familiarity and prior exposure to the language. Furthermore, it is expected that the HLLs will do quite well on the NWR task at the two- and four- syllable lengths, with moderate to considerable difficulty on the six-syllable length non-words. Contrastively, we can anticipate that the foreign language learner group will do relatively well on the two-syllable length block due to their formal experience with Korean thus far, but difficulties as early as the four-syllable length block are expected. Overall, the HLLs are predicted to perform better on the Korean NWR task and have greater PM capacities in that language than the foreign language learner group. In addition, we can expect that the HLL group will be associated with higher vocabulary test and C-test scores.

The predictions reported here are mostly based on results from Kaushanskaya and Yoo (2012), as the authors indicate that the Korean-English bilinguals experienced more robust length effects on the NWR task in their L2 English than L1 Korean. The researchers also mentioned that the participants overall were more accurate in their L1 than their L2, which is why HLLs might perform better since they were exposed to the Korean language earlier and theoretically have stronger phonological representations associated to Korean than the foreign language learner group. However, since the participants in the present study are somewhat different from the ones studied in Kaushanskaya and Yoo (2012), it is not clear whether previous findings will generalize to the population under investigation here.

Research Question 2 – PM groups

Also, it is hypothesized that high and low Korean PM participants will have similar vocabulary sizes at Time 1, since proficiency is being mildly controlled for at the intermediate level. However, the high PM group is predicted to make greater gains in vocabulary by the end of the semester (Time 1) compared to the participants in the low PM based on research suggesting a positive relationship between PM and vocabulary learning.

Research Question 3 –NWR tasks

It is predicted that PM capacity for Korean will increase for foreign language learners due to instructed learning and increased familiarity with the language's phonotactics, but English PM capacities for all participants will not change over time, reflecting self-reported language dominance in English and living in a mostly English-speaking environment. NWR task performance may be language independent as seen in the Kaushanskaya and Yoo (2012) study results where there were significant correlations between L1 Korean and L2 English.

RESULTS

Heritage and non-heritage performance

Independent samples t-tests were used to compare the vocabulary, C-test scores, and PM capacities of the two learner groups. For the scores at Time 1 and 2, Paired-Samples t-tests were run for the learner groups. See Table 3 for the mean scores and SD of the vocabulary test, C-test, and Korean and English NWR task for the two learners. Mixed ANOVA tests were used to investigate the longitudinal nature of the data collected and further confirm t-test results. The 22 participants who returned for Time 2 were the only ones included in this analysis.

	Heritage				Non-heritage			
	Time 1		Time 2		Time 1		Time 2	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Vocabulary	35.23	22.32	39.73	24.21	26.31	15.42	36.00	14.89
C-test	29.46	25.92	34.73	32.92	21.92	9.92	31.45	12.84
Korean PM	98.56	19.39	104.75	21.03	109.75	15.67	111.17	20.07
2	22.08	3.64	24.09	2.02	24.31	2.53	23.91	2.84
4	43.31	6.65	44.36	7.02	47.54	3.48	47.36	4.43
6	33.18	13.85	36.29	14.89	37.90	13.12	39.90	14.90
English PM	129.38	23.41	136.08	23.27	150.24	12.69	159.01	18.74
2	28.23	1.48	27.64	4.78	29.08	3.71	28.73	2.87
4	51.15	6.80	53.36	6.53	56.69	3.45	58.36	3.96
6	49.53	18.14	55.08	16.97	64.47	11.81	71.92	14.71

Table 3. Comparison of heritage and non-heritage learner performance at Time 1 and 2

For vocabulary, there were no significant differences between the two groups, but there were significant increases in score within groups for HLLs, t (10) = -3.81, p < .05, and non-heritage learners, t (10) = -3.11, p < .05. Hence, for both learners, vocabulary increased significantly after a semester. Meanwhile, the vocabulary scores for heritage and non-heritage learners were comparable and not significant with scores of 35.23 (SD = 22.32) and 26.31 (SD = 15.42) at Time 1 and 39.73 (SD = 24.21) and 36.00 (SD = 14.89) at Time 2 respectively. These t-test findings are in line with 2 x 2 repeated measures ANOVA that show no interaction of Time and Group, F (1, 20) = .37, p > .05, for the vocabulary measure.

The C-test that measured general proficiency in Korean was not significantly different between groups, but again significantly different within groups for HLLs, t (10) = - 2.86, p < .05, and non-heritage learners, t (10) = -2.59, p < .05. Thus the vocabulary and c-test results were very similar in that there were significant gains over the semester, but not between the two groups. This finding is reflected in the ANOVA results where there is again no interaction of Time and Group, F (1, 20) = .01, p > .05.

Statistical analysis of the tests revealed that the vocabulary and C-test results were highly correlated as seen in Table 4 below. The strong correlation between the two tests is a strong indication of the validity of the vocabulary test created for this study.

	1	2	3	4
	Students (n = 26)			
1. Vocabulary at Time 1	1			
2. Vocabulary at Time 2	.96**	1		
3. C-test at Time 1	.85**	.87**	1	
4. C-test at Time 2	.80**	.87**	.95**	1

*p < .05, ** p < .01, *** < .001

Table 4. Correlations between vocabulary and C-tests at Time 1 and 2

As for Korean PM, there were no significant differences between and within groups, which is interesting and entirely unexpected. There were no differences even at the syllable level (two-, four-, and six-) for the Korean language. Results of the ANOVA further emphasize these t-test findings. No interaction was found for Time and Group in Korean PM performance, F (1, 20) = .95, p > .05.

The English PM results revealed an entirely different account with significantly divergent results between and within groups. Non-heritage learners had higher mean scores than the HLL at Time 1, t (24) = -1.62, p < .05, and Time 2, t (24) = -2.55, p < .05, which was further evidenced by the syllable length differences for English between the two learner groups. Non-heritage learners did better on the English four-syllable non-words at Time 1, t (24) = -.76, p < .05, and Time 2, t (20) = -2.17, p < .05. Also, non-HLLs performed more accurately on the six-syllable English non-words at Time 1, t (24) = -2.49, p < .05, and Time 2, t (20) = -2.49, p < .05. The within-group results showed that both HLLs, t (10) = -3.00, p < .05, and non-heritage learners, t (10) = -2.52, p < .05, performed better on the NWR task at Time 2 than at Time 1. Results of the ANOVA verify these t-test findings where no interaction was found for Time and Group in English PM performance, F (1, 20) = .85 p > .05.

Comparison of high and low PM learners

To address research question 2, high and low PM groups for Korean were formed through a median split by Korean PM at Time 1. A median split by English PM at Time 1 was also used for further analysis. However, the high and low PM groups for Korean will be the main focus of discussion. Independent Samples t-tests were used to compare the vocabulary tests, C-tests, and PM capacities of the two groups. For the scores at Time 1 and 2, Paired-Samples t-tests were run for each PM group. See Table 5 for the mean scores and SD of the vocabulary test, C-test, and Korean and English NWR task performance for the participants with high and low Korean PM capacities. Mixed ANOVA tests were used to investigate the longitudinal nature of the data collected and further confirm t-test results. Only the 22 participants who came back for Time 2 were included in this analysis.

	High PM learners				Low PM learners			
	Time 1		Time 2		Time 1		Time 2	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Vocabulary	34.38	18.32	42.15	19.58	27.15	20.38	31.67	19.27
C-test	31.69	19.97	42.23	25.00	19.69	18.00	19.89	17.27
Korean PM	118.90	11.68	118.99	17.94	89.41	9.05	92.04	10.95
2	24.15	1.63	24.62	2.43	22.23	4.21	23.11	2.20
4	49.15	3.00	49.38	4.57	41.69	5.19	40.78	3.42
6	45.60	9.83	44.99	13.76	25.49	7.77	28.15	9.53
English PM	145.48	17.16	154.10	20.46	134.13	24.09	138.08	26.05
2	28.15	2.27	28.69	2.75	29.15	3.26	27.44	5.22
4	55.85	3.34	57.23	4.11	52.00	7.46	53.89	7.57
6	61.02	14.94	68.17	16.86	52.98	18.20	56.75	17.66

Table 5. Comparison of high- and low- PM performance at Time 1 and 2

For the vocabulary test, the difference in scores between the high and low PM learners was not significant at either Time 1 or 2. However, the high PM learners improved significantly on the vocabulary test from Time 1 to 2, $t(12) = -4.56$, $p = .001$, while the low PM learners' vocabulary scores did not increase over time. For the C-test, high and low PM learners scored comparably at Time 1. Meanwhile, at Time 2, high PM learners significantly outperformed the low learners, $t(20) = 2.32$, $p < .05$. In addition, high PM learners increased their mean scores significantly over time as well, $t(12) = -4.08$, $p < .05$, whereas low PM learners did not.

Results of a t-test confirm the statistical validity of the high and low groups showing high PM learners did significantly better on the Korean NWR task compared to the low learners at Time 1, $t(24) = 7.20$, $p < .001$, and Time 2, $t(20) = 4.00$, $p = .001$. Meanwhile, the Korean PM did not seem to change over the course of the semester for both learners. As for English PM, the difference between English PM capacities at Time 1 and 2 for both learners were minimal. However, interestingly, the high PM learners managed to do significantly better the second time around for English, $t(12) = -3.99$, $p < .05$, whereas, the low PM learners did not improve over time on the NWR task in English.

Length effects were seen between the high and low PM learners in Korean. At Time 1, there were significant differences in NWR task performance with four-, $t(24) = 4.49$, $p < .001$, and six- syllables, $t(24) = 5.79$, $p < .001$, with higher accuracy for the high PM learners. There were also significant differences at Time 2 with the four-, $t(20) = 4.78$, $p < .001$, and six-syllable non-words, $t(20) = 3.17$, $p < .05$. These results ultimately suggest that high PM learners did better with longer non-words on the NWR task.

Results of a 2 x 2 mixed-factor ANOVA suggest that learners with high Korean PM make significantly more gains on the Korean C-test over the course of the semester. There was a significant interaction effect between Time and Group, $F(1, 20) = 4.66$, $p < .05$ (see Figure 2). In addition, results from the Korean vocabulary test revealed a similar trend, indicated by a marginal interaction between Time and Group, $F(1, 20) = 3.34$, $p = .083$. These two findings suggest that learners with high PM were able to acquire significantly more lexical knowledge than the low PM learners in a semester's time and that PM capacity can influence L2 lexical growth over time. The C-test significantly correlated with the Korean PM at Time 1, $r(26) = .34$, $p < .05$, and Time 2, $r(22) = .41$, $p <. 05$, which solidifies the significant interaction found between the two for the high PM learners.
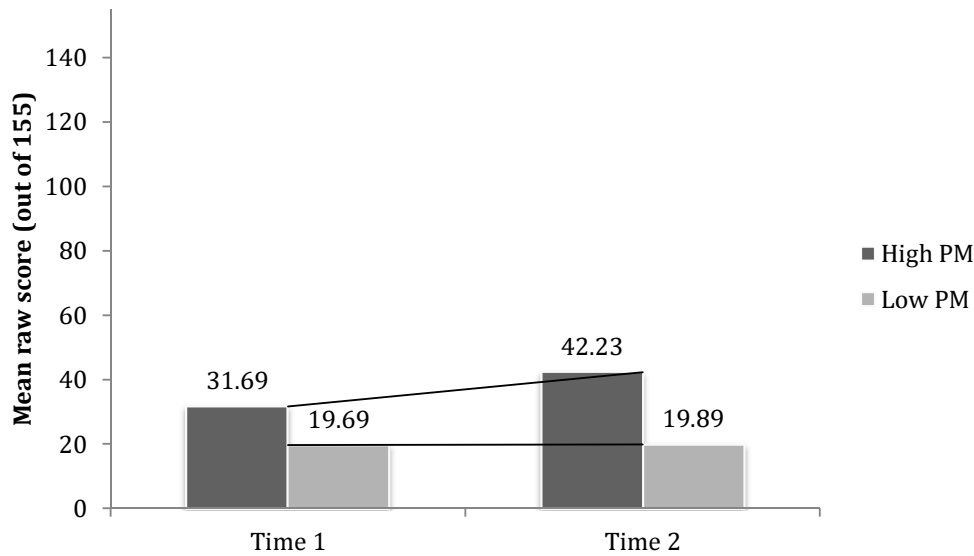
Figure 2. Average c-test scores at Time 1 and 2 by high and low groups

Korean and English NWR task performance

According to a paired-samples t-test, both high and low learners did better on the English NWR task than Korean at Time 1, t (25) = 8.64, p < .001, and Time 2, t (21) = 8.99, p < .001. There was also a significant correlation between English and Korean NWR task performance at Time 1 (r = .44, n = 26, p < .05) and 2 (r = .57, n = 22, p < .05) as seen in Table 6, indicating that NWR task performance may be language independent.

Eight out of the thirteen participants in the high PM group for Korean (62%) were also in the high PM group for English. This strengthens the idea that performance on the NWR task may not have been entirely based on language.

Students (n = 26)	1	2	3	4
1. Korean at Time 1	1			
2. Korean at Time 2	.90**	1		
3. English at Time 1	.44*	.57**	1	
4. English at Time 2	.48*	.57**	.93**	1

*p < .05, ** p < .01, *** < .001

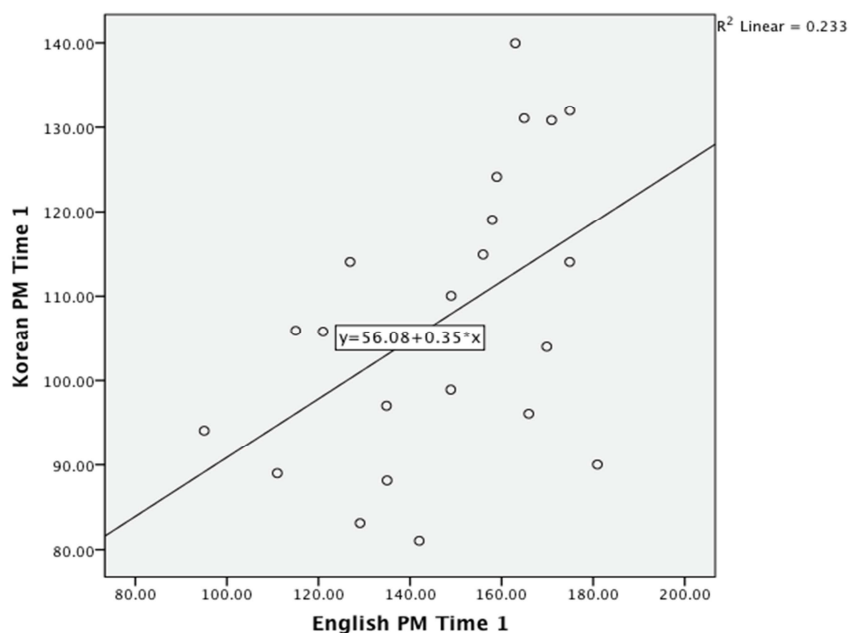**Table 6. Correlations between NWR task performance at Time 1 and 2.**

Figure 3. Correlation between Korean and English NWR task performance at Time 1

DISCUSSION

RQ 1: Heritage and non-heritage performance

The heritage and non-heritage results did not support prediction 1. There were no significant differences between heritage and non-heritage learners for either vocabulary or C-test scores at Time 1 and 2. Furthermore, there were no significant differences between heritage and non-heritage learners for the Korean NWR task as a whole and at the syllable level (two-, four-, and six-). The only difference between the two learner groups was their English PM. The English PM results showed that non-heritage language learners repeated the non-words more accurately than HLLs at the start and end of the semester. The non-heritage language learners also did better on the four- and six- syllable non-words than the HLLs at both Time 1 and 2. The differences in English PM capacity between the two learners were unexpected.

A likely explanation for the difference in English PM for the two learners might be related to the notion of smaller vocabulary sizes for early bilinguals due to differences in language frequency and context of exposure (Genesee & Nicoladis 2005; Pearson, Fernández, Lewedag, & Oller 1997). Since HLLs are learning one language at home and another at school, it has been suggested that these learners are delayed in the vocabulary development of both their languages (Bialystok, Craik, Green, & Gollan 2009). While there is currently not enough evidence for this claim in this particular set of data, it is a possibility.

RQ 2: Comparison of high and low PM learners

For vocabulary, the difference in scores between the high and low PM learners was not significant at either time point. Critically, however, the high PM learners improved on the vocabulary test at marginal significance from Time 1 to 2, while the low PM group statistically did not. The C-test results also support the idea that the high PM learner group made greater gains since they did statistically better at Time 2 than the low PM learners and improved greatly

from Time 1. These results support the prior findings in the literature that PM can aid vocabulary learning in a L2. Pedagogically, these findings reveal that home language and heritage background is not as important for L2 vocabulary learning as PM capacity.

RQ 3: Korean and English NWR task performance

High PM learners did significantly better in Korean compared to low PM learners at Time 1 and 2, but there was not much improvement from the start to end of the semester for those learners for Korean PM, which might be due to participants' level of proficiency. Research in working memory has often referred back to the question of whether L2 proficiency levels play a role in how important memory skills become. DeKeyser and Juffs (2005) note that PM plays different roles depending on the level of the learner. It seems that many of the studies conducted on PM and L2 vocabulary learning are looking at learners in the beginning to pre-intermediate levels. As for English, the difference between the PM capacities of the two learner groups was insignificant. Furthermore, for both groups, English PM capacities were significantly higher at Time 1 and 2 ($p \leq .001$) revealing the language dominance of English over Korean for all participants.

The high PM learners in Korean actually managed to do better at the end of the semester for English PM as well, which suggests that these learners are likely to be high PM learners for English, too. The fact that the high PM group did better on the longer Korean non-words (four- and six- syllables) at Time 1 and 2 reveals the exact difference between the low and high PM groups in terms of length effect. The significant interaction between Time and Group with the Korean C-test further supports the role of PM in L2 learning at least for this sample population.

Observations

A number of the participants in the present study used strategies during the NWR task such as repetition and speed. Participants would either repeat the non-word aloud before the beep or say the non-word extremely quickly immediately after the beep. These behaviors were not controlled by the experimenter, but should have been in hindsight, since PM involves the subvocal ("inner speech") rehearsal of non-words and not the actual production.

Another point worth mentioning is that the learners who did not return for Time 2 were all low PM learners. Three out of four participants who dropped out at the end had the lowest scores in the vocabulary and C-tests, which suggests that for this study, low PM learners had a tendency to perform poorly on the lexical tests. It is unfortunate that due to lack of Time 2 data these four participants could not be studied longitudinally like the other participants in the study.

Limitations and suggestions for future work

There were a number of limitations in the design of the study. In particular, the NWR stimuli used were not geared to L2 Korean learners. For example, frequencies of certain phonotactic combinations were not controlled for, since Kaushanskaya and Yoo (2012) were testing L1 Korean speakers. NWR performance usually improves for non-words that more closely match the language's specific phonotactics. Thus, inconsistent phonotactic probability may have led to poorer NWR task performance mostly among the L2 heritage learners who would be sensitive to the infrequent phonotactic combinations in the audio stimuli.

Also, a few of the HLLs were not instructed during the test period. Although there are no significant differences in instruction between the two groups (heritage and non-heritage), the lack of control in instruction may have led to the non-significant interactions in the comparison

of heritage and non-heritage learner groups. This fact may have also contributed to the lack of vocabulary gains seen in the HLL group. It might also be worthwhile to investigate whether participants improve during the NWR task, particularly if they get better during the course of the task. If learning is occurring with the participants, then the question of how valid the NWR task is arises.

Furthermore, intermediate learners of Korean were mainly studied for this project, but it would be worthwhile to see whether the same results would emerge for a different level of learner, such as Advanced or even High Advanced. It seems that many of the studies conducted on PM and L2 vocabulary learning have looked at beginning to intermediate levels, whereas little is known about the role of PM in more advanced language learners. Similarly, a larger sample size may provide a clearer picture of the current results.

Lastly, an in-depth investigation on the NWR would be worthwhile. For example, instead of mere syllable accuracy, coding could be revised to include the accuracy of stress patterns in Korean. A production versus perception study on Korean stress could be instigated based on the data collected. In addition, it might be practical to group the participants based on their NWR strategies and see whether that contributed to their performance or not. As for the participants who left the study, a qualitative interview could be set up to probe exactly why they chose not to return.

CONCLUSION

This study failed to provide any evidence that HLLs have higher phonological capacities and make stronger gains in vocabulary and proficiency over a course of the semester. However, interesting results were found when learners were divided by PM capacity instead of heritage status. First off, PM capacity was important in lexical learning on the C-test and vocabulary tests. While most of the predictions did not apply to the heritage and non-heritage groups, it did for the high and low PM groups. Secondly, based on the results of the current study, PM capacity was more important than home language exposure, which emphasizes the importance of individual differences in L2 learning. The individual differences in PM helped students learn the L2 at a greater rate, regardless of language background and experience, which is quite fascinating. Finally, the NWR task could perhaps provide a clearer and more systematic way of understanding HLL's potential for relearning the language in a formal classroom environment instead of the traditional multiple-choice placement tests readily seen at the university level.

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APPENDIX A

Background data and proficiency self-ratings questionnaire

Participant ID:
Date:

In this questionnaire, we ask for information about the languages you know. We also ask for some basic information about yourself, including your contact information. Please be assured that this information will be kept confidential and will not be shared with anybody.

If you have any questions while completing this questionnaire, please feel free to ask!

Personal information:

Name:

(first)   (last)

Sex:

Date of Birth:

(month, day, year)

Place of birth:

(city, country)

Class level:

(Freshmen, Sophomore, Junior, Senior)

E-mail address:

Phone number:

Korean class information:

What level of Korean are you currently taking?

Who is your instructor?

Did you take the placement test, or did you start from KOR 101?

Language history:

What was the first language you learned as a child?

What language do you feel most comfortable speaking in casual conversation now?

What language(s) was/were spoken in your home when you were growing up?

What is your mother's native language?

What language(s) did your mother use with you when you were a child?

What is your father's native language?

What language(s) did your father use with you when you were a child?

Please provide date of immigration to the USA, if applicable:

If you have ever lived in another country, please provide name of country and dates of stay here:

Country	Dates of stay (M/D/Y – M/D/Y)

Language background:

Please list all the languages you know **in order of most to least current use:**

1.	2.	3.	4.	5.

Please list all the languages you know **in order of when you learned them:**

1.	2.	3.	4.	5.

In no particular order, for each language, please indicate your overall proficiency on a scale of **zero to ten**.

Language:					
Overall proficiency 0 to 10:					

About your Korean:

At what age did you start learning Korean? (If you started at birth, write 0)

How long, in total, have you taken Korean classes? Please answer in years and months.

Have you studied abroad in Korea? How long? Please answer in years and months.

For how many **hours per week** do you use Korean in the following situations:
   a) in your Korean language class
   b) at work
   c) at school (outside of class)
   d) with friends/in social situations
   e) at home
   f) reading
   g) watching TV
   h) listening to radio/music
   i) language tapes/self instruction
   j) other (please explain)

On a scale of **zero to ten**, please rate your ability in Korean in the following areas:
   a) speaking
   b) understanding spoken language
   c) reading
   d) writing
   e) overall proficiency

Do you consider yourself a native speaker of Korean?

Do native speakers of Korean think you are a native speaker?

If there is any other information that you would like to share with you, please include it below:

Thank you very much!
감사합니다 ☺

APPENDIX B

Examples of English non-words by syllable
from Kaushanskaya & Yoo (2012)

	Orthography	IPA
Two-syllables (2)	gilare	gɪlɛɹ
	pomive	powmajv
	kemote	kɛmowt
	titeke	tajtik
	padod	pedad
Four syllables (4)	kugadoset	kugedowsɛt
	bisodatese	bajsadetis
	tilekamat	tajlikemæt
	dutenelage	dutɛnileg
	gidodelar	gajdownilaɹ
Six-syllables (6)	tetaditotunom	titedutowtunam
	ketesoseporole	kitisowsɛpowɹol
	gimekofenamod	gajmikofɛnemad
	tiradigenitote	tajɹedajginajtowt
	doserarosepuk	dowsiɹeɹasipək

APPENDIX C

Examples of Korean non-words by syllable
from Kaushanskaya & Yoo (2012)

	Orthography	IPA
Two-syllables (2)	힐밸	hilbel
	쥬둔	ʒjudun
	트모	tɨmo
	둑려	dugljʌ
	삭빌	sagbil
Four syllables (4)	덜삿닥곌	dʌlsatdakgel
	꾸삭잔린	k*usagʒanlin
	트꺼휘조	tɨk*ʌhɯiʒo
	찌콰밉빔	tʃ*ikʰɯamipbim
	너미테힐	nʌmitʰehil
Six-syllables (6)	케궝포멱덜ㄲ	kʰegɯiŋpʰomjʌgdʌlk*ɨ
	린힐서쥬닌균	linhilsʌʒjuningjun
	할뒹쳐바헨닌	haldɯiŋtfʰʌbahennin
	니중빔노닌쿠	niʒuŋbimnoniinkʰu
	투탕느중텀꺼	tʰutʰaŋnɨʒuŋtʰʌmk*ʌ

APPENDIX D

Vocabulary test

Thank you for your participation. There are two sections: translation and fill-in-blanks. You are not expected to complete this entire test. Please do the best you can! ☺

I. Translation (k=50): Please write the corresponding word for each item, and feel free to ask clarification questions regarding the words below.

1.

English	Korean
desk	

2.

English	Korean
	가운데

3.

English	Korean
movie	

4.

English	Korean
	저녁

5.

English	Korean
student	

6.

English	Korean
	야구

7.

English	Korean
this year	

8.

English	Korean
	모두

9.

English	Korean
sightseeing	

10.

English	Korean
	녹차

11.

English	Korean
	시합

12.

English	Korean
pants	

13.

English	Korean
	시험

14.

English	Korean
face	

15.

English	Korean
	백화점

16.

English	Korean
subway	

English	Korean

17.

	동전

18.

English	Korean
thought	

19.

English	Korean
	지방

20.

English	Korean
personality	

21.

English	Korean
	방법

22.

English	Korean
holiday	

23.

English	Korean
	설탕

24.

English	Korean
factory	

25.

English	Korean
	기침

English	Korean

26.

problem	

27.

English	Korean
	문화

28.

English	Korean
interview	

29.

English	Korean
	직장

30.

English	Korean
invitation card	

31.

English	Korean
content	

32.

English	Korean
	학사

33.

English	Korean
emotion	

34.

English	Korean
	인간관계

English	Korean

35.

truth	

36.

English	Korean
	소화

37.

English	Korean
nurse	

38.

English	Korean
	기금

39.

English	Korean
wedding ceremony	

40.

English	Korean
	관리

41.

English	Korean
	총각

42.

English	Korean
whole world	

43.

English	Korean
	정통

English	Korean

44.

(television) viewers	

45.

English	Korean
	안건

46.

English	Korean
independence	

47.

English	Korean
	내막

48.

English	Korean
unification	

49.

English	Korean
	장래

50.

English	Korean
footnote	

III. Fill-in-the blanks: Please fill in the blanks. For questions regarding this section, feel free to ask the investigator at any time.

안녕하세요. 제 이름은 김철수입니다. 저는 대학 __ __ 다닙니다. 아침에 일어 __ __ 학교 체육 __ __ __ 갑니다. 체육 __ __ __ 운동을 합 __ __ __. 운동을 한 다 __ __ 아침을 먹습니다. 아침은 기숙 __ 식당에서 먹습니다. 저는 대학 __ __ __ 한국어를 배 __ __ __. 한국어 수 __ __ 매일 오 __ 10시에 시작 __ __ __. 한국어는 쓰 __ __ 말하기가 어 __ __ __ __ __. 그렇지만 듣 __ __ 읽기는 쉽 __ __ __. 한국어 배 __ __ 것이 참 재미 __ __ __ __ __. 주말에는 친 __ __ 같이 극 __ __ __ __ 영화를 봅니다. 영화를 __ 후에 한국 식당에서 저 __ __ 먹습니다. 한국 식 __ __ 극장 바 __ 옆에 있습니다. 불고 __ __ 맛있습니다. 김치찌개는 맵습니다.

올 여름에는 가족들과 함께 제주도에 여행을 가려고 해요. 제주도는 한반 __ __ __ 남쪽에 있 __ 섬이예요. 한국의 하와이라 불 __ __ __ 제주도는 자 __ __ __ 아름다워서 신혼 __ __ __ 장소로 인 __ __ __ 굉장히 많 __ __ __. 오늘은 여행 __ __ 전화를 걸 __ 서울에서 제주도 __ __ 왕복 비행 __ __ __ 네장 예 __ __ __ __ __. 여행 __ __ __ 호텔도 소개 __ 주었지만 호텔은 아직 안 정 __ __ __. 인터넷으로 정 __ __ 더 찾아 보 __ 어느 호텔이 좋 __ 지 알아 보 __ __ __ 해요. 요 __ __ 인터넷이 있 __ __ 호텔 뿐아 __ __ __ 유명한 관 __ 명소와 맛 __ __ 식당도 찾아 볼 __ 있어서 참편리해요.

안녕하세요. 서울역 앞에 위치한 서울 백화점입니다. 저희 백화점 __ __ __ 겨울철을 맞 __ 겨울옷과 난 __ 제품을 세일 __ __ 있습니다. 직장 여 __ __ 위한 여성복 코너 __ __ __ 여성 정 __ 과 겨울 속 __ __ __ 50 프로 세일하고 있 __ , 삼층 아동 __ 코너에서도 코 __ , 목도리, 장 __ 등의 겨 __ 상품이 각 30프로씩 할 __ __ 가격에 판 __ __ __ 있습니다. 칠 __ 에서는 집안을 따 __ __ __ __ 해 줄 전 __ 히터와 가스난 __ 등 다양 __ 난방용 가 __ 제품을 특가판 __ __ __ 있습니다. 저 __ 서울 백화점과 함 __ 겨울나기 준 __ __ 시작하세요. 고객 여러분의 많은 성원 부탁드립니다. 감사합니다.

도시의 가장 큰 문제점이라면 뭐니뭐니해도 교통 문제가 제일 크다. 도로에서는 교 __ 체증으로 인 __ __ 에너지와 시 __ __ __ 낭비된다. 특히 출 __ __ __ 시간에는 한꺼 __ __ 차량이 일제 __ 몰려서 도 __ __ __ 아주 복 __ __ __ __. 게다가 뉴욕 같은 대도 __ __ __ 주차난은 매 __ 심각한 수준 __ __. 자동 __ 점점 많아 __ __ __ 반면 주 __ 공간은 제 __ __ __ __ __ 있기 때 __ __ 주차난이 생 __ __ __. 주차장이 부족하면 사람 __ __ __ 주택가 골 __ 이나 도로에까지 주차를 하 __ 경우가 많다. 이렇게 불 __ 으로 주 __ __ __ 차량은 또 다시 교통 혼 __ __ __ 원인이 되 __ 더 심 __ __ __ 교통 체증을 일으킨다. 따라서 교통 문제를 해결하기 위해서는 자가용보다는 버스나 지하철을 많이 이용해야 할 것이다.