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Impact of Phonological Working Memory on English as a Second Language Students' Vocabulary Learning

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ABSTRACT
Phonological Working Memory (Baddelely, 1990) involves a mental processing space thought to be conducive to learning new vocabulary. Previous studies have shown that phonological working memory makes an important contribution to vocabulary learning, both in young monolingual children and in older children at initial stages of learning English as a Foreign Language (EFL). Recently, Pearson (2000) investigated phonological working memory, using a nonword repetition task incorporating English phonotactic patterns, in young preschool children learning English as a Second Language (ESL). Further analyses of these data will be presented, using a less-biased nonword repetition task incorporating a more basic CVCV pattern.

Introduction
The theory of Phonological Working Memory was originally proposed by Baddeley (1986) and has since been explored with English monolingual children, second language learners, and language disordered children. Phonological Working Memory is a mental processing space that is thought to be conducive to remembering a novel series of sounds. For example, the word "mat" contains three speech sounds, also called phonemes: /m/, /æ/, and /t/. A phonological loop, which involves phonological working memory and repetition, is thought to be activated in order to rehearse words repeatedly until they are stored in long-term memory. Words shorter than "mat" require less phonological working memory, whereas longer words require more.

Review of Literature
Several lines of research have evolved from this theory. Many studies have been done involving English-speaking monolingual children. In their 1989 longitudinal study, Gathercole and Baddeley presented pseudo-words (pretend words) that conform to the dominant prosodic constraints of English to four-year-old monolingual English-speaking children who had been attending school for one month. They used the ability to immediately repeat these pseudo-words as a measurement of the child's level of phonological working memory. Examining the correlation between the children's pseudo-word repetition skills and their vocabulary at the time of initial examination, as well as one year later, Gathercole and Baddeley found that pseudo-word repetition performance at age four was a good indicator of vocabulary performance at both age four and age five, demonstrating that phonological working memory is an important component in the vocabulary learning process of monolingual

children. Various other studies (Adams & Gathercole, 1995, 1996; Gathercole & Baddeley, 1990) have also demonstrated that phonological working memory is an important component of learning new vocabulary in very young children and language delayed children. Children with higher levels of phonological working memory have been shown to have a larger vocabulary than their counterparts with lower levels of phonological working memory, as measured by pseudo-word repetition tasks.

Pseudo-word repetition, however, may not always be a good indicator of vocabulary learning potential. Gathercole, Willis, Emslie and Baddeley (1992) found that up to age five, phonological memory is an important component of vocabulary learning in monolingual children; however, after age five, it gradually becomes less important. By age eight, it appears as though prior vocabulary knowledge already stored in long-term memory plays a much more important role in new vocabulary learning than phonological working memory.

This knowledge concerning the impact of phonological working memory on vocabulary learning is being explored for use as a possible non-biased, differential, diagnostic measure for use with children who may be language disordered. Gathercole and Baddeley (1990) found that language-disordered children have a deficit of phonological memory skills. Montgomery supported these findings in his 1995 study. Tests of phonological working memory take only a few minutes to administer and thus could be an efficient and cost-effective diagnostic tool for predicting future language-learning problems. By recognizing possible problems early, children would be able to receive important language services sooner. In order to afford similar benefits to second language learners, though, further research is necessary to determine if a deficit of phonological working memory in an English as a Second Language (ESL) student is as reliable an indicator of a language disorder in the ESL student as it appears to be in the monolingual student.

Though previous work has indicated that phonological working memory decreases in importance by age eight in monolingual language learners, this also has not been demonstrated in second language learning situations. Two studies have addressed the role of phonological working memory in middle school aged students learning a second language. Service (1992) examined nine and 10-year-old English as a Foreign Language (EFL) Finnish students, comparing their verbal repetition skills at the beginning of a school year with their academic progress in English classes over the following three years. Finding a strong correlation between the two, she concluded that phonological working memory played a significant role in learning the vocabulary of a foreign language. Her conclusions were supported in a study by Cheung (1996) concerning the impact of phonological working memory on vocabulary learning in Hong Kong EFL 12-year-old students. Cheung measured the students' phonological working memory through a pseudo-word repetition task and then determined how long it took the students to learn three novel English words. He found that pseudo-word repetition was a good predictor of the rate at which students would learn new English vocabulary; however, this relationship existed only with students at lower English proficiency levels. Students at higher English proficiency levels did not appear to be as dependent on phonological working memory, relying more on long-term English vocabulary knowledge. Cheung's study supports the importance of phonological working memory as an important factor in new vocabulary learning, regardless of age, or whether it was their native language (L1) or second language (L2). Both Service's and Cheung's studies support previous findings involving monolingual English-speaking children.

The importance of phonological working memory in the vocabulary learning of English as a Second Language (ESL) students, however, is still uncertain. The children in Service's (1992) and Cheung's (1996) studies were EFL students. EFL students learn English as an academic subject in their own country, whereas ESL students learn English in a country where English is the primary language of communication. Different variables exist between the two groups. It is quite possible that a combination of varying sociocultural factors could affect the significance of phonological working memory in ESL students, factors that are not present in the learning environment of monolingual and EFL learners. Given the different circumstances in which ESL students learn English, it cannot simply be assumed that they learn in the same manner as young monolingual children or as EFL students. For example, the first language of ESL students may be suffering from attrition, which in turn may impact English language learning experiences (Kayser, 1995).

In order to address such issues, Pearson (2000) studied a group of ESL children. Twenty-three pre-school and kindergarten-aged ESL children were screened for hearing acuity and non-verbal intelligence. All were within normal limits. The students' phonological working memory skills were assessed using a modified version of The Children's Test of Nonword Repetition (Gathercole, Willis, Baddeley, & Emslie, 1994). As a measure of their phonological working memory, this test uses words based on typical English phonotactic patterns and prosodic cues. This measure was then compared with

the children's ability to learn new English words in two naturalistic play sessions and then to recall those words both immediately after each session and 24-48 hours later. She found that children's results on a pseudo-word repetition task were significantly correlated to the children's ability to immediately comprehend new words, but not significantly correlated to their ability to comprehend those same new words 24 to 48 hours following the new words' initial introduction.

Further research, however, needs to be done before definitive conclusions can be drawn regarding this population of children. The pseudo-word repetition task used by Pearson (2000) contained words that were based on English phonotactic patterns, which may be biased for or against certain first language backgrounds, a concern since the children in her study had various first languages. A test not based on English phonotactic patterns, using pseudo-words constructed from a more basic consonant-vowel-consonant-vowel (CVCV) syllable structure, might be more appropriate for such a population. Therefore, this study seeks to reanalyze Pearson's work by using a modified version of a different pseudo-word repetition task used by Dollaghan, Biber, and Campbell (1993).

Method

A reanalysis of data from Pearson (2000), using a different pseudo-word repetition task conducted at the same time as her study, was done in order to determine the impact of a different measure of phonological working memory on vocabulary learning in ESL students. The different test used, that of Dollaghan, Biber, and Campbell (1993), is made up of nonsense words with a more basic CVCV syllable structure.

Twenty-three ESL children, aged 3;1 – 6;6 were individually assessed for nonverbal IQ, hearing ability, and English language ability (see Appendix). All were sequential language learners. First languages included Korean, Slovak, Japanese, Uzbek, Farsi, Finnish, Chinese, and Arabic. The children were screened for nonverbal IQ using the matrices subtest of the Kaufman Brief Intelligence Test (Kaufman & Kaufman, 1990) and all fell within +/- one standard deviation of the norm, ensuring that no intelligence deficiencies or excesses would bias the data. Hearing acuity was also tested and all were found to be within normal limits (defined as being able to hear all test frequencies, 500-6000 Hz, at 25dB, a level set due to ambient noise in the testing environment), indicating that no hearing deficiencies existed within the population. The Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1969) was used to document systematic misarticulations due to the young age of the children and their developing phonological systems. Additionally, each child was assessed for English language proficiency using a modified version of the Preschool Language Assessment Scales (Duncan & DeAvila, 1986).

Two naturalistic play sessions were conducted where the children were exposed to six new unknown English words (each containing two syllables and five phonemes, with stress on the first syllable) at each session, for a total of 12 words. During each learning play session, each target word was incorporated into the play by the researcher 10 times. The children were then tested for both comprehension and production of the new words, using "pointing" games, immediately after the play sessions, as well as 24-48 hours later. (Data for comprehension only is used in this reanalysis.) The data were examined using bivariate correlations to determine if a relationship existed between phonological working memory, as measured by the pseudo-word repetition task with a more basic CVCV pattern, and the ability to learn new English words. Multiple regressions were also run in order to determine contributions of other possible factors, such as, age, non-verbal IQ, and prior English language skills.

Results

Bivariate correlations were run with no significant correlations found to exist between the CVCV pseudo-word repetition task and the children's ability to comprehend new English words, immediately after play sessions or 24-48 hours later. However, a significant correlation did exist at the .01 alpha level between the children's English language proficiency, as measured by a modified version of the PreLAS, and the children's ability to comprehend new words both immediately following play sessions ($r = .652$ at the .01 alpha level), as well as 24-48 hours later ($r = .418$ at the .05 alpha level). Additionally, a significant correlation ($r = .561$ at the .05 level) existed between the children's ability to recall new words immediately and the children's ability to recall the new words 24-48 hours later. (See Table 1.)

Multiple regressions were also run in order to further explore the results of the data. The following dependent variables were used: age, non-verbal IQ, PreLAS score, and the score on the nonword repetition test (NRT). The results of the multiple regressions demonstrate nonsignificance at the .05 level for both immediate comprehension (see Table 2) and also recall comprehension 24-48 hours later (see Table 3).

Discussion

The results of this study support the findings of Gathercole, Willis, Emslie, & Baddeley (1992) and Cheung (1996) concerning the decline of dependence on phonological working memory as language proficiency increases, as well as the findings of Pearson (2000) concerning the nonsignificance of

phonological working memory in ESL students, even at very young ages. First, the significant correlation between previous English proficiency, as measured by the PreLAS, and learning ability, as measured by children's ability to comprehend new words, both immediately following learning play sessions and also 24-48 hours later, supports the findings of Gathercole et al. (1992) that increased language proficiency results in decreased dependence on phonological working memory. Additionally, the data supports Cheung's (1996) conclusions that, in higher proficiency students, second language vocabulary learning, like first language vocabulary learning, is more dependent on long-term vocabulary knowledge than on phonological working memory. Also, the lack of significant correlations between performance on the less-biased CVCV psuedo-word test and children's performance in learning new words, supports Pearson's (2000) findings that phonological working memory may not play as significant a role in young monolingual children or EFL learners and thus may not be appropriate as a differential diagnostic measure in ESL populations.

This study was different from previous studies in several important ways. Although its results support those of Pearson (2000), it is distinct from that study because of its use of a more universal CVCV nonword repetition test that would be less biased towards particular first language students. Additionally, this study was different from much of Gathercole and Baddeley's work, which involved monolingual English-speaking pre-schoolers, as this study worked with second language children. Cheung (1996) and Service (1992) also both worked with second language learners, but their learners were older preteens in an EFL learning situation, whereas the participants of this study were ESL learners.

The results of this psycholinguistic approach do not supply reasons for individual variation in learning with this group of children; thus, it may be productive to consider several possible sociolinguistic explanations for the apparent lack of dependence on phonological working memory in these ESL students. There are numerous sociopolitical factors that may affect ESL students that would not affect monolingual English and EFL learners. These children, because of their native language and native culture, are oftentimes part of a minority group that may be looked down upon from the majority; they may suffer from varying degrees of discrimination and be unable to receive the same benefits afforded to non-ESL children. Even in cases where discrimination does not exist and where ESL students have equal access to education and other benefits, they still may be frustrated with adapting to a culture that is alien to them; those customs and cultural nuances that may seem perfectly natural to a member of the majority culture can be frightening and intimidating to an ESL student from another cultural background.

Additionally, because many ESL children are living in an environment in which their native language may rarely be spoken, their first language may suffer from attrition (Kayser, 1995). The students' first language(s), also, may impact their English language learning abilities. A child's knowledge of another language could cause transfer errors, mistakes in the second language because of assumptions that the two languages share common features, when, in fact, they might not. These variations could affect the English language learning progress in ESL students, a circumstance that would not play a role in the experience of monolingual or EFL children.

It is also important to consider that preschool learners lack the literacy skills of preteen students. They have not yet been influenced by the concept of words being made up of different sounds. There is also great variation in the cognitive development of a three-year-old compared with a preteen, as well. A preschooler does not have the same mental capacities that the older students of Cheung's (1996) and Service's (1992) studies would have had. Preschoolers also do not have the metalinguistic development of an older preteen student. They are not capable of grasping the abstract concepts of conscious thought about words being made up of different sounds.

All of these are factors that may influence a child's English language learning, factors that do not contribute to the same degree to the experience of a monolingual or EFL learner. While phonological working memory may play a part when exploring the learning experiences of ESL children, it may be a much smaller part than with other populations of children, regardless of the type of nonword repetition task used, because of the factors enumerated above. Therefore, it may be a less significant factor in English language learning than it is in monolingual and EFL children.

Table 1. *Correlations of Variables Impacting Comprehension of New Vocabulary Learning*

	1	2	3	4	5
1 Non-Verbal IQ	-				
2 PreLAS	.206	-			
3 NRT Score	-.001	-.100	-		
4 Imm. Comp.	.235	.652**	.015	-	
5 Comp. 24-48 hrs. later	.059	.418*	.094	.561**	-

* Correlation significant at 0.05 level (2-tailed).
** Correlation significant at 0.01 level (2-tailed).

Table 2. *Multiple Regression Involving Immediate Comprehension and Age, Non-Verbal IQ, PreLAS Modified Raw Score, and Nonword Repetition*

ANOVA

Model		Sum of Squares	df	MeanSquare	F	Sig.
1	Regression	63.797	4	15.949	3.896	019
	Residual	73.681	18	4.093		
	Total	137.478	22			

a Predictors: (Constant), NRT Score, Non-Verbal IQ, Age in Months, PreLAS Raw 2
b Dependent Variable: IC

Coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		**B**	**Std. Error**	**Beta**		
1	(Constant)	-4.046	4.905		-.825	.420
	Age	4.019E-02	.046	.184	.869	.397
	Non-Verbal IQ	2.752E-02	.042	.115	.650	.524
	PreLas Modified Raw Score	.116	.046	.536	2.511	.022
	NRT Score	2.714E-02	.140	.035	.194	.848

a Dependent Variable: Immediate Comprehension

Appendix

Descriptive Information of Children				
Native Language	**Gender**	**Age***	**Non-Verbal IQ**	**PreLAS Modified Score**
Korean	F	45	99	52
Slovak	F	48	114	50
Japanese	M	42	95	29.5
Uzbek	F	37	95	38
Farsi	F	61	99	54
Korean	M	59	112	35.5
Russian	F	78	95	38
Korean	F	70	104	66.5
Korean	M	70	88	48
Russian	M	75	97	61.5
Korean	F	75	100	66.5
Uzbek/Russ	F	68	97	36
Russian	F	68	100	59.5
Finnish	F	54	101	45.5
Chinese	F	55	105	38
Arabic	M	47	99	41
Icelandic	F	68	106	70
Arabic	M	67	100	60.5
Korean	F	64	116	44.5
Japanese	M	72	96	53.5
Korean	M	68	128	64
Korean	M	65	128	54
Korean	M	65	116	47

* age is given in months

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