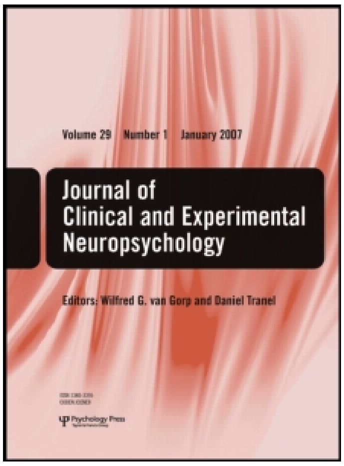

Journal of Clinical and Experimental Neuropsychology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713657736

The Effects of Literacy and Education on the Quantitative and Qualitative Aspects of Semantic Verbal Fluency

Catarina Gonzalez da Silva; Karl Magnus Petersson; Luís Faísca; Martin Ingvar; Alexandra Reis

Online Publication Date: 01 April 2004

To cite this Article Silva, Catarina Gonzalez da, Petersson, Karl Magnus, Faísca, Luís, Ingvar, Martin and Reis, Alexandra(2004)'The Effects of Literacy and Education on the Quantitative and Qualitative Aspects of Semantic Verbal Fluency',Journal of Clinical and Experimental Neuropsychology,26:2,266 — 277

To link to this Article: DOI: 10.1076/jcen.26.2.266.28089

URL: http://dx.doi.org/10.1076/jcen.26.2.266.28089

Journal of Clinical and Experimental Neuropsychology
2004, Vol. 26, No. 2, pp. 266–277

Psychology Press
Taylor & Francis Group

The Effects of Literacy and Education on the Quantitative and Qualitative Aspects of Semantic Verbal Fluency

Catarina Gonzalez da Silva[1,2], Karl Magnus Petersson[1,3,4], Luís Faísca [2], Martin Ingvar[1], and Alexandra Reis[1,2]

[1]Department of Clinical Neuroscience, Cognitive Neurophysiology Research Group R2-01, Karolinska Institutet, Karolinska Hospital, Stockholm, Sweden, [2]Departamento de Psicologia, Faculdade de Ciências Humanas e Sociais, Campus de Gambelas, Universidade do Algarve, Faro, Portugal, [3]Neurocognition of Language Research Group, Max-Planck-Institute for Psycholinguistics, Nijmegen, The Netherlands, and [4]F. C. Donders Centre for Cognitive Neuroimaging, Katholieke Universiteit Nijmegen, Nijmegen, The Netherlands

ABSTRACT

Semantic verbal fluency tasks are commonly used in neuropsychological assessment. Investigations of the influence of level of literacy have not yielded consistent results in the literature. This prompted us to investigate the ecological relevance of task specifics, in particular, the choice of semantic criteria used. Two groups of literate and illiterate subjects were compared on two verbal fluency tasks using different semantic criteria. The performance on a food criterion (supermarket fluency task), considered more ecologically relevant for the two literacy groups, and an animal criterion (animal fluency task) were compared. The data were analysed using both quantitative and qualitative measures. The quantitative analysis indicated that the two literacy groups performed equally well on the supermarket fluency task. In contrast, results differed significantly during the animal fluency task. The qualitative analyses indicated differences between groups related to the strategies used, especially with respect to the animal fluency task. The overall results suggest that there is not a substantial difference between literate and illiterate subjects related to the fundamental workings of semantic memory. However, there is indication that the content of semantic memory reflects differences in shared cultural background – in other words, formal education –, as indicated by the significant interaction between level of literacy and semantic criterion.

INTRODUCTION

Verbal fluency tasks are commonly used in neuropsychological assessment, since they are easy to administer (Carnero, Lendínez, Maestre, & Zunzunegui, 1999; Kempler, Teng, Dick, Taussig, & Davis, 1998), sensitive to brain damage and cognitive deterioration (Acevedo et al., 2000; Bruyer & Tuyumbu, 1980; Carnero et al., 1999; Chan & Poon, 1999; Joanette & Goulet, 1986; Kempler et al., 1998; Ratcliff et al., 1998; Rosen, 1980; Ruff, Light, Parker, & Levin, 1997; Stuss et al., 1998; Tombaugh, Kozak, & Rees, 1999; Troyer, Moscovitch, Winocur, Alexander, & Stuss, 1998) and can be applied to different cultural groups (Kempler et al., 1998). Verbal fluency tasks have also been applied in the investigation of illiterate and other low-level educational groups because they do not require reading or writing skills. Clear and consistent differences between literacy groups have been reported when a phonological criterion has been used (Manly

Address correspondence to: Alexandra Reis, Departamento de Psicologia, Faculdade de Ciências Humanas e Sociais, Universidade do Algarve, Campus de Gambelas, 8000-810, Faro, Portugal. Fax: +351-289818560. E-mail: aireis@ualg.pt
Accepted for publication: May 19, 2003.

et al., 1999; Ostrosky-Solís, Ardila, Rosselli, Lopez-Arango, & Uriel-Mendonza, 1998; Reis & Castro-Caldas, 1997; Rosselli, Ardila, & Rosas, 1990). In contrast, several studies, comparing literate and illiterate subjects have yielded different results when using semantic criteria (see e.g., Manly et al., 1999; Ostrosky-Solís et al., 1998; Reis & Castro-Caldas, 1997). At present the reasons for this state of affairs are unclear, but may relate to, for example, the specific semantic criteria or the particular study populations used.

In the present study we analysed in greater detail several studies where literacy groups were compared during different verbal fluency tasks using semantic criteria. Some of the studies are not directly comparable, since they include groups with different mean literacy levels and use different fluency criteria that may be important in explaining the contradictory results reported in the literature. For example, Manly et al. (1999) compared literate subjects with 3 years of education and illiterate subjects on a category fluency task (1 min) for animals, food and clothing and did not find any group differences when pooling the data over semantic categories, while a letter fluency test was significantly more difficult for the illiterate subjects. However, in a previous study (Reis & Castro-Caldas, 1997), illiterate and literate subjects with a mean education of 9 years of education were compared on a category fluency task (2 min), using animals and furniture as semantic criteria, reported a significant group difference when data was pooled over categories. In order to understand this discrepancy more clearly, we re-analysed these data separately for each of the semantic criteria used, and including only data from the first minute (Reis, unpublished data). However, significant group differences were still found for both criteria. Thus it appears that, not only reading and writing skills, but also the number of years of education in itself is of importance in this context, since this represented the main difference between the Manly et al. (1999) and Reis and Castro-Caldas (1997) studies.

That education level (i.e., the number of years of formal education) can affect task performance is well documented (Acevedo et al., 2000; Manly et al., 1999; Ostrosky-Solís, Ardila, & Rosselli, 1999; Ratcliff et al., 1998; Reis, Guerreiro, & Castro-Caldas, 1994; Reis, Petersson, Castro-Caldas, & Ingvar, 2001b; Tombaugh et al., 1999). However, consistent with the results of Reis et al. (Reis & Castro-Caldas, 1997), both Ostrosky-Solís et al. (Ostrosky-Solís et al., 1999), using animals, and Rosselli et al. (Rosselli et al., 1990), pooling data from animals and fruits as criteria, found significant differences when illiterate subjects and different educational groups, as well as high and low literacy groups were compared, respectively. However, in an earlier study of Ostrosky-Solis et al. (Ostrosky-Solís et al., 1998), this was not the case, similar to results of Manly et al. (1999)

One possible explanations for these observations, raised by Reis, Guerreiro, and Petersson (2001a) is related to the ecological or cultural relevance of the semantic criteria chosen. For example, Reis et al. (2001a) asked subjects to name different things one can buy at the supermarket. This appears to be an equally natural criterion for female literate and illiterate subjects of southern Portugal, since almost all of these subjects do a significant part of their regular shopping at supermarkets and at comparable levels. Reis et al. (2001a) found no significant difference between the three literacy groups compared using the supermarket item criterion. Therefore, the objective of the present study, given the diverging results described above and following the suggestion by Reis et al. based on preliminary data (Petersson, Reis, & Ingvar, 2001; Reis et al., 2001a), was to directly compare in the same study population two different semantic criteria in a verbal fluency task, one more and the other less ecologically relevant (Silva, Petersson, Ingvar, & Reis, 2001). Here ecologically relevant is taken to reflect different levels of shared cultural background. More specifically, we compared the performance of the same illiterate and literate subjects on two verbal fluency tasks, the first using the semantic category of food (edible) items that can be acquired at the supermarket (supermarket fluency task), and the second, animal names (animal fluency task).

Our second objective was to investigate whether formal education influences the qualitative features of verbal fluency. In order to appraise whether there is any indication that semantic knowledge is organized or retrieved differently in the different literacy groups studied here, we used an approach suggested by Troyer et al. (Troyer, 2000; Troyer, Moscovitch, & Winocur, 1997). According to Troyer and co-workers (Troyer, 2000; Troyer et al., 1997), successful fluency performance depends on the ability to employ strategic search and to organize retrieval in terms of semantically related words, and is achieved by identifying the semantic domain, search and generate representative examples within a subcategory and then shift to another subcategory after exhausting the previous one. They operationalized two qualitative aspects of verbal fluency, reflecting the strategies underlying fluency: (1) clustering – the production of related words within a given semantic subcategory, involving semantic categorization; and (2) switching, which requires initiated strategic search of subcategories through semantic memory, and cognitive flexibility to shift efficiently between semantic subcategories. Furthermore, it has been suggested that these components are related to temporal lobe functions (such as word memory and lexical storage), and frontal lobe function(s), respectively. Switching is considered to be a relatively more dependent on controlled processing than those required for clustering, which are relatively automatic in character (Troyer, 2000; Troyer et al., 1997). The correlation between switching and the frontal system as well as clustering and the temporal system functions has not always been supported by studies of clinical populations (Epker, Lacritz, & Cullum, 1999; Ho et al., 2002; Tröster et al., 1998). For example, Tröster et al. (1998) compared cortical and sub-cortical groups of patients and did not find support to the idea that impairments in word generation on semantic fluency tasks arise from fundamentally different process (i.e., retrieval failure in subcortical pathologies and degraded storage in cortical pathologies). This together with the partly unknown or complex relationship between the frontal cortex and executive functions as well as the temporal system and semantic storage make these indicators difficult to interpret cognitively in processing terms, except as a first approximation. In the present study, we used the following qualitative measures: number of semantic subcategories (basic level) as an indicator of semantic memory organization and clustering (total number of clusters and mean cluster size) and switching as an indicator of the cognitive strategy employed in order to further understand previously documented differences in verbal fluency performance when different criteria has been used. This qualitative part of our study is exploratory in character but we did predict that one possible outcome would be fewer switches in the illiterate compared to the literate sample, perhaps indicating poorer executive components.

MATERIAL AND METHODS

Participants

Thirty-seven healthy female volunteers with similar social-cultural background except for formal education and its indirect consequences, 19 literate (mean age 66 ± 7 years; mean education 5 ± 1.9 years) and 18 illiterate subjects (66 ± 6 years; no significant age difference between the groups), participated in both experimental tasks. Participants were screened with structured socio-cultural and medical-health interviews as well as a short neuropsychological test battery (Garcia, 1984; Garcia & Guerreiro, 1983; Reis et al., 2001a). The socio-cultural interview assesses variables like occupation, literacy level or, in case of being illiterate, the reasons for illiteracy and the literacy level of parents. The questions included in the socio-cultural interview are: (1) whether the subject had entered school or received formal education at any time and the reasons for not continuing school; (2) about their profession and any potential work-related difficulties; if there had been any difficulties in keeping any occupations or whether there had been any other performance problems related to work at any time; (3) the subjects were asked about the level of education of their parents. In addition, subjects were tested on a letter identification task (sequences of letters representing: the Portuguese public TV station, the Portuguese mail service, the Portuguese telephone company, the word hospital, and a random letter sequence. Subjects were also asked whether they could write their name (writing their own name was not an exclusion criterion, since most illiterate subjects have learnt to write their names by copying in order to sign different sorts of documents they encounter in ordinary life, e.g., social security forms, documents at the post office, etc.). In addition, the literate subjects were asked about their educational level and assessed on a simple reading

Table 1. A Summary from the Socio-demographic Characterization for Both Groups: Functionality and Reading Assessment. Yes = Y and No = N.

	Illiterates	Literates
Functionality assessment		
Goes shopping at the supermarket?	100% (Y)	100% (Y)
Writes a list for shopping?	–	64.7% (Y)
Does the shopping payments?	100% (Y)	100% (Y)
Payment of house bills?	100% (Y)	100% (Y)
Goes to the doctor alone?	100% (Y)	100% (Y)
Takes a bus alone whenever necessary?	100% (Y)	100% (Y)
Mother literacy?	77.8% (N)	23.1% (N)
Father literacy?	88.3% (N)	36.5% (N)
Reading assessment		
Reading a text fluently without errors	–	100%
Reading comprehension (max. = 6)	–	6.0 ± 0.0
Writing to dictation (mean of errors $\pm$ *SD*, max. = 9)	–	1.7 ± 1.0
Read letters	–	100% (Y)
Read TV legends	–	93.8% (Y)
Read Books (scale 1 frequently to 4 never)	–	56.3% Never 0% Frequently
Read Magazines (scale 1 frequently to 4 never)	–	43.8% Never 25% Frequently
Read Newspapers (scale 1 frequently to 4 never)	–	50% Never 6.3% Frequently
Write letters	–	100% (Y)
Write notes	–	100% (Y)

comprehension test (a short newspaper text followed by six comprehension questions), and asked to write nine verbally presented simple words. The medical health interview is used to rule out any significant neurological, psychiatric, or other diseases potentially involving the brain. The neuropsychological test battery for mental state assessment is used to exclude significant cognitive dysfunction. Based on these interviews and self-reports, it was estimated that the subjects included in this study were active, independent and fully functional in daily life (see Table 1 for a brief summary). Subjects were excluded based on the following criteria: (1) Significant history of neurological, psychiatric or other disease potentially affecting the brain; (2) Functional employment or daily life problems; literate subjects with problems acquiring reading and writing skills; (3) Performance at two standard deviations below normative values (Garcia, 1984; Garcia & Guerreiro, 1983) on the following tests: verbal fluency, verbal memory with interference and orientation; (4) Illiterate subjects were excluded if they were able to identify the letters in the screening test; literate subjects were excluded if they were unable to read the newspaper text fluently, answer the comprehension questions correctly, or made more than 60% spelling errors on he dictation task. (5) Subjects that had started school or an educational program but not finished, or subjects that had or were presently engaged in literacy training for adults. The main difference between the two literacy groups relates to the knowledge of how to read and write and other skills and knowledge acquired during the first years of schooling (for more details concerning the study population, procedures and subject selection see Petersson et al. (2001).

Procedure and Scoring

Two semantic fluency tasks were administered on an individual basis in a randomized fashion. Both tasks were time limited to 1 min of word generation. In the supermarket fluency task, subjects generated words corresponding to edible things (food items) that can be bought at a supermarket, and in the animal fluency task, animal names. We chose this particular version of the food category task in order to make the task more concrete, realistic, and reflect a shared common background between the two literacy groups, in line with the experimental logic of the study. In accordance with the ideas of Troyer et al. (Troyer, 2000; Troyer et al., 1997), subject responses were analyzed in order to identify semantic clusters, meaning by clusters of contiguous words belonging to the same semantic subcategory (e.g., vegetables in supermarket fluency; wild animals in animal fluency). Following the suggestion of others (e.g., Robert et al., 1998; Troyer et al., 1997), the semantic subcategories used to identify clusters were empirically defined based on the words generated by the participants during testing (cf. Appendix 1). The subject performance was classified and analyzed as follows:

(a) *Total number of words produced*: the number of correct words generated, excluding intrusions and repetitions;
(b) *Total number of semantic subcategories generated*: the number of subcategories used when producing words within clusters;
(c) *Total number of clusters generated*: following Robert et al. (1998) we defined a cluster as a group of at least three consecutively generated words belonging to the same semantic subcategory (e.g., apple, orange, pear . . . in the supermarket fluency task; dog, cat, cow . . . in the animal fluency task; cf. Appendix 1). Since isolated groups of two consecutive but related words (e.g., *cat, rat*, or *cheese, ham*) does not necessarily represent a clustering strategy (i.e., systematically searching for items within a given subcategory), this definition represents a more conservative measure with respect to the use of a clustering strategy. However, in line with Robert et al. (1998), strongly associated pairs (e.g., frequently pairs, like dog-cat; pairs based on proverbs, such as turtle-rabbit; or pragmatic criteria, such as bread-butter) were also counted as clusters;
(d) *Total number of switches*: the number of switches was calculated based on the total number of transitions between clusters (e.g., horse, cow, sheep, *tiger . . .*; *tiger* representing a switch from domestic to nondomestic animals), including single words and intrusions;
(e) *Mean cluster size*;
(f) *Total number of isolated words generated*: the number of words not generated within a cluster;
(g) Naming a subcategory was not scored if the subject had already generated words from the subcategory (e.g., naming the subcategory ‘‘fruit,’’ after the word ‘‘apple’’ or ‘‘orange’’). These types of errors were classified as intrusion of semantic subcategories;
(h) Intrusions and repetitions were scored separately;
(i) On animal fluency, no credit was given to variety in animal gender within the same species if the word was similar; for example changing only the last syllable or letter (e.g., ‘‘leão/leoa’’ – ‘‘lion/lioness’’), but accepted if the word was different (e.g., ‘‘cavalo/égua’’ – ‘‘horse/mare’’).

All protocols were scored by one of the authors as well as an independent blind rater. Inter-rater reliability was calculated using Spearman’s correlation coefficient for both tasks and for number of switches, total number of clusters and mean cluster size. The correlation coefficients ranged from 0.94 to 0.98, indicating high inter-rater reliability.

In order to assess the robustness of our findings, using the criteria described above, we also analyzed the data using slightly different defining criteria for semantic subcategories, for example, including both soft- (i.e., an item can belong to several subcategories with different degrees depending on the response context of the item; for instance, chicken was considered an exemplar of farm/domestic animals if preceded and followed by for example cow . . . pig, respectively, but could also be considered an exemplar of the bird subcategory if surrounded by for example robin . . . eagle) and hard (i.e., mutually exclusive) subcategories; variations on the defining criteria for a cluster, including Troyer’s criteria (Troyer et al., 1997) defining clusters as groups of at least two semantically related words; and including or excluding strongly related pairs in the cluster counts. All of these variations in terms of the precise definitions of the measures used yielded very similar results, indicating the robustness of the results thus being relatively independent of the precise details of the analysis employed.

RESULTS

The data were first analyzed with a repeated measures analysis of variance including all the factors of the experimental design, semantic criterion and literacy group, with the total number of correct items as the dependent variable. As we can see from Figure 1 there is a highly significant interaction between semantic criteria and literacy group, $F(1, 35) = 6.3$; $P = .02$. A post hoc analysis (Tukey HSD Test) showed that the significant interaction was related to an effect of semantic criteria within the illiterate group ($P = .02$) and a significant literacy effect for the animal criterion ($P = .004$).

The data were further analyzed separately for each semantic criterion in order to understand qualitatively differences between groups. Due to the small size of our sample, effects sizes were also computed for each comparison. For supermarket fluency (Table 2) there were no significant group differences related to the total number of words generated (a mean of 16 words for both groups), total number of clusters, or mean cluster size, although medium effect sizes were observed for the latter two measures. In addition, the total number of switches differed significantly, and was

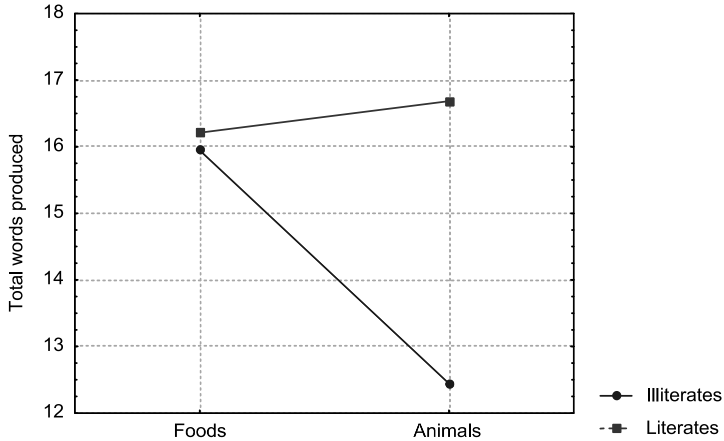

Fig. 1. A two-way interaction: literacy × semantic criteria.

Table 2. Means and Standard Deviation for the Supermarket and Animal Fluency Tasks, Between Group Comparisons (Mann-Whitney *U* test) and Effect Sizes Measured by Cohen's *d* (Cohen, 1988).

	Illiterate	Literate	*P*	*d*
Supermarket fluency				
Total words produced	15.9 ± 3.0	16.1 ± 3.8	.8	0.049
Total of subcategories	2.8 ± 1.2	2.5 ± 1.2	.4	0.264
Total of clusters	3.3 ± 1.5	2.6 ± 1.3	.2	0.462
Mean cluster size	3.9 ± 2.8	2.9 ± 0.9	.3	0.446
Total number of switches	8.4 ± 3.8	10.8 ± 2.5	.02	0.728
Total isolated words	5.1 ± 3.6	8.3 ± 2.6	.002	1.034
Animal fluency				
Total words produced	12.4 ± 4.2	16.7 ± 3.9	.006	1.067
Total of subcategories	2.2 ± 1.0	3.0 ± 0.9	.04	0.984
Total of clusters	2.4 ± 0.9	3.4 ± 0.8	.007	1.587
Mean cluster size	4.8 ± 2.6	3.7 ± 0.7	.3	0.581
Total number of switches	4.2 ± 1.7	7.7 ± 2.1	.000	1.750
Total isolated words	1.7 ± 1.5	4.3 ± 2.1	.000	1.541

mainly due to a significant difference in the total number of isolated words generated (more in the literate than the illiterate group). Nevertheless, these latter differences did not have any implications on the number of words produced nor on the total number of clusters or mean cluster size. The error type analysis did not indicate any differences in the number of repetitions, intrusions and intrusions of subcategories between groups ($P = .9$, .1, and .4, respectively).

In addition, we investigated the proportion of subjects that used a given semantic subcategory for each literacy group, and also how many subjects produced clusters related to the 9 semantic subcategories analysed in the present study (Table 3). No significant difference was found between the literacy groups.

In contrast to the results from supermarket fluency, with the exception of mean cluster size, there were significant group differences in the animal fluency results for all measures considered (Table 2). Literate subjects generated significantly more items (17 compared to 12 for the illiterate group), used more subcategories, generated more

Table 3. Percentage of Subjects in Each Literacy Group that Generated Clusters Within the Nine Semantic Subcategories Considered for the Supermarket Fluency Task (Fisher Exact One Tailed Test).

Subcategories	Illiterate (in %)	Literate (in %)	*P*
Meat/Delicatessen	11.1	15.8	.5
Vegetables	72.2	57.9	.3
Fruit	44.4	26.3	.2
Condiment/Spices	33.3	21.1	.3
Sweet food	5.6	0	.5
Drinks	11.1	0	.2
Grain Products	66.7	47.4	.2
Products of animal origin	11.1	31.6	.1
Meals	27.8	52.6	.1

clusters, generated more isolated words, and switched more often. On the other hand, the illiterate group generated larger clusters, though nonsignificantly so. There were no significant differences with respect to intrusions, repetitions, intrusion of subcategories, or gender variation ($P = .8$, .1, .8, and .1, respectively). Concerning the proportion of semantic subcategories, a significant group difference favoring the literate group, was related to the pet subcategory ($P = .003$), and, in addition, the illiterate group did not produce clusters within the reptile subcategory (Table 4).

Finally, in this study we have reported the results using nonparametric differences. One reason for using nonparametric statistics is that they are almost always valid and independent of the underlying probability distribution. This aspect may be important when investigating relatively small samples. In order to compare our results as described with a parametric approach, we reanalyzed the data within the ANOVA framework. This yielded very similar results and identical effects. In addition, since our scoring criteria differed somewhat from the standardized Troyer method, we also reanalyzed our data based on Troyer's scoring criteria. This yielded very similar results. Thus, in this respect, the results are robust and independent of the scoring criteria and test-statistics used. It should also be noted that two measures included in this study, the total number of switches and the total number of isolated words, are correlated. However isolated words were less correlated with the total scores compared to switching which means that they are less dependent of the total score. In addition, empirical inspection of the data indicated that the total number of isolated words may be a more sensitive measure compared to switches in our data. This was indeed the case, and the total number of isolated words was significantly different between the literacy groups. We thus included this result in line with the exploratory part of this study.

Table 4. Percentage of Subjects in Each Literacy Group that Generated Clusters Within the Eight Semantic Subcategories Considered for the Animal Fluency Task (Fisher Exact One Tailed Test).

Subcategories	Illiterate (in %)	Literate (in %)	*P*
Pets	50	94.7	.003
Farm animals	66.7	68.4	.6
European wild animals	11.1	15.8	.5
Non European wild animals	33.3	63.2	.07
Rodents	16.7	21.1	.5
Birds	33.3	21.1	.3
Reptiles	0	10.5	.3
Water animals	11.1	5.3	.5

DISCUSSION

The main objective of this study was to further investigate and to understand in greater detail a previously documented inconsistency in the relation between literacy/formal education and performance on verbal fluency tasks (described in more detail in the introduction), and the suggestion that this may be related to the ecologically relevance of the semantic criterion, reflecting the level of shared cultural background of the subjects. To this end, we investigated the quantitative and qualitative features of subject performance on a time limited fluency task using two different semantic criteria (food items at the supermarket and animals) in the same study population, including two groups of subjects with similar socio-cultural background except for education.

Several studies have shown that illiteracy and the level of education has consequences for several cognitive functions (for a review, see, Petersson et al., 2001). Literacy and formal education has also been associated with the capacity to acquire a broader knowledge-base of general information as well as to process this information in a more abstract and systematic manner (Ardila, Ostrosky, & Mendonza, 2000; Ceci, 1990; Ceci & Williams, 1997). The implications are that literacy and educational level can influence performance on specific psychological tasks and neuropsychological tests. Hence, it appears that literacy and formal education catalyze the development of several cognitive skills in addition to reading and writing skills.

The main result of this study was the indication that the literacy interacted strongly with the semantic criterion used in the time-constrained semantic verbal fluency task. There were only nonsignificant differences between groups on the different measures in the supermarket version (including number of words, subcategories, or clusters generated), while almost all measures differed significantly in the animal version of the fluency task. However, the results on two measures generalized across tasks. First, we observed a significant group difference in number of isolated words generated and by implication the number of switches (literate > illiterate) in both tasks. Second, although the mean cluster size was statistically similar in both groups for the two fluency tasks, it appeared that the illiterate subjects showed a consistent tendency to generate larger clusters, the flip side of generating fewer isolated words. In fact, we should have some caution when declaring null differences between groups because our sample size do not allow us to have enough power to detect medium effect sizes, such as the one observed for the mean cluster size in both tasks, using the significance level of .05.

The overall similarity in performance on the supermarket task appears to exclude a simple explanation in terms of general factors, such as cognitive speed or fluency, for the differences observed on the animal version of the fluency task. Instead, the interaction between literacy and semantic criterion may be explained in terms of similarities and differences in shared cultural background, that is, greater for supermarket items and lesser for animals. For example, *jacaré/alligator, javali/wild bore, búfalo/buffalo* were generated only by literate subjects. It is impossible, from these results, to determine whether these results imply that illiterate subjects have fewer names for, for example, animals in their vocabulary. One possibility is that this may reflect a type of frequency of exposure effect, making lexical access less readily available in illiterate subjects. In other words, this difference may be a consequence of education or a secondary effect of literacy, since the reading skills facilitates access to information, through printed media, providing the opportunity to broaden different semantic categories that bypass the shared socio-cultural background of the two literacy groups. Recently, in a different experimental setting, exposure effects on verbal fluency performance were reported in a cross-linguistic comparison between monolingual and bilingual speakers related to the semantic sub-categories generated (Rosselli et al., 2002).

However, in this context, a puzzling observation should be noted: the illiterate subjects generated fewer household pets. We have no reasonable interpretation for this finding. This may be a random observation but, if real, seems to fit less well within the socio-cultural (i.e., differences in literacy/education) interpretation suggested here. Additional aspects of our two fluency tasks may have to be taken into consideration. For example, food items (i.e., edible things) that can be bought at a supermarket represent a more concrete category than animals. A comparable animal task, in this respect, would be to ask the subjects to generate animals that can be found in the town. Tentatively one might predict that on such a task no differences between literate and illiterate subjects will be observed. Perhaps, by the same token, if the general category of food items were used instead of food items that can be bought at a supermarket, significant differences would be observed. In other words, it is not just that the two categories used in this study are different semantic categories, correlating with differences in socio-cultural background related to literacy/education, they also differ in terms of the level of reference to a concrete knowledge and specific situations.

Furthermore, the observed differences between the literacy groups may not only relate to the semantic category used, but potentially also the extension (the semantic field; the potential number of available elements) of the semantic category.

In short, written language provides the opportunity to broaden different semantic categories, and by using written language, we can access information (i.e., elements of the semantic category) that we cannot access through our direct experience. Thus, an important determinant for verbal fluency performance may relate to the type of experience we have with the elements of a semantic category. If restricting the potential experience then literacy or education may have little effect, while not restricting the answers to the knowledge acquired through the direct experience, the ability to access written information makes a difference. Put differently, reading and education becomes a cognitive instrument.

Verbal fluency depends on the ability to employ strategic search and to organize retrieval in terms of semantically related words; it is achieved by identifying the semantic domain, searching and generating representative examples within a given subcategory, and then shifting to another subcategory after exhausting the previous one (Troyer, 2000; Troyer et al., 1997). Interpreted in line with these suggestions, the differences in number of isolated words and switches generated by the literacy groups appear to indicate that the literate group adopted a more active strategic search among subcategories. These differences in strategic aspects may be related to a suggested interpretation of recent findings, indicating differences between literacy groups with respect to executive aspects of the verbal working memory as subserved by the left dorsolateral prefrontal cortex (Petersson, Reis, Askelöf, Castro-Caldas, & Ingvar, 2000). However, given the interaction between literacy and semantic category, the effectiveness of this strategy, as measured by the total number of words generated, is not independent of semantic criterion. Rather, it is modulated in some respect by literacy, secondary effects of literacy, or education, consistent with suggestions that formal education entails the acquisition of strategies for abstract information processing (e.g., Ceci, 1990). Taken together these results seem to suggest that switching and clustering may not be fully independent in all circumstances (Spearman's correlation coefficient between cluster size and number of switches, supermarket task – illiterate: -0.72, $P < .001$, literate: -0.28, ns.; animal task – illiterate: -0.46, $P < .05$, literate: -0.47, $P < .05$). Instead, the association or dissociation between these strategies may be dependent on the level of literacy and the semantic domain in which the search is taking place. This suggestion is in line with the observation of Mayr (2002), who measured temporal parameters of switch duration and the within-cluster retrieval duration, concluding that switching between categories is dependent on semantic criterion. However, these suggestions need to be investigated further in order to achieve a more complete understanding of this issue.

The present results appear to indicate that in terms of general semantic processing and organization there is not a substantial difference, between literate and illiterate subjects, related to the overall and fundamental workings of semantic memory as measured by semantic verbal fluency. Furthermore, there are substantial indications that the content, and there by aspects of the finer organization of semantic memory, is dependent on the level of formal education, reflecting differences in shared cultural background, as indicated by the interaction between level of literacy and semantic criterion. However, there are subtle aspects of the data reported here, including the slightly greater mean cluster size in the illiterate and the significantly greater number of isolated words generated by the literate group, that merit further detailed investigations. In a male sample (unpublished data), using a similar experimental design, we observed similar results: no literacy effect on the supermarket task but a significant difference on the animal task. Furthermore, no age or gender effects were observed when both literate and illiterate groups were compared on any of the tasks. This indicates that results remain similar when the gender factor is taken into account and that the educational level is the major factor affecting performance.

CONCLUSION

The present study of semantic verbal fluency shows that significant literacy effects may or may not be observed depending on the choice of semantic criterion. This illustrates the importance of developing neuropsychological instruments that are free of educational and cultural influences, or alternatively, in an effective manner handles such effects (e.g., statistically) while at the same time allow the investigation of cognitive functions of interest. Furthermore, interpretations and conclusions regarding subject performance on neuropsychological tests may need to take into account the potential contributions to the outcome by literacy and formal education. It therefore seems that, under some circumstances, neuropsychological tests and other experimental psychological tasks need to be carefully chosen and ecologically relevant when assessing illiterate subjects.

ACKNOWLEDGMENTS

This work was supported in part by Fundação para a Ciência e Tecnologia (FCT/POCIT/41669/PSI/2001), EU grant QLK6-CT-99-02140, the Swedish Medical Research council (8276,127169), the Knut and Alice Wallenberg Foundation, and the Swedish Dyslexic Association. We also want to thank Professor Alfredo Ardila for valuable comments on this manuscript.

REFERENCES

Acevedo, A., Loewenstein, D.A., Barker, W.W., Harwood, D.G., Luis, C., Bravo, M., Hurwitz, D.A., Aguero, H., Greenfield, L., & Duara, R. (2000). Category fluency test: Normative data for english- and spanish-speaking elderly. *Journal of the International Neuropsychological Society*, *6*, 760–769.

Ardila, A., Ostrosky, F., & Mendonza, V. (2000). Learning to read is much more than learning to read: A neuropsychological-based learning to read method. *Journal of the International Neuropsychological Society*, *6*, 789–801.

Bruyer, R., & Tuyumbu, B. (1980). Fluence verbale et lésions du cortex cérébral: Performances et types d'erreurs. *L'Encéphale*, *6*, 287–297.

Carnero, C., Lendínez, A., Maestre, J., & Zunzunegui, M.V. (1999). Fluencia verbal semantica en pacientes neurológicos sin demencia y bajo nivel educativo. *Revista de Neurologia*, *28*, 858–862.

Ceci, S.J. (1990). How much does schooling influence general intelligence and its cognitive components? A reassessment of the evidence. *Developmental Psychology*, *27*, 703–722.

Ceci, S.J., & Williams, W.M. (1997). Schooling, Intelligence, and Income. *American Psychologist*, *52*, 1051–1058.

Chan, A.S., & Poon, M.W. (1999). Performance of 7- to 95-year-old individuals in a Chinese version of the category fluency test. *Journal of the International Neuropsychological Society*, *5*, 525–533.

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

Epker, M.O., Lacritz, L.H., & Cullum, C.M. (1999). Comparative analysis of qualitative verbal fluency performance in normal elderly and demented populations. *Journal of Clinical and Experimental Neuropsychology*, *21*, 425–434.

Garcia, C. (1984). *A Doença de Alzheimer. Problemas de diagnóstico clínico.*, University of Lisbon, Lisbon.

Garcia, C., & Guerreiro, M. (1983). *Pseudo-Dementia in illiterates.* Paper presented at the meeting of the International Neuropsychologial Society, Lisbon.

Ho, A.K., Sahakian, B.J., Robbins, T.W., Barker, R.A., Rosser, A.E., & Hodges, J.R. (2002). Verbal fluency in Huntington's disease: A longitudinal analysis of phonemic and semantic clustering and switching. *Neuropsychologia*, *40*, 1277–1284.

Joanette, Y., & Goulet, P. (1986). Criterion-specific reduction of verbal fluency in right brain-damaged right-handers. *Neuropsychologia*, *24*, 875–879.

Kempler, D., Teng, E.L., Dick, M., Taussig, I.M., & Davis, D.S. (1998). The effects of age, education, and ethnicity on verbal fluency. *Journal of the International Neuropsychological Society*, *4*, 531–538.

Manly, J.J., Jacobs, D.M., Sano, M., Bell, K., Merchant, C.A., Small, S.A., & Stern, Y. (1999). Effect of literacy on neuropsychological test performance in nondemented, education-matched elders. *Journal of the International Neuropsychological Society*, *5*, 191–202.

Mayr, U. (2002). On the dissociation between clustering and switching in verbal fluency: Comment on Troyer, Moscovitch, Winocur, Alexander and Stuss. *Neuropsychologia*, *40*, 562–566.

Ostrosky-Solís, F., Ardila, A., & Rosselli, M. (1999). NEUROPSI: A brief neuropsychological test battery in Spanish with norms by age and educational level. *Journal of the International Neuropsychological Society*, *5*, 413–433.

Ostrosky-Solís, F., Ardila, A., Rosselli, M., Lopez-Arango, G., & Uriel-Mendonza, V. (1998). Neuropsychological test performance in illiterate subjects. *Archives of Clinical Neuropsychology*, *13*, 645–660.

Petersson, K.M., Reis, A., Askelöf, S., Castro-Caldas, A., & Ingvar, M. (2000). Language processing modulated by literacy: A network analysis of verbal repetition in literate and illiterate subjects. *Journal of Cognitive Neuroscience*, *12*, 364–382.

Petersson, K.M., Reis, A., & Ingvar, M. (2001). Cognitive processing in literate and illiterate subjects: A review of some recent behavioral and functional neuroimaging data. *Scandinavian Journal of Psychology*, *42*, 251–267.

Ratcliff, G., Ganguli, M., Chandra, V., Sharma, S., Belle, S., Seaberg, E., & Pandav, R. (1998). Effects of literacy and education on measures of word fluency. *Brain and Language*, *61*, 115–122.

Reis, A., & Castro-Caldas, A. (1997). Illiteracy: A bias for cognitive development. *Journal of the International Neuropsychological Society*, *3*, 444–450.

Reis, A., Guerreiro, M., & Castro-Caldas, A. (1994). Influence of educational level of non brain-damaged subjects on visual naming capacities. *Journal of Clinical and Experimental Neuropsychology*, *16*, 939–942.

Reis, A., Guerreiro, M., & Petersson, K.M. (2001a). Educational level on a neuropsychological battery. *Journal of the International Neuropsychological Society*, *7*, 422–423.

Reis, A., Petersson, K.M., Castro-Caldas, A., & Ingvar, M. (2001b). Formal schooling influences two-but not three-dimensional naming skills. *Brain and Cognition*, *47*, 394–411.

Robert, P.H., Lafont, V., Medecin, I., Berthet, L., Thauby, S., Baudu, C., & Darcourt, G. (1998). Clustering and switching strategies in verbal fluency tasks: Comparison between schizophrenics and healthy adults. *Journal of the International Neuropsychology Society*, *4*, 539–546.

Rosen, W.G. (1980). Verbal fluency in aging and dementia. *Journal of Clinical Neuropsychology*, *2*, 135–146.

Rosselli, M., Ardila, A., & Rosas, P. (1990). Neuropsychological assessment in illiterates: II. Language and praxic abilities. *Brain and Cognition*, *12*, 281–296.

Rosselli, M., Ardila, A., Salvatierra, J., Marquez, M., Matos, L., & Weekes, V.A. (2002). A cross-linguistic comparison of verbal fluency tests. *International Journal of Neuroscience*, *112*, 759–776.

Ruff, R.M., Light, R.H., Parker, S.B., & Levin, H.S. (1997). The psychological construct of word fluency. *Brain and Language*, *57*, 394–405.

Silva, C., Petersson, K.M., Ingvar, M., & Reis, A. (2001). The effects of formal education on the qualitative aspects of a verbal fluency task. *Journal of the International Neuropsychological Society*, *4*, 419–420.

Stuss, D.T., Alexander, M.P., Hamer, L., Palumbo, C., Dempster, R., Binns, M., Levine, B., & Izukawa, D. (1998). The effects of focal anterior and posterior brain lesions on verbal fluency. *Journal of the International Neuropsychology Society*, *4*, 265–278.

Tombaugh, T.N., Kozak, J., & Rees, L. (1999). Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. *Archives of Clinical Neuropsychology*, *14*, 167–177.

Tröster, A.I., Fields, J.A., Testa, J.A., Paul, R.H., Blanco, C.R., Hames, K.A., Salmon, D.P., & Beatty, W.W. (1998). Cortical and subcortical influences on clustering and switching in the performance of verbal fluency tasks. *Neuropsychologia*, *36*, 295–304.

Troyer, A.K. (2000). Normative data for clustering and switching on verbal fluency tasks. *Journal of Clinical and Experimental Neuropsychology*, *22*, 370–378.

Troyer, A.K., Moscovitch, M., & Winocur, G. (1997). Clustering and switching as two components of verbal fluency: Evidence from younger and older healthy adults. *Neuropsychology*, *11*, 138–146.

Troyer, A.K., Moscovitch, M., Winocur, G., Alexander, M.P., & Stuss, D. (1998). Clustering and switching on verbal fluency: The effects of focal frontal- and temporal-lobe lesions. *Neuropsychologia*, *36*, 499–504.

APPENDIX 1

The supermarket fluency task – *"Things one can buy to eat at the supermarket,"* subcategories and subordinates considered:

Strong pairs: *arroz-massa* (rice-pasta), *feijão-grão* (beans-grains), *azeite-óleo* (olive oil- oil), *queijo-fiambre* (cheese-ham), *cebola-alho* (onion-garlic). **Meat/Delicatessen**: bacon, *bifes* (steak), *carneiro* (lamb), *chouriço* (chorizo), *coelho* (rabbit), *costeleta* (chop), *enchidos* (cured sausage), *fiambre* (ham), *frango* (chicken), *pato* (duck), *perú* (turkey), *presunto* (cured ham), *salsicha* (sausage), *toucinho* (streaky bacon), *vaca* (beef). **Vegetables**: *abóbora* (pumpkin), *alface* (lettuce), *alho françês* (leek), *batata* (potato), *beterraba* (beetroot), *brócolos* (broccoli), *cenoura* (carrot), courgettes, *couves* (cabbage), *couve-flor* (cauliflower), *ervilhas* (peas), *favas* (broad bean), *feijão* (beans), *feijão verde* (green beans), *grão* (grains), *grelos* (turnip shoots), *nabiça* (turnip greens), *nabo* (turnip), *tomate* (tomato). **Fruit**: *ameixa* (plum), *ananás* (pineapple), *banana* (banana), *cereja* (cherry), *kiwi* (kiwi), *laranja* (orange), *maça* (apple), *melancia* (water-melon), *melão* (melon), *morango* (strawberry), *nêspera* (medlar), *pêra* (pear), *pêssego* (peach), *tangerina* (tangerine), *uvas* (grapes). **Condiment/ Spices**: *azeite* (olive oil), *louro* (bay leaf), *óleo* (oil), *oregão* (origan), *sal* (salt), *salsa* (parsley), *vinagre* (vinegar). **Sweet Food**: *açucar* (sugar), *bolachas* (biscuits), *bolo* (cake), *chocolate*, (chocolate), *marmelada* (quince jam), *rebuçados* (sweets). **Grain products**: *arroz* (rice), *flocos* (cornflakes), *milho* (maize), *sêmolas* (semolina), *esparguete* (spaghetti), *farinha* (flour), *massa* (pasta), *pão* (bread), *tostas* (toasts). **Drinks**: *água* (water), *aguardente* (eau-de-vie), *café* (coffee), *cerveja* (beer), *chá* (tea), *ginginha* (morello cherry liqueur), *licores* (liqueur), *sumo* (juice), *vinho* (wine), *vísque* (whisky). **Products of Animal Origin**: *iogurte* (yoghurt), *leite* (milk), *manteiga* (butter), *margarina* (margarine), *natas* (cream), *ovos* (eggs), *queijo* (cheese).

The animal fluency task – *"Animal Names,"* subcategories and subordinates considered:

Strong Pairs: *cão-gato* (dog-cat), *leão-tigre* (lion-tiger), *coelho-lebre* (rabbit- hare), *gato-rato* (cat-rat). **Pets**: *gato* (cat), *cão* (dog), *hámster* (hamster). **Farm animals**: *bode* (billy goat), *boi* (ox), *borrego* (lamb), *burro* (donkey), *cabra* (nanny-goat), *carneiro* (ram), *cavalo* (horse), *coelho* (rabbit), *égua* (mare), *mula* (mule), *ovelha* (sheep), *porco* (pig), *vaca* (cow), *galinha* (hen), *ganso* (goose), *pato* (duck), *perú* (turkey). **European Wild animals**: *alce* (moose), *gazela* (gazelle), *javali* (wild boar), *lobo* (wolf), *ouriço-cacheiro* (hedgehog), *porco-espinho* (porcupine), *raposa* (fox), *urso* (bear), *veado* (deer). **Non-European Wild animals**: (wild mammals from Africa and Australia were included): *bufalo* (buffalo), *bisonte* (bison), *camelo* (camel), *canguru* (kangaroo), *chimpanzé* (chimpanzee), *elefante* (elephant), *girafa* (giraffe), *hiena* (hyena), *hipopótamo* (hippo), *leopardo* (leopard), *leão* (lion), *macaco* (monkey), *pantera* (panther), *tigre* (tiger), *zebra* (zebra). **Rodents**: *coelho* (rabbit), *esquilo* (squirrel), *hámster* (hamster), *lebre* (hare), *rato* (mouse). **Reptiles**: *dinossauro* (dinosaur), *cobra* (snake), *crocodilo* (crocodile), *jacaré* (alligator), *lagarto* (lizard), *tartaruga* (turtle). **Birds**: *águia* (eagle), *andorinha* (swallow), *avestruz* (ostrich), *canário* (canary), *cegonha* (stork), *codorniz* (quail), *corvo* (raven), *flamingo* (flamingo), *gaivota* (seagull), *galinha* (hen), *ganso* (goose), *melro* (blackbird), *mocho* (owe), *papagaio* (parrot), *pardal* (sparrow), *pavão* (peacock), *perdiz* (partridge), *periquito* (budgerigar), *perú* (turkey), *pinguim* (penguin), *pintassilgo* (goldfinch), *pombo* (dove), *rola* (turtle-dove), *rouxinol* (nightingale), *tordo* (thruch). **Water animals**: *baleia* (whale), *besugo* (bream), boga (bogue), *choco* (cuttlefish), *foca* (seal), *golfinho* (dolphin), *lula* (squid), *peixe-aranha* (spider fish), *peixe-espada* (scabbard-fish), *pescada* (hake), *pinguim* (penguin), *rã* (frog), *sardinha* (sardine), *sapo* (toad).