UNIVERSIDADE
BEIRA INTERIOR

Fluency Protocol Validation and Norms for Adults and Older People Among the Portuguese Population

VERSÃO FINAL APÓS DEFESA

Ana Catarina Amaral Barradas

Dissertação para obtenção do Grau de Mestre em
Psicologia Clinica e da Saúde
(2º ciclo de estudos)

Orientadora: Prof. Doutora Rosa Marina Afonso
Co-orientadora: Prof. Doutora Sandra Freitas

julho de 2021

Folha em branco

Agradecimentos

À Professora Doutora Sandra Freitas, por todo o conhecimento e sabedoria transmitidos, pelos conselhos, dedicação e apoio, ao longo de todo este ano. Pela excelente profissional que é, e, acima de tudo, pela pessoa incrível que tive a oportunidade e o privilégio de conhecer. Obrigada por acreditar em mim.

À Professora Doutora Rosa Marina Afonso por toda a sua, compreensão e motivação, pelo seu trabalho incansável, e, acima de tudo, por ter sido uma inspiração desde o inicio do meu percurso académico. A sua simpatia dedicação e amabilidade são algo que nunca esquecerei. O meu muito obrigada!

Aos meus pais, que amo incondicionalmente e que me permitiram ser tudo o que sou hoje. Nunca terei palavras suficientes para vos agradecer.

Aos meus irmãos por serem uma fonte inesgotável de amor, inspiração e motivação.

À Mariana Duarte por estar sempre comigo do primeiro ao último dia.

Ao Rodolfo, que esteve sempre presente durante esta caminhada e que mesmo longe esteve sempre tão perto.

A ti Covilhã, que me viste crescer.

Folha em branco

Resumo alargado em Português

Introdução

O Protocolo de Fluência Verbal é amplamente utilizado na avaliação neuropsicológica, devido à sua brevidade, facilidade de administração e sensibilidade ao declínio cognitivo associado a diferentes patologias. A Fluência Verbal está dependente do funcionamento dos lobos frontais e temporais do hemisfério esquerdo. Pessoas com lesões nestas áreas apresentam piores desempenhos na prova o que pode ser indicador de problemas no domínio das funções executivas, da linguagem ou em ambos.
Esta prova consiste em instruir os participantes a gerarem o maior número de palavras que consigam durante sessenta segundos, seguindo instruções específicas. Este teste permite aceder a informação relativa à linguagem, funções executivas, velocidade de processamento, recuperação lexical e produção verbal, fundamental para a avaliação clínica em diferentes contextos. Apesar de se tratar de uma prova muito útil em termos clínicos e de investigação, carece de dados normativos para a população Portuguesa e, apesar da sua ampla utilização, são escassos os estudos sobre a influência das variáveis sociodemográficas no desempenho da fluência verbal. Este estudo tem como objetivos: estabelecer dados normativos para a população portuguesa e analisar a influência de variáveis sociodemográficas (idade, sexo, escolaridade, região geográfica, área de residência, com uma distribuição semelhante à observada na população portuguesa) no desempenho do teste de fluências.

Metodologia

A amostra deste estudo é constituída por 195 indivíduos voluntários cognitivamente saudáveis com idade igual ou superior a 50 anos, residentes em todo o território português. Os critérios de inclusão para a participação no estudo foram: ter idade igual ou superior a 50 anos; ser cognitivamente saudável com autonomia nas atividades de vida diária; ter a língua Portuguesa como língua materna, ter estudado em Portugal e não apresentar défices motores, visuais ou auditivos, que possam afetar o desempenho nos testes. Por outro lado, os critérios de exclusão foram: ter histórico de alcoolismo ou abuso de substâncias; doenças neurológicas ou psiquiátricas; patologias crónicas com impacto na cognição; queixas depressivas significativas e sujeitos que consumam

medicação com possível impacto na cognição (por exemplo, psicotrópicos ou psicofármacos).

Todos os participantes foram submetidos a uma entrevista individual, na qual responderam a um questionário sociodemográfico e a um inventário do estado atual de saúde, de hábitos anteriores e histórico médico. De seguida os participantes responderam a uma bateria de avaliação neuropsicológica constituída pelos seguintes testes: TeLPI, MMSE, TDR, MoCA, GDS-30 e o IAFAI. Todos os participantes que apresentaram um desempenho normal em todas as provas anteriores foram incluídos na amostra e responderam ao Protocolo de Fluências Verbais.

Resultados

Participaram no estudo 195 indivíduos (média de idade = 67.35 ± 9.137 [50-99]; média de educação = 8.69 ± 4.691 [2-22]). Relativamente aos resultados, a análise das propriedades psicométricas gerais do Protocolo de Fluências, revelou uma excelente consistência interna (α=.933). Foi também observada uma influência significativa da idade e escolaridade no desempenho dos participantes. Posteriormente foi realizada uma correlação de coeficientes com estas duas variáveis (idade e escolaridade) que permitiu verificar que o nível de escolaridade contribui significativamente para o total da variância explicada dos resultados da prova com um grande *Effect size*, destacando-se relativamente às restantes variáveis. Este resultado foi corroborado pelos modelos de regressão calculados. Assim, os dados normativos para a população portuguesa foram estabelecidos tendo em conta os níveis de escolaridade estratificados neste estudo.

Discussão de Resultados / Conclusões

Este estudo revelou que o Protocolo de Fluência é um instrumento fiável, válido, sensível e preciso para a avaliação cognitiva da População Portuguesa. As normas estabelecidas em função da escolaridade, com pontos de corte para um resultado normativo nesta prova, poderá constituir um importante indicador em termos de desenvolvimento de processos de avaliação e reabilitação neuropsicológica. Este estudo normativo poderá, assim, ter importantes repercussões ao nível da avaliação neuropsicológica, nomeadamente em quadros de disfunção cognitiva resultante de diversas patologias psiquiátricas e neurológicas e no desenvolvimento de investigação nesta área.

Palavras-chave

Fluência verbal; avaliação neuropsicológica; envelhecimento; declínio cognitivo

Folha em branco

Índice

Fluency Protocol Validation and Norms for Adults and Older People Among the Portuguese Population

Folha em branco

Introduction

The present dissertation in Clinical and Health Psychology aimed to analyze the influence of sociodemographic variables on the participant's performance and validate a more extensive fluency protocol and establish normative data for the adult and elderly Portuguese population, to ensure a more precise use of the instrument.

The Fluency Test is a widely used cognitive assessment instrument to assess cognitive functioning and neurological damage in which, the participants must generate a series of words with specific instructions within sixty seconds. Verbal fluency tests are commonly used in neuropsychological assessment due to their brevity, ease of administration they sensitivity to cognitive decline resulting from different clinical cases. These tests allow access to information regarding several cognitive domains, namely language, executive functions, processing speed, lexical retrieval, verbal production and semantic memory.

The performance of the Fluency Test depends on the activity of the frontal and temporal lobes of the left hemisphere. Poor performance can be an indicator of a problem in the domain of executive functions, language, or both. Verbal Fluency Tests can be used to identify cognitive dysfunction of multiple psychiatric and neurological pathologies. The Verbal Fluency tests are also important for dementia screening and as a differential diagnosis aid. However, despite their potentialities and widespread use, Verbal Fluency remains poorly studied and is not validated for a Portuguese Population what limits its use.

In the present study, we aim to analyze the influence of sociodemographic variables(age, gender, education level, geographic region, area of residence) and establish normative data for the adult and elderly Portuguese population, to ensure a

more precise use of the instrument and contributes to a more reliable cognitive evaluation in Portugal.

The study sample is composed of cognitively 195 healthy adults and older adults residents in the community, who were stratified according to various sociodemographic variables with a distribution similar to that observed in the Portuguese population.

In this study, the Fluency Test revealed an excellent internal consistency, verifying that there was no improvement with the exclusion of any item of the scale. Thus, in the Group Differences analyses we controlling for the effect of these covariates (age and educational level) and estimated the respective effect sizes, observing that the educational level contributed significantly to the explanation of the total explained variance of the Fluency scores with a large effect size that stands out compared to the other variables. Thus, the normative data for the Portuguese population were established considering the strata levels of education included in this study.

In conclusion, The Fluency Test is widely used to evaluate cognitive functioning and neurological damage, dementia screening, and as a differential diagnosis aid and allow us to access information regarding several cognitive domains, namely language, executive functions, processing speed, lexical retrieval, verbal production, and semantic memory. Thus, this study may have important repercussions in terms of neuropsychological assessment, in the development of research and for a more valid, reliable, sensitive, and accurate cognitive assessment instrument for the cognitive assessment of the Portuguese population.

This article is submitted in the *Applied Neuropsychology: Adult* and is awaiting a response

Folha em branco

Lista de Tabelas

Folha em branco

Lista de Acrónimos

TeLPI	Irregular Word Reading Test
MMSE	Mini-Mental State Examination
MoCA	Montreal Cognitive Assessment
GDS-30	Geriatric Depression Scale
IAFAI	Functional Assessment Inventory for Adults and Elderly
PUA	Predominantly urban areas
MUA	Moderately urban areas
PRA	Predominantly rural
MLR	Multiple Linear Regression
SPSS	Statistical Package for the Social Sciences
ANCOVA	Analysis of covariance
VIF	Variance inflation

Artigo Científico

Abstract

Fluency Tasks are commonly used in neuropsychological assessment due to their briefness, easiness of administration, independency from special equipment, and their sensitivity to cognitive decline resulting from serious clinical conditions. These tests allow the access to information regarding several cognitive domains, namely language, executive functions, processing speed, lexical retrieval, verbal production, and semantic memory. The Fluency protocol was administered to 195 cognitively healthy adults and older adults residents in the community, who were stratified according to various sociodemographic variables with a distribution similar to that observed in the Portuguese population. This study aimed to analyze the influence of sociodemographic variables on the participant's performance and establish normative data for the Portuguese population. Education level contributed significantly to the prediction of the Fluency scores. Thus, the normative data for the Portuguese population were established considering the strata levels of education included in this study.

Keywords: verbal fluency, neuropsychological assessment, aging, cognitive impairment.

Folha em branco

Fluency Protocol Validation and Norms for Adults and Older People Among the Portuguese Population

1. Introduction

The neuropsychological assessment analyses brain functioning through behaviour study (Mäder, 1996). Several tests are used in neuropsychological assessment, one of which being the Verbal Fluency. In this Test, participants must generate a series of words with specific instructions within sixty seconds (Gonzalez-Burgos et al., 2019; Pakhomov et al., 2018; Scheuringer et al., 2017). Verbal Fluency Test are commonly used in neuropsychological assessment due to their briefness, easiness of administration, independency from special equipment, and their sensitivity to cognitive decline resulting from serious clinical conditions (Clark et al., 2014; Simpson et al., 2019).

These tests allow the access to information regarding several cognitive domains, namely language, executive functions, processing speed, lexical retrieval, verbal production, and semantic memory (Kavé & Sapir-Yogev, 2020; March & Pattison, 2006; Nogueira et al., 2017; Nikolai et al., 2018; Stolwyk et al., 2015; Simpson et al., 2019; Tessaro et al., 2020; Wauters & Marquardt, 2018). The performance on Fluency Test depends on the activity of the frontal and temporal lobes of the left hemisphere. Different authors claim that people with lesions in this area show worse performance (Clark et al., 2014; Gustavson et al., 2018; Hirshorn & Thompson-Schill, 2006; Vogel et al., 2020; Wagner et al., 2014). Verbal Fluency tasks are also associated with several neuroanatomical structures, particularly the left inferior frontal gyrus (Brodmann areas 44 and 45) that is involved in language understanding and production, and is accountable for processing information associated with phonological and semantic search (Costafreda et al., 2006; Hirshorn & Thompson-Schill, 2006; Katzev et al., 2013;

Rodríguez-Aranda et al., 2016; Senhorini et al., 2011; Wagner et al., 2014). Multiple investigations affirm that Verbal Fluency is also associated with neuroanatomical structures related to executive functions such as the dorsolateral frontal cortex and the anterior cingulate cortex (Alvarez & Emory, 2006; Laisney et al., 2009; Santana & Santos, 2015; Whiteside et al., 2016).

Performance on the Verbal Fluency is connected to the level of cognitive impairment. Patients with different types of brain damage show worse performance in the task (Beber & Chaves, 2016; Tessaro et al., 2020). Poor performance can be an indicator of a problem in the domain of executive functions, language, or both (Simpson et al., 2019). Several studies highlight the validity and usefulness of the Verbal Fluency tests in identify cognitive dysfunction of multiple psychiatric and neurological pathologies (Fumagalli et al., 2018; Senhorini et al., 2011; Vogel et al., 2020), including multiple sclerosis (Barois et al., 2020), autism spectrum disorder (Ehlen et al., 2020), depression (Simpson et al., 2019), schizophrenia (Krukow et al., 2017), traumatic brain injury (Anderson et al., 2017), amyotrophic lateral sclerosis (Lepow et al., 2010), Parkinson´s disease (El-Nazer et al., 2019), focal cortical lesions (Henry & Crawford, 2004), mild cognitive impairment (McDonnell et al., 2020), Alzheimer´s disease (Tessaro et al., 2020), Huntington´s disease (Wahlin et al., 2015) and hyperactivity disorder (Andreou & Trott, 2013). The Verbal Fluency tests are also important for dementia screening and as a differential diagnosis aid (Senhorini et al., 2011). They are widely used to assess cognitive functioning and neurologicalneurological damage (Henry et al., 2004; Rodríguez-Aranda & Martinussen, 2016).

Multiple studies have demonstrated that Verbal Fluency tests are influenced by demographic variables, especially by age and educational level. Cognitive performance decreases with age, and Verbal Fluency is one of the most vulnerable cognitive

functions to the aging process (Simpson et al., 2019; Nogueira et al., 2017; Stolwyk et al., 2015; Vogel et al., 2020; Gonzalez-Burgos et al., 2019; Scheuringer et al., 2017; Kavé, 2005; Cavaco et al., 2013; Samper et al., 2011). On the other hand, people with higher levels of education have better performance, a better cognitive reserve, greater volume of white matter and grey matter, and denser neural networks that compensate for the cognitive losses in the aging process (Neves et al., 2020; Beber & Chaves, 2016; Souza et al., 2020; Rodríguez-Aranda & Martinussen, 2006; Stavrakaki et al., 2012). There are several Verbal Fluency tasks, being phonemic and semantic fluencies the most common. These tasks have been administered individually or in integration with other instruments, such as the Montreal Cognitive Assessment (MoCA). The importance and effectiveness of this test cannot be denied in the evaluation of patients with suspected neurological and psychiatric problems. However, despite their widespread use, Verbal Fluency remain poorly studied. In the present study, we aim to validate a more extensive Fluency Protocol and establish normative data for the adult and elderly Portuguese population, to ensure a more precise use of the instrument.

2. Materials and Methods

2.1.Participants

The sample of this study was composed of volunteers aged 50 years or older, residing across the Portuguese territory to ensure the representativeness of the Portuguese population. The participants were recruited from national health and social security services. During the selection of the participants, different inclusion criteria were considered, namely: (1) being aged 50 years or older; (2) having Portuguese as native language and to have studied in Portugal; (3) not having motor, visual or auditory

deficits, which can affect test performance. All individuals were cognitively healthy adults with autonomy in activities of daily living. In terms of exclusion criteria, participants were excluded if they had: (a) positive history of alcoholism or substance abuse; (b) neurological or psychiatric illnesses; (c) chronic unstable disorders with impact in cognition; (d) significant depressive complaints; (e) if they were under medication with possible impact on cognition (for example, psychotropic or psychoactive drugs). Participants were interviewed by a psychologist to answer a sociodemographic questionnaire and fill out an inventory of the current clinical health status and previous habits and medical history. In the instance of older participants, the obtained information was confirmed with third parties (individual in cohabitation, a close relative or community directors). On the second level, all subjects were required to display normal performance on the assessment battery compiled for this study in order to be included in the present study.

From the initial community-based sample of 234 participants, 39 participants (16.6%) were excluded due to the presence of cognitive impairment on the assessment battery, not meeting the cognitive criterion of having 2 to 3 normal cognitive screening tests.

The final study sample consisted of 195 individuals. Informed consent was obtained from all participants after the aims and procedures of the investigation, as well as confidentiality requirements were fully explained to the participants by a member of research group. This research complied with the ethical guidelines for human experimentation stated in the Declaration of Helsinki, and it was approved by the Faculty of Psychology and Educational Sciences Scientific Committee.

2.2. Materials and procedure

The neuropsychological assessment battery used in this study included:

a) A sociodemographic questionnaire and an inventory of current and past health status, habits, and medical history.

b) The Irregular Word Reading Test (TeLPI; Alves, Simões, & Martins, 2009), that consists in a list of 46 irregular words that the participant must read, allowing the estimation of a normal pre-morbid intelligence state.

c) The Mini-Mental State Examination (MMSE-Folstein et al., 1975; Guerreiro, 1998), which is the most widely used brief screening instrument for detecting cognitive deficits and, therefore, is not described in detail here.

d) The Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005; Simões et al., 2008; Freitas et al., 2011), which is a brief cognitive screening instrument that used for global cognitive assessment. It was developed for the screening of milder forms of cognitive impairment, through the evaluation of executive functions, visuospatial abilities, memory, language, attention, concentration, and working memory, and temporal and spatial orientation. The MoCA is a one-page paper-and-pencil tool with an administration time of approximately 15 minutes. A manual provides explicit instructions for administration and scoring. The maximum score is 30 points, with higher scores indicating better cognitive performance.

e) The Clock Drawing Test (CDR; Bat

f) The Geriatric Depression Scale (GDS-30; Barreto, Leuschner, Santos, & Sobral, 2008; Yesavage et al., 1983) is scale is composed of 30 dichotomous response questions that assess emotional and behavioural symptoms of

depression. To guarantee the exclusion criterion of depressive symptoms, all participants with 21 or more points were excluded (score range: 0–30).

g) The Functional Assessment Inventory for Adults and Elderly, (IAFAI; Vilar, Sousa, & Simões, 2015), to prove the maintenance of functionality.

Participants were required to have a result classified as normal on all previous tests in order to be included in the study sample and perform the Verbal Fluency Protocol. The Verbal Fluency Protocol includes: (i) Phonemic Fluency tasks, that require the generation of words with a specific initial letter (P, M and R); (ii) Semantic Fluency tasks, that require the generation of words belonging to a certain semantic category (Animals, Foods, and Actions); (iii) Inhibitory Fluency tasks, where the words generated must not include a certain vowel (A, E, I); and (iv) Alternating Fluency tasks, during which the examinees must produce words alternating between two semantic categories (Furniture/Fruits, Professions/Colours). This tool is used in neuropsychological assessment as measures of language, executive functions, lexical retrieval, and verbal production.

2.3. Sociodemographic variables

The sample was stratified according to the following sociodemographic variables:

1. The age ranges considered were as follows: 50-59, 60-69 and greater than or equal to 70;
2. gender (female and male);
3. educational level, where four levels of education were considered according to the number of education years successfully completed: 1-4 years (primary education), 5-9 years (middle school), 10-12 years (high school), and more

than 12 years of education (university/college). All categories correspond to the divisions of the Portuguese formal education system;

4. geographic region, where the Portuguese continental territory was divided into five geographic regions - North, Center, Lisbon, Alentejo and Algarve - according to the Nomenclature of Territorial Units for Statistics (NUTS-II) (Instituto Nacional de Estatística, 2021);
5. area of residence, which was categorized according to the types of urban areas (National Institute of Statistics, 2010): predominantly urban areas (PUA), moderately urban areas (MUA), and predominantly rural areas (PRA);
6. geographic localization (coast and inland).

2.4. Statistical analysis

Statistical analysis were conducted using the Statistical Package for the Social Sciences (SPSS), version 27.0. Descriptive statistics were computed for all sociodemographic and health variables. Cronbach's coefficients were used as a measure of internal consistency. In order to analyse the differences in the Verbal Fluency scores between the subgroups stratified according to sociodemographic variables, several tests were used such as the Student's t-test, analysis of variance (ANOVA), Tukey's HSD and Bonferroni's post hoc test. The analysis of covariance (ANCOVA) was used to evaluate the influence of the area of residence and geographic regions in the Verbal Fluency test scores, accounting for the influence of education and age. Eta squared ($\eta 2$) was used as an estimate of the effect size (Cohen, 1988). Pearson's correlation coefficient was used to investigate the correlation between Verbal Fluency scores, age and education (r; Cohen, 1988).

Multiple linear regression (MLR) analyses were performed using the enter method to investigate the significance of age and education as factors influencing the Verbal Fluency test. The tolerance statistics and variance inflation factor (VIF) were used to test multicollinearity and the analysis of effect size in the regression was treated with the coefficient of determination (R^2; Meyers, Gamst, & Guarino, 2006; Cohen, 1988). Finally, the Verbal Fluency test standards were stratified and determined according to the sociodemographic variables most significantly associated with the Verbal Fluency test scores.

3. Results

3.1.Sociodemographic Characterization

The final study sample included 195 cognitively healthy participants (mean age = 67.35 ± 9.137 [50-99]; mean education = 8.69 ± 4.691 [2-22]). The sociodemographic characteristics of the sample are shown in detail in Table 1, considering the sociodemographic variables included in this study.

Table 1 - Sociodemographic characterization and stratification of the sample

Variables	***Levels***	***Sample n (%)***	***Portugal (%)***
Age (years)	50-59	38 (19.5)	14.4%
	60-69	83 (42.6)	12.7%
	≥ 70	74 (37.9)	16.2%
Gender	Male	58 (29.7)	47.2%
	Female	137(70.3)	52.8%
Education level	Primary	71 (36.4)	19.6%
	Middle	45 (23.1)	28.2%
	High	42 (21.5)	25%
	University	37 (19.0)	23.3%
Geographic region	North	63 (32.3)	35.6%
	Center	75 (38.5)	22%
	Alentejo	8 (4.1)	7%
	Açores	47 (24.1)	2.5%
Residence area	PUA	88 (45.1)	73.2%
	MUA	39 (20.0)	14.3%
	PRA	68 (34.9)	12.5%
Other Sociodemographic Variables			
Marital status	single	11 (5.6)	_____
	Married	123 (63.1)	_____
	Divorced	16 (8.2)	
	Windowed	43 (22.1)	
	Other	2 (1.0)	

Note. PUA = predominantly urban areas; MUA = moderately urban areas; PRA = predominantly rural.

The values (n) of the Portuguese population are represented the data of the resident population Portugal aged older than 50 years (Instituto Nacional de Estatística, 2021).

3.2.Psychometric Properties

The internal consistency of the Fluency Test was estimated using Cronbach's α. It was observed an excellent (α=.933) internal consistency in this community sample. A more detailed analysis revealed that there was no improvement regarding the Cronbach's alpha value with the exclusion of any item of the scale.

In order to explore the indicators of construct validity, we carried out correlations between all the items of each Fluency task and between each item and the total score of each task.

Table 2 - Correlation coefficients inter and intra Fluency tasks

Phonemic	**M**	**P**	**R**
Total	.924**	.600**	.898**
M			
P	.718**		
R	.758**	.666**	
Semantic	**Actions**	**Foods**	**Animals**
Total	.879**	.883**	.815**
Actions			
Foods	.666**		
Animals	.704**	.677**	
Inhibitory	**A**	**E**	**I**
Total	.753**	.837**	.887**
A			
E	.487**		
I	.491**	.630**	
Alternating	**Fruit/furniture**	**Profession/color**	
Total	.881**	.942**	
Fruit/furniture			
Profession/colour	.710**		

** The correlation is significant at the level 0.01.

3.3. Influence factors on Fluency performance

Since age and educational level are the sociodemographic variables with significant influence on the performance on neurocognitive tests, and on the Fluency tasks in particular, correlation coefficients with these two variables were analysed and are presented in table 3.

Table 3 - Influence of sociodemographic variables on fluency performance

	Semantic	**Phonemic**	**Inhibitory**	**Alternating**
	r	*r*	*R*	*r*
Age (years)	-.313**	-.254**	-.226**	-.432**
Education level	.534**	.373**	.535**	.576**

** The correlation is significant at the level 0.01.

Table 4 and 5 shows intergroup variability and summarizes the analyses of the relationships between the Fluency scores and the sociodemographic variables using ANCOVA. Here we examined whether the differences in the Fluency scores were significant when controlling for the effects of the covariates (age and education level) and estimated the respective effect sizes.

Table 4 - Analysis of Group Differences on the Fluency Scores While Controlling for the Effect of Covariates and Estimation of the Effect Sizes

Variables		**Semantic**			**phonemic**		
		M±SD	*F(ANCOVA)*	*Effect Size*	*M±SD*	*F(ANCOVA)*	*Effect Size*
Age (years)	50-59 60-69 ≥ 70	51.28±*15.784* *49.34±15.397* 41.16±*11.549*	*F*(2, 140) =2.177, *p*=.117	*Small* =.031	31.00±*15.246* 27.34±*14.278* 20.04±*11.297*	*F*(2, 195) =5.750, *p*=.004	*Small* =.057
Gender	Male Female	43.46±*14.002* *48.29±14.935*	*F*(1, 140) =10.398, *p*=.002	*Medium* =.071	26.02±*13.085* 24.97±*14.465*	*F*(3, 195) =.050, *p*=.824	*Null* =.000
Education level	Primary Middle High University	39.34±*11.633* *46.45±12.780* *49.66±11.487* *60.50±16.038*	*F*(3, 140) =13.121, *p*=.000	*Large* =.226	19.94±*10.709* *24.49±14.347* 28.33±*13.403* *33.03±15.940*	*F*(3,195) =6.330, *p*=.000	*Medium* =.091
Geographic region	North Center Alentejo Açores	43.28±*12.623* *48.00±16.540* *33.29±12.298* *52.45±10.524*	*F*(3, 138) = 5.377, *p*=.002	*Medium* =.109	25.44±*12.677* 25.03±*14.569* *25.88±13.442* 24.47±*15.006*	*F*(3, 193) =.451, *p*=.717	*Nulll* =.007
Residence area	PUA MUA PRA	51.92±*15.472* 44.76±*13.908* *41.59±12.236*	*F*(2, 140) =1.338, *p*=.266	*Small* =.019	28.32±*15.064* *23.05±14.277* *22.63±11.774*	*F*(2, 195) =.540, *p*=.583	*Null* =.006
Marital Status	single Married Divorced Windowed Other	42.88±*11.432* *47.09±14,842* *53,91±17,785* 43.18±*12.508* 66.50±*20.506*	*F*(4, 140) =1.434, *p*=.226	*Small* =.041	24.45±*11.936* *25.78±13,214* *31,06±18,208* 21.07±*14.225* 43.50±*7.778*	*F*(4, 195) =1.283, *p*=.278	*Small* =.027

Note. F = analysis of covariance (ANCOVA) values. According to Cohen (1988), values of .01, .06, and .14 are considered small, medium, and large effect sizes, respectively.
PUA = predominantly urban areas; MUA = moderately urban areas; PRA = predominantly rural areas; *M* = mean; *SD* = standard deviation.

Table 5 - Analysis of Group Differences on the Fluency Scores While Controlling for the Effect of Covariates and Estimation of the Effect Size

Variables		**Inhibitory**			**Alternating**		
		M±SD	*F(ANCOVA)*	*Effect Size*	*M±SD*	*F(ANCOVA)*	*Effect size*
Age (years)	50-59 60-69 ≥ 70	27.41±*13.001* *23.78±11.308* *21.00±9.475*	*F*(2, 136) =.684, *p*=.506	*Small* =.010	28.97±*7.218* 26.44±*6.756* *21.96±4.930*	*F*(2, 133) =7.234, *p*=.001	*Medium* =.101
Gender	Male Female	22.13±*10.670* 24.19±*11.504*	*F*(1, 136) =2.469, *p*=.119	*Small* =.018	25.59±*6.954* 25.33±*6.788*	*F*(1, 133) =.488, *p*=.486	*Null* =.004
Education level	Primary Middle High University	17.15±*6.620* *24.32±10.015* 26.82±*9.060* *33.36±14.259*	*F*(3, 136) =15.040, *p*=.000	*Large* =.256	21.39±*5.112* *25.50±5.487* *28.65±6.273* *30.60±6.825*	*F*(3, 133) =12.744, *p*=.000	*Large* =.230
Geographic region	North Center Alentejo Açores	19.89±*8.825* 22.58±*12.274* *26.00±6.595* *29.14±10.804*	*F*(34, 134) =3.426, *p*=.019	*Medium* =.074	24.73±*5.864* 24.89±*7.781* *16.67±4.933* *27.45±4.702*	*F*(3, 131) =3.439, *p*=.019	*Medium* =.076
Residence area	PUA MUA PRA	26.47±*12.457* *26.61±9.024* *18.75±8.913*	*F*(2, 136) =1.984, *p*=.142	*Small* =.029	27.73±*6.252* *24.15±6.467* 23.08±*6.782*	*F*(2, 133) =1.651, *p*=.196	*Small* =.025
Marital Status	single Married Divorced Windowed Other	22.25±*9.498* *23.05±10,711* *30.36±18.294* 21.70±*8.306* 41.50±*10.607*	*F*(4, 136) =2.304, *p*=.062	*Medium* =.067	25.63±*5.181* *25.85±6.862* *28.40±7.820* 22.31±*5.945* 30.50±*6.364*	*F*(4, 133) =.443, *p*=.777	*Small* =.014

Note. F = analysis of covariance (ANCOVA) values. According to Cohen (1988), values of .01, .06, and .14 are considered small, medium, and large effect sizes, respectively.
PUA = predominantly urban areas; MUA = moderately urban areas; PRA = predominantly rural areas; *M* = mean; *SD* = standard deviation.

Considering these results, which demonstrated that the education level contributed significantly to the explanation of the total variance of the Fluency scores with a large effect size, as well as the significant correlations coefficients observed between the Fluency tasks and the education level, a MLR, , was conducted to explore the predictive value of the education level on the Fluency tasks scores. The regression models for each Fluency task were all statistically significant, as present in Table 6.

Table 6 - Regression models

Fluency Tasks	**Model**	**Model**	**Adjusted** R^2
Semantic	$F(1,139)=55.080$, $p<.001$	$\beta= .534$, $t= 7.422$, $p<.001$	.280
Phonemic	$F(1,194)=31.095$, $p<.001$	$\beta= .373$, $t= 5.576$, $p<.001$	.134
Inibitory	$F(1,135)=53.596$, $p<.001$	$\beta= .535$, $t= 7.321$, $p<.001$	.280
Alternate	$F(1,132)=64.952$, $p<.001$	$\beta= .576$, $t= 8.059$, $p<.001$	.326

Based on these results, educational level was considered as criterion in the development of the normative data of the Fluency tasks for the Portuguese population. The normative data were determined and stratified according to the educational levels considered in this study (Table 6). For comparison purposes, standard deviations of 1, 1.5 and 2 below the means can be considered as cut-off points for performance impairment.

Table 7 - Normative data of the Fluency scores according to educational level

		Semantic	**Phonemic**	**Inhibitory**	**Alternating**
		M±SD	*M±SD*	*M±SD*	*M±SD*
Education level	Primary (1-4)	*39.34±11.63* ***28 - 22 - 16***	*19.94±10.71* ***9 - 4 - 0***	*17.15±6.62* ***11 - 7 - 4***	*21.39±5.11* ***16 - 14 - 11***
	Middle (5-9)	46.45±*12.78* ***34 - 27 - 21***	*24.49±14.35* ***10 - 3 - 0***	*24.32±10.02* ***14 - 9 - 4***	25.50±*5.49* ***20 - 17 - 15***
	High (10-12)	49.66±*11.49* ***38 - 32 - 27***	*28.33±13.40* ***15 - 8 - 2***	*26.82±9.06* ***18 - 13 - 9***	*28.65±6.27* ***22 - 19 - 16***
	University (>12)	60.50±*16.04* ***44 - 36 - 28***	*33.03±15.94* ***17 - 9 - 1***	*33.36±14.26* ***19 - 12 - 5***	*30.60±6.83* ***24 - 20 - 17***

Note. Cut-off values below 1 SD, 1.5 SDs, and 2 SDs, respectively.

4.Discussion

The present study analyses the influence of sociodemographic variables on Fluency Test performance and establishes the normative data for the Portuguese population. The study sample was composed by cognitively healthy adults and older adults resident in the community, who were stratified according to various sociodemographic variables in way to represent the strata distribution observed on the target Portuguese population.

Based on our study sample, overall adequate psychometric properties were observed. The Fluency Test revealed an excellent internal consistency, revealing that there was no improvement with the exclusion of any item of the test. The correlations coefficients between all items of each Fluency task and between each item and the total score of each task were statistically significant (p<.01), suggesting the presence of construct validity.

In line with other studies for the Portuguese population (Cavaco et al., 2013), in this study, no significant associations were found between the scores of the Verbal Fluency tasks and gender, marital status, and geographic variables. By contrast, several studies have demonstrated that Verbal Fluency tests are influenced by age and educational level (Simpson et al., 2019; Nogueira et al., 2017; Stolwyk et al., 2015; Vogel et al., 2020; Gonzalez-Burgos et al., 2019; Scheuringer et al., 2017; Kavé, 2005; Cavaco et al., 2013; Samper et al., 2011). In line with previous literature, our results showed that educational level and age are significantly correlated with the scores of all Fluency tasks. The performance decreases with age and increases with the level of education. Indeed, previous studies have highlighted that Verbal Fluency is one of the cognitive functions most vulnerable to the aging process, so that performance decreases with age (Simpson et al., 2019; Nogueira et al., 2017; Stolwyk et al., 2015; Vogel et al., 2020; Gonzalez-Burgos et al., 2019; Scheuringer et al., 2017; Kavé, 2005; Cavaco et al., 2013; Samper et al., 2011). On the other hand, people with higher levels of education have better Verbal Fluency performance (Neves et al., 2020; Beber & Chaves, 2016; Souza et al., 2020; Rodríguez-Aranda & Martinussen, 2006; Stavrakaki et al., 2012; Cavaco et al., 2013).

Considering such observation, in the Group Differences analyses we statistically controlled the effect of these covariates (age and educational level) and estimated the respective effect sizes. We verified that the educational level contributed significantly to the explanation of the total variance of the Fluency scores with a large effect size that stands out when compared to the other variables. This result was corroborated by the regression models computed, where the educational level showed up as the most significant contributor to the explanation of the Fluency scores. Educational level explained 28% of the total variance on semantic and inhibitory tasks, 13.4% of the total

variance on phonemic tasks and 32.6% of the total variance on alternating tasks. Thus, the normative data for the Portuguese population were established according to the strata levels of education included in this study.

The main limitation of the present study was the exclusion of illiterate participants. An adequate assessment of illiterate participants requires a significant adaptation of the items or tools that would need to be specifically designed for this goal. Another weakness is the classification of participants as cognitively healthy adults. To guarantee this classification, strict inclusion criteria were determined, as previously explained. A small sample size that gives this study a preliminary character must be supplanted in future studies with larger sample sizes.

Although the Fluency Test is widely used in neuropsychological assessment protocols, few international studies have analyzed the influence of a wide variety of sociodemographic variables in Verbal Fluency performance, an observation that supports the pertinence of this psychometric and normative study. The distinctive point of the present study relies on the analysis of the impact of multiple sociodemographic variables before defining the criterion for establishing normative data.

In conclusion, Fluency Test was confirmed as a valid, reliable, sensitive, and accurate instrument for the cognitive evaluation of Portuguese Population with normative data established according to educational level. The existence of validated normative data contributes to a more reliable cognitive evaluation in Portugal in clinical practice and neuropsychology investigation.

References

Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: A meta-analytic review. *Neuropsychology Review*, *16*(1), 17–42. https://doi.org/10.1007/s11065-006-9002-x

Alves, L., Simões, M. R., & Martins, C. (2009). *Teste de Leitura de Palavras Irregulares* (TeLPI) [Irregular Word Reading Test]. Coimbra, Portugal: Serviço de Avaliação Psicológica da Faculdade de Psicologia e de Ciências da Educação da Universidade de Coimbra [Psychological Assessment Department, Faculty of Psychology and Educational Sciences, University of Coimbra].

Anderson, L. B., Jaroh, R., Smith, H., Strong, C. A. H., & Donders, J. (2017). Criterion validity of the D-KEFS color–word and verbal fluency switching paradigms following traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *39*(9), 890–899. https://doi.org/10.1080/13803395.2016.1277513

Andreou, G., & Trott, K. (2013). Verbal fluency in adults diagnosed with attention-deficit hyperactivity disorder (ADHD) in childhood. *ADHD Attention Deficit and Hyperactivity Disorders*, *5*(4), 343–351. https://doi.org/10.1007/s12402-013-0112-z

Balash, Y., Mordechovich, M., Shabtai, H., Giladi, N., Gurevich, T., & Korczyn, A. D. (2013). Subjective memory complaints in elders: depression, anxiety, or cognitive decline?. *Acta neurologica Scandinavica*, *127*(5), 344–350. https://doi.org/10.1111/ane.12038

Barreto, J., Leuschner, A., Santos, F., & Sobral, M. (2008). Escala de Depressão Geriátrica. In Grupo de Estudos de Envelhecimento Cerebral e Demência (Ed.), *Escalas e Testes na Demência* (pp. 69-72). Lisboa: Novartis.

Barois, E., Sagawa, Y., Yilmaz, S., Magnin, E., & Decavel, P. (2020). What (more) can verbal fluency tell us about multiple sclerosis? *Annals of Physical and Rehabilitation Medicine*. https://doi.org/10.1016/j.rehab.2020.05.002

Beber, B. C., & Chaves, M. L. F. (2016). Does previous presentation of verbal fluency tasks affect verb fluency performance? *Dementia & Neuropsychologia*, *10*(1), 31–36. https://doi.org/10.1590/s1980-57642016dn10100006

Cavaco, S., Gonçalves, A., Pinto, C., Almeida, E., Gomes, F., Moreira, I., Fernandes, J., & Teixeira-Pinto, A. (2013). Semantic fluency and phonemic fluency: Regression-based norms for the portuguese population. *Archives of Clinical Neuropsychology*, *28*(3), 262–271. https://doi.org/10.1093/arclin/act001

Clark, D. G., Wadley, V. G., Kapur, P., DeRamus, T. P., Singletary, B., Nicholas, A. P., Blanton, P. D., Lokken, K., Deshpande, H., Marson, D., & Deutsch, G. (2014). Lexical factors and cerebral regions influencing verbal fluency performance in MCI. *Neuropsychologia*, *54*(1), 98–111. https://doi.org/10.1016/j.neuropsychologia.2013.12.010

Costafreda, S. G., Fu, C. H. Y., Lee, L., Everitt, B., Brammer, M. J., & David, A. S. (2006). A systematic review and quantitative appraisal of fMRI studies of verbal fluency: Role of the left inferior frontal gyrus. *Human Brain Mapping*, *27*(10), 799–810. https://doi.org/10.1002/hbm.20221

Cohen, J. (1988). Statistical power analysis for the behavioural sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

Ehlen, F., Roepke, S., Klostermann, F., Baskow, I., Geise, P., Belica, C., Tiedt, H. O., & Behnia, B. (2020). Small Semantic Networks in Individuals with Autism Spectrum Disorder Without Intellectual Impairment: A Verbal Fluency Approach. *Journal of Autism and Developmental Disorders*, *50*(11), 3967–3987.

https://doi.org/10.1007/s10803-020-04457-9

El-Nazer, R., Adler, C. H., Beach, T. G., Belden, C. M., Artz, J., Shill, H. A., Driver-Dunckley, E., Mehta, S. H., Sabbagh, M. N., Serrano, G. E., Sue, L. I., Zamrini, E., & Benge, J. F. (2019). Regional neuropathology distribution and verbal fluency impairments in Parkinson's disease. *Parkinsonism and Related Disorders*, *65*(August 2018), 73–78. https://doi.org/10.1016/j.parkreldis.2019.05.014

Folstein, M., Folstein, S., & McHugh P. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatry Research*, *12*(3), 189-198. https://doi.org/10.1016/0022-3956(75)90026-6

Freitas, S., Simões, M. R., Alves, L., & Santana, I. (2011). Montreal Cognitive Assessment (MoCA): normative study for the Portuguese population. *Journal of Clinical and Experimental Neuropsychology*, *33*(9), 989-996. https://doi.org/10.1080/13803395.2011.589374

Freitas, S., Simões, M. R., Alves, L., & Santana, I. (2015). Mini Mental State Examination (MMSE): Normative study for the Portuguese population in a community stratified sample. *Applied Neuropsychology: Adults*, *22*, 311-319. https://doi.org/10.1080/23279095.2014.926455

Fumagalli, J. C., Soriano, F. G., Shalom, D., Barreyro, J. P., & Martínez Cuitiño, M. M. (2018). Correlational patterns in semantic and phonological fluency in school aged children. *Revista CES Psicologia*, *11*(2), 66–77. https://doi.org/10.21615/cesp.11.2.6

Gonzalez-Burgos, L., Hernández-Cabrera, J. A., Westman, E., Barroso, J., & Ferreira, D. (2019). Cognitive compensatory mechanisms in normal aging: A study on verbal fluency and the contribution of other cognitive functions. *Aging*, *11*(12), 4090–4106. https://doi.org/10.18632/aging.102040

Gustavson, D. E., Panizzon, M. S., Elman, J. A., Franz, C. E., Beck, A., Reynolds, C. A., Jacobson, K. C., Xian, H., Toomey, R., Lyons, M. J., & Kremen, W. S. (2018). Genetic and Environmental Influences on Verbal Fluency in Middle Age: A Longitudinal Twin Study. *Behavior Genetics*, *48*(5), 361–373. https://doi.org/10.1007/s10519-018-9910-6

Henry, J. D., & Crawford, J. R. (2004). A Meta-Analytic Review of Verbal Fluency Performance Following Focal Cortical Lesions. *Neuropsychology*, *18*(2), 284–295. https://doi.org/10.1037/0894-4105.18.2.284

Henry, J. D., Crawford, J. R., & Phillips, L. H. (2004). Verbal fluency performance in dementia of the Alzheimer's type: A meta-analysis. *Neuropsychologia*, *42*(9), 1212–1222. https://doi.org/10.1016/j.neuropsychologia.2004.02.001

Hirshorn, E. A., & Thompson-Schill, S. L. (2006). Role of the left inferior frontal gyrus in covert word retrieval: Neural correlates of switching during verbal fluency. *Neuropsychologia*, *44*(12), 2547–2557. https://doi.org/10.1016/j.neuropsychologia.2006.03.035

Katzev, M., Tüscher, O., Hennig, J., Weiller, C., & Kaller, C. P. (2013). Revisiting the functional specialization of left inferior frontal gyrus in phonological and semantic fluency: The crucial role of task demands and individual ability. *Journal of Neuroscience*, *33*(18), 7837–7845. https://doi.org/10.1523/JNEUROSCI.3147-12.2013

Instituto Nacional de Estatística. (2021). Portal de Estatísticas Oficiais [Portuguese official statistics]. Retrieved June 9, 2021, from http://www.ine.pt

Kavé, G., & Sapir-Yogev, S. (2020). Associations between memory and verbal fluency tasks. *Journal of Communication Disorders*, *83*(April 2019), 105968. https://doi.org/10.1016/j.jcomdis.2019.105968

Krukow, P., Harciarek, M., Morylowska-Topolska, J., Karakuła-Juchnowicz, H., & Jonak, K. (2017). Ineffective initiation contributes to deficient verbal and non-verbal fluency in patients with schizophrenia. *Cognitive Neuropsychiatry*, *22*(5), 391–406. https://doi.org/10.1080/13546805.2017.1356710

Laisney, M., Matuszewski, V., Mézenge, F., Belliard, S., De La Sayette, V., Eustache, F., & Desgranges, B. (2009). The underlying mechanisms of verbal fluency deficit in frontotemporal dementia and semantic dementia. *Journal of Neurology*, *256*(7), 1083–1094. https://doi.org/10.1007/s00415-009-5073-y

Lepow, L., Van Sweringen, J., Strutt, A. M., Jawaid, A., MacAdam, C., Harati, Y., Schulz, P. E., & York, M. K. (2010). Frontal and temporal lobe involvement on verbal fluency measures in amyotrophic lateral sclerosis. *Journal of Clinical and Experimental Neuropsychology*, *32*(9), 913–922. https://doi.org/10.1080/13803391003596439

March, E. G., & Pattison, P. (2006). Semantic verbal fluency in Alzheimer's disease: Approaches beyond the traditional scoring system. *Journal of Clinical and Experimental Neuropsychology*, *28*(4), 549–566. https://doi.org/10.1080/13803390590949502

Mäder, M. J. (1996). Avaliação neuropsicológica: aspectos históricos e situação atual. *Psicologia: Ciência e Profissão*, *16*(3), 12–18. https://doi.org/10.1590/s1414-98931996000300003

McDonnell, M., Dill, L., Panos, S., Amano, S., Brown, W., Giurgius, S., Small, G., & Miller, K. (2020). Verbal fluency as a screening tool for mild cognitive impairment. *International Psychogeriatrics*, *32*(9), 1055–1062. https://doi.org/10.1017/S1041610219000644

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for Mild Cognitive Impairment. *Journal of the American Geriatrics Society*, *53*(4), 695-699. https://doi.org/10.1111/j.1532-5415.2005.53221.x

Neves, T. R. F., de Araújo, N. B., Silva, F. de O., Ferreira, J. V. A., Nielsen, T. R., Engedal, K., Laks, J., & Deslandes, A. C. (2020). Accuracy of the semantic fluency test to separate healthy old people from patients with alzheimer's disease in a low education population. *Jornal Brasileiro de Psiquiatria*, *69*(2), 82–87. https://doi.org/10.1590/0047-2085000000270

Nikolai, T., Bezdicek, O., Markova, H., Stepankova, H., Michalec, J., Kopecek, M., Dokoupilova, M., Hort, J., & Vyhnalek, M. (2018). Semantic verbal fluency impairment is detectable in patients with subjective cognitive decline. *Applied Neuropsychology:Adult*, *25*(5), 448–457. https://doi.org/10.1080/23279095.2017.1326047

Nogueira, D. S., Reis, E. A., & Vieira, A. (2017). Verbal fluency tasks: Effects of age, gender, and education. *Folia Phoniatrica et Logopaedica*, *68*(3), 124–133. https://doi.org/10.1159/000450640

Pakhomov, S. V. S., Eberly, L. E., & Knopman, D. S. (2018). Recurrent perseverations on semantic verbal fluency tasks as an early marker of cognitive impairment. *Journal of Clinical and Experimental Neuropsychology*, *40*(8), 832–840. https://doi.org/10.1080/13803395.2018.1438372

Rodríguez-Aranda, C., Waterloo, K., Johnsen, S. H., Eldevik, P., Sparr, S., Wikran, G. C., Herder, M., & Vangberg, T. R. (2016). Neuroanatomical correlates of verbal fluency in early Alzheimer's disease and normal aging. *Brain and Language*, *155–156*, 24–35. https://doi.org/10.1016/j.bandl.2016.03.001

Santana, I., Duro, D., Freitas, S., Alves, L., & Simões, M. R. (2013). The Clock Drawing Test: Portuguese norms, by age and education, for three different scoring systems. *Archives of Clinical Neuropsychology*, *28*, 375-387. https://doi.org/10.1093/arclin/act016

Samper, J., Llibre, J., Sánchez, C., & Sosa, S. (2011). El deterioro cognitivo leve . Un paso antes de la enfermedad de Alzheimer Mild cognitive impairment . An step before Alzheimer ´ s disease. *Revista Habanera de Ciencias Médicas.*, *10*(1), 27–36.

Santana, A. P. de O., & Santos, K. P. dos. (2015). Teste de Fluência Verbal: uma revisão histórico-crítica do conceito de fluência^iptVerbal Fluency Test: a historical-critical review of fluency concept^ienTest de Fluidez Verbal:una revisión históricocrítica del concepto de fluência^ies. *Distúrb. Comun*, *27*(4), 807–818. http://pt

Scheuringer, A., Wittig, R., & Pletzer, B. (2017). Sex differences in verbal fluency: the role of strategies and instructions. *Cognitive Processing*, *18*(4), 407–417. https://doi.org/10.1007/s10339-017-0801-1

Senhorini, M. C. T., Cerqueira, C. T., Schaufelberger, M. S., Almeida, J. C., Amaro, E., Sato, J. R., Barreiros, M. A. M., Ayres, A. M., Castro, C. C., Scazufca, M., Menezes, P. R., & Busatto, G. F. (2011). Brain activity patterns during phonological verbal fluency performance with varying levels of difficulty: A functional magnetic resonance imaging study in Portuguese-speaking healthy individuals. *Journal of Clinical and Experimental Neuropsychology*, *33*(8), 864–873. https://doi.org/10.1080/13803395.2011.561299

Simões, M. R., Freitas, S., Santana, I., Firmino, H., Martins, C., Nasreddine, Z., & Vilar (2008). *Montreal Cognitive Assessment (MoCA): Versão portuguesa*. Coimbra, Portugal: Serviço de Avaliação Psicológica da Faculdade de Psicologia e de

Ciências da Educação da Universidade de Coimbra.

Simpson, I. C., Dumitrache, C. G., & Calet, N. (2019). Mental health symptoms and verbal fluency in elderly people: Evidence from the Spanish longitudinal study of aging. *Aging and Mental Health*, *23*(6), 670–679. https://doi.org/10.1080/13607863.2018.1448969

Sousa, L. B., Simões, M. R., & Vilar, M. (2013). *Inventário de Avaliação Funcional de Adultos e Idosos* (IAFAI). Coimbra: Faculdade de Psicologia e de Ciências da Educação da Universidade de Coimbra.

Souza, B. C. S. de, Teixeira, T. de O. B., Silva, L. D. da, Satler, C., & Cera, M. L. (2020). Fluência verbal de adultos e idosos do Distrito Federal: proposta normativa piloto. *Audiology - Communication Research*, *25*, 1–7. https://doi.org/10.1590/2317-6431-2020-2315

Stavrakaki, S., Megari, K., Kosmidis, M. H., Apostolidou, M., & Takou, E. (2012). Working memory and verbal fluency in simultaneous interpreters. *Journal of Clinical and Experimental Neuropsychology*, *34*(6), 624–633. https://doi.org/10.1080/13803395.2012.667068

Stolwyk, R., Bannirchelvam, B., Kraan, C., & Simpson, K. (2015). The cognitive abilities associated with verbal fluency task performance differ across fluency variants and age groups in healthy young and old adults. *Journal of Clinical and Experimental Neuropsychology*, *37*(1), 70–83. https://doi.org/10.1080/13803395.2014.988125

Tessaro, B., Hermes-Pereira, A., Schilling, L. P., Fonseca, R. P., Kochhann, R., & Hübner, L. C. (2020). Verbal fluency in alzheimer's disease and mild cognitive impairment in individuals with low educational level and its relationship with reading and writing habits. *Dementia e Neuropsychologia*, *14*(3), 300–307.

https://doi.org/10.1590/1980-57642020dn14-030011

Vogel, A., Stokholm, J., & Jørgensen, K. (2020). Normative data for eight verbal fluency measures in older Danish adults. *Aging, Neuropsychology, and Cognition*, *27*(1), 114–124. https://doi.org/10.1080/13825585.2019.1593935

Wagner, S., Sebastian, A., Lieb, K., Tüscher, O., & Tadić, A. (2014). A coordinate-based ALE functional MRI meta-analysis of brain activation during verbal fluency tasks in healthy control subjects. *BMC Neuroscience*, *15*. https://doi.org/10.1186/1471-2202-15-19

Wahlin, T. B. R., Luszcz, M. A., Wahlin, Å., & Byrne, G. J. (2015). Non-Verbal and Verbal Fluency in Prodromal Huntington's Disease. *Dementia and Geriatric Cognitive Disorders Extra*, *5*(3), 517–529. https://doi.org/10.1159/000441942

Wauters, L., & Marquardt, T. P. (2018). Category, Letter, and Emotional Verbal Fluency in Spanish-English Bilingual Speakers: A Preliminary Report. *Archives of Clinical Neuropsychology : The Official Journal of the National Academy of Neuropsychologists*, *33*(4), 444–457. https://doi.org/10.1093/arclin/acx063

Whiteside, D. M., Kealey, T., Semla, M., Luu, H., Rice, L., Basso, M. R., & Roper, B. (2016). Verbal Fluency: Language or Executive Function Measure? *Applied Neuropsychology:Adult*, *23*(1), 29–34. https://doi.org/10.1080/23279095.2015.1004574

ANEXO