Qualitative assessment of verbal fluency performance in culturally and linguistically diverse patients in the Memory Clinic

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Abstract

Background: The aim of the current study was to obtain a better understanding of the use of qualitative analysis of the Verbal Fluency task (VF task) in CALD (culturally and linguistically diverse) patients in the Netherlands. The qualitative analysis of the animal category can provide more information for the detection of Alzheimer's disease or memory problems by means of clustering and switching. Also, the influence of education on the verbal fluency task performance is examined.

Methods: This retrospective study included data from 47 patients with a non-Western background, who visited the Alzheimer Centre of the Erasmus University Medical Center. Due to difficulty to predict a pure Alzheimer's disease diagnosis, the presence or absence of a dementia diagnosis is used for the analyses. And low scores on two more extensive memory tests defined memory problems. The system of Verhage was used to determine the education level. Two independent raters assessed the verbal fluency by recording clusters and switches.

Results: Inter-rater reliability levels were high. Results of the study revealed that the VF task variables had no predictive value for a dementia diagnosis, but two VF task variables did have a predictive value for memory problems. As for the influence of education, we found that the higher the education level, the higher the total score on the VF task and the number of switches

Conclusion: To enhance diagnostics for CALD patients, future studies should take into account that the VF task animal category may not be useful as a predictor, due to low ecological relevance. Clustering and switching in VF task animal category can be a useful tool for predicting memory disorders.

Keywords: Verbal fluency task; clustering; switching; memory problems; semantic memory; CALD patients

Introduction

The verbal fluency task (VF task) is a test of language production, which is a widely used neuropsychological test to measure speeded access to lexical and semantic information (Monsch et al., 1992). Participants are asked to generate as many words as possible in response to a specific cue in a timeframe of one minute, e.g. words that begin with a specific letter (for letter word fluency) and/or "animals" for (category word fluency; Ledoux et al., 2014). The VF task provides valuable information about multiple functions, such as semantic memory, executive function, naming, attention shifting and sequencing. The evaluation of spontaneous production of words is therefore of use for diagnosis, efficacy assessment, and prognosis of many neurological disorders, like dementia (Zhao, Guo, & Hong, 2013).

To provide more information about the cognitive impairment of patients, the use of qualitative analysis of the word sequence is an addition (Zhao, Guo, & Hong, 2013). Especially for differentiating between dementia and cognitive impairment, which cannot be achieved by looking at the total number of correct words. In order to make qualitative analysis possible Troyer and colleagues (1997) pioneered by dividing the VF task into two components: "clustering" and "switching". The ability to produce words within phonetic and semantic subcategories is called clustering and it relies more on temporal lobe functions such as word storage and semantic memory (Zhao, Guo, & Hong, 2013). Whereas the ability to shift between clusters is called switching and relies more on frontal lobe functions such as sorting and attention shifting (Zhao, Guo, & Hong, 2013).

In verbal fluency, people tend to report strings of words that share some underlying feature (Gruenewald & Lockhead, 1980). The theory is that clustering reflects the organization of lexical entries in the network responsible for their generation. So, when one lexical entry is activated during retrieval, other entries that are connected by their semantic, associative or phonological relationship will be assessed through a spread of activation. This relatively automatic cognitive process of generating related words in clusters is thought to be sensitive to dysfunction in the system responsible. According to the study of Troyer and colleagues (1998) patients with Alzheimer-type dementia and patients with left temporal lobe lesions have both been found to produce smaller clusters of words that are semantically related on the VF task in comparison to healthy adults. The research of Heiss, Kalbe and Kessler (2001) showed that in adults with Parkinson's disease without dementia clustering typically remains intact despite the fact that overall word production on VT task is reduced.

In the case of switching between clusters, people tend to begin with a controlled search for a suitable subcategory and automatically retrieve related members of that

subcategory. People initiate another controlled search if they reach exhaustion of the first subcategory (Gruenewald & Lockhead, 1980). The research of Troyer and colleagues (1998) shows that adults with Alzheimer's disease or healthy controls switch more frequently to new subcategories than adults with dementia due to Parkinson's disease. Also there is a great deal of evidence that Alzheimer's disease is characterized by a prominent deficit in semantic memory (Hodges, Salmon, & Butters, 1992), therefore it is important to take memory problems per se into account when evaluating the VF task.

The above-mentioned findings about clustering and switching could be interesting for the use of the VF task in patients where the addition of quantitative information could help with diagnostics. A group that could benefit from this are culturally and linguistically diverse (CALD) patients, since research is hampered by a number of barriers. Firstly, the development of neuropsychological testing has been based on literate, urban people of homogeneous cultural backgrounds. However, as result of global migration, there are growing multicultural and multilingual societies in Europe, and this trend is predicted to continue (Irving & Mosca, 2010). Also, the number of elderly migrants in Europe is estimated to increase (Ruspini, 2009). The four traditionally large groups in the minority policy are Turkish, Moroccan, Surinamese and Antillean. Together they form almost 80% of non-western immigrant elderly living in the Netherlands (Schellingerhout, 2004). The council for public health and health care of the Netherlands concluded in 2000 that migrants benefit less from the care offer than the indigenous population in terms of accessibility and quality (Struijs & Wennink 2000). This is partly explained by little knowledge about dementia, fear of discrimination, shame (taboo) and unfamiliarity with the Dutch health care, which increases the threshold of asking for help (Rijkers, 2010; Mulkadam, Cooper, & Livingston, 2011). So, this group requires culturally and linguistically appropriate healthcare services (Leininger & McFarland, 2006) to maintain access to healthcare (Bischoff, 2006). It should be a fundamental task for neuropsychologists to take this fact into account for patients who experience a culture and/or a language barrier in the host country (Goudsmit, Parlevliet, van Campen, Schmand, 2011). Secondly, professional interpreters are critical for effective communication between CALD patients and caregivers in the delivery of patient-centered and high quality care (Giger & Davidhizar, 2008). Every country has a different set of rules regarding interpretation. Despite the requirement for an interpreter the compensation of interpretation services in the Netherlands is no longer reimbursed since in 2012 (Gentile, 2017). This makes alternative neuropsychological test instruments for CALD patients even more urgent.

Also, education plays an important role in this group. Many older people from ethnic minorities have migrated from low- and middle-income countries and have little or no formal schooling (Nielsen & Jorgensen, 2013). The report of Schellingerhout (2004) shows that there is an accumulation of factors in elderly people from ethnic minorities that are generally associated with poorer health, such as poorer education and a lower income. Illiteracy often occurs in elderly Turkish immigrants, in particular among women because of the cultural differences in women's access to formal schooling in the first part of the 20th century (Nielsen & Jorgensen, 2013). Several studies have compared verbal fluency in literate and illiterate populations. The animal category is mainly used to compare these groups. This may partly be due to the ecological relevance of the tests in the context of illiteracy (Nielsen & Waldemar, 2016). The outcome of these studies was that uneducated illiterate people have poorer semantic fluency performance in comparison to educated literate people (Brucki & Rocha, 2004; Fichman et al., 2009; Kosmidis et al., 2004; Mathuranath et al., 2003; Ostrosky-Solis et al., 1999; Youn et al., 2011). Additionally, it must be taken into account that illiterate people are usually not test wise; they are not used to being tested and may not know how to behave in a test situation. Illiteracy may also act as a substitute for other factors affecting the performance on a neuropsychological test, e.g., low socioeconomic status and lifestyle-related risk factors associated with this (Ardila et al., 2010; Nielsen & Jorgensen, 2013).

The question that surfaces from these findings is whether Alzheimer's disease can be detected in CALD patients by analyzing clustering and switching measures according to the method of Troyer and colleagues. In this study we researched if this method is sensitive enough to detect dementia, in this case in particular Alzheimer's disease or a prominent deficit in Alzheimer's disease like memory problems. The current study focused on CALD patients in the Netherlands. CALD patients could benefit from VF task as a measurement for the detection of Alzheimer's disease, since it is a simple and time-saving task where the capacities of an informal interpreter are sufficient. The study of Brucki and Rocha (2004) showed that deficits in the VF task have been observed in patients with several neurological impairments, such as focal cortical brain lesions from injury, Parkinson's disease, schizophrenia, subcortical and Alzheimer dementia. Based on research that show deficits in the VF task in patients with Alzheimer's disease, **it is expected that smaller clusters of words and more switches can indicate Alzheimer's disease**. Furthermore, it is known that low literacy and low educational levels can hinder the correct evaluation of patients with suspected cognitive impairment (Brucki & Rocha, 2004). Therefore, **the hypothesis with regards to education and literacy is that education has an influence on the quantitative**

and qualitative analysis of animal naming, such as poorer semantic fluency performance and mentioning more farm animals, due to higher ecological relevance.

Methods

Participants

This retrospective study included data from 47 patients who visited the Alzheimer Centre of the Erasmus University Medical Center, Rotterdam, The Netherlands, between 2001 and 2018. Since 2015 the department involved concerns the memory clinic for migrants within the Alzheimer center. The patients were selected on their migrant background, which had to be non-Western. These are people with a migrant background from one of the countries in Africa, Latin America and Asia (excluding Indonesia and Japan) or Turkey. Another criterion for inclusion was the use of a formal (i.e. professional) or an informal (e.g. family member, neighbor) interpreter during the verbal fluency performance test. The sample consisted of 24 male patients with ages ranged between 38-79 ($M = 58,62$, $SD = 10,57$) and 23 female patients with ages ranged between 31-82 ($M = 60,39$, $SD = 12,88$). Data from some patients have been excluded from data-analyses due to insufficient information about the participation of an interpreter, the lack of a clear diagnosis or referral for dementia or unclear handwriting on the VF task. Furthermore, retrospective research (patient file research) is not covered by the WMO ("[non-wmo-research]," n.d.). In this case, the data were not collected in the context of the research. Patients were only asked to agree to the neuropsychological examination according to the Professional Code, but not separately for participation in research.

Background and education level

The largest group respectively consisted of patients from a Turkish background (25 patients), Moroccan background (9 patients), Middle Eastern background (5 patients), Asian background (3 patients), South American background (2 patients), Cape Verdean background (2 patients) and Antillean background (1 patient). As for education the system of Verhage was used. Information about the date of birth can be an estimate, as in some cases the country of origin does not attach any value to the correct recording of this information. It is also the case that the participants, mostly from the countryside, did not receive any education. According to the system of Verhage, the level of education ranges from 1 (less than primary school) to 7 (university degree). For people without any formal education/illiterates however, another

level was added (level 0 = no education/ illiterate). An overview of the education level based on the method of Verhage divided for men and women is presented in Table 1.

Table 1. Frequency of education level based on Verhage method divided for men and women.

Education level Verhage	Men	Women	Total
Verhage 0	0	7	7
Verhage 1	7	6	13
Verhage 2	5	2	7
Verhage 3	1	2	3
Verhage 4	2	1	3
Verhage 5	6	3	9
Verhage 6	2	2	4
Verhage 7	2	0	2

Note. Verhage 0 is added for the group with no education / illiterate

Procedure

All patients underwent a standardized clinical assessment including medical history, informant-based history, physical and neurological examinations, neuropsychological assessment, laboratory tests and (often) brain imaging during their first visit to the Alzheimer center. The neuropsychological assessment included mostly the following tests: the Dutch version of the cross-cultural dementia screening (CCD), visual association test (VAT) and the verbal fluency task (VF task). On the basis of all these tests together a diagnosis is determined in multidisciplinary consensus meeting. During the intake conversation, data on age, education and complaints were collected.

Instrument; Verbal Fluency Measures

The category that will be central to this research is the category animals. Participants received clear instruction from the neuropsychologist before the test to know that they have limited time (one minute) to list as many animals as possible and as quickly as possible in their mother tongue. In these cases there was also a formal or informal (relative) interpreter present to translate the instructions. For 9 participants the words were written down in the patient's mother tongue. For the remaining 38 participants, only the translation in Dutch was written down. The qualitative scoring procedure is according to Ledoux' method of dividing the

animal names in clusters and switching described in Ledoux et al. (2014). See Appendix A for common subcategories. Words that do not belong to a subcategory were classified as errors and excluded from the total correct word count. Words that were repeated were included in clusters, but not in the total number of (correct) words. In the case of clustering, overlapping clusters (cluster within a cluster) were not counted double. When a smaller cluster is completely embedded within a larger cluster, only the larger cluster was scored. Animal names that differed by sex (e.g., *rooster* and *hen*) and age (e.g., *lamb* and sheep) were accepted. Also a subordinate category and its members were accepted (e.g., *fish* and *sardine*). Additionally, words that belonged to two successive clusters were counted twice. For example, in the string *dog, rabbit, goat, cow, sheep,* the word rabbit was counted as a member of both the PET cluster and the FARM cluster. This was the case for eleven patients, including one patient that mentioned words that fit in four successive clusters and two patients that mentioned words that fit in two successive clusters twice. The following measures are scored for each patient by two raters:

1. Total number of words (number of correct words, no repetitions and no errors)
2. Number of clusters (each cluster containing minimum of two successive words)
3. Mean cluster size (average words per cluster)
4. Number of switches (switches between clusters or to none at all)
5. Percentage total words in cluster (total words in clusters divided by total number of words including repetition and errors)

Analysis

All data analyses were conducted using IBM SPSS statistics 23.

To test the primary hypothesis whether Alzheimer's disease can be predicted by VF task animal category measures, we will conduct a ROC analyses. The ROC analyses will give us information about the sensitivity of this method, which means the fraction of people with the diagnosis of dementia that this method correctly identifies as positive. This analysis will also provide information about the specificity: the fraction of people without a diagnosis of dementia that the test correctly identifies as negative. To determine whether this method is sensitive and specific enough for detecting a dementia diagnosis, there will be a variable made to assess whether there is a presence/absence of a dementia diagnosis. Due to difficulty to predict a pure Alzheimer's disease diagnosis, the presence or absence of a dementia diagnosis is used for the analyses. We will also look at memory problems, since it is a

prominent deficit in Alzheimer's disease. To assess memory problems a variable will be made up from the score on the CCD and VAT test. A percentile score below 5 on at least one of the tasks and a score not higher than average on the other task are recorded as having memory problems. Average scores and higher are recorded as having no memory problems.

The association between education level and the quantitative analysis of animal naming will be tested using a correlation analysis. As for the qualitative analysis; we will use an independent t-test to look at the amount of animals names mentioned by patients with limited schooling and illiteracy, due to the ecological relevance of the tests in the context of illiteracy. The amount of farm animals mentioned will be corrected for the total number of words mentioned.

Results

Verbal fluency performance

An overview of the descriptive statistics of the verbal fluency task is presented in Table 2. Also, verbal fluency performance in patients with and without a dementia diagnosis (2 missing values) and patients with and without memory problems (6 missing values) are presented in Table 2.

Table 2. Verbal fluency performance in patients with memory problems

	Dementia		Memory problem		Total
	Dem	No Dem	MP	No MP	
Total correct words, mean ± SD	10.64±4.71	10.55±4.6	9.84±4.01	15.75±5.9	10.64±4.71
Clusters, mean ± SD	3.02±1.66	2.94±1.73	2.89±1.20	5.50±2.89	3.02±1.66
Cluster size, mean ± SD	2.95±0.79	2.90±0.76	3.06±0.71	2.13±0.19	2.95±0.79
Switches, mean ± SD	4.38±3.36	5.03±3.45	3.90±2.66	9.50±3.32	4.83±3.36
% words in clusters, mean ± SD	78.6±23.1	75.32±23.1	83.63±19.1	70.77±16.1	78.6±23.09

Note. N = 47, Dem = Dementia, MP = memory problem

Inter-rater reliability

To avoid inconsistency in scoring, two independent raters assessed the verbal fluency variables. Inter-rater reliability levels were determined through Pearson's r. Table 3 shows high levels of inter-rater reliability for the semantic variables on the animal category.

Table 3. Single-measure interclass correlations for the verbal fluency variables based on two raters

	Semantic fluency
Total number of correct words	1.
Number of clusters	.98
Mean cluster size	.94
Number of switches	.98
Percentage of words in clusters	.95

Main analysis

ROC analyses were conducted to test the primary hypothesis stating that; the method of Troyer and colleagues can detect a dementia diagnosis or memory problems. The presence or absence of a dementia diagnosis (2 missing variables) is used for the analyses. There is not a significant outcome for the total score on the VF task and patients with a dementia diagnosis, AUC = .550, p = .608, 95% BCa CI [.340, .760]. This means that the total score on the VF task has a predictive value for a dementia diagnosis. The results showed that the ROC-analyses were not significant for all VF task variables. So VF task variables had no predictive values for a dementia diagnosis.

We also looked at the variable memory problems to see if VF task variables can predict memory problems (6 missing values). There is a significant outcome for the total score on the VF task and patients with memory problems, AUC = .712, p = .041, 95% BCa CI [.505, .919]. This means that the total score on the VF task has a predictive value for memory problems. The ROC curve of the total score on the VF task and patients with memory problems is shown in Figure 1. The percentage of total words in clusters was a significant predictor of memory problems as well, as is shown in Figure 2, AUC = .761, p = .012, 95% BCa CI [.587, .935]. This means that the percentage words in a cluster, has a predictive value for memory problems. There were no significant outcomes for the other VF task variables and memory problems.
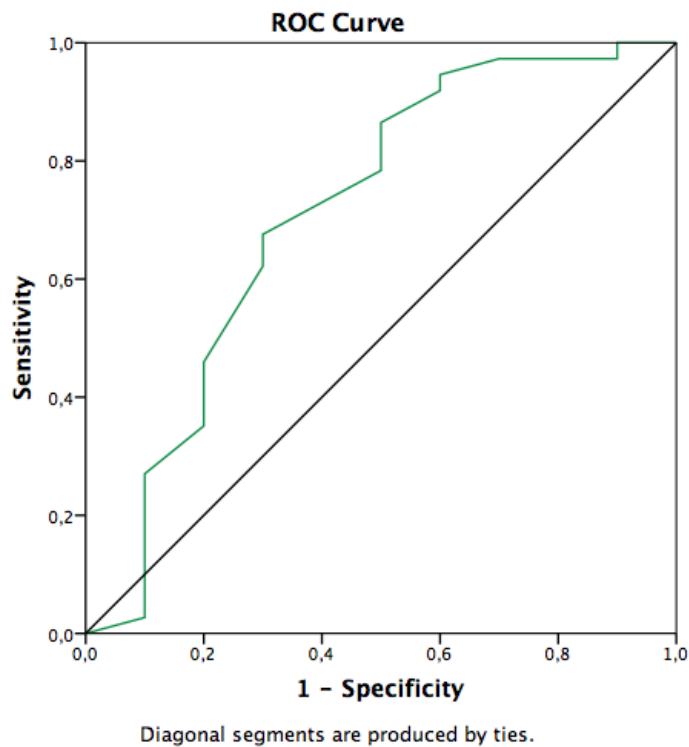
Figure 1. The ROC curve of Total score on the VF task and patients with memory problems.
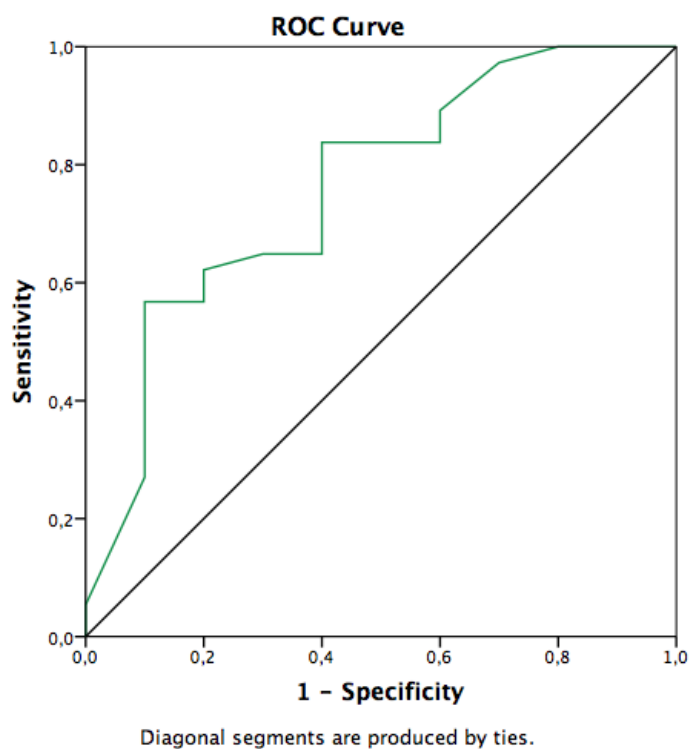

Figure 2. The ROC curve of the percentage of words in a cluster and patients with memory problems.

Relationship education level and VF task variables

A correlation analysis was conducted to test the second hypothesis stating that; low education/ illiteracy has an influence on the quantitative measures of animal naming.

The relationship between education level based on the Verhage method and the VF task variables was investigated with a Spearman correlation. There was a positive significant

relationship between education level based on the Verhage method and the total score on the VF task (n = 47), *r.* = .366, *p* = .011. There was also a positive significant relationship for education level based on Verhage method and the total number of switches, (n = 47), *r.* = .367, *p* = .011. Total clusters and the percentage of words in clusters did not show a significant relationship with education.

The qualitative analysis of animal naming and the education level based on Verhage method was investigated with an independent t-test. Patients with an education level based on Verhage method 3 and lower were categorized as not educated or low educated (n = 30). Patients with an education level based on Verhage method 4 and higher were categorized as patients that have continued their education after high school or well educated (n = 17). The difference between the group with no education or low educated (*M* = 0.367; *SD* = 0.272) and the group with an education after high school (*M* = 0.234; *SD* = 0.206) was not significant for mentioning farm animals: *t* (45) = 1.754, *p* = 0.86.

Discussion

Findings

The aim of the current study was to obtain a better understanding of the use of qualitative analysis of the VF task in CALD patients. Results of the study revealed that the VF task variables had no predictive value for a dementia diagnosis. Additionally we looked at memory problems as a second outcome measure, since this has been shown to be a prominent deficit in Alzheimer's disease. Results of the study showed that only the total score on the VF task and the percentage words in a cluster had a predictive value for memory problems. Thus, VF task variables do not seem to predict a dementia diagnosis, but two VF task variables did have a predictive value for memory problems (defined by low scores on two more extensive memory tests).

As for the relationship between education level based on the Verhage method and the VF task variables; there was a positive relationship found for the total score on the VF task and the total number of switches. Which means that the higher the education level, the higher the total score on the VF task and the number of switches.

Context

Current results are not in line with the studies of Troyer and colleagues (1998), where it was found that patients with Alzheimer-type dementia produce smaller clusters of words. The result of this study showed that patients with a dementia diagnosis have the same number of

clusters on average compared to the group without a dementia diagnosis. As for switching, there was not a big difference between the group with and without dementia, which was according to the expectation. Nevertheless, it must be taken into account that the dementia group in this research consisted of patients with different forms of dementia compared to a group with very heterogeneous diagnoses. Troyer and colleagues (1998) explicitly named patients with Alzheimer's disease or healthy controls switching more frequently to new subcategories than adults with dementia due to Parkinson's disease.

In the present study we did not find VF task variables to have a predictive value for a dementia diagnoses. This may be due to the fact that we have included all forms of dementia into one variable to differentiate it from patients without a dementia diagnosis (see limitations). Many studies have used the method of clustering and switching to differentiate between different forms of dementia, like Alzheimer's disease and Parkinson dementia (Troyer, Moscovitch & Winocur, 1997) or in varying stages of the disease of Alzheimer (Haugrud et al., 2010; Troster et al., 1998; Troyer et al., 1998).

As for memory problems, results showed that patients with memory problems produce less clusters and switches. Assuming that memory problems are a prominent deficit in Alzheimer's disease, the expectation is met for clusters, but not for switches. Opposite literature of Haugrud and colleagues (2011) found an association between patients with Alzheimer's disease and fewer switches, due to disease- related effects on the semantic store.

In the present study we did find two VF task variables to have a predictive value for memory problems. This can be a useful tool for predicting memory disorders with the VF task, which is timesaving and easier than extensive memory tests.

Education level has an influence on the total score on the VF task and the number of switches, that is the higher the education level, the higher the total score on the VF task and the number of switches. This result is in line with multiple studies stating that uneducated illiterate people have poorer semantic fluency performance in comparison to educated literate people (Brucki & Rocha, 2004; Fichman et al., 2009; Kosmidis et al., 2004; Mathuranath et al., 2003; Ostrosky-Solis et al., 1999; Youn et al., 2011).

According to Nielsen and Waldemar (2016) ecological relevance of neuropsychological tests are important in the context of illiteracy. This led to the expectation that patients with limited schooling and illiteracy have generally led a more rural life and therefore will mention more farm animals, due to higher ecological relevance. This has not

been found in current results. A possible explanation for failing to find support for this could be related to a low ecological relevance of animal names in this particular sample. The study of Nielsen and Waldemar (2016) considered the supermarket category more ecologically relevant for illiterate individuals. Also, a Portuguese study found poorer performance in illiterate people when an animal criterion was used, but not on a supermarket criterion (da Silva et al., 2004) due to a higher ecological relevance. Perhaps the use of another criterion is an option for this sample.

Strengths, limitations and implications

The present study is one of the first studies that focused on CALD patients in the Netherlands regarding qualitative analysis of the VF task. Another strength is the detailed verbal fluency scoring method that showed high inter-rater reliability.

A limitation of this study is the small number of patients with an Alzheimer's disease. More importantly, the diagnoses were very heterogeneous, with many patients receiving psychiatric diagnoses and unspecified MCI/dementia diagnoses, and few patients with Alzheimer's disease. Thus, increasing the sample with patients with Alzheimer's disease is recommended. Second, the use of the animal category showed to have less ecological relevance for this sample. So the use of another semantic category is recommended.

Despite these limitations, the results of this study can be considered as a basis for future studies with CALD patients to enhance diagnostics for this group. In the future however it should be taken into account that the VF task animal category may not be useful for CALD patients as a predictor.

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Appendix A

Animal categories according to Ledoux' method of dividing the animal names in clusters and switches

Subcategories	Examples
African	Aardvark, anteater, antelope, baboon, buffalo, camel, chameleon, cheetah, chimpanzee, cobra, dromedary, eland, elephant, gazelle, giraffe, gnu, gorilla, hippopotamus, hyena, impala, jackal, kudu, lemur, leopard, lion, manatee, meerkat, mongoose, monkey, okapi, ostrich, panther, rhinoceros, tiger, wildebeest, warthog, zebra.
Australian	Dingo, emu, kangaroo, kiwi, koala, possum, platypus, Tasmanian devil, wallaby, wombat
Artic/far north	Auk, caribou, musk, ox, penguin, polar bear, reindeer, seal.
North American	Antelope, badger, bear, beaver, bobcat, caribou, chipmunk, cougar, coyote, deer, elk, fox, groundhog, moose, mountain goat, mountain lion, opossum, porcupine, prairie dog, puma, rabbit, raccoon, skunk, squirrel, wolf, woodchuck
South American	Alpaca, guanaco, jaguar, llama, vicuna
Farm	Chicken, cow, donkey, duck, ferret, goat, goose, horse, mule, pig, rabbit, sheep, turkey, rooster
Water	Alligator, auk, beaver, crab, crocodile, dolphin, duck, fish, frog, goose, hippopotamus, lobster, manatee, muskrat, newt, octopus, otter, oyster, penguin, platypus, polar bear, salamander, sea lion, seagull, seal, shark, snail, swan, toad, turtle, whale
Desert	Buzzard, gecko, lizard, rattlesnake, scorpion
Beast of burden	Ass, camel, donkey, horse, llama, mule, ox
Used for fur	Beaver, chinchilla, fox, mink, rabbit, raccoon
Found in pet stores	Bird, canary, cat, dog, ferret, fish, gerbil, golden retriever, guinea pig, hamster, lizard, mouse, parrot, rabbit, rat, snake, turtle
Birds	Budgie, canary, condor, eagle, finch, kiwi, macaw, parrot, parakeet pelican, penguin, robin, toucan, woodpecker
Bovine	Bison, buffalo, bull, cow, musk, ox, yak
Porcine	Pig, boar, sow
Canine	Coyote, dog (bulldog, terrier, collie, etc.), fox, hyena, jackal, wolf
Equine	Donkey, horse, mule, pony, zebra
Feline	Bobcat, cat (housecat, Siamese cat, etc.), cheetah, cougar, jaguar, leopard, lion. lynx mountain lion, ocelot, panther, puma, tiger
Fish	Bass, goldfish, guppy, salmon, trout
Deer	Antelope, caribou, eland, elk, gazelle, gnu, impala, moose, reindeer, wildebeest
Camels	Alpaca, dromedary, guanaco, llama, vicuna
Insects	Ant, beetle, cockroach, flea, fly, praying mantis, spider
Insectivores	Aardvark, anteater, hedgehog, mole, shrew
Primates	Ape, baboon, chimpanzee, gibbon, gorilla, human, lemur, marmoset, monkey, orangutan, shrew, tarsier
Reptiles & amphibians	Alligator, chameleon, crocodile, dinosaur, frog, gecko, iguana, lizard, newt, salamander, snake, toad, tortoise, turtle
Rodents & rabbits	Agouti, beaver, capybara, chinchilla, chipmunk, coney, gerbil, gopher, groundhog, guinea pig, hamster, hare, hedgehog, marmot, mole, mouse, muskrat, pika, porcupine, prairie dog, rabbit, raccoon, rat, squirrel, woodchunk
Weasels	Badger, ermine ferret marten mink, mongoose, otter, skunk, stoat, weasel, wolverine

Note. Examples are provided of common subcategories and their members. However, the listings are not meant to be exhaustive.