



Phonological verbal fluency norms for Spanish-speaking middle-aged and older adults: Letters F, A, and S

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Título: Normas de fluidez verbal fonológica para adultos de mediana edad y mayores hispanohablantes: Letras F, A y S

Resumen: *Antecedentes:* Las pruebas de fluidez verbal se utilizan con frecuencia en la evaluación neuropsicológica. Este estudio presenta datos normativos de fluidez verbal fonológica (FAS) para adultos de mediana edad y mayores de habla hispana, considerando factores sociodemográficos y medidas como el número total de palabras, errores y palabras evocadas en segmentos de 15 segundos. *Método:* Participaron 920 adultos cognitivamente intactos, de 50 a 89 años. Se utilizaron procedimientos estadísticos para convertir rangos percentiles en puntuaciones escalares, obteniendo una distribución normal. Se analizaron los efectos de la edad, educación y sexo mediante coeficientes de determinación, aplicando correcciones solo a variables sociodemográficas que explicaran más del 5%. Las puntuaciones ajustadas se calcularon con regresiones lineales. *Resultados:* Se presentan las puntuaciones escalares y percentiles para todas las medidas. Se incluyen tablas suplementarias para ajustes por nivel educativo, ya que no se encontraron diferencias relacionadas con la edad y el sexo. *Conclusiones:* Este estudio ofrece datos normativos actualizados para nativos hispanohablantes europeos, de 50 a 89 años, en pruebas FAS, considerando errores y producción de palabras en segmentos de 15 segundos. Los efectos de la educación coinciden con estudios previos.

Palabras clave: Datos normativos. Fluidez verbal fonológica. Hispano hablantes europeos. Adultos de mediana edad. Adultos mayores.

Abstract: *Background:* Verbal fluency tests are easy and regularly used in neuropsychological assessment. This paper offers normative data of phonological verbal fluency tests (FAS) for Spanish middle- and older-aged adults, considering sociodemographic factors, and different measures such as the total number of words, errors, and words evoked in each 15-second segment. *Method:* A total of 920 cognitively unimpaired participants, aged between 50 and 89 years old, participated in the study. The statistical procedure includes the conversion of percentile ranges into scalar scores to obtain a normal distribution. The effects of age, education, and sex were verified by determination coefficients. Corrections were only applied for those sociodemographic variables that explained more than 5%. Linear regressions are used to calculate the scalar-adjusted scores. *Results:* Scalar scores and percentiles for all tests across different measures are shown. Supplementary tables are provided for necessary adjustments considering educational level, since the results showed no differences related to age and sex across analyses. *Conclusions:* This study provides updated and clinically useful normative data for European Spanish-speaking natives, aged from 50 to 89 years, for FAS tests, considering errors and word production over 15-second segments. The influence of education on tasks aligns with findings from previous studies.

Keywords: Normative Data. Phonological Verbal Fluency. European Spanish-speaking. Middle-aged adults. Older adults.

Introduction

Verbal fluency (VF) is not only an important aspect of expressive language ability but also an example of the relevant role that executive functions play in cognition (Amunts, et al., 2021; Greenaway, et al., 2009; Pekala, 2012). Given the simplicity of the task, VF tests have been included in a variety of neuropsychological assessment protocols as useful tools that feature straightforward administration and scoring methods and, because of their strong sensitivity to detect neurological impairments (Cottingham & Hawkins, 2010; García-Herranz et al., 2020; Herbert et al., 2014; Patra et al., 2020; Pérez et al., 2020a; Tung et al., 2021).

The structure of the task is composed of a specific type of words that can be evoked, a specific amount of time to do so, and rules defining what cannot be done during evocation. In a VF test, the participant is asked to produce as many words as possible by following a specific task for a given amount of time, often 60 seconds (Ruff et al., 1997). Four types of VF tasks can be found in the literature: semantic, grammatical, phonological, and combined forms. Phonological fluency (PF), which is the focus of the present paper,

consists in producing words beginning with the same letter (for example: S) or words not containing a certain letter (VF of letter excluded) (Lezak et al., 2004; Özdemir & Tunçer, 2021). Furthermore, each of these verbal fluency tasks can be combined with others (phonological-semantic, phonological-grammatical; semantic-grammatical), for example, alternating between fruits and words beginning with P, names of animals whose last letter is a consonant, or countries of the world whose last letter is a vowel (Marino & Alderete, 2010).

The most used forms of VF tasks, semantic/category (CF) and PF share several processes, such as self-monitoring, planning, maintaining, and updating cues, post-retrieval selection, and mental flexibility (Rende et al., 2002). CF exerts greater demands on the integrity of semantic representation underpinned by the temporal lobe (Grogan et al., 2009) and the hippocampus (Schmidt et al., 2019). However, PF was proposed to predominantly engage controlled access to memory representations and mental lexicon, supported by the frontal lobe (Baldo et al., 2010; Marko et al., 2023). Category search resembles the natural way we seek and retrieve knowledge (Shao et al., 2014); it more accurately reflects automatic associative retrieval processes. In contrast, letter search must comply with artificial constraints, thus it entails the need to suppress the natural mode of retrieving (Heim et al., 2009; Henry & Crawford, 2004), and that is why it is considered to have more executive demands. In this sense, many

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authors consider PF tasks as useful instruments that have special sensitivity in detecting cognitive disorders that affect the frontal lobe (Cipolotti et al., 2018; Rami et al., 2007).

The execution of PF requires the participant to perform a non-routine word search based on a specific lexical representation (first letter). This task relies on an executive (switching) component responsible for strategic search, response initiation, monitoring, shifting, and cognitive flexibility, and an association (clustering), inhibition, and maintenance of effort without the support of hierarchical organization of the semantic memory (Strauss et al., 2006). Inhibition is needed to suppress competitive responses and to avoid perseveration errors (Fisk & Sharp, 2004). Letter fluency implies controlled executive suppression of habitual semantic associates, whereas category fluency primarily engages a free-associative (automatic) retrieval (Marko et al., 2023); PF was proposed to predominantly engage controlled access to memory representations and mental lexicon, supported by the frontal lobe (Baldo et al., 2010), and encourage a search strategy based on phonological/orthographic criteria (Heim et al., 2009).

Numerous studies have pointed to the influence of socio-demographic variables on VF, with age, sex, and education among the most studied (Ekström et al., 2024; Henry & Phillips, 2006; Hirnstein et al., 2023; Mathuranath et al., 2003). Most of the studies have failed to detect differences between men and women in PF (Cavaco et al., 2013; Costa et al., 2014; Khalil, 2010; Kozora & Cullum, 1995; Stewart et al., 2001; Wang et al., 2011), although there are some showing gender differences in a phonological fluency task in Spanish speakers aged between 50-99 (Simpson et al., 2019). Most studies have found a progressive age-related decrease in the number of words generated, as executive processes also show a gradual decline (see, for example, Cavaco et al., 2013; Peña-Casanova et al., 2009; Santos Nogueira et al., 2016). However, others did not find such an effect of age on verbal fluency (Delgado et al., 2024; Khalil, 2010).

The impact of education level on VF performance was articulated substantially in the neuropsychology literature. Most studies indicate that education is one of the demographic variables with the greatest influence on PF. In this sense, a higher number of words produced have been found associated with higher levels of education (Contador et al., 2016; Ratcliff et al., 199f, et al., 1996; Vogel et al., 2019). The notable impact of education level on PF could be linked to the fact that these tasks are more challenging than semantic versions and are more frequently affected by executive dysfunctions (Shores et al., 2006).

Regarding potential interaction between socio-demographic variables in verbal fluency tests, some previous studies have reported for healthy adult people (from 54 to 99 years old) that the best performance on semantic and phonemic tasks is observed in younger people with greater educational level (Kempler et al., 1998). Zimmermann et al. (2014) found an interaction effect between age and educational level but restricted to the discrepancy score between

semantic and phonemic verbal fluency. More recently, Vicente et al. (2011) evaluated the effects of demographic variables on all PF scores (letters F, A, S, and M) using multiple regression analyses. The full regression models included as predictors: age, age², education, education², sex, and all two-way interactions between these variables. The scores for letters F, A, and S were affected by a quadratic age effect, showing a curvilinear pattern of the scores according to age. All scores were affected by education so those with higher education generated more words in each letter. They found an interaction between education² and sex for Letter F so that women outperformed men when they both have between 1-6 and 15 or more years of education. Instead, men outperformed women when they both have between 7-14 years of education.

Previous studies have provided norms for PF tests in the adult population in Spain. One of the first initiatives was developed by Rami et al. (2007), they conducted a study that offered normative values for the population over 60 years of age for tests that evaluated frontal cognitive function. The study involved 110 neurologically healthy people from different primary care centers in Barcelona who were evaluated with the A-line test, the FAS verbal fluency test, and the similarity test. The results showed that years of schooling were a very significant predictor of performance in the three tests. Another pioneering study was conducted by Peña-Casanova et al. (2009), they provided age- and education-adjusted norms for three PF tasks (words beginning with P, M, and R), three semantic fluency tasks (animals, fruit and vegetables, and kitchen tools), and three excluded letter fluency tasks (excluded A, E, and S). The sample in this study consists of 346 participants who are cognitively normal, community-dwelling and range in age from 50 to 94 years. Peña-Casanova et al. used a statistical procedure to distribute their sample across 10 midpoint age groups (aged from 55 to more than 80 years). Lubrini et al. (2022) have provided normative data for F, A, and S and for "proper names," "animals," and "fruits and vegetables" in a study with 257 healthy subjects. Their results pointed out that education was the best predictor of performance in all tasks, followed by age. Lubrini and colleagues assessed participants aged from 17 to 100 years. Their sample was stratified into two groups depending on the number of years of education (less than 13 and equal or more than 13 years), and in two age levels (<60, ≥60) within the low-educational level group. In all cases, the sample sizes were relatively small, and the authors indicated that fact as a limitation of their work. García-Herranz et al. (2022) published normative data using a sample of 382 cognitively healthy 60- to 90-year-old Spanish monolingual participants from the Autonomous Community of Madrid (Spain) having 0-22 years of education. They included commonly used tests in neuropsychological assessment (VF tests, the Trail Making Test [TMT], and the Rey-Osterrieth Complex Figure test [ROCF]). Authors adopted an overlapping interval strategy that involved cell and midpoint techniques, and that assessed the influence of age, education, and sex.

Their results showed that age and education were associated with the scores in the VF tests (as well as TMT and ROCF), while sex only significantly affected the TMT results. More recently, Delgado-Losada et al. (2024) offered normative data of PF (letters P, M, R) based on data obtained with 1165 Spanish adults cognitively unimpaired participants between 50 and 89 years old. The study considered sociodemographic factors (sex, age, and educational level), and different measures such as the total number of words, errors (perseveration and intrusions), and 15 sec-segmented scores. Adjustments were calculated for educational level, since this variable reached the criterion (explains at least 5% of the variance) in some measures, whereas sex and age did not.

Performance on a PF task is typically assessed by the total number of correct words produced within a time limit (Pekkala, 2012). However, this score has some limitations as it doesn't offer insight into the cognitive processes that contribute to fluency performance. This is the reason why some researchers have suggested other measures, such as errors in PF (perseverations and intrusions; Crowe, 1998; Thiele et al., 2016). By tracking the number of perseveration errors, one can gain more information about the status of the central executive component of working memory. Perseverations are linked to problems in the frontal lobe, which often leads to a rigid way of thinking, and a lack of cognitive flexibility (Miller & Cohen, 2001). Intrusions on a PF task could have a phonetic/spelling origin (Rofes et al., 2019) or be executive errors (e.g., forgetting the rule; McDowd et al., 2011). The clinical utility of analyzing error patterns depends on the broader context of the neuropsychological assessment. Other studies have focused on timing; in this case, the emphasis is on generating elements during four segments of 15 seconds each. Generally, participants produce most of their words in the initial stages of the task (the first 30 seconds) by using a semi-automatic rapid retrieval process. As time progresses, lexical retrieval becomes more challenging, resulting in fewer words being produced, particularly those of lower frequency, towards the end of the task (Crowe, 1998; Venegas & Mansur, 2011). Furthermore, education has a positive and significant effect on the first-time segments in PF, however, a significant effect of age has not been found (Venegas & Mansur, 2011).

This paper offers normative data of different PF (F, A, S) for Spanish-speaking older adults natives from Spain (over 50 years old) considering sociodemographic factors (age, education, and sex). A novel feature of the present study is the inclusion of both errors (perseveration and intrusions) and temporal-segmented analyses (i.e., 60-second timeframe analyzed in 15-second increments).

Method

Participants

A total of 920 cognitively unimpaired monolingual Spanish speakers (634 women and 286 men), aged between 50

and 89 years ($M = 69.08$; $SD = 7.62$) were recruited for the study. Females represent approximately 69% of the total sample. Educational level was coded into five categories: without formal education, primary, secondary, or higher according to the National Classification of Education (NCED). The level "without formal education" corresponds to people who are literate but only could go to school for 2 or 3 years (they have only basic reading and writing skills and simple mathematical calculation) (7.5%), "primary" refers to people with primary education or 8 years of formal education (29.4%), "secondary" includes people with secondary and intermediate education or 9 to 12 years of formal education (31.3%), and "higher" incorporates people with higher education and university studies or more than 12 years of formal education (31.8%). Table 1 shows the distribution by sex, educational level, and age group, for the total sample.

Table 1
Distribution of women and men by educational level and age group.

| | | Sex | | |
|-----------|--------------------------|--------|------|-------|
| | | Female | Male | Total |
| Education | Without formal education | 52 | 17 | 69 |
| | Primary | 216 | 54 | 270 |
| | Secondary | 201 | 87 | 288 |
| | Higher | 165 | 128 | 293 |
| Age | 50-59 | 70 | 39 | 109 |
| | 60-69 | 246 | 93 | 339 |
| | 70-79 | 276 | 135 | 411 |
| | 80-89 | 42 | 19 | 61 |

All participants were recruited between 2011 and 2022. Sampling was non-probabilistic incidental; most individuals reside in urban areas of the Autonomous Community of Madrid, were recruited in cultural centers, associations, co-housing centers, and university programs for older adults, and did not receive any remuneration for their participation. Participants were chosen based on the following inclusion criteria: (1) individuals living in the community; (2) aged 50 years or older; (3) a score of 24 or higher on the Mini-Mental State Exam (MMSE; Folstein, Folstein & McHugh, 1975), with adjustments made for educational level (Delgado-Losada et al., 2021); (4) a score of 9 or lower on the 15-item Geriatric Depression Scale (GDS-15; Yesavage et al., 1983); (5) normal cognitive functioning, without meeting the diagnostic criteria for Mild Cognitive Impairment (MCI) (Petersen, 2004) in at least two consecutive prior assessments; (6) the ability to live independently without any severe cognitive or psychiatric disorders that hinder daily activities; (7) normal or corrected hearing and vision; (8) basic skills in reading, comprehension, and writing in Spanish.

This normative study takes the data from one source of European Spanish-speaking cohort study derived from a series of projects of the group CogTra at the Complutense University of Madrid (PSI2012-38375-C03-03; PSI2015-68793-C3-3-R; RTI2018-098762-B-C31; PID2021-122979OB-C22). All studies complied with the ethical standards of the Declaration of Helsinki and were approved by

the local Ethics Committees of the participant institutions. In the projects cited above, the PVF tasks as well as the tests mentioned in the inclusion criteria formed part of more extensive neuropsychological evaluation protocols.

Instruments

In the study, three PF tests were used with the letters F, A, and S. Those screening tests previously mentioned were also included in the assessment protocol (MMSE, GDS-15). Participants were asked to generate as many words as possible beginning with these initial letters in 60 seconds. As a global PF score, it used the number of correct words, excluding intrusions and perseverations. Repetitions and intrusions were counted separately.

PF tests display near-perfect interrater reliability of $r = .98$ (Norris et al., 1995) and a high test-retest reliability of $r = .74$ (Ruff et al., 1996), as well as adequate sensitivity and specificity values, for example, to detect the presence of traumatic brain injury (Henry et al., 2004).

Procedure

Participants completed a structured interview to collect socio-demographic data, and a neuropsychological assessment was conducted by trained neuropsychologists. They were informed about the main research aspects and signed a written informed consent before performing any study procedure.

Following standard instructions (e.g., Lezak et al., 2012), participants were asked to generate as many words as possible that began with each letter in 60 seconds, excluding proper names and derived words or repetitions of the same word with different endings. The examiner recorded repetitions and intrusions – as well as correct words – in the order that they were generated.

To verify the reliability of the scoring procedure for total correct words and errors (intrusions and perseverations), a second rater was used to test interrater reliability. In all cases, reliability coefficients were .99.

Statistical analysis

First, a table of scalar scores (SS) was prepared. Cumulative frequency distribution of the raw scores was generated, and percentile ranges were assigned to the raw scores depending on their place in the distribution. After that, the percentile ranges were converted to SS (see Delgado et al., 2024), using the formula $SS = 10 + 3 * Z$, where Z is the normalized standard score corresponding to the percentile. The transformation of raw scores produced a normal distribution ($M = 10$ and $SD = 3$), which allows us to check whether the sociodemographic variables significantly influence the number of words evoked in the different tasks, as well as to calculate the adjusted scalar scores ($SS_{adjusted}$).

Then, the possible effects of age, education, and sex were verified. Correlation (r) and determination coefficients (R^2) of univariate regressions were calculated of SS s with age, education, and sex for each of the three PF tests considered. Corrections were only applied for those sociodemographic variables that explained more than 5% of the variance and that also had a significant regression coefficient with $p < .05$ (Ferguson, 2009; Peña-Casanova et al., 2009), thus those conditions are used for clinical significance. Finally, the regression coefficient (β) was used as the basis for the corrections. Adjustments were made according to age, education, and sex on the SS , using the following formula:

$$SS_{adjusted} = SS - [\beta_1 * (Age - 70.64) + \beta_2 * (Education - 2) + \beta_3 * Sex]$$

where Age is subtracted by participants' mean age (70.64) and Education by participants' median in education (2: secondary studies), given that education is an ordinal level measured in our study. The inclusion of the central tendency statistic corresponding to each variable allows for obtaining adjusted scores that provide a fine standardized reference. All analyses were performed with SPSS version 25.

Results

Results are presented in the three following subsections. It should be noted that these norms have been obtained only with participants from Spain, thus it might not be valid for other Spanish speakers.

Norms for the total number of correct words produced in PF tests

Table 2 shows descriptive statistics (number of cases, mean, and standard deviation) by sociodemographic variables and PF tests. The effects of age, education, and sex on participants' PF tests are shown in Table 3, which includes correlation (r) and determination coefficients (R^2) for each PF test considered. Results involving age and sex do not reach the criterion value in any case. Furthermore, an analysis including age squared as a predictor did not reach the 5% threshold in any case. Determination coefficients corresponding to education exceed the criterion in F, A, and S, in which this variable explained 11.3%, 14.9%, and 10.2% of the total variance, respectively.

Table 4 includes scalar scores and percentile ranges corresponding to the total number of words evoked by participants across PF tests.

Table 5 presents the adjustments by education (the only variable with a Determination coefficient that exceeded the criterion) in F, A, and S. To explain how to use tables to select the correct scalar score given a raw score and how to use the correction on scalar scores if needed, let us consider an example. If a patient without formal Education produced 16 words with the letter F, we first locate the raw score (16) in

Table 4, then we see the percentile range at the left (81-86) and the corresponding scalar score (13). Since there is a significant influence of educational level in the PF task with the letter F, and this patient has the lowest educational level, it is necessary to correct his/her scalar score by adding two points. Thus, his/her final scalar score would be equal to 15. In the case of a patient with the same raw score but having a higher educational level, his/her scalar score must be corrected by subtracting two points.

Table 2
Descriptive statistics by socio-demographic variables and Total scores in PF Tests: N, Mean and Standard Deviation (SD). N for the total sample is 920.

| | | | | Total F | Total A | Total S |
|-----------|--------------------------|------|-------|---------|---------|---------|
| Sex | Male | Mean | 13.15 | 12.78 | 13.76 | |
| | | N | 286 | 286 | 286 | |
| | | SD | 4.99 | 5.13 | 5.50 | |
| | Female | Mean | 11.94 | 11.69 | 12.74 | |
| | | N | 634 | 634 | 634 | |
| | | SD | 4.69 | 4.55 | 4.77 | |
| Education | Without formal education | Mean | 8.97 | 8.58 | 9.68 | |
| | | N | 69 | 69 | 69 | |
| | | SD | 4.03 | 3.84 | 4.16 | |

| | | | | Total F | Total A | Total S |
|--------|-----------|-------|-------|---------|---------|---------|
| Age | Primary | Mean | 10.76 | 10.25 | 11.67 | |
| | | N | 270 | 270 | 270 | |
| | | SD | 4.57 | 4.34 | 4.58 | |
| | Secondary | Mean | 12.74 | 12.31 | 13.24 | |
| | | N | 288 | 288 | 288 | |
| | | SD | 4.84 | 4.41 | 5.01 | |
| Higher | Mean | 14.14 | 14.24 | 14.98 | | |
| | N | 293 | 293 | 293 | | |
| | SD | 4.32 | 4.55 | 4.81 | | |
| Age | 50-59 | Mean | 14.33 | 13.96 | 14.37 | |
| | | N | 109 | 109 | 109 | |
| | | SD | 3.68 | 3.85 | 4.35 | |
| | 60-69 | Mean | 12.27 | 12.12 | 13.25 | |
| | | N | 339 | 339 | 339 | |
| | | SD | 4.97 | 4.78 | 5.19 | |
| | 70-79 | Mean | 11.97 | 11.72 | 12.73 | |
| | | N | 411 | 411 | 411 | |
| | | SD | 4.94 | 4.87 | 5.07 | |
| 80-89 | Mean | 11.31 | 10.10 | 11.75 | | |
| | N | 61 | 61 | 61 | | |
| | SD | 4.08 | 4.32 | 4.46 | | |
| Total | Mean | 12.32 | 12.03 | 13.06 | | |
| | SD | 4.82 | 4.76 | 5.03 | | |

Table 3
Correlations (r), Significance (p), Confidence Intervals (CI), and Determination Coefficients (R²) for Socio-demographic Variables Across Total Scores of PF Tests.

| | Age | | | | | Education | | | | | Sex | | | | |
|---------|-------|-------|--------|--------|----------------|-----------|-------|--------|--------|----------------|------|-------|--------|--------|----------------|
| | r | p | 95% CI | | R ² | r | p | 95% CI | | R ² | r | p | 95% CI | | R ² |
| | | | Lower | Higher | | | | Lower | Higher | | | | Lower | Higher | |
| Total F | -.171 | <.000 | -.233 | -.108 | .027 | .342 | <.000 | .283 | .397 | .113 | .118 | <.000 | .054 | .181 | .014 |
| Total A | -.187 | <.000 | -.249 | -.124 | .033 | .384 | <.000 | .327 | .438 | .149 | .106 | .001 | .041 | .169 | .011 |
| Total S | -.143 | <.000 | -.206 | -.079 | .022 | .320 | <.000 | .261 | .377 | .102 | .089 | .007 | .024 | .153 | .009 |

Table 4
Scalar Scores and Percentile Ranges Corresponding to the Total Number of words produced by participants Across PF Tests. How to use the table: first locate the raw score, then see the percentile range at the left and the corresponding scalar score.

| Scalar score | Total F | | Total A | | Total S | |
|--------------|-------------------|------------|-------------------|------------|-------------------|------------|
| | Percentile ranges | Raw scores | Percentile ranges | Raw scores | Percentile ranges | Raw scores |
| 2 | <1 | 1 | | | | |
| 3 | 1 | 2 | ≤1 | 1-2 | ≤1 | 2 |
| 4 | 2 | 3 | 2 | 3 | 2 | 3 |
| 5 | 4 | 4 | 4 | 4 | 3-6 | 4-5 |
| 6 | 8-11 | 5-6 | 7-12 | 5-6 | 9 | 6 |
| 7 | 15 | 7 | 19 | 7 | 15-19 | 7-8 |
| 8 | 21-29 | 8-9 | 25-31 | 8-9 | 24 | 9 |
| 9 | 37 | 10 | 41 | 10 | 32-39 | 10-11 |
| 10 | 45-53 | 11-12 | 48-56 | 11-12 | 47-55 | 12-13 |
| 11 | 62 | 13 | 64 | 13 | 62-69 | 14-15 |
| 12 | 69-77 | 14-15 | 71-76 | 14-15 | 76 | 16 |
| 13 | 81-86 | 16-17 | 81-87 | 16-17 | 82-87 | 17-18 |
| 14 | 90-92 | 18-19 | 90-93 | 18-19 | 90-92 | 19-20 |
| 15 | 94-96 | 20-21 | 95 | 20 | 96 | 21 |
| 16 | 97-98 | 22-23 | 97-98 | 21-22 | 97-98 | 22-25 |
| 17 | 99 | 24 | 99 | 23 | 99 | 26-27 |
| 18 | >99 | 25-27 | >99 | 24-26 | >99 | 28-30 |

Table 5
Regression coefficients (β) and Adjustments by Educational Level for the Total scores of the PF Tests.

| | Regression coefficients (β) | Education | | | |
|---------|-----------------------------|--------------------------|---------|-----------|--------|
| | | Without formal education | Primary | Secondary | Higher |
| Total F | 1.074 | +2 | +1 | 0 | -2 |
| Total A | 1.211 | +2 | +1 | 0 | -2 |
| Total S | 0.975 | +1 | 0 | 0 | -1 |

Note. Once the corresponding scale score has been identified in Table 4, it will be corrected according to the person's educational level by adding or subtracting the points that appear in this table.

Norms for errors (perseverations and intrusions)

Table 6 summarizes descriptive statistics by socio-demographic variables and PF tests for participants' errors (perseverations and intrusions).

Table 6
Descriptive Statistics (Mean and SD) for Perseverations and Intrusions by Sociodemographic Variables and PF Tests.

| | | Perseverations | | | Intrusions | | | |
|-----------|--------------------------|----------------|-----|-----|------------|-----|-----|-----|
| | | F | A | S | F | A | S | |
| Sex | Male | Mean | .41 | .34 | .46 | .34 | .39 | .46 |
| | | N | 59 | 59 | 59 | 59 | 59 | 59 |
| | | SD | .67 | .57 | 1.05 | .75 | .83 | .91 |
| | Female | Mean | .38 | .45 | .63 | .22 | .25 | .39 |
| | | N | 89 | 88 | 88 | 89 | 88 | 88 |
| | | SD | .63 | .80 | .92 | .53 | .55 | .74 |
| Total | Mean | .39 | .41 | .56 | .27 | .31 | .41 | |
| | N | 148 | 147 | 147 | 148 | 147 | 147 | |
| | SD | .64 | .71 | .98 | .63 | .67 | .81 | |
| Education | Without formal education | Mean | .50 | .50 | 1.17 | .17 | .33 | .33 |
| | | N | 6 | 6 | 6 | 6 | 6 | 6 |
| | | SD | .83 | .83 | 2.40 | .40 | .81 | .51 |
| | Primary | Mean | .21 | .42 | .58 | .11 | .11 | .42 |
| | | N | 19 | 19 | 19 | 19 | 19 | 19 |
| | | SD | .41 | .83 | .90 | .31 | .31 | .60 |
| | Secondary | Mean | .43 | .47 | .65 | .35 | .43 | .57 |
| | | N | 60 | 60 | 60 | 60 | 60 | 60 |
| | | SD | .67 | .83 | .95 | .65 | .74 | .90 |
| | Higher | Mean | .40 | .34 | .40 | .25 | .24 | .27 |
| | | N | 63 | 62 | 62 | 63 | 62 | 62 |
| | | SD | .66 | .54 | .79 | .69 | .67 | .79 |
| Total | Mean | .39 | .41 | .56 | .27 | .31 | .41 | |
| | N | 148 | 147 | 147 | 148 | 147 | 147 | |
| | SD | .64 | .71 | .98 | .63 | .67 | .81 | |
| Age | 50-59 | Mean | .39 | .26 | .42 | .39 | .35 | .42 |
| | | N | 31 | 31 | 31 | 31 | 31 | 31 |
| | | SD | .61 | .44 | .76 | .76 | .55 | .76 |
| | 60-69 | Mean | .30 | .60 | .60 | .23 | .43 | .36 |
| | | N | 47 | 47 | 47 | 47 | 47 | 47 |
| | | SD | .58 | .92 | .99 | .42 | .92 | .73 |
| | 70-79 | Mean | .49 | .41 | .63 | .25 | .24 | .39 |
| | | N | 59 | 59 | 59 | 59 | 59 | 59 |
| | | SD | .70 | .67 | .99 | .73 | .53 | .74 |
| | 80-89 | Mean | .27 | .00 | .40 | .18 | .00 | .80 |
| | | N | 11 | 10 | 10 | 11 | 10 | 10 |
| | | SD | .64 | .00 | .96 | .40 | .00 | .99 |
| Total | Mean | .39 | .41 | .56 | .27 | .31 | .41 | |
| | N | 148 | 147 | 147 | 148 | 147 | 147 | |
| | SD | .64 | .71 | .98 | .63 | .67 | .81 | |

Scalar scores and percentile ranges corresponding to perseveration and intrusion errors across PF tests are shown in Table 7. Education, as well as the other socio-demographic variables, do not reach the 5% criterion in any test, so no adjustment is necessary in this case.

Table 7
Scalar Scores and Percentile Ranges Corresponding to Perseverations and Intrusions Across PF Tests.

| | | Perseverations | | | | | |
|--------------|-------------------|----------------|-------------------|------------|-------------------|------------|-------------------|
| | | F | | A | | S | |
| Scalar score | Percentile ranges | Raw scores | Percentile ranges | Raw scores | Percentile ranges | Raw scores | Percentile ranges |
| 11 | | | | | | | ≤ 65 |
| 12 | ≤ 70 | 0 | ≤ 69 | 0 | | | |
| 13 | | | | | | | 66-88 |
| 14 | 71-91 | 1 | 70-92 | 1 | | | |
| 15 | | | | | | | 89-94 |
| 16 | | | 93-98 | 2 | | | 95-98 |
| 17 | | | 99 | 3 | | | 99 |
| 18 | | | > 99 | 4 | | | > 99 |
| 19 | > 91 | 2 | | | | | |

| | | Intrusions | | | | | |
|--------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|
| | | F | | A | | S | |
| Scalar score | Percentile ranges | Raw scores | Percentile ranges | Raw scores | Percentile ranges | Raw scores | Percentile ranges |
| 12 | ≤ 80 | 0 | ≤ 78 | 0 | | | ≤ 72 |
| 13 | | | | | | | |
| 14 | | | | | | | 73-92 |
| 15 | 81-96 | 1 | 79-94 | 1 | | | 93-96 |
| 16 | 97-98 | 2 | 95-98 | 2 | | | |
| 17 | 99 | 3 | 99 | 3 | | | 97-99 |
| 18 | > 99 | 4 | > 99 | 4 | | | > 99 |
| 19 | | | | | | | |

Norms for the total number of words produced every 15 seconds in each test

Descriptive statistics corresponding to the total number of words produced every 15 seconds by subjects in each PF test are shown in Table 8.

Tables 9a, b, and c show scalar scores, and percentile ranges corresponding to this measure across tests.

Table 8
Descriptive Statistics of the Total Number of Words Produced Every 15 Seconds by Participants in PF Tests Considering Sociodemographic Variables.

| | | F | | | | A | | | | S | | | | |
|--------|------|------|-------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|------|
| | | 1-15 | 16-30 | 31-45 | 46-60 | 1-15 | 16-30 | 31-45 | 46-60 | 1-15 | 16-30 | 31-45 | 46-60 | |
| Sex | Male | M | 4.73 | 3.38 | 2.49 | 2.14 | 4.49 | 3.19 | 2.77 | 2.53 | 4.53 | 3.49 | 2.86 | 2.52 |
| | | N | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 |
| | | SD | 1.73 | 1.71 | 1.73 | 1.42 | 1.68 | 1.82 | 1.69 | 1.69 | 1.74 | 1.65 | 1.63 | 1.63 |
| Female | M | 4.95 | 3.23 | 2.33 | 2.20 | 4.54 | 3.29 | 2.50 | 2.18 | 4.86 | 3.48 | 2.78 | 2.50 | |
| | N | 150 | 150 | 150 | 150 | 149 | 148 | 148 | 148 | 148 | 149 | 149 | 149 | |
| | SD | 1.85 | 1.70 | 1.46 | 1.36 | 1.82 | 1.74 | 1.55 | 1.41 | 1.64 | 1.62 | 1.61 | 1.58 | |
| Total | M | 4.87 | 3.28 | 2.39 | 2.18 | 4.52 | 3.25 | 2.59 | 2.30 | 4.75 | 3.48 | 2.81 | 2.51 | |
| | N | 231 | 231 | 231 | 231 | 230 | 229 | 229 | 229 | 229 | 230 | 230 | 230 | |
| | SD | 1.81 | 1.70 | 1.56 | 1.38 | 1.77 | 1.77 | 1.60 | 1.52 | 1.68 | 1.63 | 1.61 | 1.59 | |

| | | F | | | | A | | | | S | | | |
|--------------------------|-----------|------|-------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|
| | | 1-15 | 16-30 | 31-45 | 46-60 | 1-15 | 16-30 | 31-45 | 46-60 | 1-15 | 16-30 | 31-45 | 46-60 |
| Education | | | | | | | | | | | | | |
| Without formal education | <i>M</i> | 3.60 | 2.50 | 1.30 | 1.30 | 2.70 | 2.00 | 1.70 | 1.30 | 3.67 | 1.60 | 2.00 | 1.90 |
| | <i>N</i> | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 10 | 10 | 10 |
| | <i>SD</i> | 1.95 | 1.43 | 1.05 | .82 | 1.63 | 1.76 | 1.49 | 1.33 | 1.22 | 1.07 | 1.41 | 1.10 |
| Primary | <i>M</i> | 4.10 | 2.61 | 1.80 | 1.97 | 3.64 | 2.45 | 2.13 | 1.72 | 4.10 | 2.97 | 2.10 | 2.11 |
| | <i>N</i> | 61 | 61 | 61 | 61 | 61 | 60 | 60 | 60 | 61 | 61 | 61 | 61 |
| | <i>SD</i> | 1.72 | 1.74 | 1.27 | 1.35 | 1.79 | 1.51 | 1.38 | 1.41 | 1.65 | 1.44 | 1.45 | 1.29 |
| Secondary | <i>M</i> | 5.09 | 3.30 | 2.40 | 2.35 | 4.77 | 3.31 | 2.59 | 2.47 | 4.94 | 3.57 | 2.90 | 2.59 |
| | <i>N</i> | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 |
| | <i>SD</i> | 1.56 | 1.43 | 1.36 | 1.28 | 1.43 | 1.49 | 1.58 | 1.36 | 1.61 | 1.52 | 1.46 | 1.58 |
| Higher | <i>M</i> | 5.44 | 3.94 | 3.03 | 2.26 | 5.23 | 4.04 | 3.11 | 2.73 | 5.20 | 4.08 | 3.42 | 2.83 |
| | <i>N</i> | 72 | 72 | 72 | 72 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 |
| | <i>SD</i> | 1.86 | 1.77 | 1.79 | 1.52 | 1.70 | 1.92 | 1.68 | 1.64 | 1.64 | 1.66 | 1.69 | 1.83 |
| Total | <i>M</i> | 4.87 | 3.28 | 2.39 | 2.18 | 4.52 | 3.25 | 2.59 | 2.30 | 4.75 | 3.48 | 2.81 | 2.51 |
| | <i>N</i> | 231 | 231 | 231 | 231 | 230 | 229 | 229 | 229 | 229 | 230 | 230 | 230 |
| | <i>SD</i> | 1.81 | 1.70 | 1.56 | 1.38 | 1.77 | 1.77 | 1.60 | 1.52 | 1.68 | 1.63 | 1.61 | 1.59 |
| Age | | | | | | | | | | | | | |
| 50-59 | <i>M</i> | 5.68 | 3.94 | 2.74 | 2.03 | 5.32 | 3.65 | 2.52 | 2.74 | 5.55 | 3.61 | 2.90 | 2.87 |
| | <i>N</i> | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| | <i>SD</i> | 1.42 | 1.78 | 1.31 | 1.27 | 1.40 | 1.78 | 1.65 | 1.46 | 1.52 | 1.64 | 1.46 | 1.38 |
| 60-69 | <i>M</i> | 4.91 | 3.20 | 2.40 | 2.30 | 4.34 | 3.09 | 2.63 | 2.26 | 4.76 | 3.29 | 2.87 | 2.61 |
| | <i>N</i> | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 |
| | <i>SD</i> | 2.00 | 1.66 | 1.64 | 1.37 | 1.95 | 1.73 | 1.53 | 1.48 | 1.72 | 1.58 | 1.61 | 1.96 |
| 70-79 | <i>M</i> | 4.69 | 3.16 | 2.32 | 2.08 | 4.43 | 3.25 | 2.63 | 2.35 | 4.52 | 3.58 | 2.74 | 2.40 |
| | <i>N</i> | 111 | 111 | 111 | 111 | 111 | 110 | 110 | 110 | 110 | 111 | 111 | 111 |
| | <i>SD</i> | 1.77 | 1.71 | 1.57 | 1.37 | 1.62 | 1.80 | 1.68 | 1.60 | 1.64 | 1.60 | 1.66 | 1.53 |
| 80-89 | <i>M</i> | 4.47 | 3.21 | 2.16 | 2.53 | 4.39 | 3.22 | 2.39 | 1.44 | 4.72 | 3.44 | 2.83 | 2.17 |
| | <i>N</i> | 19 | 19 | 19 | 19 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| | <i>SD</i> | 1.54 | 1.54 | 1.53 | 1.61 | 2.22 | 1.73 | 1.46 | 1.04 | 1.70 | 1.97 | 1.68 | 1.88 |
| Total | <i>M</i> | 4.87 | 3.28 | 2.39 | 2.18 | 4.52 | 3.25 | 2.59 | 2.30 | 4.75 | 3.48 | 2.81 | 2.51 |
| | <i>N</i> | 231 | 231 | 231 | 231 | 230 | 229 | 229 | 229 | 229 | 230 | 230 | 230 |
| | <i>SD</i> | 1.81 | 1.70 | 1.56 | 1.38 | 1.77 | 1.77 | 1.60 | 1.52 | 1.68 | 1.63 | 1.61 | 1.59 |

Table 9a

Scalar Scores and Percentile Ranges for the Total of Words Starting with F Evoked by Participants every 15 Seconds.

| Scalar score | F | | | | | | | |
|--------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|------------|
| | 0-15 | | 16-30 | | 31-45 | | 46-60 | |
| | Percentile ranges | Raw scores |
| 2 | <1 | 0 | | | | | | |
| 5 | 1-4 | 1 | ≤4 | 0 | | | | |
| 6 | 5-11 | 2 | | | ≤11 | 0 | ≤10 | 0 |
| 7 | 12-19 | 3 | 5-14 | 1 | | | | |
| 8 | | | | | | | | |
| 9 | 20-42 | 4 | 15-33 | 2 | 12-31 | 1 | 11-34 | 1 |
| 10 | | | | | 32-54 | 2 | | |
| 11 | 43-63 | 5 | 34-59 | 3 | | | 35-61 | 2 |
| 12 | | | 60-75 | 4 | 55-79 | 3 | | |
| 13 | 64-81 | 6 | | | | | 62-84 | 3 |
| 14 | | | 76-90 | 5 | 80-88 | 4 | | |
| 15 | 82-94 | 7 | | | | | 85-94 | 4 |
| 16 | 95-98 | 8 | 91-97 | 6 | 89-97 | 5 | 95-98 | 5 |
| 17 | | | 98-99 | 7 | | | | |
| 18 | 99 | 9 | >99 | 8 | 98-99 | 6 | ≥99 | 6-7 |
| 19 | >99 | 10 | | | >99 | 7 | | |

Table 9b
Scalar Scores and Percentile Ranges for the Total of Words Starting with A Evoked by Participants every 15 Seconds

| Scalar score | A | | | | | | | |
|--------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|------------|
| | 0-15 | | 16-30 | | 31-45 | | 46-60 | |
| | Percentile ranges | Raw scores |
| 4 | <2 | 0 | | | | | | |
| 5 | 2-5 | 1 | ≤4 | 0 | | | | |
| 6 | | | | | ≤9 | 0 | | |
| 7 | 6-16 | 2 | 5-16 | 1 | | | ≤13 | 0 |
| 8 | 17-27 | 3 | | | 10-27 | 1 | | |
| 9 | | | 17-38 | 2 | | | 14-32 | 1 |
| 10 | 28-43 | 4 | | | 28-51 | 2 | 33-55 | 2 |
| 11 | 44-69 | 5 | 39-60 | 3 | | | | |
| 12 | | | 61-75 | 4 | 52-73 | 3 | | |
| 13 | | | 76-87 | 5 | 74-86 | 4 | 56-80 | 3 |
| 14 | 70-90 | 6 | | | | | 81-93 | 4 |
| 15 | | | 88-96 | 6 | 87-95 | 5 | | |
| 16 | 91-97 | 7 | | | | | 94-97 | 5 |
| 17 | 98-99 | 8 | 97-99 | 7 | 96-99 | 6 | | |
| 18 | >99 | 9 | >99 | 8 | >99 | 7 | ≥98 | 6-8 |

Table 9c. Scalar Scores and Percentile Ranges for the Total of Words Starting with S Evoked by Participants every 15 Seconds

| Scalar score | S | | | | | | | |
|--------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|------------|
| | 0-15 | | 16-30 | | 31-45 | | 46-60 | |
| | Percentile ranges | Raw scores |
| 3 | ≤1 | 0 | | | | | | |
| 5 | 2-3 | 1 | ≤4 | 0 | | | | |
| 6 | 3-8 | 2 | 5-10 | 1 | <8 | 0 | <11 | 0 |
| 8 | 9-24 | 3 | 11-26 | 2 | 8-22 | 1 | 11-27 | 1 |
| 9 | 25-41 | 4 | | | 23-43 | 2 | | |
| 10 | | | 27-54 | 3 | | | 28-53 | 2 |
| 11 | 42-65 | 5 | | | | | | |
| 12 | | | 55-73 | 4 | 44-70 | 3 | 54-75 | 3 |
| 13 | 66-86 | 6 | 74-87 | 5 | 71-85 | 4 | | |
| 14 | | | | | 86-93 | 5 | 76-89 | 4 |
| 15 | | | | | | | 90-95 | 5 |
| 16 | 87-97 | 7 | 88-97 | 6 | | | | |
| 17 | 98-99 | 8 | | | | | | |
| 18 | >99 | 9 | ≥98 | 7 | ≥94 | 6-8 | ≥96 | 6-8 |

The only socio-demographic variable that affects the results obtained in the PF tests (according to the criterion of the 5% of the total variance explained) is educational level, in all the time segments of the studied letters except for the last

one of the letter F test (46 to 60 sec.: $r = .131, R^2 = .017$) and the letter S test (46 to 60 sec.: $r = .172, R^2 = .030$). Table 10 provides the education adjustments for these time segments in these tests.

Table 10
Correlations (r), Significance (p), Confidence Intervals (CI), Determination Coefficients (R^2), and Regression Coefficients (B) for the Education adjustment of the 15-sec. time segments in all the PF Tests.

| | | Education | | | | | | | | | |
|---|-------|-----------|-------|-------|--------|-------|----------------|-----------|---------|-----------|--------|
| | | Effects | | | | | Adjustments | | | | |
| | | 95% CI | | | | | Without formal | | | | |
| | | r | p | Lower | Higher | R^2 | B | education | Primary | Secondary | Higher |
| F | 0-15 | .327 | <.000 | .206 | .437 | .107 | 1.219 | +2 | +1 | 0 | -1 |
| | 16-30 | .314 | <.000 | .192 | .425 | .098 | 1.054 | +2 | +1 | 0 | -1 |
| | 31-45 | .327 | <.000 | .207 | .438 | .107 | 1.116 | +2 | +1 | 0 | -1 |
| | 46-60 | .131 | .047 | .002 | .256 | .017 | .421 | 0 | 0 | 0 | -1 |
| A | 0-15 | .395 | <.000 | .280 | .499 | .156 | 1.436 | +2 | +1 | 0 | -1 |
| | 16-30 | .375 | <.000 | .258 | .482 | .141 | 1.211 | +2 | +1 | 0 | -1 |
| | 31-45 | .253 | <.000 | .127 | .370 | .064 | .833 | +1 | 0 | 0 | -1 |
| | 46-60 | .268 | <.000 | .144 | .385 | .072 | .863 | +1 | 0 | 0 | -1 |

| | Education | | | | | | | | | | |
|---|-----------|----------|---------------|------|-----------------------|----------|--------------------------|-----------|--------|---|----|
| | Effects | | | | | | Adjustments | | | | |
| | <i>r</i> | <i>p</i> | 95% <i>CI</i> | | <i>R</i> ² | <i>B</i> | Without formal education | | | | |
| | | Lower | Higher | | | | Primary | Secondary | Higher | | |
| S | 0-15 | .267 | <.000 | .142 | .383 | .071 | .965 | +1 | 0 | 0 | -1 |
| | 16-30 | .348 | <.000 | .229 | .457 | .121 | 1.228 | +2 | +1 | 0 | -1 |
| | 31-45 | .324 | <.000 | .204 | .435 | .105 | 1.129 | +2 | +1 | 0 | -1 |
| | 46-60 | .172 | .009 | .043 | .295 | .030 | .609 | 0 | 0 | 0 | -1 |

Discussion

The main purpose of this study is to offer updated normative data of three PF tests (F, A, S) for Spanish-speaking adults natives from Spain (from 50 to 89 years old) considering age, education, and sex, as potentially influential socio-demographic factors. In addition to the data related to the total number of words evoked in each task, the study provides normative data on both errors (perseveration and intrusions) and temporal-segmented analyses (15-second segments).

Results regarding the total number of words produced by participants point out that education is the only significant variable since it explains between 10 and 15% of the total variance. Age and sex do not reach the 5% criterion, and they haven't a significant effect on the data analysis. The absence of a significant age-related decline in phonological verbal fluency among middle-aged and older adults can be attributed to different interconnected factors. For example, one of the most plausible explanations is that PF tasks primarily rely on well-established language networks and lexical retrieval processes that tend to remain relatively stable until very advanced ages. Research suggests that while executive functions and certain cognitive domains decline progressively with age, language-related abilities, especially lexical access and phonological processing, are often preserved longer due to their reliance on highly automatized neural pathways (Turrini et al., 2023). Additionally, the age range studied (50-89 years) may not be sufficiently extreme to capture the subtle declines that typically become more pronounced in very old age (e.g., beyond 85 or 90). Within this middle to older adult spectrum, individual differences such as education, cognitive reserve, and lifestyle factors can also buffer against observable declines, leading to a relatively stable performance across age groups.

The main results, which point to the prominent role of educational level in PF, coincide with those obtained in many previous studies. For example, Tombaugh et al. (1999) conclude in their paper that education accounted for 18% of the total variance in phonological tests (F, A, S), in contrast to the effect of age, reaching 11% of the variance, or the one due to sex, which accounted less than 1%. Dursun et al. (2002) reported similar results regarding the effects of age, total years of education, and sex, on PF scores. Mathuranath et al. (2003) in a study with unimpaired elderly subjects (55-84 years) reported that the level of education, but not age or gender, significantly influenced the letter fluency task they

used. Peña-Casanova et al. (2009) reported the influence of age and education in different PF tests, but sex wasn't found to be a significant variable. Machado et al. (2009) reported that the performance of Brazilian elderly people in the FAS tests of PF is significantly influenced by education, where individuals with a higher educational level perform better than those with fewer years of schooling; however, age and sex were not significant with the FAS.

Fonseca et al. (2021) found an education effect across age groups (young and elderly participants) on PF. Lubrini et al. (2022) provided normative data for F, A, and S (as well as for specific categories) in a study with 257 healthy subjects, and pointed out that education was the best predictor of performance in all tasks, followed by age. Finally, to conclude this list of evidence regarding the prominent role of education on healthy adults' performance on PF tasks, we can also cite a recent study that has presented normative data for European Spanish-speaking adults from 50 to 89 years. García-Herranz et al. (2022) reported a significant effect of educational level (and age) on verbal fluency scores (words beginning with the letter /p/ and names of animals) obtained by healthy participants aged between 60 to 90 years old. Delgado-Losada et al. (2024) offered normative data of PF with letters P, M, and R, with a sample of 1165 participants. The study considered sociodemographic factors (sex, age, and educational level), and different measures such as the total number of words, errors (perseveration and intrusions), and 15 sec-segmented scores, as in the study we describe in this paper. The authors conclude that educational level influenced most of the measures, whereas sex and age did not.

These results regarding the prominent role of education are also consistent with those found in other research conducted by Moraes et al. (2013), which reported that education had the greatest effect on all verbal fluency tasks in their study with 260 healthy adults aged 19 to 75 years. This pattern was also found in a normative study with 932 French-speaking participants, ranging from 19 to 91 years old, from Quebec (St-Hilaire et al., 2016). Pereira et al. (2018) carried out a study using three verbal fluency modalities, phonemic, semantic, and unconstrained, with a sample of 260 healthy adults (from 18 to 80 years old). They concluded that educational level had a greater effect on all three tasks. A normative study with 415 Turkish-speaking individuals showed that the level of education had a main effect on all verbal fluency tasks used, but age and gender had no effect on PF (Aki et al., 2022).

Why is educational level the main variable influencing PF? As noted earlier, PF relies on search and retrieval strategies that depend on accessing the internal lexicon. Individuals with a higher level of education typically possess a larger vocabulary and improved capacity for lexical retrieval, along with the ability to employ more effective retrieval strategies (Brothers et al., 2017; Federmeier et al., 2010). Additionally, formal education and cognitively enriching experiences during early life (cognitive reserve) can promote brain development and influence cognitive functioning in later life (Noble et al., 2015). For example, education and stimulating experiences would increase vocabulary knowledge, which is a strong predictor of PF performance with age (Cegolon & Jenkins, 2022; Henry & Phillips, 2006).

There is evidence indicating that analyzing task performance based on errors provides additional valuable insights (Pakhomov et al., 2018). Our findings do not reveal any impact of sociodemographic variables on the number of errors made by participants. The ranges in raw scores are indeed small, as the sample consists of healthy older adults, making higher scalar scores highly significant for identifying individuals at risk. These results align with the findings of Kozora and Cullum (1995), who noted that the frequency of intrusion and perseveration errors does not seem to increase with normal aging. However, these errors are linked to subjective cognitive impairment and mild cognitive impairment (MCI), and they help differentiate between various neurodegenerative diseases (Nikolai et al., 2018; Pérez et al., 2020; Tessaro et al., 2020).

Regarding measures of participants' word generation performance in 15-second intervals, the analyses indicate that the only socio-demographic variable that affects (in a significant manner) the results obtained in almost all the temporal segments across the PF tests is again the participants' educational level. Similar results have been found in a recent normative study conducted with Spanish-speaking participants in Spain (Delgado-Losada et al., 2024). Demetriou & Holtzer (2017) reported that people with higher educational attainment showed an advantage in the last 15-second segment of the task and explained their results arguing that these subjects have a larger lexicon, greater verbal lexical retrieval capacity, and more efficient information retrieval strategies in comparison to participants with a low educational level. Our results in this subsection also align with findings in the adult population which show that in healthy individuals, the highest word production occurs during the initial phases of the task and gradually decreases, as cognitive demand increases (Buriel et al., 2004). In the last three quartiles, individuals focus on planning, searching, selecting, and monitoring their execution, which helps them generate correct responses while avoiding repetitions and intrusions (Demetriou & Holtzer, 2017). Temporal analysis of PF tests may be useful as a screening tool for cognitive impairment and as an aid in

the differential diagnosis of various neurodegenerative diseases (Jacobs et al., 2021; Pakhomov et al., 2018; Tessaro et al., 2020) attending especially to the level of education of the participants.

Many clinicians and researchers continue using PF tasks with the letters F, A, and S, although there are certain cautions to consider with this choice (Fortuny et al., 1998). Words beginning with the letter F are infrequent in Spanish. In addition, words beginning with the letter A are common, but the starting HA (as in *harina*, flour) is also very frequent, which may be a problem for low literacy people since the letter H is silent in Spanish. Furthermore, the S sound may be confusing in some regions of Spain, which again poses a disadvantage for people with low literacy. For example, C in sequences CE/CI, -as in *cigarro*, cigarette-, and Z in sequences ZA/ZO/ZU, -as in *zorro*, fox-, is pronounced like S.

A potential limitation of this research is that we did not employ epidemiological recruitment methods, which means that potential medical and/or psychological conditions that could affect cognition and self-reported mood were not assessed. Additionally, we did not include illiterate participants, as they are quite rare in Spain. While this choice enhances the representativeness of our sample concerning the Spanish population, the unequal distribution of sexes within the sample should also be noted as a limitation. Furthermore, it is important to mention that these normative data cannot be generalized to Spanish speakers outside of Spain.

In conclusion, this study provides updated normative data for European Spanish-speaking healthy adults in PF tasks with the letters F, A, and S. The influence of education on PF tasks aligns with findings from previous studies. These normative data could be valuable for the correct interpretation of the results obtained by a person in these psychological instruments and for comparisons with other normative studies conducted in Spain and abroad. This study also offers normative data on the number of errors (perseverations and intrusions) and the number of words produced in 15-second intervals in PF tasks with the mentioned letters (F, A, S), which is a novel contribution. Having accurate normative data for PF tasks in specific populations serves as a useful resource for clinical and research purposes, potentially aiding in the early detection of cognitive impairment, diagnosis, prognosis, treatment planning, and monitoring of clinically significant changes.

Complementary information

Conflict of interest.- The authors declare no conflict of interest.

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