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Unconstrained, Phonemic and Semantic Verbal Fluency: Age and Education Effects, Norms and Discrepancies

Fluência Verbal Livre, Fonêmica e Semântica: Efeitos de Idade e Escolaridade, Normas e Discrepâncias

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Abstract

Objective: To present performance norms and discrepancy score of three one-minute verbal fluency tasks (VFTs); to investigate age and education effects; to analyze the differences between time intervals; and to investigate whether these differences varied according to age and education. Method: Three hundred adults divided into three age groups (19-39; 40-59; 60-75) and two groups of educational level (2 to 7 years; 8 years or more) performed unconstrained, semantic, and phonemic VFTs. We compared the performance of the groups using two-way ANOVA with *post-hoc* Bonferroni test. The depression scale score was covariate. The time interval of verbal fluency was the variable used for subjects' comparison (repeated measures ANOVA). Results and conclusions: Our results suggest that there are age and education effects on phonemic and unconstrained VFTs. We also found an interaction between those variables in the semantic VFT (time intervals and total time) and in the differences between semantic and phonemic tasks. The repeated measures analysis revealed age effects on semantic VFTs and education effects on the phonemic and semantic VFTs. Such findings are relevant for clinical neuropsychology, contributing to avoid false-positive or false-negative interpretation.

Keywords: Neuropsychology, psychological tests, age groups, educational level, cognition.

Resumo

Objetivo: Esse estudo teve como objetivo apresentar normas de desempenho e discrepância em três tarefas de fluência verbal de um minuto e investigar os efeitos de idade e escolaridade. Além disso, investigamos as diferenças entre os intervalos de tempo e se essas diferenças variaram em função da idade e escolaridade. Método: Participaram 300 adultos divididos em três grupos de idade (19-39; 40-59; 60-75) e anos de escolaridade (2 a 7; 8 ou mais), avaliados com tarefas de fluência verbal livre, fonêmica ou semântica. O desempenho entre grupos foi comparado por uma *two-way* ANOVA com *post-hoc* Bonferroni, com o escore da escala de depressão como co-variável. A variável de comparação intragrupos foi o tempo da fluência verbal (ANOVA medidas repetidas). Resultados e conclusões: Os resultados indicaram efeitos principais de idade e escolaridade nas tarefas ortográfica e livre, e uma interação entre essas variáveis na tarefa semântica (intervalos e total), e na discrepância entre as tarefas semântica e ortográfica. A análise de medidas repetidas demonstrou efeitos principais de idade na tarefa semântica e de educação nas tarefas semântica e ortográfica. Tais achados são relevantes para futuras interpretações de dados clínicos, evitando assim falsos positivos ou negativos.

Palavras-chave: Neuropsicologia, testes psicológicos, grupos de idade, escolaridade, cognição.

Verbal fluency tasks (VFT) are a traditional paradigm for neuropsychological assessment. Performance on cognitive tasks may vary depending on socio-demographic and cultural factors, like age and education. In this context, clinical evidence has shown education can override the effects of brain damage (Beausoleil, Fortin, Blanc, & Joanette, 2003) and if not considered in clinical setting might even produce false-positive results (Lecours et al., 1987). Such findings are particularly relevant in Latin American countries as a reason of population's level and quality of education, as well as their increased life expectancy. In this context, the stratification of cognitive performance norms according to age and education is crucial for clinical practice and research.

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Socio-demographic and cultural factors have been shown to have an impact in verbal fluency performance of healthy subjects, yet findings are divergent. A great majority of studies found an age-related decline in performance of phonemic and semantic VFT, as demonstrated by the metanorms of Loonstra, Tarlow and Sellers (2001), in accordance with findings from further research (Bryan, Luszcz, & Crawford, 1997; Butman, Allegri, Harris, & Drake, 2000; Lanting, Haugrud, & Crossley, 2009; Peña-Casanova et al., 2009). Conversely, there is evidence of an education effect, showing that highly educated outperform low education individuals (Buriel, Gramunt Fombuena, Böhm, Rodés, & Peña-Casanova, 2004; Butman et al., 2000; Kosmidis, Vlahou, Panagiotaki, & Kiosseoglou, 2004; Peña-Casanova et al., 2009; Rami, Serradell, Bosch, Villar, & Molinuevo, 2007; Van Der Elst, Van Boxtel, Van Breukelen, & Jolles, 2006; Villodre et al., 2006). However, some investigations present different findings (Buriel et al., 2004; Hughes & Bryan, 2002; Machado et al., 2009; Steiner, Mansur, Brucki, & Nitrini, 2008; Tallberg, Ivachova, Tingha, & Östberg, 2008; Tombaugh, Kozak, & Rees, 1999; Villodre et al., 2006), most likely due to population sampling and data analysis heterogeneous methods, such as reduced time for word searching. Ardila, Ostrosky-Solis, Rosselli, and Gomez (2000) proposed that education plays a complex role in cognition through the lifespan, in a way a single relationship between age and education cannot be established. In spite of several studies have supported this idea, findings are still inconclusive.

An important and specific aspect of the verbal fluency paradigm is the difference in performance expected depending on the criteria used (semantic or phonemic, for example). Clinical studies still search for evidence about the most accurate criteria for cognitive impairment diagnosis (Kavé, Heled, Vakil, & Agranov, 2010). In addition, neuroimaging studies shed light for different activated areas depending on the VFT modality (Birn et al., 2010). Since many studies still investigate only one verbal criterion, it remains not consensual if socio-demographic and cultural factors might play different roles in verbal fluency performance.

On the other hand, studies have been advancing in verbal fluency analysis. As proposed by Troyer (2000), the total number of words retrieved does not provide enough data about cognitive processes involved in verbal fluency or about in what clinical groups differ, for example. Some methods of alternative analysis were developed, like switching and clustering analyses (Rosselli, Tappen, Williams, Salvatierra, & Zoller, 2009), interpretation of the prototypicality of words (Beausoleil et al., 2003), of differences between VFT paradigms (for example, between semantic and phonemic task performance; Lonie et al., 2009) and number of words retrieved through different time intervals (Hurks et al., 2004). Performance along the task has been especially used to understand the relationship of automatic versus controlled processes involved in words retrieval, which represents for some authors underlying executive processes. Such analysis has been highlighting differences in normal development of children (Hurks et al., 2010) and in clinical samples, as Attention Deficit Hyperactivity Disorder (ADHD; Hurks et al., 2004). At this point, the question arises as to whether adults groups differ at performance through time in verbal fluency. Furthermore, till date, no standardized scores obtained for normative data for adults, which would be useful to compare clinical samples.

Moreover, performance discrepancy between task criteria (uconstrained, phonemic or semantic) has been pointed out as an important discriminant characteristic of some types of dementia. For example, Lonie et al. (2009) found that the discrepancy score between semantic and phonemic tasks of amnesic Mild Cognitive Impairment and Alzheimer's disease patients is significantly higher than between healthy controls and depressed patients. Differences in verbal fluency performance have been described in several samples, as in traumatic brain injury (Kavé et al., 2010). Cerhan et al. (2002) analyzed discrepancy score in Alzheimer's disease and the authors had found similar results as those described above when comparing to a paired sample. However, they could not establish a cut-off point that could discriminate the clinical group with Alzheimer dementia of the matched healthy controls. This observation was later reported in a meta-analysis by Laws, Duncan, and Gale (2010), when the authors pointed out such discrepancy might be a normal tendency, since this score does not differ between Alzheimer's dementia and normal controls. Nevertheless, a study has shown discrepancy score of phonemic and semantic VFT differentiates Fronto-temporal Dementia and Alzheimer's dementia groups. In addition, the greater the time of diagnosis, an increase of difference between score was found. Also, the perseverative errors in VFT were higher in both tasks (semantic and phonemic) for the Fronto-temporal dementia group. The authors suggest that the involvement of different cerebral areas in the two diseases may explain these findings (Rascovsky, Salmon, & Thal, 2007). Given the disparity of findings on this topic, diagnosis utility of discrepancy score remains unclear, since no norms have been published for different age and education samples using these scores.

Therefore, towards a better comprehension of the role of individual, socio-cultural, and time on VFT performance, this study aimed to (a) present unconstrained, phonemic and semantic VFT age and education based norms for traditional scores besides for discrepancy score between tasks; (b) to investigate whether education and/or age have an effect on the performance of VFT and their discrepancies, and, based on that, to study these differences regarding the performance of the tasks between the groups; (c) to investigate whether there are differences between 30-seconds time intervals and whether there is interaction between time intervals, age and education in the three VFT.

Method

Participants

Three hundred neurologically healthy adults were included from the normative sample of the adaptation of the Montreal Evaluation Communication (MEC) Battery to Brazilian Portuguese (Fonseca, Parente, Côté, Ska, & Joanette, 2008; Joanette, Ska, & Côté, 2004). A quantitative description of the socio-demographic variables of the group is shown in Table 1. Participants' characteristics were as follows: all of them were born in Brazil, they did not have history of neurological and/or psychiatric and/or uncorrected sensory disorders, and none of them had a history of alcohol or other drug abuse. We investigated signs suggestive of major depression using the Geriatric Depression Scale (GDS; Almeida & Almeida, 1999; Yesavage, Brink, Rose, & Lurn, 1983). In addition, deficits suggestive of dementia were investigated among 40-year-old or older participants using the Mini-Mental State Examination (Chaves & Izquierdo, 1992). Low education group was comprised of participants that studied two to six years; while high education sample was composed by whom studied seven years or more.

Table 1
Means and Standard-Deviations of the Socio-Demographic and Cultural Variables According to Age and Education

Socio-demographic and cultural variables	High educational level						Low educational level					
	19-39		40-59		60-75		19-39		40-59		60-75	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age	25.24	5.28	47.82	5.02	66.98	4.86	29.80	5.20	49.02	4.88	67.18	5.14
Education (years)	14.92	3.07	15.34	4.93	14.84	5.14	5.36	1.12	4.90	1.56	4.62	1.18
Sex (F/M)	34/16		40/10		37/13		31/19		45/5		44/6	
MMSE[a]	[a]		28.82	1.08	27.58	1.83	[a]		26.64	1.96	26.02	2.35
GDS-30[b]	6.32	4.59	7.74	5.04	6.30	3.60	8.70	4.87	7.42	4.18	7.18	5.42
Social class classification[c]	33.00	9.83	35.62	9.89	27.98	6.47	16.56	6.26	19.66	8.10	18.70	5.65

[a]Mini-Mental State Examination (administered only to 40-year-old or older individuals); [b]Geriatric Depression Scale; [c]Brazilian Criterion of Economic Classification.

Based on a comparative analysis between the groups using one-way ANOVA with Tukey's *post-hoc* test ($p \leq .05$) regarding the data shown in Table 1, we found that low education 19-39 years-old age group was a bit older than the high education comparative group ($p < .001$); and that groups differ with regards to socioeconomic score, which was partially expected since it correlated with years of education ($r = .648$; $p < .001$). The sample was also different in relation to sex variable, with more woman than men in all normative groups ($p < .001$). Finally, there were no differences among groups in GDS-30 score.

Procedures

Participants were recruited through convenience sampling. They were recruited through university classes, senior citizen groups, employment companies and word of mouth. Their participation in the study was voluntary. This project was approved by the Research Ethics Committee at *Universidade Federal do Rio Grande do Sul* (project number: 2003207).

Instruments

The instruments used during data collection for screening, sample characterization, and cognitive performance are described next:

Socio-Demographic and Cultural Questionnaire. This instrument was used to investigate cultural habits, demographic aspects, and medical history (general health and sensory health). This questionnaire was described in detail by Pawlowski et al. (2012).

Verbal Fluency Tasks (VFT) *of the MEC Battery* (Fonseca et al., 2008). During the three tasks, the words mentioned were recorded using audio devices and then transcribed in 30-second time intervals. The dependent variables for each task used in this study were the sum of total correct words retrieved in one minute and the words retrieved in time intervals of 30 seconds. Clinical validity for the use of one minute verbal fluency paradigm can be consulted in Ferré et al. (2009) and Zimmermann, Scherer, Ska, Joanette, and Fonseca (2011). The scoring system consisted in the sum of total correct words. Variance of gender, number, and degree were not accepted, as well as words that did not fit in the criteria used, for example, to retrieve accessories in the semantic task. However, variation of word grammatical class was accepted.

Unconstrained Verbal Fluency Task (UVFT). During this task, the subject was asked to say as many words as possible, except for names and numbers, while keeping his eyes closed during 2.5 minutes.

Phonemic Verbal Fluency Task (PVFT). The subject was asked to say as many words as possible starting with the letter P, except for names. This task takes 2 minutes to be completed.

Semantic Verbal Fluency Task (SVFT). The subject should say as many words as possible related to articles of clothing during 2 minutes.

Geriatric Depression Scale - 30 Items (GDS-30; Almeida & Almeida, 1999; Yesavage et al., 1983). This scale is composed by 30 questions which investigate depressive symptoms by means of "yes" or "no" answers, one point is scored for each answer suggestive of depression. A cut-off of 20 points is established for exclusion of severe depressive symptoms.

Data Analysis

In order to achieve our first objective (definition of norms), we performed a descriptive analysis calculating the means and standard deviations of the total scores (sum of the first two blocks), subtotal scores of two 30-second blocks, and discrepancies (subtraction between total scores, as follows: SVFT-PVFT; UVFT-SVFT; UVFT-PVFT). We suggest the use of *Z* score (patient's score - mean of the group/standard deviation = *Z* score) in order to evaluate accuracy of cognitive performance (as proposed by Kavé et al., 2010 and Schoenberg et al., 2006). The Kolmogorov-Smirnov test was used to assess the distribution of test scores for each group. Results showed that distribution of test's scores is normal ($p>.05$). In order to achieve our second objective, we performed a two-way ANOVA with Bonferroni's *post-hoc* test ($p \leq .001$), using age and education as independent variables and the score on the GDS-30 as the covariate. Finally, with regard to our third objective, we performed a repeated measures ANOVA using the time interval variables 0-30 and 31-60 seconds for intragroup comparison considering the VFT.

Results

The normative data on the participants' neuropsychological performance and the discrepancy score are shown in Table 2. The means and standard deviations of each group were also included in Table 2.

The results of the analysis of covariance with Bonferroni's *post-hoc* test are shown in Table 3.

Table 2
Normative Data on Performance and Discrepancy score According to Age and Educational Level

Task variables		High educational level						Low educational level					
		19-39		40-59		60-75		19-39		40-59		60-75	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Unconstrained	Interval 1	17.32	6.81	16.16	6.50	13.10	3.99	12.32	6.33	12.06	5.50	9.64	4.71
	Interval 2	13.02	5.21	12.40	5.67	9.80	3.69	8.18	4.62	7.84	4.35	6.28	3.59
	Total	30.34	11.31	28.56	11.63	22.90	7.12	20.50	10.27	19.90	9.02	15.92	7.29
Phonemic	Interval 1	11.32	2.97	11.16	3.36	9.06	3.22	8.14	3.15	7.68	3.54	6.78	2.35
	Interval 2	6.72	2.24	5.86	2.70	4.82	2.34	5.26	3.17	4.00	2.19	3.56	2.04
	Total	18.04	4.32	17.02	5.15	13.88	4.95	13.40	5.78	11.68	5.12	10.34	3.79
Semantic	Interval 1	15.26	3.61	13.36	4.49	10.84	2.88	10.38	3.21	9.76	3.17	8.46	2.62
	Interval 2	7.56	2.90	6.36	2.73	6.22	2.02	4.40	2.36	4.92	2.13	4.16	2.06
	Total	22.82	5.12	19.72	5.89	17.06	3.69	14.78	4.43	14.68	4.22	12.62	3.62
Unconstrained -Phonemic[a]		12.30	10.45	11.54	10.05	9.02	6.14	7.10	8.00	8.22	8.65	5.58	6.16
Unconstrained -Semantic[a]		7.52	9.79	8.84	10.57	5.84	5.86	5.72	8.61	5.22	8.79	3.30	6.71
Semantic-Phonemic[a]		4.78	5.42	2.70	5.25	3.18	4.48	1.38	4.75	3.00	5.44	2.28	3.87

Note. M = mean; *SD* = standard deviation.
[a]Discrepancy score.

Effect size analysis can be consulted in Table 4. The results of the intragroup analysis using repeated measures ANOVA regarding time interval and covariance between the variables depression score on the GDS-30, age group, and educational level are shown in Table 5. Decomposition of interactions suggested that education showed a

higher effect as younger was the group; in other words, the youngest the group is, the greater is the role of education in its performance, while the oldest the group is, the less is the influence of education in its scores.

Table 3
Age and Education Effects, Interactions between Variables, and Post-Hoc Results between Groups in VFT (interval, total and discrepancy score)

Verbal fluency tasks		Education group[c]		Age group[d]		Age vs. Education Groups		GDS score[b, c]		19-39 vs. 40-59	19-39 vs. 60-75	40-59 vs. 60-75	Low vs. high education
		p	*f*	*p*	*f*	*p*	*f*	*p*	*f*	*p*			
Unconstrained verbal fluency task	Interval 1	<.001	38.665	<.001	10.263	.665	.409	.514	.426	1.000	<.001	.002	<.001
	Interval 2	<.001	64.519	<.001	8.893	.572	.560	.642	.217	1.000	<.001	.004	<.001
	Total	<.001	56.827	<.001	11.103	.593	.523	.541	.374	1.000	<.001	.001	<.001
Phonemic verbal fluency task	Interval 1	<.001	67.764	<.001	9.451	.372	.991	.829	.047	1.000	<.001	.003	<.001
	Interval 2	<.001	27.073	<.001	13.587	.642	.444	.338	.921	.080	<.001	.091	<.001
	Total	<.001	62.077	<.001	13.875	.419	.873	.729	.121	.148	<.001	.004	<.001
Semantic verbal fluency task	Interval 1	<.001	87.447	<.001	21.586	.028	3.628	.223	1.492	0.026	<.001	<.001	<.001
	Interval 2	<.001	64.196	.070	2.678	.037	3.345	.783	.076	0.946	.065	.579	<.001
	Total	<.001	123.816	<.001	18.475	.010	4.730	.295	4.73	0.041	<.001	.001	<.001
Semantic-Phonemic [a]		.013	6.177	.907	0.098	.018	4.100	.186	1.759	1.000	1.000	1.000	.013
Unconstrained-Semantic [a]		.011	6.471	.076	2.595	.668	.405	.212	1.562	1.000	.229	.103	.013
Unconstrained-Phonemic [a]		.001	16.182	.051	3.003	.712	.340	.620	.246	1.000	.126	.087	<.001

Note. Pearson coefficient showed no significant correlation between age and education (r=-.089; p=.125).
[a]Discrepancy score between tasks. [b]Raw score of the Geriatric Depression Scale; [c]Degree of freedom = 1.293; [d]Degree of freedom = 2.293.

Table 4
Effect Size (η^2) of Significant Main Effects (age and education) and Interaction

Tasks/variables	Unconstrained verbal fluency task			Phonemic verbal fluency task			Semantic verbal fluency task		
	Interval 1	Interval 2	Total	Interval 1	Interval 2	Total	Interval 1	Interval 2	Total
Age	.010[a]	.011[a]	.011[a]	.007	.017[a]	.010[a]	**	**	**
Education	.019[a]	.038[a]	.027[a]	.024[a]	.017[a]	.022[a]	**	**	**
Age vs. education	*	*	*	*	*	*	.002	.003	.002

Note. *non-significant effects ($p \leq .05$); **Main effect was not considered when interaction was significant.
[a]Small effect size (Cohen, 1988).

The analyses shown in Table 5 demonstrate interactions between the time interval and the variables age or education, suggesting that time has an influence on the participants' performance on the SVFT task in an independent manner for age and education groups. However, on the PVFT task, there was an interaction only between time and education, suggesting that there was a more important reduction from time interval 1 to time interval 2 in high education groups. We found no interaction between the time interval and a score suggestive of late-life depression. There were not triple interactions.

Table 5
Main Effects and Interactions Related to Performance thorough Time on the VFT (repeated measures ANOVA)

Tasks/variables	Unconstrained verbal fluency task		Phonemic verbal fluency task		Semantic verbal fluency task	
	F	*p*	*F*	*p*	*F*	*p*
Time[1]	89.207	<.001	151.487	<.001	187.278	<.001
Time *vs*.GDS score[a]	.168	.682	1.197	.275	.893	.345
Time *vs*.Age group[b]	1.436	.239	2.324	.100	10.309	<.001
Time *vs.* Education group[a]	.094	.759	21.154	<.001	11.447	.001
Time *vs.* Age group *vs*.Education group[b]	.133	.875	.492	.612	1.683	.188

Note. For interaction analysis, a Mixed ANOVA was used.
[a]Degree of freedom = 1.293; [b] Degree of freedom = 2.293.

Discussion

In order to present normative data, to investigate age and education effects and its possible interactions, and the relation of these variables with time of retrieval in verbal fluency, three VFT (unconstrained, phonemic and semantic criteria, and discrepancy score among them) were assessed in adult with age-range 19 to 75 years old of two educational backgrounds (low versus high education). Our results indicated age and education had main effects in accuracy performance of the two time intervals and total scores of UVFT and PVFT tasks; while it was found an interaction of these variables in SVFT and in the discrepancy score of SVFT-PVFT. Discrepancy score of UVFT-SVFT and UVFT-PVFT showed to be affected only by education. Regarding time interval difference analysis, education had an effect on performance of SVFT and PVFT, whereas age presented an effect only in SVFT. In summary, this section is going to discuss effects of age, education and its interactions and time intervals in dependent variables described above.

Age Effects in Verbal Fluency Task Performance

With regard to the age variable, we found a significant age effect on the total score and on the two time intervals in the UVFT and PVFT tasks; in addition, older adults had lower scores than those participants in the 19-39 and 40-59 years age groups. Our findings regarding the UVFT task cannot be compared with previous studies because we could not find other studies with healthy populations. In terms of the total time to complete the PVFT task, several studies have confirmed our findings regarding the age effect (Bryan et al., 1997; Lanting et al., 2009). Concerning the factors that may have an influence on or mediate the relation between age and the PVFT task, there is evidence supporting that verbal knowledge (mediated also by educational level) is not able to compensate for age-related cognitive declines (Bryan et al., 1997). In spite of that, some studies using the FAS paradigm have not detected the age effect. This might have occurred because their samples only included elderly (Machado et al., 2009) or young and middle-aged adults (Buriel et al., 2004; Villodre et al., 2006). Nevertheless, other studies have investigated different age groups and have not found the age effect either (Hughes & Bryan, 2002; Steiner et al., 2008; Tallberg et al., 2008). Such discordant findings may be explained by differences in the sample sizes, inclusion criteria, and statistical analyses used in each study.

The analysis of time intervals through task in contrasting age groups is not commonly found in studies of healthy adults. Hurks et al. (2004) found in a healthy sample of children and adolescents different age maturation processes by means of time intervals analysis. The most automatic processes evaluated by the first 15 seconds is matured first than more controlled cognitive processes involved in the following 16-60 seconds. In line of this finding, SVFT task showed the production of words through time is also affected by age development; descriptive analysis shows that performance decreases with the increase of age. In a sample of elderly individuals (61 to 81 years-old), Venegas and Mansur (2011) could not find age effects.

Time and age did not interact in UVFT and PVFT tasks. Different patterns of findings among tasks might represent distinct underlying processes: UVFT might be over productive and less effortful requiring fewer strategies of retrieval and PVFT little productive and requires too much effort to improve performance through time, equally in young and old age. Finally, SVFT might be assessing predominantly semantic memory strategic retrieval and thus aging influences the ability to maintain performance through time. As proposed by Goulet, Joanette, Sabourin, and Giroux (1997), some studies are biased to consider certain verbal fluency task as the best measure to identify deficits in clinical samples, since productivity might vary among verbal fluency criteria. However, our findings corroborate SVFT might be important (Kavé et al., 2010; Lonie et al., 2009), especially when age is considered.

No significant main effect of age was found in UVFT-SVFT and UVFT-PVFT discrepancy score; overall, this data suggest those measures are not useful to identify age-related changes in performance, perhaps because performance variability in UVFT is too large. These results are in agreement with some age-related changes hypothesis, as the one from Salthouse's guiding to a decrease in the speed of information processing (Clay et al., 2009; Rajah & McIntosh, 2008; Salthouse, 1996). It is also in accordance with the Frontal Aging Hypothesis (Greenwood, 2000), which explains cognitive decline influenced by performance reduction frontal lobe functions.

Education Effect in VFT Performance

In our study, education had main effect on PVFT and UVFT measures (time intervals and total score), in a way that participants with higher educational level had a better performance than those with lower educational level in all of them. This finding reinforces the importance of this social and cultural variable for clinical neuropsychology, since it may contribute to the occurrence of false-positive results. In relation to the PVFT task, the literature confirms this relation regardless of the letter used (Buriel et al., 2004; Rami et al., 2007; Villodre et al., 2006) which may be related to the required amount of lexical-semantic-phonological knowledge acquired in formal learning environments and preserved through cultural habits. It is worth noting that this effect was independent from the participants' age in our study, which means formal education plays a robust and constant role in this ability through lifespan. Our findings about PVFT performance and education are in agreement with previous studies from Venegas and Mansur (2011) with a sample of elderly adults.

Discrepancy score of UVFT-SVFT and UVFT-PVFT revealed to be affected by education, with less educated groups showing a smaller discrepancy score. These data suggests perhaps UVFT might be a differential challenging task for low educated sample when compared to other tasks. Interestingly, performance through time interval did not vary in a function of education in UVFT, indicating regardless of educational background word retrieval through time remains constant but still with different accuracy levels. In addition, UVFT might demand more initiation and less inhibitory processes.

Furthermore, SVFT and PVFT performance varied with time in different educational levels, which means years of education have affected positively maintenance of word production during these one minute tasks. Venegas and Mansur (2011) found education plays a role in the two first 15 seconds intervals of SVFT, while PVFT is affected by education from the first to the third minute quartile. Together these results suggest PVFT might be more demanding over time than SVFT. In addition, the findings also corroborate both better performance of cognitive functions like semantic memory storage and executive functions in high education individuals (Al-Ghatani, Obonsawin, Binshaig, & Al-Moutaery, 2011; Constantinidou, Christodoulou, & Prokopiou, 2012).

Age and Education Interaction in VFT

Some interactions between age and education were found. Specifically in the performance measured by the SVFT task (time intervals and total score), the educational level effect seemed be less important in performance in the older group, as Brucki and Rocha (2004) and Ostrosky-Solís, Gutierrez, Floresa and Ardila (2007) had found. Discrepancy score performance of SVFT-PVFT, the same direction of results was observed. The complex effect of education during normal aging was described for Ardila et al. (2000) in semantic verbal fluency, that is, education has different effects on cognition depending on the age years. For example, in people with low education maximum performance was observed in middle-aged adults; while in high education group maximum score was observed in the youngest group. The "confluence downwards" as proposed by Capitani, Barbarotto, and Laicana (1996) and the described "protection effect of illiteracy" by Ardila et al. (2000), proposed that in low education or in illiterates performance is low and remains low across years, while in high education score are high in young people and decrease more importantly across aging. These findings seem to be in agreement to ours findings. In line with these authors, cognitive reserve research has pointed education is part of a large range of protective factors associated with cognitive decline or neurodegenerative disorders manifestations across the lifespan (Stern, 2009).

Conclusion

In conclusion, VFT seem to be differentially affected by age and education. We found that more variables were affected by education than for age, which represents a great concern in terms of importance of education for cognition during adulthood as a hole, leading to more investment in education policies. Discussion about impairment of the low educated or overstimulation of high educated individuals remains a matter of debate (Ardila et al., 2000). However, as it was also discussed for Ardila et al. (2000), education might not be the only factor related to cognitive performance. Recently, Pawlowski et al. (2012) showed writing and reading habits are especially important for cognitive performance of low educated individuals. Some limitations of our study should be mentioned, namely: the absence of a group of oldest old adults and the large range of each educational level, leading to only two groups. Another important aspect is that our findings demonstrate the effects of secondary categorical variables, originally continuous factors, what at the same time can be helpful to comprehend age and education groups. Such relation could also be investigated in future studies by assessing a larger sample, with linear regression analysis. Also, results related to the

UVFT task are new and not well known. Furthermore, a more detailed analysis of clustering and switching strategies should be conducted (Lanting et al., 2009).

Finally, SVFT task results indicated this might be the most promising paradigm to investigate some issues, such as the complex relationship among socio-demographic and cultural factors; time variance through intervals and its cognitive underlying mechanisms; and discrepancy score with PVFT for investigation of clinical conditions. This modality may be considered as an important target to be considered in verbal fluency paradigms for functional neuroimaging studies.

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