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Non-word repetition performance in Korean-English bilingual children

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Abstract

The goals of this research were (1) to compare bilingual and monolingual children on Korean non-word repetition performance, and (2) to examine the relations between non-word repetition and vocabulary skills in bilingual and monolingual children. Sixty children aged from 3–5 years participated in this study, including 30 Korean-English bilinguals and 30 Korean monolinguals. The Korean-English bilingual children were sequential bilinguals who spoke Korean at home and English at school. Children were tested on a non-word repetition task and their Korean and English vocabulary skills were measured by standardized tests. The results showed that bilingual children were significantly lower on standardized vocabulary scores ($p < .01$). However, there was no difference between bilinguals and monolinguals on non-word repetition performance. Correlation analyses showed a significant association between non-word repetition performance and vocabulary skills of the tested language in both groups, while the association between non-word repetition and age was significant in the monolingual group. These results demonstrated that the non-word repetition task measures general language learning ability and is a sensitive predictor of vocabulary skills in linguistically diverse children.

Keywords: *Bilingual, non-word repetition, phonological memory, language development.*

Introduction

Bilingual children are increasingly found in the caseloads of speech-language pathologists in many countries. However, differentiating language disorders from language differences in these bilingual children is challenging because their linguistic characteristics overlap with those of monolingual children with language impairment (LI) (Kohnert, Windsor, & Yim, 2006; Paradis, Rice, Crago, & Marquis, 2008; Yim, 2011).

Recent studies with culturally and linguistically diverse children indicate that processing measures may be less biased than traditional language assessment tasks (Campbell, Dollaghan, Needleman, & Janosky, 1997; Dollaghan & Campbell, 1998; Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, 7 Jones, 2000; Rodekohr & Haynes, 2001; Yim, 2011). Non-word repetition (NWR) is one of the language processing tasks that has been widely studied. In NWR, children immediately repeat auditorily presented nonsense words. The task has been accepted as a measure of phonological memory capacity (Gathercole & Baddeley, 1989, 1990), even though it involves various underlying processes, including speech perception, lexical and phonological knowledge, motor planning, and articulation (Coady & Evans, 2007). Phonological memory refers to one's ability to establish the phonological form of a new word, and is a critical aspect of vocabulary acquisition (Archibald, 2008; Gathercole, Hitch, Service, & Martin, 1997; Gathercole, Willis, Emslie, & Baddeley, 1991, 1992; Graf Estes, Evans, & Else-Quest, 2007). Children with better phonological memory skills (i.e., children who are better able to remember auditorily presented novel words) acquire vocabulary more rapidly than children with less phonological memory skills (Gathercole, 2006). Thus, NWR has been proposed as a valid general language ability measure in children (Bowey, 1996; Chiat & Roy, 2007; Gathercole & Adams, 1993, 1994; Gathercole & Baddeley, 1989, 1990; Gathercole et al., 1992; Gathercole, Service, Hitch, Adams, & Martin, 1999; Hoff, Core, & Bridges, 2008).

One of the critical contributions of NWR as a measure of general language learning ability is that it is a less biased method of assessing performance in culturally and linguistically diverse children than most, if not all, standardized tests. These children usually perform more poorly than their monolingual peers on standardized measurements due to their lack of previous world knowledge or experience in the language (Girbau & Schwartz, 2008; Gutiérrez-Clellen

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& Simon-Cereijido, 2010; Kohnert et al., 2006; Thorn & Gathercole, 1999; Windsor, Kohnert, Lobitz, & Pham, 2010; Yim, 2011). Until recently, NWR has been considered to be successful in assessing integrity of the language-learning system in minority children because it minimizes the influence of differences in language experience (Campbell et al., 1997; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Rodekohr & Haynes, 2001).

However, unlike its contribution to assessing culturally diverse populations, NWR as a truly non-biased measure for *linguistically* diverse children is still in debate. Even though NWR does not assess prior language knowledge but the ability to process new linguistic information (Campbell et al., 1997), the performance on NWR has been found to be affected by prior language knowledge or experiences (Girbau & Schwartz, 2008; Gutiérrez-Clellen & Simon-Cereijido, 2010; Kohnert et al., 2006; Thorn & Gathercole, 1999; Windsor et al., 2010). For example, Parra, Hoff, and Core (2011) investigated the relationship between NWR and language experience in bilingual children, in which relative exposure to each language was gathered by parental report. Their findings suggested that there are language-specific relations between phonological memory and vocabulary skills. A longitudinal study by Engel de Abreu (2011) also supported that NWR performance is affected by the language skills used in the NWR task. The results showed that the bilinguals' performance on NWR was reduced compared to that of their monolingual peers. Engel de Abreu (2011) interpreted their results as supporting the theory that bilingual children have weak underlying phonological representation of a target language because of limited exposure to each language, which results in poorer NWR performance than shown by their monolingual peers. In the recent study which examined English NWR performance in 7-year-old monolingual English, Korean-English bilingual, Chinese-English bilingual, and Spanish-English bilingual children (Lee & Gorman, 2012), the overall repetition accuracy was similar among the four linguistic groups. However, they showed different correlation patterns among NWR, vocabulary, and phonological awareness. The authors suggested that, even in bilingual children with relatively strong English skills, NWR tasks do not eliminate the role of linguistic experience.

Although most of the research has focused on English-speaking children with English-based non-words, some studies have adapted NWR for children speaking other languages (Bortolini, Arfé, Caselli, Degasperi, Deevy, & Leonard, 2006; Ebert, Kalanek, Cordero, & Kohnert, 2008, Girbau & Schwartz, 2007; Radeborg, Barthelo, Sjobertg, & Sahlén, 2006; Sahlén, Reuterskiöld-Wagner, Nettelbladt, & Radeborg, 1999; Saito, 1995; Stokes, Wong, Fletcher, & Leonard, 2006; Thordardottir, 2008; Windsor et al., 2010). Developing language-specific NWR allows for the building and confirmation of a relationship between NWR and language development in languages other than English. Up until now Spanish NWR has been developed by different researchers (Ebert et al., 2008, Girbau & Schwartz, 2007; Windsor et al., 2010) as well as Italian (Bortolini et al., 2006), Icelandic (Thordardottir, 2008), and Swedish (Radeborg et al., 2006).

Although most studies have conducted investigation with Western languages, Stokes et al. (2006) examined whether Cantonese NWR can be useful in measuring linguistic abilities in Cantonese-speaking children. Cantonese-speaking children aged 4 years 2 months to 5 years 7 months with and without LI were tested with NWR following the phonotactic rules of Cantonese. The results showed that there was no difference between the groups with and without LI. The authors suggested that children learning Cantonese can more easily reconstruct the phonological representation because of the specific characteristics of the phonological structure of the language. Thus, the authors concluded that there might be limits to the usefulness of NWR in some languages. The results implied that not only language experience but also the language structure itself are likely to play a role in determining the suitability of NWR as a measure of basic phonological processing skills.

Thus, developing language-specific NWR and gathering data from diverse languages are needed to provide further evidence for determining whether NWR truly measures general language learning ability. Up until now, however, few studies have investigated NWR following the phonotactic rules of the native language concerned (Girbau & Schwartz, 2008; Gutiérrez-Clellen & Simon-Cereijido, 2010; Windsor et al., 2010). Most studies using NWR in different languages other than English tested children who used the tested language as their native language. However, in the study by Windsor et al. (2010), two languages, the participants' mother tongue and their second language, were used for the tested language in NWR. The children who were monolinguals used English as their native language with LI and without LI, and Spanish-English speaking children with LI and without LI were tested. The unique study method used in this study involved the children repeating both English and Spanish non-words. For example, monolingual children whose native language was English repeated not only English NWR but also Spanish NWR. The main findings from this study were first, NWR was able to distinguish between children with and without LI, and, second, NWR was language-specific. NWR performance was better if children repeated non-words in their native language (English monolinguals repeat English non-words better than Spanish non-words and vice versa for bilinguals). Windsor et al. (2010) concluded that NWR is influenced by both LI and native language experience.

Thus, it is important to explore whether previous findings will be held constant in a Korean context. The application of NWR in bilingual population has not yet been addressed in the Korean context. Especially, for the younger bilingual children, accurate measurement is needed to identify language ability in the Korean community due to the increasing cultural and linguistic diversity. From a theoretical perspective, it will allow us to determine which elements influence, which may be different from English, the performance of Korean NWR.

Korean and English differ in the number of sounds available to produce contrasting phonotactic structures: Korean uses 19 consonants and seven vowels (excluding 11 diphthongs), but English uses 13 vowels and 24 consonants (Shin, 2005). English has tense-lax distinction in vowel. In Korean, there is three-way distinction among tense, lax, and aspirated stops which is rather unlike the phonation-type contrasts that exist in the other languages such as the aspiration contrast of English and Cantonese or the voicing contrast of Spanish. Whereas English allows three-consonant clusters in word initial position, Korean allows only one consonant. Thus, due to Korean's specific phonotactic rules, NWR performance may be influenced by its language-specific characteristics, as shown in Cantonese (Stokes et al., 2006).

Thus, the two purposes of this study are (1) to investigate whether NWR measures basic phonological memory skills and (2) to examine whether NWR is linked to language skills in linguistically diverse children. If NWR taps basic phonological memory skills yet is sensitive to language skills, then it can be used as a viable option for testing bilingual children's overall language skills. However, if NWR solely requires proficiency in the test language, then it would be difficult to accurately measure bilingual children's underlying language learning ability. Thus, in the current study, monolingual children were compared to bilingual children on their NWR and language skills (as indicated by vocabulary scores on standardized tests).

Our hypotheses are as follows: If the NWR task measures basic phonological memory skills, there should be no difference between the monolingual children and bilingual children, since they are all developing normally with relatively strong Korean skills. Additionally, if NWR is sensitive to experience in the test language as described in previous studies, then we would still find a strong correlation between NWR and test language skills.

Method

Participants

Children were recruited by advertising on a Korean community website for parents and by contacting parents in a Korean community. Bilingual (BI) children were recruited from Southern California in the US, and monolingual (MO) children were recruited from South Korea. Parents who were interested in participating in the research contacted the first author of the study. She explained the study to the parents, and, if the child was willing to participate, parents signed the consent form. Parental consent was obtained for each child. Parents were also given a questionnaire to fill out to check that the children's primary language was Korean, the children had no history of neurological disorders, the children's auditory and visual acuity were normal, and the children had normal articulation and language development. All of the children came from families with middle-class socioeconomic backgrounds. All children scored within normal limits on a non-verbal intelligence (IQ) sub-test of the Korean-Wechsler Preschool and Primary Scale of Intelligence (BI, $M = 111.80$, $SD = 16.18$; MO, $M = 109.33$, $SD = 13.06$, $p = .423$) (Table I).

There was a total of 60 children, composed of 30 Korean-English bilingual children (15 girls, 15 boys aged from 41–67 months, $M = 54.33$, $SD = 8.25$) and 30 Korean monolinguals (15 girls, 15 boys aged from 39–70 months, $M = 53.83$, $SD = 9.89$). Bilingual children were all born in the US and were living in Los Angeles. These children spoke Korean at home and English at school and were defined as sequential bilinguals. They attended a local bilingual early childhood education programme and were exposed to both Korean and English on a daily basis in their bilingual classroom from 2 years of age. The monolingual children were born in Korea and living in Seoul and had not been exposed to English at all. These monolingual children spoke only Korean at home and at school. They attended a Korean local early childhood education program.

Both groups completed the receptive vocabulary sub-test of the Korean Receptive and Expressive Vocabulary Test (REVT: Kim, Hong, Kim, Chang, & Lee, 2009), the standardized Korean vocabulary test, while the bilingual group additionally completed the Peabody Picture Vocabulary Test-third edition (PPVT). REVT (2009) is an individually administered norm-referenced test, which is designed to measure an examinee's Korean receptive and expressive vocabulary. The test consists of an expressive vocabulary test (REVT-E) and a receptive vocabulary test (REVT-R). Each test contains four training items and 185 test items. The item sets are arranged in order of increasing difficulty. REVT (2009) was standardized nationally on a stratified sample of 5200 persons. The split-half reliability coefficients are .792 for REVT-R and .886 for REVT-E. Content and criterion validity were also completed for this test. The correlations with other measures of vocabulary are .946 for REVT R and .884 for REVT-E.

Even though the bilingual children were reported to have normal development and used Korean at home, the monolingual children significantly outperformed the bilingual children (BI, $M = 27.67$, $SD = 9.03$; MO, $M = 47.53$, $SD = 15.20$, $t = 6.156$,

$p < .01$) on the REVT: the bilingual children's mean raw score was 42.27 ($SD = 17.94$) on the PPVT.

Materials and procedure

A set of 20 non-word stimuli were constructed to adhere to the phonotactic constraints of Korean. These stimuli are listed in the Appendix. Korean contains 19 consonants and 18 vowels including seven monophthongs and 11 diphthongs; the non-word stimuli included all seven monophthongs of the vowels (/i/, /ɛ/, /a/, /o/, /u/, /ɯ/, /ʌ/) and 16 of the consonants (/k/, /k͈/, /kʰ/, /t/, /t͈/, /tʰ/, /p/, /p͈/, /pʰ/, /tɕ/, /tɕ͈/, /tɕʰ/, /m/, /n/, /l/, /ŋ/). In the consonants, later developing consonants /s/ and /s͈/ and the weak consonant /h/ were excluded to minimize interference from articulatory limitations on task performance. In the vowels, 11 diphthongs were excluded because these are combinations of /j/ or /w/ and vowels. Most syllables were constructed following the consonant-vowel pattern that is most frequent in Korean as opposed to the consonant-vowel-consonant pattern of English. The total number of phonemes in the 20 non-word stimuli was 159, and the number of syllables was 80. The shortest non-word stimuli were two syllables in length and stimuli of up to six syllables were included. A total of four non-words of each syllable length (i.e., two, three, four, five, and six syllables) were constructed.

A native Korean speaker recorded the 20 non-words onto a minidisk. Each child was tested individually in a quiet room. The task was administered via free-field speakers. The child was told that he or she would hear some "funny made up words" and was asked to listen carefully and repeat them exactly as they were heard. The two practice items were presented before the test began. A trial was repeated once if the child's response was incorrect. No feedback was given on test items, but encouragement was given as required. Each experimental item was presented only once. The non-words were presented in order of increasing difficulty (all 2-syllable non-words, followed by 3-syllable non-words, etc.). All responses were recorded verbatim and an audio was recorded for later transcription.

In this study, two scoring methods were used: percentage-syllables-correct and percentage-phonemes-correct. Since there was no major difference between the two scoring methods, we scored the NWR accuracy at the phoneme level according to previous studies. Following Dollaghan and Campbell (1998), we first scored each phoneme as correct or incorrect in relation to its target phoneme, after which the number of correct phonemes was divided by the total number of phoneme targets at each non-word length. Following Dollaghan and Campbell (1998), who considered NWR as a measure of phonological memory, phoneme distortions and additions were not counted as errors, whereas phoneme omissions and substitutions were considered incorrect. Because they were interested in the extent to which participants were able to represent the target phonemes in memory long enough to repeat them, additions by definition do not reflect a loss of information about the target phonemes themselves.

Data for 12 of the 60 participants were independently transcribed and scored by an additional coder. The inter-coder reliability was 93% ($p < .01$).

Results

First, an analysis of covariance (ANCOVA) with age as a covariate was used to compare group difference in NWR. Second, we investigated the relationship between NWR and vocabulary scores. First, correlation analyses were conducted to determine the extent to which the Korean and English vocabulary scores correlated with NWR. Then, stepwise regression analyses were conducted to determine which variable best explained vocabulary scores.

There was no significant difference between the groups in NWR performance (BI, $M = 81.00$, $SD = 9.93$; MO, $M = 83.42$, $SD = 12.15$, $p = .423$).

There was a significant main effect of syllable length ($F_{(4, 55)} = 29.068, \eta^2 = .350, p < .001$). Length effects are illustrated in Figure 1 levels declined from three to six syllables, except for 2-syllable length non-words for which children scored the second lowest accuracy following 6-syllable length non-words. Pairwise comparisons of the overall mean accuracy indicated that decreases between three and two syllables ($p < .01$), three and four syllables ($p < .001$), and four and five syllables ($p < .001$) were all significant. However, there was no significant group by syllable length interaction effect.

The second analysis focused on the relationship between NWR and vocabulary scores. As expected, age and vocabulary skills were significantly correlated; English vocabulary scores were correlated with age in the bilingual group ($d = .630$, $p < .001$), while Korean vocabulary scores were correlated with age in the monolingual group ($d = .722$, $p < .001$).

In bilingual children, NWR performance was significantly related to Korean vocabulary but not to English vocabulary. As can be seen in Table II, correlation analyses showed a significant association

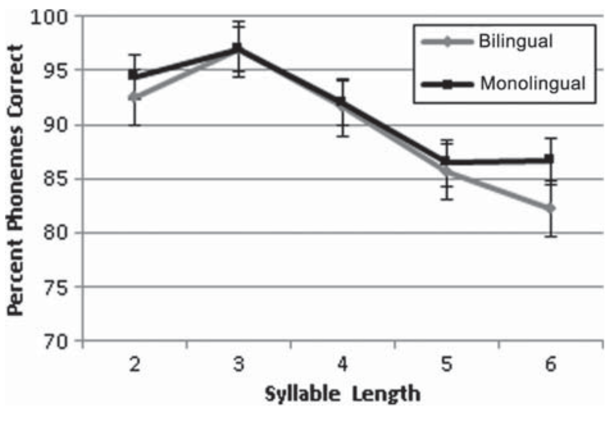

Figure 1. Mean percentage phonemes correct across syllable lengths for each group.

Table I. Group mean and standard deviations on age, non-verbal IQ and vocabulary test scores.

	Age in months	K-WPPSI	REVT	PPVT-III
Bilingual (BI)	54.33 (8.25)	111.80 (16.18)	27.67 (9.03)	42.27 (17.94)
Monolingual (MO)	53.83 (9.89)	109.33 (13.06)	47.53 (15.20)	—

K-WPPSI, non-verbal sub-test of the Korean-Wechsler Preschool and Primary Scale of Intelligence (Park, Kwak, & Park, 1996); REVT, receptive vocabulary sub-test of the Korean Receptive and Expressive Vocabulary Test (Kim et al., 2009); PPVT-III, the Peabody Picture Vocabulary Test-third edition (Dunn & Dunn, 1997). Standard deviations are indicated in parentheses.

between NWR and Korean vocabulary scores in the bilingual ($d = .381$, $p < .05$) and monolingual ($d = .481$, $p < .01$) groups, while age in months was additionally correlated with NWR in the monolingual group ($d = .473$, $p < .01$).

Then, we first carried out a multiple regression to predict Korean vocabulary scores with age, non-verbal IQ, NWR, and the bilingual status. For this analysis, we created a dummy variable (0 = monolingual, 1 = bilingual) to investigate whether there was a significant contribution of bilingual experience in predicting vocabulary scores and to test whether any of the predictor variables interacted significantly with bilingual status. In the first block of the regression analysis, we entered age, non-verbal IQ, and NWR as predictors. In the second block, we entered the dummy variable, and in the final block, we entered the interactions between the dummy and predictor variables. Table III shows the results of the multiple regression analysis.

The final regression model was significant, $F_{(4, 55)} = 26.74$, $p < .05$, and explained a total of 66% variance (R^2). The regression model showed that, in the first block, age (18%, $p < .01$) and NWR (7%, $p < .05$) accounted for a significant amount of the total sum of squares in the Korean vocabulary score. In the second block, the dummy variable (38%, $p < .001$), the bilingual status, was significant in predicting vocabulary scores. The final model—including the block with the age × dummy variable interaction, non-verbal IQ × dummy variable interaction, and the NWR × dummy variable interaction—accounted for a significant amount of the total sum of squares in the Korean vocabulary score data (4%, $p < .05$). The age × dummy variable interaction was significant ($p < .05$). The non-verbal IQ × dummy variable interaction ($p = .23$) and the NWR × dummy variable interaction ($p = .98$) were not significant.

Second, we carried out the multiple regression analysis with English vocabulary score as the outcome variable. We entered age, non-verbal IQ, and NWR as predictors. Only the bilingual group was included because the monolingual group has not been administered the English vocabulary test. Table III shows the results of the multiple regression analysis. The regression model showed that age accounted for a significant amount of the total sum of squares in the English vocabulary score (40%, $p < .001$). The IQ and NWR were not significant.

The regression analyses results showed that group status significantly predicts Korean vocabulary scores and that the strength of the predictors is different for the bilingual children, as the age interacted with group status. Two correlation analyses carried out

Table II. Summary of inter-correlations for age in months, non-verbal IQ, Korean vocabulary, and English vocabulary as a function of bilingualism.

	1	2	3	4	5
1. Age	–	.165	.257	.630**	.135
2. K-WPPSI	.130	–	−.223	.194	−.170
3. REVT	.722**	.269	–	.135	.381*
4. PPVT-III	–	–	–	–	−.053
5. NWR	.473**	−.090	.481**	–	–

Inter-correlations for bilingual children ($n = 30$) are presented above the diagonal, and inter-correlations for monolingual children ($n = 30$) are presented below the diagonal.
K-WPPSI, non-verbal sub-test of the Korean-Wechsler Preschool and Primary Scale of Intelligence (Park et al., 1996); REVT, receptive vocabulary sub-test of the Korean Receptive and Expressive Vocabulary Test (Kim et al., 2009); PPVT-III, the Peabody Picture Vocabulary Test-third edition (Dunn & Dunn, 1997).
*Significant at $p < .05$ (two-tailed). **Significant at $p < .01$ (two-tailed).

Table III. Multiple regression analysis predicting Korean vocabulary score in the bilingual and monolingual children (represented by the dummy predictor).

	REVT		PPVT	
Predictor	ΔR^2	β	ΔR^2	β
Step 1	.24**		.40***	
Age in months		.55**		.63***
NWR		.16*		−.09
Non-verbal IQ		.11		−.14
Step 2	.38***			
Dummy		.65***		
Step 3	.04*			
Dummy × Age in months		−1.30*		
Dummy × Non-verbal IQ		−.49		
Dummy × NWR		−.02		
Total R^2	.66*		.40***	
n	60		30	

REVT, receptive vocabulary sub-test of the Korean Receptive and Expressive Vocabulary Test (Kim et al., 2009).
*Significant at $p < .05$ (two-tailed). **Significant at $p < .01$ (two-tailed). ***Significant at $p < .01$ (two-tailed).

separately for two groups showed that the age factor did not correlate with Korean vocabulary score for bilingual children ($r = .26$, $p > .05$), whereas the age factor strongly correlated with NWR for monolingual children ($r = .72$, $p < .01$).

Discussion

The first purpose of this study was to examine whether the NWR task taps basic phonological memory skills, particularly with regard to language skills. Our results showed comparable group performance on NWR, which suggests that, if children are developing normally and have relatively strong language skills tested, they will perform as well as other children on NWR (Campbell et al., 1997; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Lee & Gorman, 2012; Rodekohr & Haynes, 2001). However, given that several studies found that bilingual children scored lower than monolingual children on NWR (Engel de Abreu, 2011; Kohnert et al., 2006), a possible explanation for the inconsistent findings may be that, due to Korean's specific phonotactic rules such as a small inventory of syllable shapes, NWR performance may be influenced by its language-specific characteristics, as shown in Cantonese (Stokes et al., 2006).

Another explanation is that, unlike most previous studies with bilingual children, we used NWR which followed the phonotactic rules of the bilingual children's native language. Our bilingual children were living in the US, but their first language was Korean and the NWR followed Korean phonotactic features. Pre-school bilingual Korean children who predominantly use their first language may have solid phonological representations in their native language, even though the amount of vocabulary knowledge may be different from Korean monolingual children. In line with this, Windsor et al. (2010) explained that NWR relies on the influence of both LI and native language experience. In their investigation, Spanish-English bilingual children repeated non-words in their mother tongue better than English non-words, although the study was still able to distinguish between children with and without LI. Thus, our results further suggest that the bilingual children's NWR performance is equivalent to monolinguals who share the same mother tongue. However, one limitation of our current study is that there was no data on bilingual children's English NWR performance. Thus, for a future study, it will be important to examine both first and second language NWR in bilingual children compared to NWR in monolingual children who use the same language.

Additionally, there was an age effect and a length effect in both groups. The older children (5-year olds) performed significantly better than the younger children (3-year olds). This developmental effect is consistent with previous research with pre-school-aged children (Ebert et al., 2008; Gathercole, 1995; Majerus, Poncelet, Elsen, & Van der Linden, 2006; Radeborg et al., 2006; Roy & Chiat, 2004). In addition, the length effects were statistically significant. Overall, accuracy levels declined from three to six syllables, which is shown in Figure 1. The results of our study on typical bilingual and monolingual Korean speakers replicate the results of previous studies (Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990; Gathercole et al., 1991; Girbau & Schwartz, 2008; Radeborg et al., 2006).

However, unexpectedly, the children scored lower in 2-syllable length non-words than in 3-syllable length ones. One previous study (Gathercole et al., 1991) also documented children's lower accuracy on the shortest non-words than on the longer ones. The authors explained that the unexpectedly low level of repetition accuracy in shortest non-words reflects the specific articulatory contrast sampled in the items rather than a more general property of short non-words. However, the effects of the presence of fricative/affricate articulatory features in non-words do not seem to fit our non-word stimuli. Rather, the results may be explained by the perceptual salience effect in which the 2-syllable length was too short to be perceived accurately (Bates & MacWhinney, 1987). Given that initial phonological perception or encoding of phonological forms may be more difficult in short non-words (Alt, 2010; Majerus et al., 2006), the unexpectedly low repetition accuracy with the shortest non-words may be due to a greater proportion of perceptually demanding *linguistic* features in the stimuli rather than just acoustic features in the stimuli.

Overall, the findings are consistent with previous evidence showing comparable levels of performance on NWR in bilingual and monolingual children (Campbell et al., 1997; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Kaushanskaya, Blumenfeld, & Marian, 2011; Rodekohr & Haynes, 2001). Thus, our results suggest that Korean NWR developed in this study is a predictive measure of language skills for linguistically diverse children.

Our second goal of research was to investigate the relationship between NWR and vocabulary skills. In both groups, there was a significant correlation between NWR performance and vocabulary skills. Additionally, from the regression analyses, NWR performance significantly predicted vocabulary scores. This is in line with previous findings of a significant correlation between NWR accuracy and vocabulary measures (Bowey, 1996, 2001; Gathercole & Adams, 1993, 1994; Gathercole & Baddeley, 1989; Gathercole et al., 1992, 1999; Lee & Gorman, 2012; Thorn & Gathercole, 1999). However, our results in the bilingual group showed that the correlation is specific to test language skills only. A significant body of previous research provides evidence that NWR performance is influenced by the corresponding language experience, particularly (Parra et al., 2011) when the language experience is qualitative (strong phonological representation) rather than quantitative (the number of words).

Moreover, there were different tendencies between the monolinguals and bilinguals when examining the relationship between vocabulary skills and NWR. The regression analysis in which the bilingual and monolingual groups were included showed that both age and NWR performance significantly predicted Korean vocabulary score. Bilingual status also significantly predicted Korean vocabulary scores. It is important to note that in this sample there was a significant group status × age interaction. This interaction results indicated that the "age" variable influences differently for the two groups. For bilingual children, the age variable was not strongly associated with Korean vocabulary score than in monolingual children. Indeed, a correlation analysis demonstrated that for the monolingual children Korean vocabulary score was more strongly associated with age than for the bilingual children.

Additionally, the bilinguals' NWR performance was not correlated with their English vocabulary size. In monolinguals, age may be a critical factor which predicts vocabulary score, coupled with NWR performance. However, for bilinguals, developmental age may not be as critical a factor for predicting vocabulary score. For bilinguals, time of exposure to each language may be more important than chronological age, since bilingual children are experiencing two languages in contrast to monolinguals (Yim, 2011; Yim & Rudoy, in press). Thus, for future study, the relationship between the amount of usage of each language and competency in that language needs to be investigated using qualitative analysis.

Given that phonological memory skill is in part dependent on language experience in bilingual children (Parra et al., 2011), the percentages of children's language exposure in each language should be estimated. Despite the lack of information about language exposure, however, there is evidence in the current data that the relationship between phonological memory and vocabulary development is different in bilingual and monolingual children. Moreover, although the relationship between phonological memory and vocabulary size was the focus of the investigation, future research is needed to explore the relationship between performance in NWR tasks and other measures of language development (Yim & Windsor, 2010).

Overall, our findings with Korean-English bilingual and monolingual children draw two important conclusions. First, if bilingual children are developing normally as reported by their parents, their NWR performance as measured by their native language would be comparable to the NWR performance of normally-developing monolingual children. Second, NWR is highly related to vocabulary skills in both groups, with age more strongly influencing NWR performance in monolinguals. Thus, based on our findings, we can conclude that NWR taps general language learning ability and is a sensitive predictor of vocabulary skills. However, it is important to note that, in order to confirm the usage of NWR as a specific and sensitive diagnostic tool in identifying LI, these children should be included in the data for analysis. Thus, further study will have to include children with LI for more rigorous investigation to test the possibility of using NWR as a clinical tool for bilingual children.

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Appendix: Non-word stimuli.

2 Syllables	3 Syllables	4 Syllables	5 Syllables	6 Syllables
/nɯpɛ/	/pʌkuti/	/t^{h}obokai/	/comɛnupʌri/	/rumitamarino/
/matu/	/kɛcat^{h}i/	/ikunaŋpul/	/lɛbiɛt^{h}imʌ/	/romitirɯcʌni/
/cona/	/mokuta/	/p^{h}ɯkat^{h}ɛci/	/nupicɛkumi/	/bomɛinaŋkaŋbi/
/p^{h}ʌti/	/niak^{h}o/	/nʌbakʌno/	/bacɯdakʌni/	/rikidoak^{h}ɛma/

Note: The IPA symbol ⟨^{h}⟩ (a superscript h) is used to denote the aspirated consonants /p^h/, /t^h/, /k^h/. The IPA symbol ⟨◌͈⟩ (a subscript double straight quotation mark) is used to denote the tensed consonants /p͈/, /t͈/, /k͈/.