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Normative Data of the Phonemic Fluency Test in Korean Middle-Aged and Elderly Population

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Objective：The available normative data for the phonemic fluency test in Korean older adults have concerns for its utility. The aim of the currently study is to provide the normative data that overcome the issues of the previous norms.

Methods：Total of 443 middle- and old-aged non-demented adults participated in this study. All participants underwent comprehensive assessments conducted by trained psychiatrists and psychologists. Diagnosis was made based on formal guidelines prior to administering the phonemic fluency test.

Results：The norms on two age groups (50−59 and 60−90 years) with different strata of the education levels for the age groups are provided.

Conclusion：The goal of the current study, which was to overcome the shortcomings of the previously published normative data and establish an updated reference for the Korean version of the phonemic fluency test, is achieved.

KEY WORDS：Normative data · Korean older Adults · Phonemic fluency test.

Introduction

Phonemic fluency test is a commonly used neuropsychological assessment tool to investigate lexical skills in patients with language disorders of neurological origin, such as aphasia or other cognitive-linguistic impairments due to neurodegenerative diseases or brain injuries, among others. This test is generally considered to impose demands upon executive functions.[1)] On this task, examinees are asked to orally generate words beginning with a given letter in a limited time, typically 60 seconds. Sociodemographic variables, such as formal education, age and sex, may interfere with individual performance on such tasks,[2-4)] therefore, studies investigating appropriate reference values in different populations are vital in order for it to be used meaningfully.

Similar to the English version of the phonemic fluency test, the Korean version uses three Korean consonants and the time limit is also 60 seconds per letter. Although a normative reference is available (Seoul Neuropsychological Screening Battery-second edition; SNSB-II),[5)] several weaknesses may limit its utilization. First, the process that was applied to exclude individuals with possible dementia was not based on a combination of comprehensive clinical and neuropsychological assessments.[6)] Rather, individuals with "suspicious" scores on a battery of cognitive tests were deemed as having dementia and were excluded without clinical decision made by clinicians with expertise in aging and dementia. Second, while the published normative data appear to offer detailed reference norm blocks (i.e., nine age groups between 45 years to 90 years of age; seven educational groups between illiterate to 21 years; and, two sex groups), majority of the blocks included less than 20 individuals with some blocks less than 5 individuals or as little as one. In an attempt to derive means and standard deviations (SD) for the norm blocks with insufficient size, the authors applied statistical manipulations to derive a mean or SD.[5)] Given that a reference norm block with size less than 30 individuals can be problematic,[7,8)] it leaves its users with concerns and risks. Third, the normative reference of the SNSB-II is based on the data collected by 78 test administrators; as such, inter-

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rater reliability can be a serious issue.

Therefore, the aim of the current study was to provide an updated normative data for the Korean version of the phonemic fluency test that addressed the abovementioned issues of the previously published normative data, thereby providing users with options.

Subjects and Methods

Participants

The sample included 443 community dwelling healthy non-demented participants from the Korean Brain Aging Study for the Early Diagnosis and Prediction of Alzheimer's disease (KBASE) cohort (249 females and 194 males; 50–90 years of age; zero to 21 years of education). The participants' mean age was 69.96 years and mean years of education was 11.32.

The details of the KBASE cohort are provided in a previous article.[9] At the time of the enrollment, a psychiatrist with advanced training in neuropsychiatry and dementia and a psychometrist with extensive training in administering neuropsychological tests to older adults assessed each participant according to the KBASE protocol based on the Korean version of the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) assessment battery,[10] which includes comprehensive clinical as well as neuropsychological evaluations. A clinical review panel consisted of several board-certified psychiatrist and a clinical neuropsychologist with expertise in the field of dementia research reviewed all available data from the evaluations and made clinical decisions on the diagnosis. Individuals diagnosed with dementia according to the criteria detailed in the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, text revision (DSM-IV-TR)[11] were not included in the current sample. Furthermore, individuals with evidence of serious medical, psychiatric or neurological disorders were not included; for example, individuals with evidence of focal brain lesions on MRI, presence of severe behavioral or communication problems that would make a neuropsychological assessment uninterpretable, or inability to read Korean were excluded. All participants showed adequate vision and hearing for the assessments.

This study was approved by the Institutional Review Board of Seoul National University Hospital (SNUH, IRB No. 1401-027-547), and all subjects provided written informed consent before participation.

Measurement

The F-A-S form of the phonemic fluency test is the most widely cited in international literature and commonly employed in clinical settings.[12,13] For the Korean version, three consonants (ㄱ, ㅇ, ㅅ) were selected based on the frequency of phonemes.[14] The administration rule is identical to the English version,[15,16] where a practice trial was given with an example letter prior to the actual trial. The participants were given one minute for each letter. Names of places or persons, perseverations, and intrusions were counted as incorrect responses. Also, multiple words using the same stem with a different suffix (e.g., go, gone, going) were not accepted and only the first one was counted as correct if it was a valid word. The number of valid words generated for each trial was summed to derive a score for each letter; and, the total score was the sum of all three trials.

Four trained psychometrists administered the test to the participants. In order to ensure inter-rater reliability, each psychometrist was trained on the administration and scoring rule by a clinical neuropsychologist (DY); and, the scoring of the responses was reviewed by at least one more psychometrist other than the test administrator.

Table 1. Correlation coefficients of age, education, and sex with the sub-scores of the phonemic fluency test

	Age	Education	Sex†
Letter "ㄱ"	-0.250*	0.519*	0.148*
Letter "ㅇ"	-0.147*	0.453*	0.209*
Letter "ㅅ"	-0.238*	0.466*	0.181*

*: p<0.01. †: Point-biserial correlation coefficient

Statistical analyses

All analyses were performed using the statistical software SPSS, version 25.0 (IBM Corp., Armonk, NY, USA). The significance level considered was $p<0.05$.

Results

Bivariate correlation analyses between the demographic variables and the phonemic fluency test total scores showed that education had the strongest association with the total score ($r=0.53$, $n=443$, $p<0.001$); age also had statistically significant association with the total score ($r=-0.24$, $n=443$, $p<0.001$). Sex showed relatively weaker but statistically significant association with the total score ($r_{pb}=0.20$, $n=443$, $p<0.001$). Correlation coefficients between the demographic variables and the sub-scores of the phonemic fluency test are shown in Table 1.

The relative effects of age, education and sex on the phonemic fluency test total score was explored by using regression analyses where each variable was entered separately. Education accounted for 28.5% of the variance; in contrast, age accounted for only 5.5% of the variance and sex accounted for 4.0%. Hierarchical linear regression analysis was performed by entering education, age, and sex in order based on the

above analyses. The variance of the effects explained by age and sex were reduced to 1.9% and 0.1%, respectively.

Although the performance on the phonemic fluency test was affected by all demographic variables, given that sex accounted for less than 1% of the variance, the following analyses on the main effects were conducted on the data stratified by education and age only. For further exploration of the data, it was divided into 3 age groups and 3 educational levels based on observation of frequency distribution of the current data, in order to ensure sufficient size in each cell. Figure 1 shows that within each age group the total score increases with higher education.

A 3×3 factorial design analysis of variance was conducted to determine presence of any interaction effects as well as main effects of the age groups and education groups on the phonemic fluency test total score (Fig. 1). It was shown that only education was found to have significant main effects on the total score of the phonemic fluency test [F (2, 443)=68.26, p<0.001]; age groups did not show statistically significant main effects on the total score [F (2, 443)=1.68, p=0.19]. However, a significant interaction effects was found between education and age [F (4, 443)=5.48, p<0.001], which was largely driven by the young and highly educated group. The total score of the phonemic fluency test decreased with decreasing levels of education for all age groups. The effect of education was particularly strong among the youngest group, likely due to the fact that almost all individuals in this age group are highly educated. Among the lowly educated group, the total score did not differ between the age groups [F (2, 118)=0.89, p=0.41]. Regarding the older groups, Tukey's post hoc tests revealed that there were no statistically significant differences on the total score between the 60−74 and 75−90 age groups at each level of education.

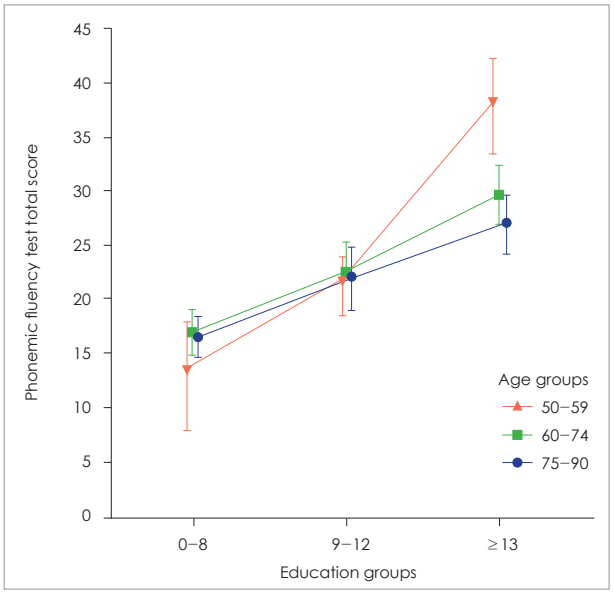

Figure 1. Performance on the phonemic fluency test as a function of three education levels and three age groups.

Normative data

On the basis of these analyses and visual inspection of the data, it was decided to provide the norms on two age groups (50−59 and 60−90 years), with different strata of the education levels for the age groups: Two levels of education (9−12 and ≥13 years) applied to the 50−59 age group as there were insufficient participants with education less than 9 years and four levels of education (0−6, 7−12, 13−16, and ≥17 years) applied to the 60−90 age group. As expected, education had significant main effects on the total score for the 60−90 age group [F (3, 374)=35.74, p<0.001]; Tukey's post hoc test revealed significant differences between the four education groups for the 60−90 age group. The normative data for total score of the phonemic fluency test are provided in Table 2. Table 2 shows that within each age level the total score increases with increasing education. Normative information for each letter is provided in the Appendix 1−3.

Discussion

In this study, we presented normative values for the Korean version of the phonemic fluency test derived from a large sample of non-demented middle- and old-aged individuals in South Korea. The population was stratified into two age groups with two or four levels of education. Different levels of education for each age group were applied for the normative data given the fact that most middle-aged adults in their 50s are highly educated. In both age groups, performance was significantly influenced by education, where subjects

Table 2. Normative data for phonemic fluency test: total score

Statistics	Age 50−59 years		Age 60−90 years			
	Education (years)		Education (years)			
	9−12 (n=26)	≥13 (n=35)	0−6 (n=97)	7−12 (n=155)	13−16 (n=93)	≥17 (n=30)
Mean	21.11	38.06	16.09	22.51	27.34	35.50
Standard deviation	6.67	12.60	7.48	9.38	9.90	11.16
Median	21.00	38.00	15.00	21.00	27.00	33.50
5th percentile	8.40	12.80	4.00	10.60	13.00	10.60
95th percentile	33.30	68.20	31.00	40.40	44.90	49.90

with higher educational attainment performed significantly better than those with lower education. Compared to the current normative data, the previously published normative data appear to overestimate performance of lowly educated younger group and underestimate highly educated older group.

The goal of the current study, which was to overcome the shortcomings of the previously published normative data and establish an updated reference for the Korean version of the phonemic fluency test, is achieved. A fundamental issue of establishing a normative reference group in older population is with identifying their healthy non-demented status. For the previously published normative data, authors reported that they excluded the participants with "suspicious" scores—including the performance on the phonemic fluency test—as they were deemed to have dementia; however, this was not corroborated by evidence from comprehensive clinical assessments. Consequently, it is unclear whether or not those excluded actually met the dementia diagnosis. In contrast, the current study established non-demented status from clinical decisions made by expert clinicians based on comprehensive clinical and neuropsychological evaluations. Such process made it possible to clearly identify the individuals who met the formal criteria of dementia[11,17] and therefore be excluded, independent of the performance on the phonemic fluency test.

Obtaining a sufficient size for each norm block is important for establishing good quality normative data. Most norm blocks in the current study are based on 30 individuals or more, with the smallest size norm block based on 26 individuals. In contrast, several norm blocks of the previously published normative data have less than 5 individuals.[5] In addition, while it offers normative data for sex groups separately, majority of norm blocks have less than 20 individuals. Moreover, some norm blocks have no participants (e.g., female older than 80 years old with higher than 13 years of education, etc.). Yet, the SNSB-II manual still presents means and SDs for those norm blocks based on the estimates derived from a model-based standardization approach,[5] heavily relying on statistical manipulations rather than true observations.

The previously published normative data are gathered from the works of 78 test administrators consisted of psychologists, graduate students as well as undergraduate students who were trained by the authors.[5] While efforts were made to improve inter-rater reliability, such as providing training through a workshop, the degree of inter-rater reliability between the 78 test administrators is unknown. In the current study, only four psychometrists—all of who were trained by a clinical neuropsychologist—participated in testing the entire study sample.

Taken together, the current study offers the normative data that have overcome a couple of major issues that the previous normative data were unable to address. The users are provided with options to choose from based on their needs and suitability. While there are many strengths of the current study, future studies with increased sample size for each norm block will be beneficial. In addition, given that the Korean adults in their 50s and younger are generally very highly educated, an updated normative study would be imperative as the Korean middle-aged adults age. While a limitation of the current study is lack of normative reference in lowly educated younger group, it likely will not affect its utility as individuals in their 50s are rarely undereducated. In addition, similarly to the English phonemic fluency test, development of different versions using other letters will be helpful.

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□ Appendix □

Appendix 1. Normative data for phonemic fluency test: first letter "ㄱ"

Statistics	Age 50–59 years		Age 60–90 years			
	Education (years)		Education (years)			
	9–12 (n=26)	≥13 (n=35)	0–6 (n=97)	7–12 (n=155)	13–16 (n=93)	≥17 (n=30)
Mean	7.08	13.00	5.31	7.46	8.90	11.50
Standard deviation	2.02	4.30	3.17	3.34	3.17	4.24
Median	7.00	13.00	5.00	7.00	9.00	12.00
5th percentile	2.70	4.60	0.00	3.00	4.70	3.65
95th percentile	10.65	22.60	11.00	14.00	14.30	18.45

Appendix 2. Normative data for phonemic fluency test: first letter "ㅇ"

Statistics	Age 50–59 years		Age 60–90 years			
	Education (years)		Education (years)			
	9–12 (n=26)	≥13 (n=35)	0–6 (n=97)	7–12 (n=155)	13–16 (n=93)	≥17 (n=30)
Mean	6.46	12.00	5.19	7.32	8.96	10.80
Standard deviation	3.37	4.63	3.14	3.78	4.19	4.47
Median	6.00	12.00	5.00	7.00	9.00	10.50
5th percentile	1.00	3.00	0.00	2.00	3.00	2.10
95th percentile	12.95	21.20	11.10	15.00	17.30	17.45

Appendix 3. Normative data for phonemic fluency test: first letter "ㅅ"

Statistics	Age 50–59 years		Age 60–90 years			
	Education (years)		Education (years)			
	9–12 (n=26)	≥13 (n=35)	0–6 (n=97)	7–12 (n=155)	13–16 (n=93)	≥17 (n=30)
Mean	7.58	13.06	5.60	7.72	9.48	10.20
Standard deviation	2.96	4.88	2.87	3.74	4.16	3.68
Median	7.00	12.00	5.00	8.00	9.00	10.00
5th percentile	3.35	4.40	1.00	3.00	3.70	2.65
95th percentile	13.65	24.00	11.20	14.00	16.30	16.45