Icelandic Norms for Verbal Fluency Tests

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Abstract

The Verbal Fluency Test (VFT) is one of the most used instruments in measuring cognitive functioning. In this study, two VFT (a letter fluency test and a category fluency test) were administrated to a sample of 405 individuals. The aim of this study was to create norms for VFT for the Icelandic population. The hypothesis was that the performance on VFT is dependent on the variables age, gender and education. In addition, it was hypothesised that performance on VFT was impaired among subjects with depression and dyslexia. Results of factorial analysis of variance revealed that age and education, but not gender had main effects on performance on VFT. Depression did not influence verbal fluency but dyslexia did. The normative data for the Icelandic population were created.

Útdráttur

Orðaflæðipróf (Verbal Fluency Test eða VFT) er eitt af algengustu mælitækjunum sem notuð eru til að mæla vitræna starfsemi. Í þessari rannsókn voru tvö VFT próf (bókstafsflæðipróf og flokkunarflæðipróf) lögð fyrir 405 manna úrtak. Markmið þessarar rannsóknar var að búa til viðmiðunargildi fyrir VFT fyrir íslenskt þýði. Tilgátan var sú að árangur á VFT væri háð breytum aldurs, kyns og menntunar. Auka-tilgátan var sú að árangur á VFT væri lakari meðal einstaklinga með þunglyndi eða lesblindu. Niðurstöður af fjölþátta dreifigreiningu leiddu í ljós að aldur og menntun, en ekki kyn, hafa megin-áhrif á árangur á VFT. Þunglyndi hafði ekki áhrif á orðaflæði en lesblinda hafði áhrif. Viðmiðunargildi fyrir íslenskt þýði var búið til.

Foreword and Acknowledgement

Submitted in partial fulfilment of the requirements of the BSc Psychology degree, Reykjavík University, this thesis is presented in the style of an article for submission to a peer-reviewed journal.

This research article is part of a bigger study on the effects of genetic variation on schizophrenia as well as neurological and developmental disorders, a collaboration of Decode Genetics, Division of Psychiatry, University Hospital and other partners within in Iceland and abroad.

Icelandic Norms for Verbal Fluency Test

The Verbal Fluency Test (VFT) is one of the most used instruments in measuring cognitive functioning. This test requires organizational strategies for retrieval, recall, self-monitoring, self-initiation, and inhibition, and therefore is considered a measure of executive functions (Sherman, Spreen, & Strauss, 2006). VFT are usually either tests of phonological fluency (Letter Fluency, e.g. letter F, A, S) or semantic fluency (Category Fluency, e.g. animals) (Sherman et al., 2006).

Rosen and Engle (1997) theorised that category fluency, which involves four retrieval components (activation from the cue, self-monitoring for repetitions and errors, suppression and generation of cues), is thought to be impaired if a person has attention deficits causing decrease in performance (very likely self-monitoring or suppression because they are the most demanding). Other studies suggest that the decreased performance may be due to less mental speed (Salthouse, Atkinson, & Berish 2003).

Some known factors may influence performance on VFT. Kavé (2005) has shown that performance on letter fluency differs between ages, dramatically improving between ages five and seven, peaking at about 30-39 years, and steadily decreasing in old age. For category fluency, the increase in childhood is not as rapid as in letter fluency and becomes quite stable by the age of 11-12 years (Sauzeon, Lestage, Raboutet, N'Kaoua, Claverie, 2004). The slow decrease in category fluency begins by the age of 20 (Mitrushina, Boone, Razani, & D'Elia, 2005). Genders differences are rarely found. There are few studies that have managed to show tendencies for women to score higher than men on VFT (e.g. Bolla, Bonaccorsy & Bleecker, 1990; Kavé, 2005; Mitrushina et al., 2005; Weiss et al., 2006), but the women sampled had a higher level of education than the men, so the result may be related to education rather than gender. Loonstra, Tarlow, and Sellers (2001) reported small advantage on letter fluency tests by women over to men. Other studies suggested that the gender differences might be more

visible among diverse categories of category fluency test (Sherman et al., 2006). When the effects of education are explored, there are some more visible differences on performance on both letter and category fluency tests, and many studies agree that education is a good predictor of performance on VFT (Tallberg, Ivachova, Jones Tinghag and Östberg, 2008; Tombaugh, Kozak, & Rees, 1999; Sherman et al., 2006). Crossley and colleagues conducted a study in 1997 where they measured scores on both tests among healthy participants with different levels of education. They found that people with the highest level of education produced twice as many words than those with the lowest level of education (Sherman et al., 2006).

Besides demographic characteristics, there are other factors that may contribute to performance on the VFT. Henry and Crawford (2005) conducted a meta-analytic research of 42 studies (2206 participants) and their aim was to evaluate how depression affects scores on VFT. Their results showed that there was an impairment on performance among patients diagnosed with depression and they proposed that it could be related to the cognitive slowing associated with depression (Henry & Crawford, 2005). Ravdin, Katzen, Agrawal, and Relkin (2003) studied elderly subjects and reported that depression affects letter but not category fluency, and that this discrepancy is visible even in cases of mild depression. Other studies suggested that dyslexia could be another factor for lower scores on VFT (Kavé, 2005; Brosnan, Demetre, Hamill, Robson, Shepherd, & Cody, 2002) as well as individual factors (e.g., phonological awareness, vocabulary development, articulation rate, retrieval or executive functioning).

Earlier researches have indicated that age and education might be the most reliable predictors of performance on VFT, while gender differences tend to show unstable patterns on VFT scores. In addition, there could be factors that may have influence on VFT scores, other than demographic characteristics (e.g., depression, dyslexia). The aim of this study was to

create norms for VFT for the Icelandic population. The hypothesis was that the performance on VFT is dependent on the variables age, gender and education. In addition, it was hypothesised that performance on VFT was impaired among subjects with depression and dyslexia.

Method

Participants

This research article is a part of a bigger study on the relationship between genes, schizophrenia and epilepsy which is a collaboration of Decode Genetics, Division of Psychiatry, University Hospital and other partners within Iceland and abroad.

The data used in this analysis collected from September 2009 to June 2012. The initial sample consisted of 1200 individuals, collected by the convenience (accidental) sampling method. All participants were offered 10,000 ISK (80$, taxable) as compensation for transportation costs or a sweater (most chose the sweater). Each participant received an informational brochure about the research, an application form, and a phone call from one of the researchers a week later. Informed consent form was obtained from each participant and only those who signed the consent were allowed to participate in the study. Icelandic was the first language of all the participants.

Excluded from the sample of healthy individuals were people with neurological disorders (epilepsy, MS), psychiatric disorders, developmental disorders or head trauma. Excluded from the sample entirely were subjects that were missing demographic information such as education, gender or age. The youngest (18-19 years) and oldest (60-65 years) age groups were excluded from this analysis, as the number of participants in each group was too low. The final size of the normative sample was 405 individuals (40% male) ranging from 20 to 59 years of age (M=44.42, SD=10.15).

Measures

In this study, the letters H and S were used, being the Icelandic equivalent of the standard FAS test, made by María K. Jónsdóttir (unpublished) (the letter F was also used, but only in a practice test). According to the Icelandic Frequency Dictionary, the letters S and H are the two the most frequent first letters of words in the Icelandic language (Íslensk orðtíðnibók, 1991). In addition, the mean score from both letters was used to establish average performance on the letter fluency test. In category fluency, the category *Animals* was used. The variables were named Letter S, Letter H, Letter Fluency (the mean score of S and H together) and Category Fluency. All variables were measured within the time frame of one minute.

Participants were also assessed with other neuropsychological tests, a mental state interview (M.I.N.I.), the short version of the Wechsler intelligence test (WASI), an oculomotor control test and blood tests. The neuropsychological tests were meant to evaluate a wide range of cognitive skills such as memory, attention, concentration and response inhibition. The M.I.N.I. neuropsychiatric interview was used as screening interview for mental pathologies such as depression, anxiety and psychotic disorders. All instruments used in this research have been translated into Icelandic and are in wide use in clinical practice in Iceland. The translations and standardizations have not been published.

Research Design

For factorial ANOVA analysis, the independent variables were age, gender and education level, while the dependent variable was performance on the VFT (on letter H, S, Letter Fluency and Category Fluency). For one-way ANOVA analysis, the independent variables were depression and dyslexia, while the dependent variable was performance on the VFT (on letter H, S, Letter Fluency and Category Fluency).The aim of this study, and reason for this

research design was to create norms for Icelandic population and to compare them with other normative data from other countries.

Procedure

Before the study could begin, the approval from the Data Protection Authority was obtained. Each participant was studied once and individually. The entire procedure took three hours. Four highly qualified researchers (psychologists) were responsible for the procedure and asked to take notes where they could share their comments (if there were any). All additional information that was meaningful for the study was collected (e.g., dyslexia, history of head trauma).

The procedure for the VLT for each participant was the same (for detailed procedure see Appendix A). First, participants received a practice test where they were asked to name as many words that start with letter F as they can within one minute. The actual test started with the naming of words that start with the letter H, then the letter S, and finished with the category fluency test. In category fluency, participants were asked to name as many *Animals* as they could within the same time frame (1 minute). Researcher wrote down all the words that participant managed to name within the time limit of one minute. Researchers recorded repetition, intrusional and rule breaking errors. If the word naming did not start within the first 15 seconds, the test was stopped and repeated. If participants stopped before time ended, researcher encouraged them to continue.

Statistical Analysis

Main statistical analysis were conducted in SPSS version 21. The main analysis were T-tests, analyses of variance (factorial ANOVA), one-way ANOVA and correlations.

Results

The final size of the normative sample was 405 individuals (40% male) ranging from 20 to 59 years of age (*M*=44.42, *SD*=10.15). Participants were divided into five age groups based on changes in cognitive factors according to age (Sherman et al., 2006). The normative sample and its comparison to the Icelandic population for the year 2012 are presented in Table 1. The data was obtained from *Statistics Iceland* (Hagstofa Íslands, 2013).

Table 1.
The Age and Gender of the Normative Sample and of the Population

Study sample						Population				
Age	Total	Female	Male	% males	% of total	Total	Female	Male	% males	% of total
20-34	75	42	33	44.0	18.5	69658	34090	35568	51.1	40.0
35-44	115	71	44	38.3	28.4	41790	20681	21109	50.5	24.0
45-49	75	50	25	33.3	18.5	21717	11051	10666	49.1	12.5
50-54	76	52	24	31.6	18.8	21425	10735	10690	49.9	12.3
55-59	64	30	34	53.1	15.8	19652	9730	9922	50.5	11.3
Total	405	245	160	39.5		174242				

The comparison of the normative sample with population is helpful in normative studies as it allows judging representativeness of the normative sample.

Information about dyslexia and depression were obtained during an unstructured interview and it depended on self-report rather than official diagnosis of the disorder. Therefore, they were only indications of the aforementioned disorders, and were analysed to check if they indicated higher than normal frequency of these disorders in the normative sample. Frequencies in the normative group and prevalence in population are listed in Table 2. The data about education in population was obtained from *Statistics Iceland* and is valid for year 2011 (data for 2012 was not available at the time) (Hagstofa Íslands, 2013). The information about prevalence of disorders in the population was obtained from Icelandic and European studies (Gísladóttir, 2013; Wittchen and Jacobi, 2005).

Table 2.
Frequencies in Education Groups

	Study sample		Population
	Frequency	% of total	% of total
Elementary school	143	35	30
Secondary school	154	38	38
University degree	108	27	29
Dyslexia	18	4	17
Depression	31	8	5-9

Age, Gender, Education and the Verbal Fluency Test

Dependent t-test showed that on average, participants scored higher on letter S (M =15.51, SE=.26) than on letter H (M = 14.31, SE = .29) with $t(404) = -6.17$, $p<.001$. Also on average, participants produced more words on Category Test (M=22.41, SE =.26) than on Letter Fluency Test (M = 14.91, SE = .26) with $t(404)= -28.98$, $p<.001$

Correlations among the demographic variables and scores on the Verbal Fluency Tests (see Table 3) show that age was significantly correlated with the scores on the tests with the letter H (r = -.120, $p<.05$) and education significantly correlated with gender (r = .156, $p<.01$). Education also correlated with scores on all VFT.

Table 3.
Correlations of Gender, Education, Age with Scores on VFT

	Age	Gender	Education	Letter H	Letter S	LF (mean)
Age	1					
Gender	-.023	1				
Education	.084	.156**	1			
Letter H	-.120*	.006	.228**	1		
Letter S	-.073	.019	.221**	.749**	1	
Letter Fluency (mean)	-.105*	.013	.240**	.942**	.928**	1
Category Fluency	-.111*	-.088	.222**	.461**	.458**	.491**

*$p<0.05$ (2-tailed), **$p< 0.01$ (2-tailed).

Figures 1a and 1b present the mean scores on Letter and Category Fluency tests stratified by age and education level. The Kolomogorov-Smirnov test of normality showed that for Letter Fluency, the youngest group and the age group 45-54 years were not normally distributed while on the Category Fluency test only two groups (45-54 and 55-59 years) were normally distributed. Inspection of these figures allows comparing mean scores between ages and education levels. There is visible trend showing worse performance as people get older and better performance with higher levels of education.

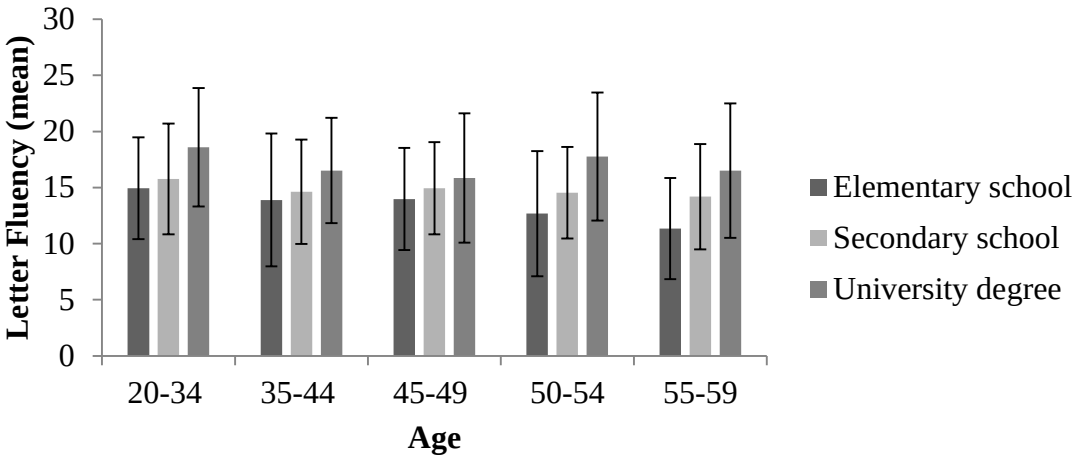

Figure 1a. Mean scores on the Letter Fluency test stratified by age and education

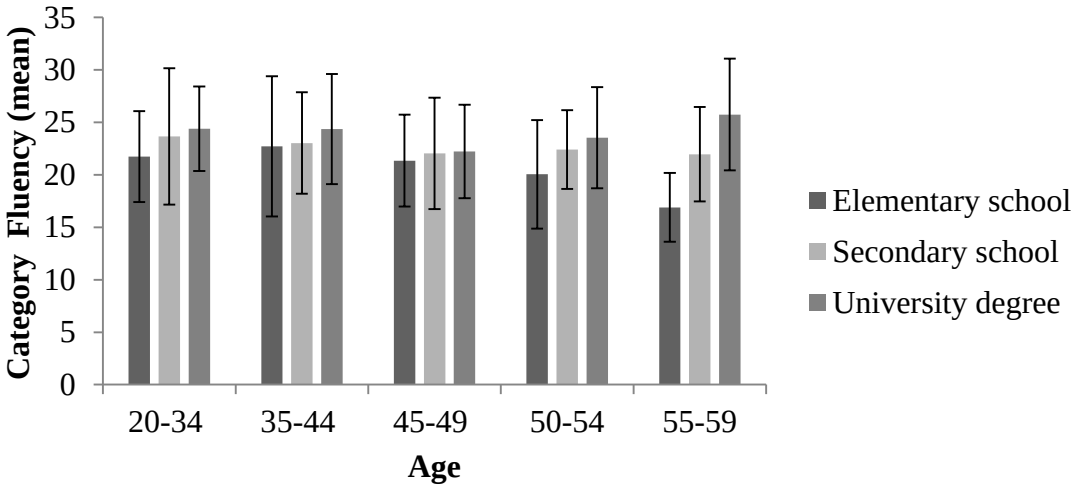

Figure 1b. Mean scores on the Category Fluency test stratified by age and education

The 5 (age) x 3 (education) x 2 (gender) factorial ANOVA was used to determine any main effects or interactions among demographic variables (see Table 4). Results showed that there was a significant main effect for the letter H, education ($F = 8.57$, $p < 0.01$) and age ($F = 3.02$, $p < 0.05$). For the letter S only education ($F = 7.67$, $p < 0.01$) had a significant main effect. There were no interactions among the demographic variables. In Letter Fluency (mean) education ($F = 9.36$, $p < 0.01$) had significant main effect. In the Category Fluency test, the assumption of homogeneity was violated (significant Levene´s test) therefore, the results were not reliable but there were also indications that education ($F = 13.55$, $p < 0.01$) and age ($F = 2.41$, $p < 0.05$) had a significant main effect on the performance on the test. In both tests, education was strong predictor while gender did not have any main effect on scores.

Table 4.
The 5x3x2 Analysis of Variance for Main Effects and Interactions among Age, Education, and Gender on the Verbal Fluency Test

	Main effect		Interaction	
	Variable	*F*	Variable	*F*
Letter H	Age	3.02*	Age x Education	.64
	Education	8.57**	Age x Gender	.63
	Gender	.005	Education x Gender	2.7
			Age x Education x Gender	.39
Letter S	Age	.95	Age x Education	.42
	Education	7.67**	Age x Gender	.19
	Gender	.02	Education x Gender	1.17
			Age x Education x Gender	1.39
Letter Fluency	Age	2.16	Age x Education	.51
	Education	9.36**	Age x Gender	.41
	Gender	.001	Education x Gender	2.18
			Age x Education x Gender	1.16
Category Fluency	Age	2.41*	Age x Education	2.14*
	Education	13.55**	Age x Gender	1.14
	Gender	2.91	Education x Gender	2.29
			Age x Education x Gender	1.32

*$p<0.05$, **$p< 0.01$

Normative Data

Following the results of factorial ANOVA, norms on VFT were created based on education and age, as they had a significant effect. Table 5 presents the normative data for Letter Fluency, stratified by age and education, transformed into percentile scores. Table 6 present the normative data for Category Fluency, stratified by age and education, transformed into percentile scores. Additional tables with norms are presented in Appendix B.

Table 5.
Norms for Letter Fluency Stratified by Age and Education.

	Age groups								
	20-34			35-44			45-49		
	Elementary school	Secondary school	University degree	Elementary school	Secondary school	University degree	Elementary school	Secondary school	University degree
Percentile									
95	22.7	27.4	.	24.9	25.4	25.7	23.5	23.8	29.4
90	22.0	23.6	27.7	22.4	19.8	23.0	18.9	19.5	21.8
75	18.8	18.5	21.0	18.0	18.0	20.0	17.5	16.5	18.5
50	13.8	14.5	17.5	13.5	14.0	16.0	13.5	15.5	16.0
25	11.6	12.0	14.5	9.5	11.0	13.0	12.0	13.5	12.0
10	10.0	9.0	11.9	5.8	9.0	11.1	7.2	9.3	6.4
5	8.5	9.0	11.5	3.6	7.1	9.5	5.0	4.7	4.8
M	14.9	15.8	18.6	13.9	14.6	16.5	14.0	14.9	15.9
SD	4.5	4.9	5.3	5.9	4.6	4.7	4.6	4.1	5.8

Note. M=mean, SD=standard deviation

Table 5 (continued).

	Age groups					
	50-54			55-59		
	Elementary school	Secondary school	University degree	Elementary school	Secondary school	University degree
Percentile						
95	25.2	19.9	.	.	24.9	.
90	21.8	19.5	27.7	17.0	19.6	26.0
75	16.1	18.0	20.0	14.5	17.3	20.5
50	12.2	14.5	16.0	11.0	14.0	15.5
25	8.1	11.0	14.0	7.0	10.3	11.5
10	5.0	8.4	11.2	5.0	8.0	10.0
5	4.6	7.4	10.0	4.5	6.7	7.5
M	12.7	14..5	17.8	11.3	14.2	16.5
SD	5.6	4.1	5.7	4.5	4.7	6.0

Note. M=mean, SD=standard deviation

Table 6.
Norms for Category Fluency Stratified by Age and Education.

	Age groups								
	20-34			35-44			45-49		
	Elementary school	Secondary school	University degree	Elementary school	Secondary school	University degree	Elementary school	Secondary school	University degree
Percentile									
95	29.0	41.6	.	35.0	31.8	34.8	27.8	36.1	30.0
90	27.3	31.6	30.9	31.8	30.6	31.0	26.6	31.0	29.2
75	25.0	27.0	27.0	27.0	26.0	29.0	25.0	23.0	27.0
50	22.0	23.0	24.0	23.0	23.0	24.0	23.0	21.0	21.0
25	19.0	18.0	21.0	16.5	19.0	21.0	18.0	19.0	19.0
10	16.0	17.0	19.7	15.2	17.4	17.0	14.4	16.0	16.8
5	14.3	15.4	19.0	11.2	16.2	16.0	14.0	14.6	15.4
M	21.7	23.7	24.4	22.7	23.0	24.4	21.4	22.0	22.2
SD	4.3	6.5	4.0	6.7	4.8	5.3	4.4	5.3	4.4

Note. M=mean, SD=standard deviation

Table 6 (continued).

	Age groups					
	50-54			55-59		
	Elementary school	Secondary school	University degree	Elementary school	Secondary school	University degree
Percentile						
95	30.8	29.2	.	.	29.7	.
90	27.0	29.0	31.4	22.0	29.0	35.0
75	24.8	24.0	28.0	19.0	26.3	28.0
50	19.0	22.0	22.0	17.0	21.0	24.0
25	16.0	19.5	20.0	14.0	19.8	22.0
10	14.0	17.0	17.6	13.0	16.8	20.0
5	11.8	16.9	17.0	12.0	12.7	20.0
M	20.0	22.4	23.5	16.9	22.0	25.7
SD	5.2	3.8	4.8	3.3	4.5	5.3

Note. M=mean, SD=standard deviation

Self-reported disorders and Verbal Fluency Tests

Self-reports of the disorders depression and dyslexia were analysed with one-way ANOVA. There was a significant effect of dyslexia on number of words produced on the letter S, $F(1, 403)=4.64$, $p<.05$, and that was the only significant result found among self-reported disorders. Participants that reported dyslexia scored on average $M=12.94$, $SD=4.26$, while

participants that had not indicated dyslexia produced, on average, *M*=15.63, *SD*=5.21 words on the Letter S.

Discussion

The present study presented normative data for Icelandic-speaking adults, for two Verbal Fluency Tests (letter and category fluency). The tests are frequently used for clinical and research purposes in Iceland but adequate norms have not been created. This study confirmed and extended previous findings (Bolla et al., 1990; Kavé, 2005; Tombaugh et al., 1999) by showing that measures of letter and category fluency are sensitive to age and education level while being uninfluenced by gender.

A comparison of the normative sample and the Icelandic population indicated some small differences e.g., the sample consisted of proportionally more women than of men and the age distribution did not exactly resemble the distribution in the population. These differences could have influenced the results (they could explain the small effect of age and gender) and therefore any generalizing of these variables on to the population should be made with caution. Normative sample and population had very similar distribution of education levels and self-reported diseases, which made the study sample well fitted for generalization of these factors on to the Icelandic population.

The relation between fluency performances, and demographic characteristics including gender, education and age were investigated. In general, existing differences emphasized the importance of collecting information concerning demographic characteristics, and background history for the evaluation of the subject's performance. There was weak, positive correlation between levels of education and the results on VFT, which was quite disappointing because many previous studies proved strong correlation between these factors (Loonstra et al., 2001; Tombaugh et al., 1999). This study hypothesized that the correlation between these factors

could be the strongest of all the variables. There was also weak, negative correlation between age and performance on one of the letter fluency tests (on letter H). This result indicated reduction in performance as the age progressed, which is consistent with other studies (Kavé, 2005; Mitrushina et al., 2005). When the genders were compared, there was no significant difference in scores, but men performed slightly better on category fluency test than did women. On the other hand, women scored higher on letter fluency test, which is consistent with the tendency for gender to be an unstable predictor for performance on the Verbal Fluency Test (Sherman et al., 2006). Even though these differences were not significant, they might relate to the possibility of diverging effectiveness in the use of strategies for word retrieval, with women being more effective in clustering and switching than men (Weiss et al., 2006).

Analysis of variance (factorial ANOVA) revealed that education was the one factor that had the main effect on performance on all tests of Verbal Fluency. Therefore, it was the strongest predictor of all variables. Age also had the main effect on letter H and on Category Fluency. The reason for scores on letter H being different from scores on letter S could possibly be related to the fact that the letter S is the most frequent letter in the Icelandic language (Íslensk orðtíðnibók, 1991), and it could be the easiest one. Therefore, age as a factor was not as sensitive to the letter S as to the letter H. The effect size was not calculated in the study therefore it is not known how important the effects were. To calculate effect size in factorial ANOVA it is recommended to use omega squared (ω^2), however one of its assumptions is that it can be calculated only when there are equal numbers of participants in each group (Field, 2009), which was not the case in this study. Future studies would have to use more elaborate procedures explained by Rosnow, Rosenthal, and Rubin (2000).

Inspection of mean scores between age groups and education levels revealed that there was visible trend in decrease of performance as age progresses. Education level had a strong

influence on the mean number produced on the test (the higher level of education, the higher the score). These results, again, are consistent with other studies (Kavé, 2005; Mitrushina et al., 2005). The tendency for older participants to perform worse on the Word Fluency is consistent with findings from the study of Rodriguez-Aranda et al. (2007) where they found that elderly subjects had a longer reaction time and also articulated words more slowly (Tallberg et al., 2008). The level of performance did not show the clear decreasing pattern for participants with a higher education level, and even in case of the oldest group with a university degree, there was an improvement in performance. All this can possibly indicate that as age progress, the performance decreases but education might work as a protective factor against age-related slowing in reaction time.

Results from the analysis of self-reported diseases revealed that depression had no significant impact on performance, which is not consistent with previous studies (Henry & Crawford, 2005; Ravdin et al., 2003) which indicate inhibited performance on VFT due to cognitive slowing. Dyslexia influenced the scores on letter S and this result was expected to be even more clear due to the previous studies (Kavé, 2005; Brosnan et al., 2002). The reason why these variables were not revealed to have a stronger impact on the performance on VFT could be because none of the participants was assessed and diagnosed by a specialist, and there was a chance of wrong self-diagnoses. The other factor was the sample size; there were very few subjects in each group.

The present study has several strengths. First, the sample size was adequate to provide comprehensive normative data. Second, individuals with epilepsy, schizophrenia, neurological diseases affecting the central nervous system, psychotic diseases, head traumas and autism were excluded from the study (so there was a little chance for existence of confounding factors such as dementia). Third, the additional characteristics (depression and dyslexia) were investigated, pointing out significant differences in scores among individuals

who have reported dyslexia, which is consistent with findings from earlier studies (Kavé, 2005; Brosnan et al., 2002). Fourth, the sample characteristics resembled those of the Icelandic population (especially in distribution of education levels, depression and dyslexia). Finally, the study consisted of many additional assessments of participants (e.g., M.I.N.I, WASI and a range of neuropsychological tests) which allowed for better evaluation and selection of the participants.

On the other hand, there are also limitations. First, the study used the letters H and S, which is unusual (but not coincidental) for VFT. Most normative studies use the letters F, A, and S and usually present their results in the form of a combined score for these three letters (Sherman et al., 2006). Therefore, direct comparison was not possible. Second, there is no data available about any study with the same design as this one in Iceland and therefore, again, it is not possible to compare results or evaluate the reliability and the validity of the Icelandic version of the VFT. Third, the sample was not randomly selected as would be ideal for normative studies but instead the convenience sampling method was used. Fourth, some information went missing in the data collection and this resulted in a decrease in sample size. In addition, some more complicated statistical calculations in analysis of data were omitted (e.g., effect size in factorial ANOVA) which limited the evaluation of the results.

In summation, the present study created norms for the Icelandic population on Verbal Fluency Tests. Results showed that education was the most reliable predictor for performance on letter and category fluency tests, with age being the second most predictive factor. The major goal of these norms was to increase the ability of neuropsychologists to determine more precisely the possible impairment in patients of varying demographical characteristics. This study introduced norms for both letter and category fluency to give to the specialist the additional advantage of determining whether one type of verbal fluency is more affected than the other. Two important aspects should be kept in mind when using the current norms. First,

the norms are applicable only when the mean scores on Letter Fluency for letters H, and S or the category of *Animals* are used. Second, the current norms are only applicable when the person is fluent in Icelandic.

It is recommended for future studies to carefully collect data, making sure that form and content are stable along the collection procedures (to avoid uncertainty and missing values). This is essential for normative studies as they rely on a large number of participants and valid data. It is also important to preserve resemblance to the population characteristics, to make generalization of the results possible. The fact that many variables have influence on VFT scores emphasises the importance of collecting information concerning demographic characteristics, and background history for the evaluation of the subject's performance. Future studies could focus on the precise interactions between education and performance on VFT, whether the effect of education is related to overall improvement of the executive functioning or if it is due to the increased verbal intelligence. Closer evaluation of education and verbal fluency might be meaningful for future studies as this research indicates that it could be the protective factor against decrease in verbal fluency as age progresses.

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Appendix A

Detailed procedure of VFT

The researcher started the test by saying: *"I'm going to asking you to tell me as many words as you can remember starting with a certain letter. You may not use the proper noun, which are words that are associated with capitalization, such as personal names or names of places. If we take the letter R, for example you may not say Rachel, Reykjavik. You may not use the same words with different endings, like a vacuum, vacuumed. Examples of words that you could say are: red, raisins and rose. Are you ready? Now tell me as many words as you can remember starting with letter H."* The researcher started the stopwatch and wrote all the words, which the participant managed to name within one minute, down on the form (using paper and pencil). The form was divided into 15 seconds intervals. The same procedure was used for the letter F (but just as a practice run, without recording data) and the letter S. In Category Fluency, the participant was asked to name as many animals as they could within the same time frame (one minute). The researcher recorded repetition, intrusional and rule breaking errors. If the word naming did not start within first 15 seconds, the test was stopped and repeated. If participants stopped before the time ended, the researcher encouraged them to continue.

Appendix B

Additional tables with norms

Table B1. *Norms for Letter Fluency stratified by education.*

	Education					
Percentile	Elementary school		Secondary school		University degree	
	LF	CF	LF	CF	LF	CF
95	23.70	30.60	22.00	31.00	27.28	33.55
90	21.30	28.00	19.50	29.50	24.60	31.00
75	17.00	25.00	18.00	25.00	20.00	27.00
50	13.00	20.00	14.75	22.00	16.00	24.00
25	10.50	17.00	11.50	19.00	13.13	20.00
10	7.00	14.00	9.00	17.00	11.00	18.00
5	5.00	13.00	7.50	16.00	8.90	17.00

Note. LF=Letter Fluency, CF= Category Fluency

Table B2. *Norms for Letter Fluency stratified by age.*

	Age									
Percentile	20-34		35-44		45-49		50-54		55-59	
	LF	CF	LF	CF	LF	CF	LF	CF	LF	CF
95	26.70	31.20	25.10	34.00	24.60	30.00	24.50	29.30	25.13	32.50
90	22.20	29.00	22.20	31.00	19.90	28.00	19.65	28.30	21.25	29.00
75	20.00	25.00	18.50	27.00	17.50	25.00	18.00	25.00	16.88	24.75
50	14.50	23.00	15.00	23.00	15.50	21.00	14.50	21.00	14.00	21.00
25	12.00	19.00	11.00	19.00	12.50	19.00	11.13	19.00	10.50	19.00
10	10.00	16.60	8.00	16.00	7.50	16.00	8.00	16.00	7.25	14.00
5	9.00	15.80	7.00	15.80	5.70	14.80	6.28	14.85	5.63	13.00

Note. LF=Letter Fluency, CF= Category Fluency