



# THE VERBAL FLUENCY TEST AS A TOOL FOR THE DIFFERENTIAL DIAGNOSIS OF DEMENTIA AND MILD COGNITIVE IMPAIRMENT, AS AGAINST NORMAL AGEING: A RESEARCH REVIEW STUDY

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## Abstract

Dementia can ultimately be understood as a linguistic, neurogenic, and cognitive disorder. With the increasing average life expectancy, the number of individuals affected by dementia continues to rise, underscoring the importance of early and accurate diagnosis. A detailed assessment of not only language processes can provide valuable information to both healthcare professionals and family members, particularly in developing an appropriate therapeutic plan. Results of the verbal fluency test reflect not only the overall level of language abilities, but also the functional integrity of executive functions and semantic memory. Due to its simplicity and time efficiency, the verbal fluency test appears to be a suitable tool for the differential diagnosis of dementia, mild cognitive impairment, and normal ageing. This review article summarizes current findings on its clinical utility, with particular attention given to clustering and switching strategies.

## Keywords

verbal fluency test, clustering and switching, dementia, mild cognitive impairment

## Background and Introduction

Dementia is one of the most common consequences of neurodegenerative diseases. The name comes from the Latin *de* (without) and *mens* (mind), which translates as “mindlessness”. (Rusina & Matěj, 2019). According to a 2025 report by the Czech Ministry of Labour and Social Affairs (MoLSA), approximately 10% of people over the age of 65 suffer from dementia; at age 65, it is about 5%,

and every following 5 years the incidence almost doubles — e.g. at the age of 80 it reaches 25–30% (Ministry of Labour and Social Affairs, 2025; Cao et al., 2020). According to the annual report of the Czech Alzheimer's Society for 2023, based on data from the Czech Statistical Office (as of December 31<sup>st</sup>, 2023), there are almost 171,000 people living with dementia in the Czech Republic, of which 54,220 are men and 116,563 are women (Czech Alzheimer's Society, o.p.s., 2024). Alzheimer's dementia accounts for the largest proportion of all dementias (up to 60%). Other types include e.g. frontotemporal dementia (Pidrman, 2007; Rusina & Matěj, 2019).

The relatively broad spectrum between normal ageing and the clinical stage of dementia is referred to in the literature as mild cognitive impairment (Oh et al., 2019). The probability of progression to dementia is up to 50%, which is why it is often referred to as a risk factor regarding its development (Bartoš & Hasalíková, 2010; Hauke, 2017). People with mild cognitive impairment are typically characterized by a deterioration in memory abilities beyond what is normal for their age. However, other studies have also noted deterioration in speech, attention, executive functions, abstract thinking, and spatio-temporal orientation (Jacobs et al., 2012; Oh et al., 2019; Malhotra, 2019). Distinguishing mild cognitive impairment from the dementia syndrome and from physiological ageing is absolutely crucial for the due initiation of follow-up care (Lužný, 2012).

Although the diagnosis of dementia is often primarily focused on memory, speech and language disorders are a significant but often neglected feature of many types

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of dementias (Zapletalová, 2023; Stanyon et al., 2016).

Language deficits in people with dementia can be classified at the level of words, sentences and discourse (Kavé & Goral, 2016; Healey et al., 2019). Phonological and semantic deficits include phonological paraphrases, anomies, neologisms, and difficulties in naming in spontaneous speech (Banovic et al., 2018; Jokel et al., 2019). Semantic paraphasia changes as the disease progresses. This leads to the substitution of concepts from the same semantic level (cohyponyms) to the use of only higher-order terms (hypernyms) (Marková et al., 2012). On a syntactic level, agrammatisms occur (Klimova & Kuca, 2016). Discourse is complicated by disparate speech and frequent repetition of content (Pistono et al., 2019). As the disease progresses, the content of the message becomes more meaningless and inadequate (Forbes-McKay et al., 2013). In addition, communication disorders in people with dementia are also greatly affected by deficits in cognitive functions. Sentence comprehension is impaired in people with dementia due to impaired attention and memory, while the understanding of more complex sentence structures deteriorates even in mild dementia (Liu et al., 2019; Hane et al., 2017). In later stages there may be a decrease in speech fluency (Forbes-McKay et al., 2013). Slower information processing complicates the recognition of the main idea of the message and the perception of intonation (Banovic et al., 2018; Marková et al., 2012; O'Brien & Thomas, 2017). Memory deficits cause difficulties with recalling words and remembering multiple instructions (Klimova & Kuca, 2016). Cognition is limited when it comes to understanding abstract concepts, humour, and social norms (Luzzi et al., 2020; Clark et al., 2015) but has been little studied in these diseases. We designed a semi-structured informant questionnaire to assess humor behavior and preferences in patients with behavioral variant of frontotemporal dementia (bvFTD; n=15. Executive function disruption reduces the ability to plan, judge, control emotions, and complete tasks (Thabtah et al., 2020; Scheltens et al., 2021; O'Brien & Thomas, 2017). These deficits are already evident in the early stages (Cheran et al., 2019).

### Verbal fluency

Speech fluency represents the ability to produce a continuous flow of speech,

which should have appropriate pace, speed and rhythm. Normal speech fluency is considered to be 90–120 words per minute (Mumenthaler et al., 2004). The pertinent assessment is the degree of fluency of spontaneous speech production (Preiss, 2012). Its disruption may be related to intellectual disorders and reflects the ability to organize thoughts (Obereigners, 2024). What is meant by verbal fluency is the whole complex of cognitive neuronal processes in which words from long-term and semantic memory are recalled based on selected aspects. This is assessed using a verbal fluency test, which measures the ability to quickly and efficiently generate words according to specified criteria (Hummelová & Janoušová, 2014).

### Verbal fluency test

The primary reference source for the test is considered to be the 1962 Thurston study. Five years later, A. L. Benton included the task of verbal fluency of the sounds F, A and S in the test battery of the Neurosensory Center Examination for Aphasia (Preiss, 1997). The verbal fluency test is among the most widely used neuropsychological methods for assessing cognitive processes (Nikolai et al., 2015). It is a practical test with a simple assignment, of short duration, but high difficulty for the test taker – they must follow the rules, generate words quickly and avoid repetition (Bartoš & Raisová, 2019). In addition to mapping speech characteristics, the test is used to diagnose deficits in executive functions, semantic memory, and psychomotor pace (Preiss, 2012). It is also part of many test batteries, such as the Assessment of neuropsychological status update (RBANS), the Addenbrook Cognitive Test (ACE-R), the Montreal Cognitive Test (MoCA), the CERAD Neuropsychological Battery, the Mattis Dementia Scale DRS-2 or the Delis-Kaplan executive function system (D-KEFS) (Nikolai et al., 2015; Preiss, 2012). In addition to clinical practice, it is also used in research. It is widely used, for example, in the examination of brain function by imaging methods. As evidenced, for example, in their study of fMRI in people with dementia and cognitively typically developing older adults (Paek et al., 2020), verbal fluency can also serve not only as a cognitive, but also as a neural marker of frontal lobe deficits observed in neurodegenerative diseases.

The verbal fluency test traditionally has two versions, the phonemic (letter) and categorical (semantic). Within phonemic,

the subject has the task of listing as many words as possible in a certain period of time that start with a specific sound. Within the categorical type, their task is to list as many words as possible belonging to a certain category, for example, animals, fruits, vegetables etc. The resulting word count is compared with the norm (Mueller et al., 2015; Vichová et al., 2020). From a neuroanatomical point of view, the left precentral and inferior frontal gyrus of the frontal lobe are more involved in the phonemic version, while in the semantic version, the anterior left part of the gyrus medialis and the left occipitotemporal sulcus of the temporal lobe are active (Birn et al., 2010). Given poor performance in both verbal fluency tests, one can generally identify reduced flexibility and certain difficulties not only with the organization of speech but also with cognition (Beber et al., 2023). Words recalled at the beginning of the test inform about the availability of words in semantic memory, while words evoked later point to a strategy for successful word search in the lexicon (Preiss, 2012). All of the aforementioned difficulties are reflected not only in the overall test score, but also in perseverance and confabulations (Bartoš & Raisová, 2019; Villalobos et al., 2023). Performance in verbal fluency tasks is influenced by sociodemographic variables (Lehtinen et al., 2023; Santos Nogueira et al., 2016). Therefore, especially for phonemic verbal fluency, the adaptation of norms to the specific cultural and linguistic environment of a given country is strongly recommended (Thiele et al., 2016; Becker and Salles, 2016; Franzen et al., 2020; Villalobos et al., 2023).

In the Czech Republic, there are standards for the phonemic version of the word count test for the sounds N, K, P and S. Since words beginning with the sound N have a lower frequency in the Czech language, this task is generally considered to be more demanding (Kopeček and Kuncová, 2006; Vichová et al., 2020). That is why some authors use the S sound (Nikolai et al., 2015). Standards for children and adults are also offered by Preiss (2012). Nikolai et al. (2015) analysed performance in the semantic version for the animals and vegetables category. The threshold number of words within the animals, fruit and shopping list category was further dealt with by Bartoš and Raisová (2019). They compared the performance of healthy seniors with the performance of people with mild cognitive impairment and people with Alzheimer's dementia.

As part of the instructions of the phonemic verbal fluency test, the subject has the task of listing as many words as possible for a given letter, in one minute. Names, or same word variations (with other endings) are not permissible (Preiss, 2012). In addition, Bartoš and Raisová (2019) add the restriction of not naming cities or countries, nor using words that differ in the singular and plural, and word diminutives. Conversely, they emphasize the option to use all parts of speech. The recommended practice for scoring is to discard repeating words and any words that fall outside the conditions. Words with different meanings with the same root do not count, nor do the 'listed words' taught in school, [being a list of rote-learned exceptionally spelled Czech words with 'y' after a consonant], and words formed with the prefix "ne" [negating the meaning, equivalent to "un-" or "non-" in English]. However, the evaluation of words with the negative prefix "ne" is not yet uniform. Conversely, some authors (Víchová et al., 2020) do accept words formed in this way. Rude words are not penalized (Preiss, 2012; Preiss et al., 2006). The instructions for the category words production test are similar. The subject is tasked with naming as many words as possible belonging to a certain category. Words can begin with any letter, they must not be repeated and it is not permissible to form singular and plural variants, nor diminutives. Despite the fact that both versions have a similar principle, these are tests of differing complexity and clinical importance (Bartoš & Raisová, 2019).

The use of the verbal fluency test in diagnostics is justified. It can be used both in the diagnosis of mild cognitive impairment and the initial stage of dementia, as well as in differential diagnosis, when we need to distinguish different types of dementia from one another or dementia from phatic disorders, or from impaired communication skills in depression (Qianhua & Qihao, 2013; Nikolai et al., 2015). People with mild cognitive impairment are much more likely to have impaired scores within the semantic variant of the test than with the phonemic one (Vonk et al., 2019; McDonnell et al., 2020). Bartoš & Raisová (2019) agree with this conclusion, stating that people with Alzheimer's dementia and people with mild cognitive impairment perform worse in the categorical version of the word production test than do normally ageing individuals. In addition, they report different outcomes for healthy seniors and those who develop dementia even some

20 years later. Similar results are presented by other research (Quaranta et al., 2023; Liampas et al., 2023; Vaughan et al., 2018), where the categorical version is considered a diagnostic tool capable of differentiating a group of people with progressive dementia from those with non-progressive mild cognitive impairment. In contrast, the results in the phonemic version are stable for a long time, both in the preclinical phase and in the early stage of Alzheimer's dementia (Bartoš & Raisová, 2019).

### *Clustering and switching in the verbal fluency test*

Moreover, in both versions of the verbal fluency test, there are more comprehensive options for evaluating performance in terms of cognitive strategies. These are known as clustering and switching. Clustering is the ability to produce words within a single category, i.e. to organize words into logical units (Mueller et al., 2015; Víchová et al., 2020). One example might be the following generation of words in the animals category: whale, dolphin, goat, sheep. The first two words belong to the subcategory of marine mammals. In contrast, the other two terms belong to the subcategory of livestock (Fong et al., 2020). Another subcategory to consider would be words starting with two identical phonemes, such as the Czech words *koza* and *kohout* [goat, rooster]. From a neuroanatomical point of view, temporal lobe processes such as verbal memory and the way words are stored and recalled are responsible for the clustering ability (Fong et al., 2020; Unsworth et al., 2011). On the other hand, switching means moving between individual clusters/categories after the previous topic area is exhausted. In practice, this might lead to a list of domestic animals followed by a list of exotic animals. This involves frontal lobe processes such as search strategy, executive function, and attention (Beber et al., 2023; Patra et al., 2020). In addition, it has been found that even if the subjects give a performance consistent with the norm in word count, subsequent analysis of the clustering and switching strategy may point to deviations indicative of some deficit (Lehtinen et al., 2023).

Qualitative evaluation of the test was addressed by Pešek (2023). In his work, he proposed using vector analysis to create qualitative indices of semantic verbal fluency in people with Alzheimer's dementia. A significant difference between the control group and people with

Alzheimer's dementia was found in all qualitative indices, for the vegetables category. These indices were the total number of clusters, the average number of words in the cluster, and the total number of switches. Bairami et al. (2023) report progressively impaired performance in switching as well as clustering between healthy individuals, those with mild cognitive impairment, and those with Alzheimer's dementia. The same results were found by Zhao et al., (2013), who also included people with vascular dementia; they performed better on the test than those with Alzheimer's dementia, but worse than those with mild cognitive impairment. The importance of using verbal fluency tests for preclinical Alzheimer's dementia is also emphasized by Mueller et al. (2015), who report lower scores in both the semantic and phonemic versions of the test among those with mild cognitive impairment compared with healthy individuals. Increased interest in the quantitative and qualitative analysis of the above tests is also declared by research that, among other things, provides normative data for the verbal fluency test for phonemes (M, A, B) and categories (animals, fruits and vegetables) for people of Lebanese origin (El-Hayeck et al., 2023).

A categorical version of the test in people with presymptomatic and prodromal frontotemporal dementia was discussed by Jiskoot et al. (2023) in their longitudinal study. The results suggest a relationship between the loss of grey matter in the temporal areas of the brain and of words more frequently used (based on language corpora) and words previously acquired. Conversely, correlating with a lower number of clusters, their size and switching between them was the loss of grey matter in the frontal cortex area. The amount of switching between clusters is seen by Oh et al. (2019) as an even more sensitive predictor of the existence of mild cognitive impairment than is the mere number of correctly evoked words.

Interesting research was carried out by Beber et al. (2023), who analysed clustering and switching in a verbal fluency test focused on verbs, in people with Alzheimer's dementia. The instruction made clear only verbs were permissible, and these were subsequently classified into categories of movement (run, climb, fall), routine actions (sweep, bathe, dream, drink, exercise), actions with objects (sell, buy, sew, paint) and psychological phenomena and states (laugh, love, speak, think). The results showed significant differences

in performance in the number of switches between clusters and in the total number of correctly worded words to the detriment of participants with dementia.

### Adapting clustering and switching rules to the Czech environment

Although the assessment of clustering and switching in verbal fluency tests is a common procedure abroad, almost no attention is paid to it in the Czech environment. Accordingly, there were no systematized rules for their classification until recently. The first to address this was Velkoborská (2013), who in her master thesis presented a possible localisation of the phonemic cluster evaluation rules, in the phonemic version of the test.

The above-mentioned procedure for assessing clustering and switching in both versions of the verbal fluency test with respect to the Czech environment was then proposed by Víchová et al. (2020). These were based mainly on the adaptation of studies abroad, by Troyer et al. (1997), Abwender et al. (2001) and Tallberg et al. (2011). In the thesis, she presents rules for the evaluation of *phonemic clusters*, where a cluster is considered to exist for words that (a) begin with two identical letters (*koza-kopyto*) (b) rhyme (*noha-nota*) or (c) have the same first and last phoneme (*puk-pak*). Not included in the same category are

words that differ in (a) the number of vowels (*kápě-kámen-kamarád-kalhoty* would be two separate clusters) (b) diphthongs (*poukaz-pórek* do not belong to one cluster). Giving proper names and words that differ only in their ending is not permissible. Words that contain the negating prefix *ne-* are not penalized.

The rules for evaluating *semantic clusters* in the *animals* category are as follows: animals belonging to a certain category (reptiles, rodents). A cluster is also considered to be (a) a superior term followed by a list of members (*bird-eagle-titmouse* is considered a cluster of two), (b) both sexes of the animal (*tomcat-cat*). In the case of the *supermarket/shop* category, two consecutive words that belong to a certain category are considered a cluster. Víchová (2020) lists all categories, such as food, beverages and drugstore items. Additional categories were included such as household, as well as an abstract category that covers words that are intangible, experiential or abstract. The same applies to clusters in the *fruit* category, where the variety is classified into a specific category, such as pomes (fleshy fruit with a core), drupes (fruit with a skin and a central stone), tropical fruits, and others. (Víchová et al., 2020).

### Conclusion

The verbal fluency test is a simple, time-saving tool that proves useful in diag-

nosing dementia, mild cognitive impairment and physiological ageing. In addition to overall language performance, it provides important information about executive functions and semantic memory, especially through the analysis of clustering and switching strategies. Due to the increasing prevalence of dementia and its impact on language and cognitive functions, more attention needs to be paid to early diagnosis. At the same time, speech therapy practice lacks tools that would effectively take into account language and cognition. The verbal fluency test has considerable potential in this regard. Further research and adaptation of the assessment methodology for the Czech environment can support its wider use in clinical practice.

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## Literature

- ABWENDER, D. A.; SWAN, J. G.; BOWERMAN, J. T. & CONNOLLY, S. W., 2001. *Qualitative analysis of verbal fluency output: Review and comparison of several scoring methods*. Online. *Assessment*, vol. 8, no. 3, pp. 323-338. DOI: 10.1177/107319110100800308. Available from: [Qualitative analysis of verbal fluency output: review and comparison of several scoring methods - PubMed](#).
- BAIRAMI, S.; FOLIA, V.; LIAMPAS, I.; NTANASI, E.; PATRIKELIS, P. et al., 2023. *Exploring verbal fluency strategies among individuals with normal cognition, amnesic and non-amnesic mild cognitive impairment, and Alzheimer's disease*. Online. *Medicina*, vol. 59, no. 10, p. 1860. DOI: 10.3390/medicina59101860. Available from: [Exploring Verbal Fluency Strategies among Individuals with Normal Cognition, Amnesic and Non-Amnesic Mild Cognitive Impairment, and Alzheimer's Disease - PubMed](#).
- BANOVIĆ, S.; ZUNIC, L. & SINANOVIĆ, O., 2018. *Communication difficulties as a result of dementia*. Online. *Materia Socio Medica*, vol. 30, no. 2, pp. 221-224. DOI: 10.5455/msm.2018.30.221-224. Available from: [Communication Difficulties as a Result of Dementia - PMC](#).
- BARTOŠ, A. & HASALÍKOVÁ, M., 2010. *Poznejte demenci správně a včas: příručka pro klinickou praxi*. [Recognize Dementia correctly and early: A Guide for Clinical Practice]. Prague: Mladá fronta. ISBN 978-80-204-2282-8.
- BARTOŠ, A. & RAISOVÁ, M., 2019. *Testy a dotazníky pro vyšetřování kognitivních funkcí, nálady a soběstačnosti*. [Tests and questionnaires to investigate cognitive function, mood and self-sufficiency]. 2<sup>nd</sup> revised and supplemented edition. Prague: Mladá fronta. ISBN 978-80-204-5490-4.
- BEBER, B. C.; LIEDTKE, F. V.; OLIVEIRA, F. S.; MÜLLER-SILVEIRA, L.; ALVES, E. V. et al., 2023. *Análise de clustering e switching da fluência de verbos em indivíduos com doença de Alzheimer*. Online. *CoDAS*, vol. 35, no. 2, p. e20210179. DOI: 10.1590/2317-1782/20232021179pt. Available from: [Análise de clustering e switching da fluência de verbos em indivíduos com doença de Alzheimer](#).

- BECKER, N. & DE SALLES, J. F., 2016. *Methodological criteria for scoring clustering and switching in verbal fluency tasks*. Online. *Psico-USF*, vol. 21, no. 3, pp. 445-457. DOI: 10.1590/1413-82712016210301. Available from: <https://www.scielo.br/j/pusf/a/qnvtnhGmbfFwGrBYzhDVj8k/?lang=en>.
- BIRN, R. M.; KENWORTHY, L.; CASE, L.; CARAVELLA, R.; JONES, T. B. et al., 2010. *Neural systems supporting lexical search guided by letter and semantic category cues: A self-paced overt response fMRI study of verbal fluency*. Online. *NeuroImage*, vol. 49, no. 1, pp. 1099-1107. DOI: 10.1016/j.neuroimage.2009.07.036. Available from: [Neural systems supporting lexical search guided by letter and semantic category cues: A self-paced overt response fMRI study of verbal fluency - ScienceDirect](#).
- CAO, Q.; TAN, C. C.; XU, W.; HU, H.; CAO, X. P. et al., 2020. *The prevalence of dementia: A systematic review and meta-analysis*. Online. *Journal of Alzheimer's Disease*, vol. 73, no. 3, pp. 1157-1166. DOI: 10.3233/JAD-191092. Available from: [The Prevalence of Dementia: A Systematic Review and Meta-Analysis - PubMed](#).
- CHERAN, G.; WU, L.; LEE, S.; MANOOCHEHRI, M.; CINES, S. et al., 2019. *Cognitive indicators of preclinical behavioral variant frontotemporal dementia in MAPT carriers*. Online. *Journal of the International Neuropsychological Society*, vol. 25, no. 2, pp. 184-194. DOI: 10.1017/S1355617718001005. Available from: [Cognitive Indicators of Preclinical Behavioral Variant Frontotemporal Dementia in MAPT Carriers - PubMed](#).
- CLARK, C. N.; NICHOLAS, J. M.; GORDON, E.; GOLDEN, H. L.; COHEN, M. H. et al., 2015. *Altered sense of humor in dementia*. Online. *Journal of Alzheimer's Disease*, vol. 49, no. 1, pp. 111-119. DOI: 10.3233/JAD-150413. Available from: [Altered sense of humor in dementia - PubMed](#).
- ČESKÁ ALZHEIMEROVSKÁ SPOLEČNOST, O. P. S. [CZECH ALZHEIMER'S SOCIETY], 2024. *Annual Report 2023*. Online. Available from: <https://www.alzheimer.cz/res/archive/008/000943.pdf?seek=1719392234>.
- EL-HAYECK, R.; WEHBÉ, A.; BADDOURA, R.; KHOURY, R.; BASSIL, N. et al., 2023. *Letter and category fluency: Normative data for Lebanese older adults*. Online. *Journal of Alzheimer's Disease*, vol. 93, no. 1, pp. 321-332. DOI: 10.3233/JAD-221121. Available from: [Letter and Category Fluency: Normative Data for Lebanese Older Adults - PubMed](#).
- FONG, M. C.-M.; HUI, N. Y.; FUNG, E. S.-W.; MA, M. K.-H.; LAW, T. S.-T. et al., 2020. *Which cognitive functions subserve clustering and switching in category fluency? Generalisations from an extended set of semantic categories using linear mixed-effects modelling*. Online. *Quarterly Journal of Experimental Psychology*, vol. 73, no. 12, pp. 2132-2147. DOI: 10.1177/1747021820957135. Available from: [Which cognitive functions subserve clustering and switching in category fluency? Generalisations from an extended set of semantic categories using linear mixed-effects modelling - PubMed](#).
- FORBES-MCKAY, K.; SHANKS, M. F. & VENNERI, A., 2013. *Profiling spontaneous speech decline in Alzheimer's disease: a longitudinal study*. Online. *Acta Neuropsychiatrica*, vol. 25, no. 6, pp. 320-327. DOI: 10.1017/neu.2013.16. Available from: [Profiling spontaneous speech decline in Alzheimer's disease: a longitudinal study - PubMed](#).
- FRANZEN, S.; VAN DEN BERG, E.; GOUDSMIT, M.; JURGENS, C. K.; VAN DE WIEL, L. et al., 2020. *A systematic review of neuropsychological tests for the assessment of dementia in non-Western, low-educated or illiterate populations*. Online. *Journal of the International Neuropsychological Society*, vol. 26, no. 3, pp. 331-351. DOI: 10.1017/S1355617719000894. Available from: [A Systematic Review of Neuropsychological Tests for the Assessment of Dementia in Non-Western, Low-Educated or Illiterate Populations - PubMed](#).
- HANE, F. T.; ROBINSON, M.; LEE, B. Y.; BAI, O.; LEONENKO, Z. et al., 2017. *Recent progress in Alzheimer's disease research, Part 3: Diagnosis and treatment*. Online. *Journal of Alzheimer's Disease*, vol. 57, no. 3, pp. 645-665. DOI: 10.3233/JAD-160907. Available from: [Recent Progress in Alzheimer's Disease Research, Part 3: Diagnosis and Treatment - PubMed](#).
- HAUKE, M., 2017. *Když do života vstoupí demence aneb Praktický průvodce péčí o osoby s demencí nejen v domácím prostředí* [When Dementia Enters your Life or A Practical Guide to Caring for People with Dementia not only at Home]. Tábor: Asociace poskytovatelů sociálních služeb ČR. ISBN 978-80-906320-7-3.
- HEALEY, M.; SPOTORNO, N.; OLM, C.; IRWIN, D. J. & GROSSMAN, M., 2019. *Cognitive and neuroanatomic accounts of referential communication in focal dementia*. Online. *eNeuro*, vol. 6, no. 5, p. ENEURO.0488-18.2019. DOI: 10.1523/ENEURO.0488-18.2019. Available from: [Cognitive and Neuroanatomic Accounts of Referential Communication in Focal Dementia - PubMed](#).
- HUMMELOVÁ, Z. & JANOUŠOVÁ, E., 2014. *Limity zkoušky verbální fluence v diferenciální diagnostice neurologických onemocnění*. [Limits of the verbal fluency test in the differential diagnosis of neurological diseases]. *Česká a slovenská neurologie a neurochirurgie*, vol. 77/110, no. 4, pp. 487-492. ISSN 1803-6597. Available from: <https://www.csnn.eu/casopisy/ceska-slovenska-neurologie/2014-4-1/limity-zkousky-verbalni-fluence-v-diferencialni-diagnostice-neurologickych-onemocneni-49308>.
- JACOBS, H. I. L.; VAN BOXTEL, M. P. J.; JOLLES, J.; VERHEY, F. R. J. & UYLINGS, H. B. M., 2012. *Parietal cortex matters in Alzheimer's disease: An overview of structural, functional and metabolic findings*. Online. *Neuroscience & Biobehavioral Reviews*, vol. 36, no. 1, pp. 297-309. DOI: 10.1016/j.neubiorev.2011.06.009. Available from: [Parietal cortex matters in Alzheimer's disease: an overview of structural, functional and metabolic findings - PubMed](#).

- JISKOOT, L. C.; VAN DEN BERG, E.; LAENEN, S. A. A. M.; POOS, J. M.; GIANNINI, L. A. A. et al., 2023. *Longitudinal changes in qualitative aspects of semantic fluency in presymptomatic and prodromal genetic frontotemporal dementia*. Online. *Journal of Neurology*, vol. 270, no. 11, pp. 5418-5435. DOI: 10.1007/s00415-023-11845-5. Available from: [Longitudinal changes in qualitative aspects of semantic fluency in presymptomatic and prodromal genetic frontotemporal dementia - PubMed](#).
- JOKEL, R.; SEIXAS LIMA, B.; FERNANDEZ, A. & MURPHY, K. J., 2019. *Language in amnesic mild cognitive impairment and dementia of Alzheimer's type: Quantitatively or qualitatively different?* Online. *Dementia and Geriatric Cognitive Disorders Extra*, vol. 9, no. 1, pp. 136-151. DOI: 10.1159/000496824. Available from: [Language in Amnesic Mild Cognitive Impairment and Dementia of Alzheimer's Type: Quantitatively or Qualitatively Different? | Dementia and Geriatric Cognitive Disorders Extra | Karger Publishers](#).
- KAVÉ, G. & GORAL, M., 2016. *Word retrieval in picture descriptions produced by individuals with Alzheimer's disease*. Online. *Journal of Clinical and Experimental Neuropsychology*, vol. 38, no. 9, pp. 958-966. DOI: 10.1080/13803395.2016.1179266. Available from: [Word retrieval in picture descriptions produced by individuals with Alzheimer's disease - PubMed](#).
- KLIMOVÁ, B. & KUČA, K., 2016. *Speech and language impairments in dementia*. Online. *Journal of Applied Biomedicine*, vol. 14, no. 2, pp. 97-103. DOI:10.1016/j.jab.2016.02.002. Available from: [Speech and language impairments in dementia](#).
- KOPEČEK, M. & KUNCOVÁ, A., 2006. *Efekt nácviku testu generování slov a testování alternativní verze*. [The effect of practicing the word generation test and testing the alternative version]. *Pilot study*. *Psychiatrie*, roč. 10, č. 4, pp. 211-215. ISSN 1211-7579.
- LEHTINEN, N.; LUOTONEN, I. & KAUTTO, A., 2023. *Systematic administration and analysis of verbal fluency tasks: Preliminary evidence for reliable exploration of processes underlying task performance*. Online. *Applied Neuropsychology: Adult*, vol. 30, no. 6, pp. 727-739. DOI: 10.1080/23279095.2021.1973471. Available from: [Systematic administration and analysis of verbal fluency tasks: Preliminary evidence for reliable exploration of processes underlying task performance - PubMed](#).
- LIAMPAS, I.; FOLIA, V.; MORFAKIDOU, R.; SIOKAS, V.; YANNAKOULIA, M. et al., 2023. *Language differences among individuals with normal cognition, amnesic and non-amnesic MCI, and Alzheimer's disease*. Online. *Archives of Clinical Neuropsychology*, vol. 38, no. 4, pp. 525-536. DOI: 10.1093/arclin/acac080. Available from: [Language Differences Among Individuals with Normal Cognition, Amnesic and Non-Amnesic MCI, and Alzheimer's Disease - PubMed](#).
- LIU, X.; WANG, W.; WANG, H. & SUN, Y., 2019. *Sentence comprehension in patients with dementia of the Alzheimer's type*. Online. *PeerJ*, vol. 7, p. e8181. DOI: 10.7717/peerj.8181. Available from: [Sentence comprehension in patients with dementia of the Alzheimer's type - PubMed](#).
- LUZZI, S.; BALDINELLI, S.; RANALDI, V.; FIORI, C.; PLUTINO, A. et al., 2020. *The neural bases of discourse semantic and pragmatic deficits in patients with frontotemporal dementia and Alzheimer's disease*. Online. *Cortex*, vol. 128, pp. 174-191. DOI: 10.1016/j.cortex.2020.03.012. Available from: [The neural bases of discourse semantic and pragmatic deficits in patients with frontotemporal dementia and Alzheimer's disease - PubMed](#).
- LUŽNÝ, J., 2012. *Gerontopsychiatrie*. [Geriatric psychiatry]. Prague: Triton. ISBN 978-80-7387-573-2.
- MALHOTRA, P. A., 2019. *Impairments of attention in Alzheimer's disease*. Online. *Current Opinion in Psychology*, vol. 29, pp. 41-48. DOI: 10.1016/j.copsyc.2018.11.002. Available from: [Impairments of attention in Alzheimer's disease - PubMed](#).
- MARKOVÁ, J.; CSÉFALVAY, Z. & HRUBÁ, I., 2012. *Narušená komunikačná schopnosť pri demencii*. [Impaired communication ability in dementia]. In: *Demencia*. Bratislava: Osveta, pp. 96-136. ISBN 978-80-8063-382-0.
- MCDONNELL, M.; DILL, L.; PANOS, S.; AMANO, S.; BROWN, W. et al., 2020. *Verbal fluency as a screening tool for mild cognitive impairment*. Online. *International Psychogeriatrics*, vol. 32, no. 9, pp. 1055-1062. DOI: 10.1017/S1041610219000644. Available from: [Verbal fluency as a screening tool for mild cognitive impairment - PubMed](#).
- MINISTRY OF LABOUR AND SOCIAL AFFAIRS OF THE CZECH REPUBLIC, 2025. *Duševní zdraví seniorů v ČR 2025*. [Mental Health of Seniors in the Czech Republic]. Available from: [https://www.mpsv.cz/cms/documents/5895dde0-e679-4089-7ada-3107c229e84a/Du%C5%A1evn%C3%AD%20zdrav%C3%AD%20senior%C5%AF\\_2025\\_MPSV.pdf](https://www.mpsv.cz/cms/documents/5895dde0-e679-4089-7ada-3107c229e84a/Du%C5%A1evn%C3%AD%20zdrav%C3%AD%20senior%C5%AF_2025_MPSV.pdf).
- MUELLER, K. D.; KOSCIK, R. L.; LARUE, A.; CLARK, L. R.; HERMANN, B. et al., 2015. *Verbal fluency and early memory decline: Results from the Wisconsin Registry for Alzheimer's Prevention*. Online. *Archives of Clinical Neuropsychology*, vol. 30, no. 5, pp. 448-457. DOI: 10.1093/arclin/acv030. Available from: [Verbal Fluency and Early Memory Decline: Results from the Wisconsin Registry for Alzheimer's Prevention - PubMed](#).
- MUMENTHALER, M.; MATTLE, H. & MUMENTHALER, M., 2004. *Neurology: 210 tables*. 4., rev. extended ed. Stuttgart, New York: Thieme. ISBN 978-3-13-523904-0.
- NIKOLAI, T.; ŠTĚPÁNKOVÁ, H.; MICHÁLEC, J.; BEZDÍČEK, O.; HORÁKOVÁ, K. et al., 2015. *Tests of verbal fluency, Czech normative study in older patients*. Online. *Czech and Slovak Neurology and Neurosurgery*, vol. 78/111, no. 3, pp. 292-299. DOI: 10.14735/amcsnn2015292. Available from: [Testy verbální f... | Česká a slovenská neurologie a neurochirurgie](#).
- OBEREIGNERŮ, R., 2024. *Afázie*. In: *Klinická neuropsychologie v praxi*. Prague: Karolinum, pp. 147-177. ISBN 978-80-246-5197-2.
- O'BRIEN, J. T. & THOMAS, A., 2017. *Vascular dementia*. Online. *Focus*, vol. 15, no. 1, pp. 101-109. DOI: 10.1176/appi.focus.1510. Available from: [Vascular dementia - PubMed](#).

- OH, S. J.; SUNG, J. E.; CHOI, S. J. & JEONG, J. H., 2019. *Clustering and switching patterns in semantic fluency and their relationship to working memory in mild cognitive impairment*. Online. *Dementia and Neurocognitive Disorders*, vol. 18, no. 2, pp. 47-56. DOI: 10.12779/dnd.2019.18.2.47. Available from: [Clustering and Switching Patterns in Semantic Fluency and Their Relationship to Working Memory in Mild Cognitive Impairment - PMC](#).
- PAEK, E. J.; MURRAY, L. L. & NEWMAN, S. D., 2020. *Neural correlates of verb fluency performance in cognitively healthy older adults and individuals with dementia: A pilot fMRI study*. Online. *Frontiers in Aging Neuroscience*, vol. 12, p. 73. DOI: 10.3389/fnagi.2020.00073. Available from: [Neural Correlates of Verb Fluency Performance in Cognitively Healthy Older Adults and Individuals With Dementia: A Pilot fMRI Study - PMC](#).
- PATRA, A.; BOSE, A. & MARINIS, T., 2020. *Performance difference in verbal fluency in bilingual and monolingual speakers*. Online. *Bilingualism: Language and Cognition*, vol. 23, no. 1, pp. 204-218. DOI: 10.1017/S1366728918001098. Available from: [Performance difference in verbal fluency in bilingual and monolingual speakers | Bilingualism: Language and Cognition | Cambridge Core](#).
- PEŠEK, J., 2023. *Verbální fluence u pacientů s Alzheimerovou nemocí*. [Verbal fluency in patients with Alzheimer's disease]. Bachelor's thesis. Prague: Charles University, Faculty of Arts, Department of Psychology. Supervisor Mgr. Tomáš Nikolai, Ph.D. Available from: <https://dspace.cuni.cz/bitstream/handle/20.500.11956/183216/130354639.pdf?sequence=1&isAllowed=y>.
- PIDRMAN, V., 2007. *Demence*. [Dementia]. Prague: Grada. ISBN 978-80-247-1490-5.
- PISTONO, A.; JUCLA, M.; BĚZY, C.; LEMESLE, B.; LE MEN, J. et al., 2019. *Discourse macrolinguistic impairment as a marker of linguistic and extralinguistic functions decline in early Alzheimer's disease*. Online. *International Journal of Language & Communication Disorders*, vol. 54, no. 3, pp. 390-400. DOI: 10.1111/1460-6984.12444. Available from: [Discourse macrolinguistic impairment as a marker of linguistic and extralinguistic functions decline in early Alzheimer's disease - PubMed](#).
- PREISS, M., 1997. *Verbální fluence, metoda vyšetřování poškození mozku u dětí a dospělých*. [Verbal fluency, a method of investigating brain damage in children and adults]. *Československá psychologie*, roč. 41, č. 3, pp. 244-249. ISSN 0009-062X.
- PREISS, M., 2012. *Neuropsychologická baterie Psychiatrického centra Praha: klinické vyšetření základních kognitivních funkcí*. [Neuropsychological Battery of the Psychiatric Centre in Prague: Clinical Examination of Basic Cognitive Functions]. 3<sup>rd</sup>, revised ed. Prague: Psychiatrické centrum. ISBN 978-80-87142-19-6.
- PREISS, M.; KUČEROVÁ, H.; KRIVOŠÍKOVÁ, M.; KULIŠŤÁK, P. & KOPEČEK, M., 2006. *Neuropsychologie v psychiatrii*. [Neuropsychology in psychiatry]. Prague: Grada. ISBN 80-247-1460-4.
- QIANHUA, Z. & QIHAO, G., 2013. *Clustering and switching during a semantic verbal fluency test contribute to differential diagnosis of cognitive impairment*. Online. *Neuroscience bulletin*, vol. 29, no. 1, pp. 75-82. DOI: 10.1007/s12264-013-1301-7. Available from: [Clustering and switching during a semantic verbal fluency test contribute to differential diagnosis of cognitive impairment - PubMed](#).
- QUARANTA, D.; CARAGLIA, N.; L'ABBATE, F.; GIUFFRÈ, G. M.; GUGLIELMI, V. et al., 2023. *Neuropsychological predictors of conversion from mild cognitive impairment to dementia at different timepoints*. Online. *Brain and Behavior*, vol. 13, no. 9, p. e3098. DOI: 10.1002/brb3.3098. Available from: [Neuropsychological predictors of conversion from mild cognitive impairment to dementia at different timepoints - PubMed](#).
- RUSINA, R. & MATĚJ, R., 2019. *Neurodegenerativní onemocnění*. [Neurodegenerative diseases]. 2<sup>nd</sup>, revised and supplemented edition. Prague: Mladá fronta. ISBN 978-80-204-5123-1.
- SANTOS NOGUEIRA, D.; AZEVEDO REIS, E. & VIEIRA, A., 2016. *Verbal fluency tasks: Effects of age, gender, and education*. Online. *Folia Phoniatrica et Logopaedica*, vol. 68, no. 3, pp. 124-133. DOI: 10.1159/000450640. Available from: <https://karger.com/fpl/article-abstract/68/3/124/140948/Verbal-Fluency-Tasks-Effects-of-Age-Gender-and?redirectedFrom=fulltext>.
- SCHELTENS, P.; DE STROOPER, B.; KIVIPELTO, M.; HOLSTEGE, H.; CHÉTELAT, G. et al., 2021. *Alzheimer's disease*. Online. *The Lancet*, vol. 397, no. 10284, pp. 1577-1590. DOI: 10.1016/S0140-6736(20)32205-4. Available from: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)32205-4/abstract](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)32205-4/abstract).
- STANYON, M. R.; GRIFFITHS, A.; THOMAS, S. A. & GORDON, A. L., 2016. *The facilitators of communication with people with dementia in a care setting: an interview study with healthcare workers*. Online. *Age and Ageing*, vol. 45, no. 1, pp. 164-170. DOI: 10.1093/ageing/afv161. Available from: [The facilitators of communication with people with dementia in a care setting: an interview study with healthcare workers - PubMed](#).
- TALLBERG, I. M.; CARLSSON, S. & LIEBERMAN, M., 2011. *Children's word fluency strategies*. Online. *Scandinavian Journal of Psychology*, vol. 52, no. 1, pp. 35-42. DOI: doi.org/10.1111/j.1467-9450.2010.00842.x. Available from: [Children's word fluency strategies - PubMed](#).
- THABTAH, F.; SPENCER, R. & YE, Y., 2020. *The correlation of everyday cognition test scores and the progression of Alzheimer's disease: a data analytics study*. Online. *Health Information Science and Systems*, vol. 8, no. 1, p. 24. DOI: 10.1007/s13755-020-00114-8. Available from: [The correlation of everyday cognition test scores and the progression of Alzheimer's disease: a data analytics study - PMC](#).

THIELE, K.; QUINTING, J. M. & STENNEKEN, P., 2016. *New ways to analyze word generation performance in brain injury: A systematic review and meta-analysis of additional performance measures*. Online. *Journal of Clinical and Experimental Neuropsychology*, vol. 38, no. 7, pp. 764-781. DOI: 10.1080/13803395.2016.1163327. Available from: [New ways to analyze word generation performance in brain injury: A systematic review and meta-analysis of additional performance measures - PubMed](#).

TROYER, A. K., MOSCOVITCH, M. & WINOCUR, G., 1997. *Clustering and switching as two components of verbal fluency: Evidence from younger and older healthy adults*. Online. *Neuropsychology*, vol. 11, no. 1, pp. 138-146. DOI: 10.1037/0894-4105.11.1.138. Available from: [Clustering and switching as two components of verbal fluency: evidence from younger and older healthy adults - PubMed](#).

UNSWORTH, N.; SPILLERS, G. J. & BREWER, G. A., 2011. *Variation in verbal fluency: A latent variable analysis of clustering, switching, and overall performance*. Online. *Quarterly Journal of Experimental Psychology*, vol. 64, no. 3, pp. 447-466. DOI: 10.1080/17470218.2010.505292. Available from: [Variation in verbal fluency: a latent variable analysis of clustering, switching, and overall performance - PubMed](#).

VAUGHAN, R. M.; COEN, R. F.; KENNY, R. & LAWLOR, B. A., 2018. *Semantic and phonemic verbal fluency discrepancy in mild cognitive impairment: Potential predictor of progression to Alzheimer's disease*. Online. *Journal of the American Geriatrics Society*, vol. 66, no. 4, pp. 755-759. DOI: 10.1111/jgs.15294. Available from: [Semantic and Phonemic Verbal Fluency Discrepancy in Mild Cognitive Impairment: Potential Predictor of Progression to Alzheimer's Disease - PubMed](#).

VELKOBORSKÁ, Z., 2013. *Validizační studie testu fonemické verbální fluence k diagnostice kognitivního deficitu u amnestické mírné kognitivní poruchy a Alzheimerovy choroby*. [A Phonemic Verbal Fluency Test Validation Study for the Diagnosis of Cognitive Deficit in Amnesic Mild Cognitive Impairment and Alzheimer's Disease]. Master's thesis. Brno: Masaryk University. Supervisor prof. PhDr. Tomáš Urbánek, Ph.D. Available from: <https://theses.cz/id/c4aadw/>.

VÍCHOVÁ, M., 2020. *Jazyk a kognice u lidí se schizofrenním onemocněním: Test slovních asociací – Test verbální fluence – subtest Slovník*. [Language and cognition in people with schizophrenia: Word Association Test – Verbal Fluency Test – Vocabulary Subtest]. Doctoral thesis. Brno: Masaryk University. Supervisor prof. PhDr. Tomáš Urbánek, Ph.D. Available from: [https://is.muni.cz/th/pzswm/Dizertacni\\_prace\\_Vichova.pdf](https://is.muni.cz/th/pzswm/Dizertacni_prace_Vichova.pdf).

VÍCHOVÁ, M.; DOKOUPILOVÁ, M.; CHROMÝ, R.; URBÁNEK, J. & NIKOLAI, T., 2020. *Shlukování a přepínání v Testu verbální fluence: Návrh adaptace kritérií do českého jazyka a shoda posuzovatelů*. [Clustering and switching in the Verbal Fluency Test: Proposal for adaptation of the criteria to the Czech language and evaluator consensus]. *Československá psychologie*, roč. LXIV, č. 3, pp. 306-320. ISSN 0009-062X.

VILLALOBOS, D.; TORRES-SIMÓN, L.; PACIOS, J.; PAÚL, N. & DEL RÍO, D., 2023. *A systematic review of normative data for verbal fluency test in different languages*. Online. *Neuropsychology Review*, vol. 33, no. 4, pp. 733-764. DOI: 10.1007/s11065-022-09549-0. Available from: [A Systematic Review of Normative Data for Verbal Fluency Test in Different Languages - PubMed](#).

VONK, J. M. J.; FLORES, R. J.; ROSADO, D.; QIAN, C.; CABO, R. et al., 2019. *Semantic network function captured by word frequency in nondemented APOE ε4 carriers*. Online. *Neuropsychology*, vol. 33, no. 2, pp. 256-262. DOI: 10.1037/neu0000508. Available from: [Semantic network function captured by word frequency in nondemented APOE ε4 carriers - PubMed](#).

ZAPLETALOVÁ, M., 2023. *Analýza jazykových deficitů u osob s neurodegenerativním onemocněním mozku*. [Analysis of language deficits in people with neurodegenerative brain disease]. Master's thesis, Palacký University in Olomouc, Faculty of Education. Supervisor Mgr. Lucie Kytnarová, Ph.D. Available from: [https://theses.cz/id/0ygefu/Diplomova\\_pra\\_ce\\_Zapletalova\\_.pdf?zpet=%2Fvyhledavani%2F%3Fsearch%3Danal%C3%BDza%20jazykov%C3%BDch%20deficit%C5%AF%26start%3D1](https://theses.cz/id/0ygefu/Diplomova_pra_ce_Zapletalova_.pdf?zpet=%2Fvyhledavani%2F%3Fsearch%3Danal%C3%BDza%20jazykov%C3%BDch%20deficit%C5%AF%26start%3D1).

ZHAO, Q.; QIHAO, G. & HONG, Z., 2013. *Clustering and switching during a semantic verbal fluency test contribute to differential diagnosis of cognitive impairment*. Online. *Neuroscience Bulletin*, vol. 29, no. 1, pp. 75-82. DOI: 10.1007/s12264-013-1301-7. Available from: [Clustering and switching during a semantic verbal fluency test contribute to differential diagnosis of cognitive impairment - PubMed](#).