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Extended verbal fluency in older adults: Results of a 2-minute test across animal, object, and food categories with frequently listed words

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ABSTRACT

Background: Verbal fluency tests are widely used to assess cognitive function in dementia and evaluate word retrieval in stroke, typically within one minute. Although extending the test duration improves sensitivity to cognitive decline, 2-minute data in older Thai adults remain limited.

Objectives: This study aimed to evaluate the performance of older adults in Nonthaburi on a 2-minute verbal fluency test across animal, object, and food categories, reporting frequently listed words and exploring influential factors such as age, gender, and education.

Materials and Methods: This cross-sectional study recruited 147 healthy adults aged 60-89, categorized into three age groups: 60-69, 70-79, and 80-89. All participants were Central Thai speakers, had no history of neurological disorders, scored above 23 on the Thai Mental State Examination (TMSE), and underwent an oral reading of the Noo Jaew Passage and an oral motor examination by speech-language pathologists. Participants completed a 2-minute verbal fluency task in three categories: animal, object, and food. Responses were transcribed and analyzed using one-way ANOVA, independent t-tests, and regression analysis to examine the relationships between verbal fluency performance and relevant variables. Inter-rater reliability was assessed using the Intraclass Correlation Coefficient (ICC).

Results: Participants had an average age of 70.6 (SD=7.3) years, and 75% were females. The average TMSE score was 28.3 (SD=1.5), and the average years of education was 13.4 (SD=4.6). The 2-minute test yielded an average of 26.3 (SD=7.0) animals, 32.0 (SD=10.2) objects, and 24.2 (SD=7.3) foods. Significant differences were found across age groups ($p \leq 0.001$), with the 60-69 group outperforming older groups in the animal category. Gender influenced performance only in the food category. ICC values ranged from 0.982 to 0.997, indicating excellent inter-rater reliability.

Conclusion: This study reported the performance of older Thai adults on a 2-minute verbal fluency test, highlighting the effects of age, education, gender, and language-specific scoring. Frequently listed words may inform culturally relevant assessments and training materials. Future research should investigate alternative measures beyond word count to enhance cognitive assessments in clinical settings.

Introduction

Verbal fluency assessments are valuable tools for evaluating cognitive impairments associated with stroke and dementia. These tests measure the capacity for word retrieval in aphasia and cognitive functions, typically within one minute. Verbal fluency has two types: semantic fluency, which involves listing words that belong to a specific category, and phonemic fluency, which requires generating

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words that begin with a specified letter.[1] Phonemic fluency tests require literacy skills, whereas semantic fluency tests are typically less demanding but can be influenced by educational levels.[2] Previous studies on the 1-minute verbal fluency of Thai adults have reported an average of 17.3-19.4 words in the animal category,[2-5] 20.2 words in the object category, and 15.0 words in the food category.[4] Expanding beyond the animal category can enhance assessment options.[4]

Thailand has transitioned into an "Aging Society," with 19% of its 66 million population, or 13 million individuals, aged 60 years or older.[6] In Nonthaburi, 20.5% of the residents are seniors.[6] This aging population is at an increased risk for dementia, with a prevalence rate ranging from 2.4% in adults over 45[7] to 3.4-9.9% in those 60 years and older in Thailand.[8,9] These situations contribute to the need for more nuanced cognitive tests. Extending the administration time of the verbal fluency test to two minutes increases sensitivity to detect cognitive changes associated with aging. A longer duration allows for observing declines in word retrieval capabilities, offering a more comprehensive assessment.[10] Individuals with neurodegenerative diseases, such as those with amyotrophic lateral sclerosis (ALS), produced a significantly lower number of responses (p=0.008).[11] Cognitive decline is a common issue among individuals with various neurological conditions, and having a baseline for healthy older adults can facilitate early detection and intervention. There is no established data on 2-minute verbal fluency performance among older adults in Thailand.

This study aimed to address this gap by assessing performance on a 2-minute verbal fluency test involving animal, object, and food categories among older Nonthaburi individuals aged 60-69, 70-79, and 80-89. This study also aimed to identify factors such as age, gender, and education influencing word count. In line with previous research, this study hypothesized that verbal fluency performance might decline slightly with age, and that gender, education, and cognitive status could also be possible contributing factors to the number of words generated. These insights will assist in interpreting the results and planning targeted training. Moreover, the study reported frequently listed words by older Thai individuals. The collection of these words will help create assessment tools and treatment programs for Thai patients.

Materials and methods

This study employed a cross-sectional design and was reported following the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines. The research involved a group of healthy elderly individuals from Nonthaburi, Thailand. The sample size was calculated using the finite sample proportion method through the n4Studies application,[12] based on 2019 data from the Department of Older Persons, which reported a senior population of 239,410 in Nonthaburi.[13] The participants were organized into age groups: 60-69, 70-79, and 80-89, reflecting the demographic distribution.[14] The calculated sample size was 140, with an additional 5% added for potential data loss, resulting in 147 participants. The study included 147 participants, with 84 individuals aged 60-69, 45 aged 70-79, and 18 aged 80-89. Purposive sampling was utilized to select participants who were either healthy clients or caregivers at the Sirindhorn National Medical Rehabilitation Institute and elderly individuals engaged in activities at the Center for Older People's Quality of Life in Nonthaburi. Data were collected in person at these locations from October 2020 to July 2021. No participants withdrew from the study during data collection.

Inclusion and exclusion criteria: the study targeted healthy Thai individuals aged between 60 and 89 who spoke the Central Thai dialect. Eligibility criteria required that participants have no history of cerebral or neurological diseases, no severe visual or auditory impairments, and the ability to perform daily tasks independently. Participants were excluded if their TMSE (Thai Mental State Examination) score was ≤23,[15] if they demonstrated an inability to read or repeat the passage intelligibly, or if they failed the oral motor examination.

Participants were initially screened for dementia using the TMSE.[15] Visual and auditory functions were assessed by inquiring about any existing impairments and through practical tests to confirm their ability to see images and read text, which was particularly important during the TMSE and while reading the Noo Jaew Passage.[16] Auditory capabilities were evaluated using a finger-rubbing test[17] to ensure auditory clarity. The oral reading of the Noo Jaew Passage helped assess speech intelligibility; participants who were unable to read were asked to repeat the text after hearing it from an examiner. Oral motor examinations were conducted by speech-language pathologists (SLPs) to assess the functionality of speech-related organs.

All participants provided written informed consent before participating in the study. Screenings and assessments were carried out by researchers and speech-language pathologists (SLPs), ensuring that only participants with clear and intelligible speech were included in the study.

Participants were given two minutes per category (animal, object, and food) to generate as many words as possible without any cues. Categories were randomly assigned to avoid bias, and no examples were provided. The researchers used neutral nonverbal expressions, such as slight smiling or nodding, to encourage appropriate responses, without giving any corrective or negative feedback. Participants who paused or expressed difficulty were gently encouraged to continue. The researchers defined "food" as any edible, typically complete dish. Each valid and intelligible word within its category was scored once. Repeated words, words not in the target language, intrusions (words outside the intended category), and non-specific terms (e.g., "cooked food," "fried food," or "fish" without specifying how it was prepared) received no points. Variations of words (beginning or ending with the same word) were scored up to two times. For instance, "noodles" and "fish noodles" would result in a score only for "fish noodles." Similarly, "fried chicken," "fried fish," and "fried meat" would collectively score only twice. Synonyms such as "dog" and "canine" (or "สุนัข" and "หมา"

in Thai) or "TV" and "television" (or "ทีวี" and "โทรทัศน์" in Thai) were counted once.

Data analysis

The researchers transcribed the recordings and tallied the words produced. Inter-rater reliability was assessed on a randomly selected 10% of responses (N=14) using alphanumer cal codes. Sample size for estimating the intraclass correlation coefficient (ICC) was calculated using the n4Studies Plus application.[18,19] Based on a two-tailed test (expected agreement=0.95, minimum acceptable value=0.75, two raters, α=0.05, power=80%), the required sample size was 12; thus, the selected 14 participants provided sufficient power for reliability analysis. A third speech therapist, with 18 years of clinical experience and blinded to the initial scores, independently re-scored these recordings. ICCs were calculated with 95% confidence interval using a two-way random-effects model with an absolute agreement definition. Values less than 0.5 indicated poor reliability; values between 0.5 and 0.75 indicated moderate reliability; values between 0.75 and 0.9 indicated good reliability, and values greater than 0.90 indicated excellent reliability.[20]

Demographic data were presented as percentages, means, standard deviations, and 95% confidence intervals. A one-way ANOVA was conducted to compare means across the three age groups; Independent T-tests were used to compare means between genders; and multiple regression analysis was employed to investigate how age, TMSE score, gender, and education influenced word counts in each category. All statistical analyses were performed using SPSS 29.0.

Results

The study included 147 healthy older adults in Nonthaburi, 110 women and 37 men, 70 participants from the Center for Older People's Quality of Life, and 77 from Sirindhorn National Medical Rehabilitation Institute. The average TMSE score across the sample was 28.3 (SD=1.5). Statistical analysis using one-way ANOVA demonstrated significant differences in TMSE scores among the three age groups (p=0.017, η^2=0.055, medium effect), as detailed in Table 1. A Chi-square test revealed no significant gender distribution differences among age groups (p=0.096, Cramér's V=0.179, small effect). Bonferroni-adjusted post hoc comparisons following one-way ANOVA revealed that individuals aged 60-69 exhibited significantly higher TMSE scores than those aged 80-89 (p=0.024).

Table 1 Demographic data and average words within 2 minutes of each age group.

Variables	60-69 (N=84)	70-79 (N=45)	80-89 (N=18)	Total (N=147)	*p* value	Effect size
Age	65.1±2.7 (64.5, 65.7)	75.5±1.5 (75.0, 75.9)	84.1±1.9 (83.2, 85.1)	70.6 ± 7.3 (69.4, 71.8)	<0.001**	0.902
Female (%)	67 (80%)	33 (73%)	10 (56%)	110 (75%)	0.096	0.179
TMSE	28.5±1.4 (28.2, 28.8)	28.1±1.5 (27.6, 28.5)	27.5±1.8 (26.6, 28.4)	28.3±1.5 (28.0, 28.5)	0.017*	0.055
Education (years)	13.5±4.5 (12.6, 14.5)	13.6±4.4 (12.2, 14.9)	12.3±5.7 (9.5, 15.2)	13.4±4.6 (12.6, 14.1)	0.586	0.007
Animal	28.0±6.1 (26.6, 29.3)	24.8±6.7 (22.7, 26.8)	22.2±9.3 (17.5, 26.8)	26.3±7.0 (25.1, 27.4)	0.001**	0.090
Object	34.6±9.1 (32.6, 36.6)	31.0±10.4 (27.9, 34.1)	22.4±8.3 (18.3, 26.5)	32.0±10.2 (30.4, 33.7)	< 0.001**	0.152
Food	26.1±7.2 (24.5, 27.6)	23.1±5.4 (21.4, 24.7)	18.3±8.5 (14.1, 22.6)	24.2±7.3 (23.0, 25.4)	< 0.001**	0.124

*Note: Values are reported as mean±SD (95% CI lower, 95% CI upper), p values from one-way ANOVA and Chi-square test (Female), *p<0.05, **p<0.01, considered statistically significant. Effect sizes are reported as Eta squared (η^2; 0.01=small, 0.06=medium, 0.14=large), and Cramér's V for Female (0.10=small, 0.30=medium, 0.50=large).*[21]

Regarding education, the average length of education across the sample was 13.4 (SD=4.6), showing no significant differences between the age groups (p=0.586, η^2=0.007, small effect). Education levels among participants were as follows: one individual was illiterate with non-formal education; 17 individuals had completed primary education (4-6 years); 38 had completed secondary education (7-12 years); and 91 had completed tertiary education (13-21 years). Within the tertiary education category, 12 held diplomas, 50 held bachelor's degrees, 27 held master's degrees, and two had earned doctoral degrees.

The 2-minute verbal fluency test yielded an average of 26.3 (SD=7.0) words for animals, 32.0 (SD=10.2) words for objects, and 24.2 (SD=7.3) words for food. There were marked differences in performance across these categories among different age groups (p≤0.001, η^2=0.090-0.152, medium to large effects). Bonferroni-adjusted post hoc comparisons indicated that participants aged 60-69 produced significantly more animal words than those aged 70-79 and 80-89 (p=0.034, p=0.004). The 80-89 age group produced significantly fewer words for objects compared to the 60–69 and 70-79 groups (p<0.001, p=0.004), and for

food compared to the 60-69 and 70-79 groups (p<0.001, p=0.045), as presented in Table 2.

A multiple linear regression analysis exploring the factors influencing verbal fluency revealed that advancing age significantly predicted lower word counts across all categories (β=-0.213 to -0.277, p≤0.005), with adjusted R^2 values of 0.241 for animals, 0.402 for objects, and 0.312 for food. In contrast, higher TMSE scores were associated with increased verbal fluency in all categories (β=0.251 to 0.313, p≤0.002), and extended period of education was also significantly correlated with greater word counts in the animal, object, and food categories (β=0.215 to 0.323, p≤0.008), as shown in Table 3.

Table 2 Comparative analysis of age, TMSE, education, and verbal fluency between different age groups.

Variables	60-69 vs 70-79	60-69 vs 80-89	70-79 vs 80-89
Age	-10.4 (-11.4, -9.4) p<0.001**	-19.0 (-20.5, -17.6) p<0.001**	-8.6 (-10.2, -7.1) p<0.001**
TMSE	0.5 (-0.2, 1.1) p=0.269	1.0 (0.1, 2.0) p=0.024*	0.6 (-0.4, 1.6) p=0.521
Education (years)	0.0 (-2.1, 2.0) p=1.000	1.2 (-1.7, 4.1) p=0.965	1.2 (-1.9, 4.3) p=1.000
Animal	3.2 (0.2, 6.2) p=0.034*	5.8 (1.5, 10.1) p=0.004**	2.6 (-2.0, 7.2) p=0.516
Object	3.6 (-0.6, 7.8) p=0.119	12.2 (6.3, 18.1) p<0.001**	8.6 (2.3, 15.0) p=0.004**
Food	3.0 (-0.1, 6.1) p=0.062	7.7 (3.4, 12.1) p<0.001**	4.7 (0.1, 9.4) p=0.045*

*Note: Values are reported as mean difference (95% CI lower, 95% CI upper), p values were obtained from Bonferroni-adjusted post hoc comparisons following one-way ANOVA, *p<0.05, and **p<0.01, considered statistically significant.*

Table 3 Regression coefficients and significance levels of each verbal fluency (N=147).

Predictor	Animal Adjusted R^2=0.241	Object Adjusted R^2=0.402	Food Adjusted R^2=0.312
Age	B=-0.207 β=-0.213 p=0.005**	B=-0.374 β=-0.268 p<0.001**	B=-0.279 β=-0.277 p<0.001**
TMSE	B=1.310 β=0.283 p=0.001**	B=2.089 β=0.313 p<0.001**	B=1.206 β=0.251 p=0.002**
Education	B=0.329 β=0.215 p=0.008**	B=0.714 β=0.323 p<0.001**	B=0.383 β=0.241 p=0.002**
Gender	B=1.451 β=0.090 p=0.225	B=2.881 β=0.124 p=0.061	B=3.339 β=0.199 p=0.005**

*Note: Analyses were conducted using data from 147 participants. B: unstandardized regression coefficients β: standardized coefficients and corresponding p-values, *p<0.05 and **p<0.01, considered statistically significant, adjusted R^2: percentage of variance in the target variable explained by the predictors, a value of 1 reflects perfect prediction, whereas a value less than or equal to 0 indicates that the model has no predictive value.*

Gender did not significantly affect word count in the animal and object categories (p=0.225 and 0.061, respectively), but it did significantly impact the food category according to regression analysis (β=0.199, p=0.005). This finding was consistent with the results from the independent t-test, where gender differences were statistically significant in average age (p=0.043, d=0.387) and word count in the food category (p=0.008, d=- 0.515), as presented in Table 4.

For reliability, Table 5 shows that ICC ranged from 0.982 to 0.997, indicating excellent inter-rater reliability. Scores obtained from the examiner with less clinical experience strongly agreed with the senior assessors.

Table 4 Comparison of characteristics by gender.

Variables	Female (N=110)	Male (N=37)	*p* value	Cohen's *d*
Age	69.9±6.8 (68.7, 71.1)	72.7±8.3 (70.1, 75.3)	0.043*	0.387
TMSE	28.3±1.5 (28.0, 28.6)	28.2±1.5 (27.7, 28.7)	0.919	-0.019
Education	13.1±4.8 (12.2, 14.0)	14.3±3.9 (13.0, 15.5)	0.165	0.265
Animal	26.7±6.9 (25.4, 28.0)	25.0±7.3 (22.8, 27.4)	0.215	-0.237
Object	32.8±10.2 (30.8, 34.6)	29.7±9.8 (26.5, 33.2)	0.106	-0.309
Food	25.1±6.8 (23.9, 26.3)	21.4±8.2 (18.7, 24.2)	0.008**	-0.515

*Note: Values are reported as mean±SD (95% CI lower, 95% CI upper), p values were obtained from an independent T-test; *p<0.05 and **p<0.01, considered statistically significant, effect sizes are reported as d (Cohen's d; 0.2=small, 0.5=medium, 0.8=large).*[21]

Table 5 Inter-rater reliability.

(N=14)	Intraclass correlation[b]	95% Confidence interval	
		Lower bound	Upper bound
Animal	0.989	0.966	0.996
Object	0.997	0.992	0.999
Food	0.982	0.946	0.994

Note: [b]Type A intraclass correlation coefficients using a two-way random-effects model with absolute agreement definition.

Discussion

This study is the first known investigation of 2-minute verbal fluency among older Thai adults, focusing on animal, object, and food vocabulary. A literature review revealed no prior studies on word counts in the object or food categories in 2-minute fluency, with existing research limited to the animal category fluency.[2-5] Therefore, our comparisons are confined to 1-minute fluency within the same demographic[4] and 2-minute animal fluency across languages,[11,22,23] as shown in Tables 6-8.

Table 6 Comparison of 1-minute and 2-minute verbal fluency test results by age group and category.

Category	Age group	1-minute test	2-minute test	Difference
Animal	60-69 (N=84)	20.6±5.0 (19.5, 21.7)	28.0±6.1 (26.6, 29.3)	7.3±7.9 (5.6, 9.0)
	70-79 (N=45)	18.1±5.1 (16.6, 19.6)	24.8±6.7 (22.7, 26.8)	6.7±8.4 (4.2, 9.1)
	80-89 (N=18)	16.6±5.2 (14.2, 18.9)	22.2±9.3 (17.5, 26.8)	5.6±10.7 (0.7, 10.5)
	60-89 (N=147)	19.4±5.3 (18.5, 20.2)	26.3±7.0 (25.1, 27.4)	6.9±8.8 (5.5, 8.3)
Object	60-69 (N=84)	21.9±6.2 (20.5, 23.2)	34.6±9.1 (32.6, 36.6)	12.8±11.0 (10.4, 15.1)
	70-79 (N=45)	19.4±6.9 (17.4, 21.5)	31.0±10.4 (27.9, 34.1)	11.6±12.5 (7.9, 15.2)
	80-89 (N=18)	14.3±4.9 (12.0, 16.6)	22.4±8.3 (18.3, 26.5)	8.1±9.6 (3.7, 12.6)
	60-89 (N=147)	20.2±6.7 (19.1, 21.3)	32.0±10.2 (30.4, 33.7)	11.8±12.2 (9.9, 13.8)

Table 6 Comparison of 1-minute and 2-minute verbal fluency test results by age group and category. (Continue)

Category	Age group	1-minute test	2-minute test	Difference
Food	60-69 (N=84)	16.4±4.7 (15.3, 17.4)	26.1±7.2 (24.9, 27.6)	9.7±8.6 (7.9, 11.5)
	70-79 (N=45)	13.7±3.2 (12.8, 14.7)	23.1±5.4 (21.5, 24.7)	9.4±6.3 (7.5, 11.2)
	80-89 (N=18)	12.1±4.6 (10.0, 14.2)	18.3±8.5 (14.1, 22.6)	6.2±9.7 (1.8, 10.7)
	60-89 (N=147)	15.0±4.6 (14.3, 15.8)	24.2±7.3 (23.0, 25.4)	9.2±8.6 (7.8, 10.6)

Note: Values are reported as mean±SD (95% CI lower, 95% CI upper).

Table 7 Comparison of 1-minute and 2-minute verbal fluency test results by gender and category.

Category	Gender	1-Minute Test	2-Minute test	Difference
Animal	Female (N=110)	19.7±5.4 (18.7, 20.7)	26.7±6.9 (25.4, 28.0)	7.0±8.8 (5.4, 8.6)
	Male (N=37)	18.4±4.8 (16.8, 19.9)	25.0±7.3 (22.8, 27.4)	6.7±8.7 (3.9, 9.5)
	All (N=147)	19.4±5.3 (18.5, 20.2)	26.3±7.0 (25.1, 27.4)	6.9±8.8 (5.5, 8.3)
Object	Female (N=110)	20.7±7.0 (19.4, 21.9)	32.8±10.2 (30.8, 34.6)	9.5±8.2 (8.0, 11.1)
	Male (N=37)	18.8±5.8 (17.0, 20.7)	29.7±9.8 (26.5, 33.2)	8.1±9.2 (5.2, 11.1)
	All (N=147)	20.2±6.7 (19.1, 21.3)	32.0±10.2 (30.4, 33.7)	9.2±8.6 (7.8, 10.6)
Food	Female (N=110)	15.6±4.6 (14.7, 16.5)	25.1±6.8 (23.9, 26.3)	12.1±12.3 (9.8, 14.5)
	Male (N=37)	13.3±4.0 (12.0, 14.6)	21.4±8.2 (18.7, 24.2)	10.9±11.4 (7.2, 14.5)
	All (N=147)	15.0±4.6 (14.3, 15.8)	24.2±7.3 (23.0, 25.4)	11.8±12.2 (9.9, 13.8)

Note: Values are reported as mean±SD (95% CI lower, 95% CI upper).

Table 8 Comparison of 2-minute verbal fluency test results across studies and populations.

Study	Population	N	Age	Semantic verbal fluency (animals)	Language
This Study	Healthy	147	70.6±7.3 (69.4, 71.8)	26.3±7.0 (25.1, 27.4)	Thai
Barois *et al.*[22]	MS patients	68	52.3±12.1	24.6±8.4	French
	Healthy	33	49.4±9.6	34.9±7.5	French
Scholtissen *et al.*[23]	PD patients	25	66.4±10.6	29.7±8.1	Dutch
	Healthy	15	66.6±13.1	34.3±11.9	Dutch
Perez *et al.*[11]	ALS patients	42	Median 62 (IQR=15)	Median 25 (IQR=13)	Spanish
	Healthy	42	Median 62 (IQR=16)	Median 30.5 (IQR=13)	Spanish

Note: Values are reported as mean±SD or median, IQR: interquartile range, 75th percentile-25th percentile).

The analysis revealed excellent inter-rater reliability, with ICC values ranging from 0.982 to 0.997 across all categories and time intervals, as values above 0.90 indicate excellent agreement.[20] These findings align with those reported by Carnero-Pardo et al.,[24] who found an ICC of 0.96 for the semantic verbal fluency test. Although Woods *et al*.[25] used a computerized scoring system and reported test–retest rather than inter-rater reliability, the ICCs were lower: 0.77 for semantic and 0.91 for phonemic verbal fluency. The high inter-rater reliability observed in the present study may be attributed to scoring procedures and audio-recorded responses. This level of consistency supports the robustness and objectivity of the data used for further analysis.

Compared to the 1-minute results,[4] Table 6 shows that the 60-69 age group produced the highest word increase with the extra minute across all categories, with gains of 7.3 words for animal, 12.8 for object, and 9.7 for food. The 70-79 group also outperformed the 80–89 group in each category. When comparing by gender in Table 7, females consistently produced more words than males across all categories, with increases of 7.0 words for animal, 9.5 for object, and 12.1 for food.

Verbal fluency scores vary across languages and are influenced by age, education, cultural context, and scoring criteria.[4,26,27] In 1-minute verbal fluency Thai studies, findings from Charernboon and Suttichujit *et al*. are consistent, with both studies reporting an average of 19.4 words, with standard deviations of 5.0 and 5.3, respectively.[2,4] During the 1-minute tests, the 60-69 age group outperformed the 70-79 and 80-89 groups in the animal and food categories.[4] When extended to two minutes, only their animal category scores remained significantly higher. In contrast, the 80s group showed lower performance than the 60s and 70s groups in the object category during the 1-minute test, which further declined in the food category during the 2-minute test.

Extending the test duration to 2 minutes provides a more nuanced view of verbal fluency, capturing delays and discrepancies that may signal early cognitive decline in older adults. This additional time helps reveal variations in word production strategies across different categories. Regression analysis showed that while age is associated with reduced word output across all categories, higher TMSE scores and more education correlate with increased word production. Our study observed significant gender differences only in the food category, possibly due to cultural factors, as Thai women traditionally play a central role in food preparation.[28] Cultural influences, including gender roles and educational access, can impact verbal fluency across languages.

The rationale for using a 2-minute test to uncover cognitive challenges aligns with research on verbal fluency differences between patients and healthy controls, as shown in Table 8. Studies by Barois *et al*., Scholtissen *et al*., and Perez *et al*. have investigated how neurological conditions like multiple sclerosis (MS), Parkinson's disease (PD), and amyotrophic lateral sclerosis (ALS) impact verbal fluency.[11,22,23] Compared to healthy controls, ALS and MS patients produced significantly fewer responses (p=0.008; p<0.001).[11,22] MS patients also demonstrated significantly longer delays before the first word, slower production speeds, and extended inflection times (p<0.001), suggesting substantial executive and linguistic processing difficulties.[22] In contrast, PD patients showed no significant differences in total word count, switching, or clustering abilities (p=0.16, p=0.48, p=0.99, respectively), indicating that PD primarily affects motor switching and concept-shifting rather than the processes of cognitive switching needed in the fluency task.[23]

Compared with 2-minute results from other studies, Barois *et al*.[22] found a significant difference in semantic verbal fluency scores between French-speaking MS patients and healthy controls (p<0.001), and Perez *et al*.[11] also found a significant difference between Spanish-speaking ALS patients and healthy controls (p=0.008). In contrast, Scholtissen *et al*.[23] reported no significant difference between Dutch-speaking PD patients and healthy controls (p=0.16), as detailed in Table 8.

In this study, the lower word count compared to other languages likely stems from distinct scoring criteria and the structure of the Thai language, which encourages repetition. In the animal category, Thai vocabulary includes many subgroups, such as words beginning with ปลา (pla:; fish) and นก (nók; bird) or set phrases like หมูหมากาไก่ (mŭ: mă: ka: kàj; pig, dog, crow, chicken). Food names also follow similar patterns based on protein type, as seen with ก๋วยเตี๋ยว (kŭaj tĭ:aw; noodles) and ข้าวผัด (kʰâ:w pʰàt; fried rice) variations, making it easier to recall familiar patterns rather than unique items. Additionally, longer, complex dish names slow down recall. For instance, ข้าวหน้าปลาซาบะทอดซีอิ๊ว (kʰâ:w nâ:p la: sa: bàʔ tʰɔ̂:t si: ʔíw; grilled saba with soy sauce over rice, eight syllables) and ต้มจืดผักกาดขาวใส่เต้าหู้หลอด (tôm tɕù:t pʰàk kà:t kʰă:w sàj tâw hû: lɔ̀:t; clear soup with cabbage and tofu, nine syllables) require more time to articulate, limiting opportunities for additional responses.

The scoring rule of this study, which limits credit to two words per subgroup, further challenges participants by restricting patterned responses. This approach mainly affects categories like animal and food, where similar prefixes and subgroup patterns are common, whereas the object category shows fewer subgroup repetitions, allowing more unique responses. This scoring approach aligns with the criteria outlined in Olabarrieta-Landa et al.'s study.[29] Superordinate words (e.g., "fish") were allowed if specific examples from that category (e.g., "shark," "sardine") were not also included. Proper names, unrelated words, repeated words, and variations due to number, diminutives, or augmentations were excluded. In the animal category, words showing gender variations (e.g., "cow," "bull") and developmental stages of the same animal (e.g., "calf," "cow") were accepted. Additionally, extinct animals and mythical or magical creatures were allowed.[29]

Perez's and Scholtissen's studies[11,23] used Troyer *et al*.'s method,[30] which involves counting clusters and switching in verbal fluency tasks. In this approach, clusters are divided into subgroups, such as farm animals, pets,

aquatic animals, and insects, and switching is measured by tracking transitions between clusters to reflect participants' cognitive flexibility. In contrast, Barois's study did not measure clusters or switching but instead evaluated factors like first-word delay and inflection time to capture processing speed and executive function.[22]

Based on these findings, the following suggestions are proposed to support clinical decision-making regarding verbal fluency assessment. In patients with brain injuries, such as traumatic brain injuries or cerebrovascular accidents, a 1-minute verbal fluency test is generally sufficient. Extending the test to 2 minutes may cause stress for participants who experience word-finding difficulties. However, for adults without brain lesions, a 1-minute test may be insufficient to detect subtle cognitive impairments related to language function. In such cases, a 2-minute test serves as a more suitable tool. It is easy to administer, does not require specialized equipment or motor function, and is not time-consuming. Regarding category selection, the food category appears less influenced by participants' educational level, making it particularly suitable for individuals with low or no formal education.[4] However, men who do not typically engage in cooking activities may be disadvantaged by this category and might perform better with object-related tasks. Moreover, repeated administration of the animal category may result in task familiarity or learning effects. Therefore, incorporating alternative categories can help reduce potential bias and support a more accurate assessment result. The collected word lists may help develop culturally appropriate tools for assessment and intervention in Thai adults.

Limitation

This study has several limitations. The sample included relatively few participants aged 80 and above, and most participants were from Nonthaburi province, which is like Bangkok, but may not fully represent the broader Thai older adult population. These factors may limit the generalizability of the findings to other sociocultural contexts. Therefore, variables such as age, education, and cultural background should be considered when interpreting verbal fluency performance.

To enhance representativeness and external validity, future research should recruit participants from diverse regions, age groups, and socioeconomic backgrounds. There is also a need to develop a comprehensive Thai verbal fluency assessment that incorporates both semantic and phonemic components. Although the F-A-S format is widely adopted for phonemic verbal fluency testing in English,[31,32] Thai-language studies have thus far been limited to one-minute tasks using consonants such as /k/ ("ก")[33] and /s/ ("ส")[3] and evidence on 2-minute phonemic fluency still lacking. Moreover, the current study focused solely on category-based semantic fluency; phonemic fluency and more nuanced performance features such as clustering and switching were not assessed. Furthermore, additional performance features, including clustering (grouping words into subcategories), switching (shifting between clusters), intrusions, and perseverations, should be explored to capture the full complexity of verbal fluency and improve its diagnostic utility in both clinical and research contexts.

Conclusion

This study provides valuable insights into 2-minute verbal fluency among older Thai adults, particularly in the unique linguistic and cultural contexts of animal, object, and food vocabulary. Our findings highlight the effects of age, education, and gender on verbal fluency performance and the role of language-specific scoring criteria that influence response diversity, especially in categories like animal and food. Extending the fluency test to 2 minutes proved effective in identifying variations in cognitive processing and early signs of cognitive decline, suggesting its potential as an early detection tool. Comparisons with previous research also emphasize the need for flexible, culturally relevant scoring systems, given how linguistic structure impacts fluency performance.

Ethical approval

This study received ethical approval from the Sirindhorn National Medical Rehabilitation Institute Human Ethics Committee in Nonthaburi Province, Thailand (Approval No. 63017).

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

CReDIT authorship contribution statement

Nicha Kripanan: conceptualization, methodology, validation, formal analysis, investigation, data curation, writing - original draft, visualization, project administration; **Somjit Ruamsuk:** investigation, resources, writing - review and editing, supervision, funding acquisition; **Thanwarat Artayakul:** validation, data curation, writing - review and editing, visualization; **Isara Suttichujit:** investigation, data curation, funding acquisition.

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Appendix

Frequently listed words from the 2-minute verbal fluency test results from all participants

This table presents the 30 most frequently listed words from a verbal fluency task, categorized into three semantic groups: Object, Animal, and Food. Each entry includes the Thai word, its International Phonetic Alphabet (IPA) transcription, the English translation, and the frequency count based on participant responses. In cases where multiple words shared the same frequency at the final rank (rank 30), those words are presented together under the same ranking.

	Object		**Animal**		**Food**	
1	โต๊ะ /tó?/ Table	147	ช้าง /tɕʰáːŋ/ Elephant	137	ก๋วยเตี๋ยว /kŭaj tĭːaw/ Noodles	141
2	รถยนต์ /rót jon/ Car	134	ควาย /kʰwaːj/ Buffalo	130	แกงจืด/ต้มจืด /kɛːŋ tɕɯ̀ːt/, /tôm tɕɯ̀ːt/ Clear soup	130
3	เก้าอี้ /kâw ʔîː/ Chair	125	วัว /wuːa/ Cow	130	ข้าวผัด /kʰâːw pʰàt/ Fried rice	106
4	รองเท้า /rɔːŋ tʰáːw/ Shoes	111	หมา /mă:/ Dog	129	ผัดกะเพรา /pʰàt kàʔ pʰraw/ Stir fried with basil	101
5	ช้อน /tɕʰɔ́ːn/ Spoon	107	แมว /mɛːw/ Cat	123	ต้มยำ /tôm jam/ Tom yum soup	97
6	เตียง /tiːaŋ/ Bed	101	ไก่ /kàj/ Chicken	115	แกงส้ม /kɛːŋ sôm/ Sour curry	95
7	พัดลม /pʰát lom/ Fan	94	ม้า /máː/ Horse	112	ยำ /jam/ Spicy salad	94
8	กางเกง /kaːŋ keːŋ/ Pants	93	ปลา /plaː/ Fish	110	แกงเขียวหวาน /kɛːŋ kʰĭːaw wăːn/ Green curry	89
9	ปากกา /pàːk kaː/ Pen	91	นก /nók/ Bird	107	น้ำพริก /nám pʰrík/ Chili paste	82
10	กระทะ /kràʔ tʰáʔ/ Pan	88	เสือ /sŭ̌ːa/ Tiger	105	ปลาทอด /plaː tʰɔ̂ːt/ Fried fish	69
11	ดินสอ /din sɔ̌ː/ Pencil	85	หมู /mŭː/ Pig	101	แกงเผ็ด /kɛːŋ pʰèt/ Spicy curry	63
12	โทรศัพท์ /tʰoː rá sàp/ Phone	82	งู /ŋuː/ Snake	97	ผัดผัก /pʰàt pʰàk/ Stir-fried vegetables	63
13	หม้อ /mɔ̂ː/ Pot	81	ลิง /liŋ/ Monkey	96	ราดหน้า /râːt nâː/ Stir-fried noodles in gravy sauce	62
14	นาฬิกา /naː líʔ kaː/ Clock / Watch	80	สิงโต /sĭŋ toː/ Lion	95	ผัดเผ็ด /pʰàt pʰèt/ Spicy stir-fried curry	57

	Object		Animal		Food	
15	เสื้อ /sɯ̂ːa/ Shirt	80	ยีราฟ /jiːráːp/ Giraffe	88	ลาบ /lâːp/ Spicy minced meat salad	57
16	กระเป๋า /kràʔ păw/ Bag	79	จระเข้ /tɕɔː ráʔ kʰêː/ Crocodile	86	ไข่เจียว /kʰàj tɕiːaw/ Omelet	54
17	ทีวี /tʰiː wiː/ TV	78	เป็ด /pèt/ Duck	76	ข้าวเหนียว /kʰâːw nǐːaw/ Sticky rice	54
18	ชาม /tɕʰaːm/ Bowl	74	กระต่าย /kràʔ tàːj/ Rabbit	67	ส้มตำ /sôm tam/ Papaya salad	52
19	ตู้เย็น /tûː jen/ Refrigerator	74	หนู /nǔː/ Rat	64	ขนมจีน /kʰà nɔ̌m tɕiːn/ Fermented rice noodles	50
20	จาน /tɕaːn/ Plate	72	กระรอก /kràʔ rɔ̂ːk/ Squirrel	61	ผัดไทย /pʰàt tʰaj/ Pad Thai	48
21	แก้ว /kêːw/ Glass	70	จิ้งจก /tɕîŋ tɕòk/ Lizard	60	แกงมัสมั่น /kɛːŋ mát sà màn/ Massaman curry	42
22	ตู้ /tûː/ Cabinet	70	แรด /rɛ̂ːt/ Rhinoceros	57	ผัดซีอิ๊ว /pʰàt siː ʔíw/ Stir-fried noodles in soy sauce	42
23	เสื้อผ้า /sɯ̂ːa pʰâː/ Clothes	63	เต่า /tàw/ Turtle	55	แกงไก่ /kɛːŋ kàj/ Chicken curry	39
24	ถ้วย /tʰûaj/ Cup	62	ปลาวาฬ /plaː waːn/ Whale	53	แกงเลียง /kɛːŋ liːaŋ/ Herbal mixed vegetable soup	39
25	ถุงเท้า /tʰŭŋ tʰáːw/ Socks	60	ม้าลาย /máː laːj/ Zebra	53	สลัด /sà làt/ Salad	38
26	แว่นตา /wɛ̂ːn taː/ Glasses	59	กวาง /kwaːŋ/ Deer	49	ไก่ย่าง /kàj jâːŋ/ Grilled chicken	37
27	หมอน /mɔ̌ːn/ Pillow	59	ชะนี /tɕʰáʔ niː/ Gibbon	46	สเต็ก /sà tèk/ Steak	37
28	ขวด /kʰùːat/ Bottle	54	อิปโปฯ /híp poː/ Hippopotamus	46	บะหมี่ /bàʔ mìː/ Egg noodles	36
29	ส้อม /sɔ̂ːm/ Fork	53	ตุ๊กแก /túk kɛː/ Gecko	45	ข้าวต้ม /kʰâːw tôm/ Boiled rice	34

	Object		Animal		Food	
30	กะละมัง /kàʔ láʔ maŋ/ Basin	50	หมี /mǐː/ Bear	42	ทองหยอด /tʰɔːŋ jɔ̀ːt/ Golden egg-yolk drops	33
	สบู่ /sà bùː/ Soap	50				
	แอร์ /ʔɛː/ Air conditioner	50				
	ยาสีฟัน /jaː sǐː fan/ Toothpaste	50				

Note: IPA transcriptions were from thai-language.com; English dish names were cross-referenced and adapted from thaifoodmaster.com.