

# Vocabulary Knowledge is Not a Predictor of General Cognitive Functioning in Elderly People with Very Low Educational Attainment

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**Background and Purpose** Vocabulary knowledge is used as a representative index of general intelligence, and is regarded as a marker for cognitive reserve in elderly people. However, vocabulary knowledge mainly depends on formal education, hence, it may not fully represent cognitive functioning in elderly people with poor educational backgrounds. Herein, we investigated whether vocabulary knowledge is a measure of general cognitive ability among normal elderly people with few years of formal education.

**Methods** The association between vocabulary knowledge and general cognitive functioning was compared between 35 elderly females with very low educational attainment and 68 elderly females with higher education.

**Results** The vocabulary knowledge was a significant predictor of general cognitive functioning in elderly individuals with more than primary education, even after controlling the effects of age and years of education. However, it was not a significant predictor of general cognitive functioning in elderly individuals with very low educational attainment.

**Conclusions** Vocabulary assessment was effective in estimating general cognitive functioning in elderly individuals who received  $\geq 6$  years of education. Our findings suggested that vocabulary knowledge may not be an effective proxy of premorbid intelligence or cognitive reserve in people who have not completed elementary schooling.

**Key Words** vocabulary knowledge, premorbid intelligence, cognitive aging, cognitive reserve, education.

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## INTRODUCTION

The population is rapidly aging worldwide, which has made it important for clinicians to determine the characteristic changes in cognitive function that accompany normal aging, and distinguish it from pathological aging. Assessing cognitive decline involves an objective assessment of how much the individual's cognitive performance falls below the average within the normative sample. Further, estimating an individual's pre-

morbid or baseline cognitive functioning and assessing how much change has occurred involves the need to consider individual differences within the normative sample. According to the revised diagnostic and statistical manual of mental disorder,<sup>1</sup> significant cognitive decline from premorbid cognitive performance is an important criterion for diagnosing neurocognitive disorders, which challenges the clinicians to effectively estimate premorbid functioning for the diagnosis of dementia and other neurocognitive disorders.

Educational attainment is an important factor to consider in neuropsychological evaluation. Studies have shown that elderly people with very low educational attainment have distinctive neurocognitive characteristics from well-educated elderly individuals in both quantitative and qualitative aspects.

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Specifically, the performance on neuropsychological assessment in normal elderly people with very low educational attainment is significantly lower with greater variability than those with more educational attainment.<sup>2,3</sup> This puts elderly people with low education at higher risk for misdiagnosis with pathological aging in the clinical setting, including mild cognitive impairment.<sup>4-6</sup> Estimating premorbid cognitive functioning with an appropriate measure is crucial for accurate diagnosis and thereby, would contribute to effective prevention and treatment of neurocognitive disorders in these individuals.

Vocabulary knowledge has been widely used as a representative index of general intelligence in late adult life.<sup>7-9</sup> One of the reasons for the widespread use of vocabulary knowledge is that it does not decline with age and is sustained even in late life.<sup>10</sup> Further, it is relatively well preserved in various pathological aging conditions including mild cognitive impairment, early-stage Alzheimer's disease,<sup>11</sup> and Parkinson's disease.<sup>12</sup> Lastly, vocabulary knowledge has been shown to have a strong association with general cognitive functioning in normal elderly people.<sup>13,14</sup> Vocabulary knowledge has also been frequently used as a proxy of an individual's cognitive reserve, which protects against the negative effects of late-life neuropathology.<sup>15-18</sup> However, it is unclear whether vocabulary knowledge can be used to represent general cognitive functioning in the elderly population with very low educational background, since it is greatly influenced by educational and cultural experience.<sup>19</sup> Previous studies that have examined the relationship between late-life vocabulary knowledge and other cognitive functions, have been conducted mainly on elderly people with at least high-school education and the educational differences in the elderly participants was not considered. Therefore, validation of vocabulary knowledge as a measure to reflect general cognitive functioning among elderly individuals with little educational experience is required.

This study aimed to investigate whether vocabulary knowledge is related to the general cognitive functioning status in elderly people with low education. A total of 103 normal elderly females aged between 65 and 87 years were recruited and divided into two groups based on their level of education. We first examined whether the effect of vocabulary on general

cognitive functioning was significant in the entire sample. Then, the association between vocabulary and general cognitive functioning was separately analysed in the "unschooled" group (years of education <6) and compared with those in the "schooled" group (years of education ≥6). Considering that vocabulary knowledge is greatly influenced by educational experience, we hypothesized that vocabulary knowledge is not effective in predicting general cognitive functioning in "unschooled" elderly people, whereas it is effective in predicting general cognitive functioning in the "schooled" group.

## METHODS

### Participants

Female elderly individuals were recruited from local senior welfare-centers in Seoul, Korea. Of the 127 participants, 103 were determined as normal by clinical experts and included in the final analyses. The subjects were between the ages of 65 and 87 years (mean age=73.56, SD=5.15), had no history of neurological disorders, major psychiatric disorders, history of brain injury (such as head trauma or brain surgery), history of diabetes or hypertension that was difficult to regulate with medication, and had no problem with hearing and vision that could cause difficulty in performing the cognitive tasks. Also, their cognitive function assessment [Korean Dementia Rating Scale-2 (KDRS-2)]<sup>20</sup> results were within the normal range. Within this sample, we classified participants with <6 years of education as the "unschooled" group ( $n=35$ ), while participants with ≥6 years of education were categorized as the "schooled" group ( $n=68$ ), considering that 6-years of primary schooling was obligatory in Korea until 1984. Demographic data on the participants within each group are presented in Table 1. All participants provided written informed consent, and the study was approved by the Seoul National University Institutional Review Board.

### Cognitive tests

#### Korean Dementia Rating Scale-2

The KDRS-2<sup>20</sup> was used to assess general cognitive function-

**Table 1.** Means and SDs of age, education, and the K-WAIS-IV vocabulary and KDRS-2 total scores by group: two-sample *t*-test

	Unschooled ( $n=35$ )		Schooled ( $n=68$ )		<i>t</i>	<i>p</i>
	M	SD	M	SD		
Years of age	76.06	4.80	72.28	4.88	3.74	<0.001
Years of education	2.43	1.84	8.66	2.71	-13.78	<0.001
K-WAIS-IV vocabulary	11.00	4.86	22.06	9.27	-7.94	<0.001
KDRS-2 total	123.29	8.76	131.69	6.53	-5.50	<0.001

KDRS-2: Korean Dementia Rating Scale-2, K-WAIS-IV: Korean Wechsler Adult Intelligence Scale 4th ed. M: mean, SD: standard deviation.

ing of the elderly participants, and to screen individuals with neurocognitive disorders. The Dementia Rating Scale (DRS)<sup>21</sup> is a widely used neuropsychological tool for assessing general cognitive abilities of normal elderly individuals as well as patients with dementia of the Alzheimer's type.<sup>22-24</sup> The KDRS-2 is the second edition of the Korean version of the DRS<sup>2</sup> that was standardized to suit the elderly population in Korea. The KDRS-2 comprises of five subtests, namely attention, initiation/perseveration, construction, conceptualization, and memory, each worth 37 points, 37 points, 6 points, 39 points, and 25 points respectively, for a total of 144 points. The K-DRS total score significantly correlates ( $r=0.82, p<0.01$ ) with the Mini-Mental State Examination-Korean<sup>25</sup> and shows significant differences in performance between dementia patients and normal controls, supporting its clinical validity.<sup>2</sup> Moreover, structural magnetic resonance imaging studies have demonstrated that K-DRS scores correlate with regional volumes in elderly brains.<sup>26</sup>

#### Korean Wechsler Adult Intelligence Scale 4th ed vocabulary subtest

The Korean Wechsler Adult Intelligence Scale 4th ed (K-WAIS-IV)<sup>27</sup> vocabulary subtest was administered to measure vocabulary knowledge of the elderly participants. This test was developed to measure the examinee's knowledge on vocabulary and concept formation, while its score is widely used to estimate verbal intelligence.<sup>28</sup> There are a total of 30 items, including 3 picture items and 27 word items. The picture items require the examinee to name the object that is presented visually and the word items require the examinee to state the meaning of the words that are presented in print as well as orally. Examinees can receive either 0 or 1 point on each of the picture items and 0, 1, or 2 points on each of the word items for a total of 57 points. A K-WAIS-IV standardization study showed that the internal consistency of the vocabulary subtest among the entire sample was  $r=0.88$ , test-retest reliability was  $r=0.82$ , and inter-rater reliability was  $r=0.97$ , supporting the reliability of the subtest. Also, the vocabulary subtest was highly correlated with other subtests of verbal intelligence, suggesting that it is a valid test of verbal intelligence.<sup>27</sup>

#### Procedure and analyses

The K-WAIS-IV, KDRS-2, and neuropsychological interviews were administered by clinical trainees and clinical psychologists. Three clinical psychologists participated in case conferences that determined whether the participants met the inclusionary criteria. Hearing difficulty and vision problems were determined at the beginning of each interview, and participants were encouraged to use their glasses and/or hearing aids. Those who had significant difficulty hearing our instructions or seeing the stimuli with the available aids were excluded from the study.

The collected data were analysed in two steps using the IBM SPSS statistics 21 software (SPSS Inc., Armonk, NY, USA). First, we conducted a regression analysis using the K-WAIS-IV vocabulary subtest score, years of education, and age as regressors and the KDRS-2 total score as a dependent variable in the entire sample of 103 elderly participants, to determine whether the explanatory power of vocabulary knowledge on the overall status of cognitive function of all participants was significant even after controlling for age and years of education. Second, we divided participants into the "unschooled" and "schooled" education groups and applied the same regression model on the data of each group, to investigate whether vocabulary knowledge is a valid predictor of general cognitive functioning in elderly people with less than primary education as well as those with or above primary education.

## RESULTS

Initially, we performed a multiple regression analysis in the entire sample of 103 elderly individuals. The regression model placed the KDRS-2 total score as a dependent variable, while age, years of education, and the K-WAIS-IV vocabulary subtest score were used as regressors. The results showed significant effects of K-WAIS-IV vocabulary subtest score,  $p=0.009$ , as well as age,  $p=0.001$ , and years of education,  $p=0.016$ , on the KDRS-2 total score (Table 2).

Next, to investigate whether the relationship between vocabulary knowledge and general cognitive functioning differed based on educational attainment, we divided the participants

**Table 2.** Multiple regression model on general cognitive functioning with age, education, and vocabulary knowledge ( $n=103$ )

Regressors	B	Std. error	$\beta$	<i>t</i>	<i>p</i>	R <sup>2</sup>
Constant	153.55	10.19		15.08	<0.001	
Age (years)	-0.45	0.13	-0.28	-3.42	0.001	0.421
Education (years)	0.57	0.23	0.26	2.44	0.016	
K-WAIS-IV vocabulary	0.25	0.09	0.29	2.66	0.009	

B: regression coefficients, K-WAIS-IV: Korean Wechsler Adult Intelligence Scale 4th ed, Std. error: standard error of regression coefficient,  $\beta$ : standardized regression coefficient.

into two groups: the “unschooled” group (years of education <6) versus the “schooled” group (years of education  $\geq 6$ ) and conducted a comparative evaluation. A two-sample *t*-test showed that the differences in the mean and variance in cognitive test results were significant between the groups as expected (Table 1). The K-WAIS-IV vocabulary subtest scores were lower in the unschooled group than in the schooled group,  $t(101)=-7.94, p<0.001$ , as were the KDRS-2 total scores,  $t(101)=-5.50, p<0.001$ . Since the difference in age was significant between the two groups,  $t(101)=3.74, p<0.001$ , we conducted an analysis of covariance analysis with age as a covariate. The results showed that the effect of education on the K-WAIS-IV vocabulary subtest score,  $F(1,100)=7.14, p<0.001$ , and the KDRS-2 total scores,  $F(1,100)=3.11, p=0.001$ , were significant even after controlling the effect of age. Meanwhile, Levene’s test for assessing the equality of variances on cognitive scores in the two groups showed that the variance in the K-WAIS-IV vocabulary subtest score was significantly lower in the unschooled group, as compared to the schooled group,  $F(1,101)=19.43, p<0.001$ ; whereas the variance in the KDRS-2 total score showed no significant group-wise difference,  $F(1,101)=3.82, p=0.053$ .

Likewise, for each of the two groups, the “unschooled” and the “schooled”, we conducted the same regression model as in the entire sample (Table 3). Within the schooled group, the K-WAIS-IV vocabulary subtest score showed significant effects on the KDRS-2 total score,  $p=0.003$ , while age and years of education showed no significant effects,  $p=0.460, p=0.715$ , respectively; in contrast, in the “unschooled” group, the K-WAIS-IV vocabulary subtest score did not predict the KDRS-2 total scores,  $p=0.365$ , while both age and years of education showed significant effects,  $p<0.001, p=0.039$ , respectively.

## DISCUSSION

Overall, the results of the study indicated that vocabulary knowledge was not able to predict overall cognitive functioning of elderly people with minimal education. The K-WAIS-IV vocabulary score did not significantly predict the KDRS-2 total score, while age and years of education significantly predicted the KDRS-2 total score in elderly individuals with <6 years of formal education. However, consistent with previous studies, the K-WAIS-IV vocabulary score was a significant predictor of the KDRS-2 total score among those who had completed or received more than primary education,  $p=0.003$ .

Traditionally, vocabulary knowledge has been widely used as a representative linguistic intelligence measure;<sup>7-9</sup> and when administering a short version of an intelligence test, such as the Wechsler Adult Intelligence Scale, the raw scores of the vocabulary subtest are frequently utilized to estimate the regression-based premorbid intelligence of an individual.<sup>29-32</sup> Our current findings suggested that estimating premorbid or current cognitive functioning using vocabulary knowledge may not be appropriate for elderly people with little educational experience. One of the reasons for the lack of association between the two measures was that the performance of the elderly people who did not complete primary education was very low with less variability than those with higher education, suggesting that vocabulary knowledge was generally poor among elderly individuals who did not complete primary education. Considering that vocabulary knowledge is acquired heavily during schooling, it is highly possible that people with minimal education do not acquire this knowledge; hence, utilizing vocabulary knowledge as a representative cognitive measure in these people can be ineffective.

Further investigations are necessary to clarify whether vocabulary measures are invalid in determining the general cog-

**Table 3.** Group-wise differences in the multiple regression model on general cognitive functioning with age, education, and vocabulary knowledge

Regressors	B	Std. error	$\beta$	<i>t</i>	<i>p</i>	R <sup>2</sup>
Unschooled ( <i>n</i> =35)						
Constant	195.44	19.26		10.15	<0.001	
Age (years)	-1.02	0.24	-0.56	-4.27	<0.001	0.514
Education (years)	1.34	0.62	0.28	2.16	0.039	
K-WAIS-IV vocabulary	0.22	0.24	0.12	0.92	0.365	
Schooled ( <i>n</i> =68)						
Constant	132.20	11.18		11.82	<0.001	
Age (years)	-0.11	0.15	-0.08	-0.74	0.460	0.217
Education (years)	0.12	0.32	0.05	0.37	0.715	
K-WAIS-IV vocabulary	0.30	0.10	0.42	3.11	0.003	

B: regression coefficients, K-WAIS-IV: Korean Wechsler Adult Intelligence Scale 4th ed, Std. error: standard error of regression coefficient,  $\beta$ : standardized regression coefficient.

nitive functioning in this group of elderly people or the occurrence of problems in the measurement process. It is possible that the vocabulary in the K-WAIS-IV vocabulary subtest were too difficult for the less educated elderly people, or the recall format was disadvantageous for people with less education. Nevertheless, our findings suggested that clinicians should be cautious when estimating premorbid or current general intelligence utilizing Wechsler intelligence test vocabulary scores in elderly people with minimal education.

Another important implication of this study is the possibility that vocabulary knowledge may not be a valid or effective proxy of cognitive reserve in elderly people with low education. Vocabulary knowledge is also well known to be preserved in normal aging and various pathological aging conditions.<sup>7,10-12</sup> Also, ever since Snowdon et al.<sup>33</sup> reported that linguistic ability in early life had a strong association with neuropathology of Alzheimer's disease as well as cognitive functioning in late life, many studies have reported that vocabulary knowledge is positively correlated with cognitive performance in elderly individuals.<sup>13,14</sup> Based on these, many studies have regarded vocabulary knowledge as the individual ability to compensate for the negative effect of late-life changes in the brain, and used vocabulary knowledge as a representative measure of cognitive reserve.<sup>15-18</sup> However, it is unknown whether vocabulary knowledge can equally serve as a proxy for cognitive reserve in all elderly population, since the studies that have explored vocabulary knowledge as a factor of cognitive reserve have mainly included elderly people who have received more than primary education. For example, Riley et al.<sup>13</sup> investigated the association between early life vocabulary and late life cognitive function in an elderly group in which >82% of the participants had finished high school. Also, Tucker-Drob et al.<sup>14</sup> addressed the correlation between vocabulary knowledge and current cognitive ability based on subjects who received average high-school education (mean education=13.4, SD=2.7). In this study, we showed that vocabulary knowledge was not significantly associated with general cognitive functioning of elderly people with <6 years of education, which suggests that it might not be an effective proxy of cognitive reserve in this sub-set of the elderly population.

The elderly individuals who did not receive formal primary education in early life might have developed their cognitive ability through other accumulated experiences outside school. Thus, it is possible that they might have a different form of cognitive reserve from those of well-educated people. Several previous studies have attempted to measure cognitive reserve by assessing daily activities such as social, physical and leisure activities.<sup>34-36</sup> Leon and colleagues validated the Cognitive Reserve Scale (CRS), which assesses various activities in four cat-

egories such as daily living, training-information, hobbies, and social life, and showed that there was no significant relationship between the CRS total score and vocabulary knowledge; whereas, education was significantly associated with the CRS total score.<sup>37</sup> This is consistent with our findings, and further supports the possibility that vocabulary knowledge may not be an appropriate proxy for cognitive reserve in the elderly population with a wide-range of education.

Our study has some limitations. We included only female elderly individuals in the analyses, since the number of male elderly people who did not complete primary schooling is smaller than that of the female elderly population in Korea. Also, the number of the participants in the "unschooled" group was relatively small, as compared to that of the "schooled" group. Future studies with a larger number of cases including male elderly people are needed to generalize the findings of this study.

In conclusion, this study investigated the usefulness of vocabulary knowledge measure in estimating premorbid or current-status of cognitive functioning. The results showed that vocabulary knowledge was not a predictor of cognitive ability in elderly people with minimal educational attainment, while it was a predictor of cognitive ability in those who had completed primary schooling or above. These findings highlight the importance of the educational factor in the assessment of cognitive aging and dementia, and provide evidence that vocabulary knowledge is not an effective measure to estimate premorbid general cognitive functioning or cognitive reserve in the elderly population with very low educational attainment. Alternative proxies of cognitive reserve and premorbid cognitive function need to be identified or developed for these elderly people.

#### Conflicts of Interest

The authors have no financial conflicts of interest.

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