The Value of Neuropsychological Assessment in the Differentiation Between Behavioral Variant Frontotemporal Dementia and Late-Onset Psychiatric Disorders

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ABSTRACT

Objective: To investigate which neuropsychological tests can discriminate between behavioral variant frontotemporal dementia (bvFTD) and psychiatric disorders presenting with similar late-onset frontal behavioral changes, such as apathy, disinhibition, reduced empathy, or compulsive behavior.

Methods: Patients presenting with frontal behavioral changes in middle or late adulthood received extensive baseline examinations, including neuropsychological assessment and brain imaging. After 2 years, examinations were repeated and patients were diagnosed according to *DSM-IV* or international bvFTD consensus criteria. The study period was April 2011–June 2015. Two groups were selected: 32 patients with bvFTD and 53 patients with a psychiatric or psychological diagnosis. Associations between neuropsychological test scores and diagnostic group were investigated with logistic regression analyses, and diagnostic accuracy was investigated with a receiver operating characteristic curve.

Results: BvFTD patients scored lower on tests for confrontational naming, gestalt completion, and verbal abstraction compared to psychiatric patients (*P* < .01). The confrontational naming test (Boston Naming Test) showed the strongest association with diagnostic group: a lower score indicated a higher probability for a bvFTD diagnosis (*P* < .001). This test could discriminate between the groups with good diagnostic accuracy (area under the curve = 0.81). Tests for attention, memory, and executive functions showed no discriminative ability between the groups.

Conclusions: Although one of the criteria of bvFTD is low performance on executive tests, these tests are not useful in differentiating bvFTD from psychiatric disorders. We recommend administering language tests, especially an extensive confrontational naming test, to aid differentiation between bvFTD and a psychiatric disorder in patients presenting with late-onset frontal behavioral changes.

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Clinical Points

- Differentiating between behavioral variant frontotemporal dementia (bvFTD) and psychiatric disorders remains a diagnostic challenge. There is a large overlap of behavioral symptoms, such as apathy, disinhibition, reduced empathy, and compulsive behavior. Cognitive impairments occur in both patient groups, and it is unclear whether neuropsychological tests can aid in the differentiation.

- This study showed a good differentiating ability of a confrontational naming test: a high score indicated a high probability of a psychiatric diagnosis, and a low score indicated a high probability of a bvFTD diagnosis. Therefore, to aid differentiation between bvFTD and psychiatric disorder in patients presenting with late-onset frontal behavioral change, it is recommended to include a naming test in the neuropsychological assessment. Other cognitive tests showed less or no diagnostic value.

In middle or late adulthood, abnormal changes in personality and behavior can arise, with symptoms such as increased apathy, disinhibition, compulsive behavior, or reduced empathy. These symptoms reflect a dysfunction of the frontal lobes or the fronto-subcortical circuits of the brain and can be caused by a neurodegenerative disease or a psychiatric disorder such as depression.[1] Patients are often referred to a psychiatrist or neurologist, who also receives the challenge to give the right diagnosis. An early and accurate diagnosis is crucial: while neurodegenerative diseases are progressive and, at present, incurable, most psychiatric disorders can be treated.

Several different neurodegenerative diseases can present with behavioral changes. Many of these can be diagnosed using nonbehavioral criteria. For instance, Alzheimer's disease and cerebrovascular disease can be reliably diagnosed with biomarkers or brain imaging.[2,3] Lewy body disease can be identified by several specific other symptoms, such as parkinsonism and REM sleep behavior disorder.[4] When these neurodegenerative diseases have been ruled out, the distinction often remains between behavioral variant frontotemporal dementia (bvFTD) and psychiatric disorders.

BvFTD is characterized mostly by personality and behavioral changes, along with cognitive deterioration.[5] Specifically, the behavioral criteria for bvFTD are disinhibition, apathy, reduced empathy, compulsive/stereotypical behavior, and hyperorality/diet change. All of these behavioral changes can also occur in psychiatric disorders, for instance, disinhibition in bipolar disorder and schizophrenia, apathy and reduced empathy in depression and schizophrenia, compulsive or stereotypical behavior in obsessive-compulsive disorder, and dietary changes in depression.[5–7] All disorders can present with similar daily life dysfunction: social withdrawal, reduced self-care, and relationship problems.[6] This large overlap in symptoms makes the diagnostic differentiation very difficult. In fact, a high proportion of bvFTD patients initially receive a psychiatric diagnosis (most often depression), and significant time can pass before the right diagnosis is given.[8,9] The reverse also occurs: patients with a psychiatric disorder incorrectly receive bvFTD diagnoses,[10] preventing patients from receiving appropriate treatment.

Despite the main identifying characteristics being behavioral, several biomarkers can assist in the diagnosis of bvFTD. Disproportional degrees of frontal and/or temporal atrophy on magnetic resonance imaging (MRI), hypometabolism of ^{18}F-fluorodeoxyglucose (FDG) positron emission tomography (PET) scan, and certain combinations of cerebrospinal fluid markers all have high sensitivity but moderate specificity for detecting bvFTD.[11,12] Brain atrophy or hypometabolism is also found in depression.[13] Approximately 10%–30% of bvFTD cases are familial and due to mutations in known genes.[14] Genetic screening is reliable but is useful only in cases with a positive family history for bvFTD. Therefore, biomarkers can assist in the diagnosis of bvFTD, but they are not conclusive.

Another criterion of bvFTD is a neuropsychological profile with executive impairments and relative sparing of memory and visuospatial functions.[5] Although this profile is typical for bvFTD, impairments have been reported in other cognitive domains such as memory[15,16] and language.[16–18]

It is unclear whether bvFTD and psychiatric patients can be differentiated with a neuropsychological assessment. Psychiatric disorders can also cause cognitive impairments, for example, reduced memory and executive functions in patients with depression and bipolar disorder.[19,20]

There is little literature comparing neuropsychological functioning between patients with bvFTD and psychiatric disorders. One of our previous studies showed that bvFTD and psychiatric patients cannot be distinguished using the typical neuropsychological profile of bvFTD.[21] BvFTD patients, however, scored lower on an emotion recognition test compared to psychiatric patients.[22] Other studies show mixed results. In one study, bvFTD patients had higher executive and memory performance than patients with bipolar disorder or depression and lower verbal fluency performance than patients with bipolar disorder.[23] Another study showed lower executive, but better memory performance of bvFTD patients compared to depressive patients.[24] A review comparing studies with depressed patients and studies with FTD patients suggests worse performances by FTD patients on verbal fluency, semantic memory, and executive functions.[25] Compared to patients with schizophrenia, bvFTD patients performed better or worse on executive tests[23,26,27] and worse on verbal fluency tests.[27]

The most consistent of these results is better memory and lower verbal fluency performance of bvFTD patients compared to psychiatric patients. One caveat of many of these described studies, however, is that the patients were retrospectively selected and some studies included chronically ill psychiatric patients, who might have had more cognitive deficits. These patients may differ from undiagnosed patients with shorter symptom duration and therefore be less clinically representative.

Our aim was to investigate which neuropsychological tests can discriminate between bvFTD and psychiatric diagnoses in a clinically representative, prospective cohort of patients presenting with frontal behavioral changes.

METHODS

Study Sample

Data were derived from the Late-Onset Frontal lobe (LOF) study: a prospective, longitudinal study aimed at providing an early and accurate diagnosis in patients with late-onset frontal behavioral changes.[28] Patients were recruited at the Alzheimer Center of the VU Medical Center and the Department of Old Age Psychiatry of GGZ InGeest between April 2011 and June 2013. The ethical review boards approved the study protocol, and written informed consent was obtained. The inclusion criteria were behavioral changes consisting of apathy, disinhibition, and/or compulsive/stereotypical behavior; age between 45–75 years with symptom onset between age 40–70 years; and a Frontal Behavior Inventory[29] score of 11 or higher and/or Stereotypy Rating Inventory[30] score of 10 or higher. The most important exclusion criteria were an established medical diagnosis that could explain the behavioral problems, such as dementia, a psychiatric disorder, or traumatic brain injury; Mini-Mental State Examination (MMSE) score < 18; and clinically apparent aphasia. These criteria resulted in a group with late-onset frontal behavioral changes of unknown cause.

At baseline, all patients underwent an extensive standardized assessment, including neurologic and psychiatric examinations, a clinical evaluation from a neurologist and a geriatric psychiatrist, neuropsychological assessment, laboratory tests, genetic screening, and MRI using a 3T-SignaHDxt scanner (GE Medical Systems, Milwaukee, Wisconsin). In case of insufficiently explanatory MRI results, an ^{18}F-FDG PET scan was performed using an ECAT-EXACT-HR+ scanner (Siemens/CTI, Knoxville, Tennessee). This multidisciplinary assessment, including questionnaires, neuropsychological assessment, and brain imaging, was repeated after 2 years. Patients who were less testable due to disease progression received a shorter assessment. The diagnosis after 2 years was based mainly on progression in clinical symptoms and brain atrophy. The diagnoses were based on the international diagnostic criteria for bvFTD[5] and the *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, Text Revision.[7] The full selection criteria and the diagnostic procedure have been described in more detail previously.[28] The final study sample consisted of 137 patients with different psychiatric and neurologic diagnoses.

For the present study, 2 patient groups were selected based on the diagnosis at year 2. The first group consisted of 32 patients with a diagnosis of probable (n = 28) or definite (n = 4) bvFTD. The second group consisted of 53 patients with a psychiatric or psychological diagnosis: depression (n = 14), minor depression (n = 4), bipolar disorder (n = 7), schizophrenia (n = 1), anxiety disorder (n = 1), obsessive-compulsive disorder (n = 1), autism (n = 3), personality disorder (n = 6), other psychiatric disorder (n = 5), subjective complaints (n = 5), or relational problems (n = 6). Not included were patients with possible bvFTD (n = 5) or other neurodegenerative or neurologic diagnoses (n = 42), patients for whom more than half of the neuropsychological tests were missing (n = 2), and patients with an unreliable diagnosis as result of limited or missing follow-up examinations (n = 3).

Measurements

Sample characteristics. In the baseline assessment, information was collected on age, gender, and years of education. Premorbid intelligence was estimated using the Dutch Reading Test for Adults.[31] Global cognitive functioning was evaluated with the MMSE[32] and frontal cognitive functioning with the Frontal Assessment Battery (FAB).[33]

Basic attention and processing speed. Verbal attention was measured with the test Digit Span Forward.[34] Visual attention and processing speed were assessed by the Trail Making Test, Part A.[35] Reading and color naming speed was measured by the Stroop test cards 1 and 2.[36]

Memory. Verbal memory was assessed with the Dutch version of the 15-word Auditory Verbal Learning Test.[31] Associative memory was assessed with the Visual Association Test.[31]

Executive function. Working memory was assessed with the test Digit Span Backward.[34] Inhibition was assessed with the Stroop test card 3.[36] Mental flexibility was assessed with several different tests: the Meander test, a written alternating sequencing task[31]; the Rule Shift Cards Test[37]; and the Trail Making Test Part B.[35] Phonemic fluency was assessed with the Dutch version of the Controlled Oral Word Association Test.[31] Visual planning was measured with the Mazes Test.[38] Estimation abilities were measured with the Cognitive Estimation Test.[39] Finally, strategy forming was assessed with the Key Search Test.[37]

Language. The ability to retrieve information from semantic memory was assessed with the animal fluency test.[31] Confrontational picture naming was assessed with the 29-item version of the Boston Naming Test.[40] Verbal abstraction was assessed with the Similarities Test.[34]

Visuospatial functioning. Visual construction was assessed with the copy part of the Rey Complex Figure Test.[41] Visual perception was assessed with a fragmented Figures Discovery Test.[42]

Social cognition. Social cognition was assessed with the Ekman Faces Test, an emotion recognition test, used in the additional analysis.[43]

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 23). First, median group scores were compared to cutoff scores used in clinical practice.[31] Subsequently, differences between the bvFTD and psychiatric groups in demographics and baseline test scores were compared using χ^2 analysis, Student *t* test, or

Mann-Whitney U test depending on the normality of the variables. Additionally, to investigate whether test scores at baseline are associated with diagnosis at year 2, univariate logistic regression analyses were performed for each test, with diagnostic group as dichotomous outcome variable. As age and gender might influence neuropsychological test performances, these variables were included as covariates.

Subsequently, tests that were associated with diagnostic group with $P < .05$ were combined into a multivariate logistic regression model to investigate which tests show the highest association. Manual backward selection was used to obtain a model to which all variables contributed significantly. Potential multicollinearity was investigated by checking that the variance inflation factor was < 5 for all variables using linear regression analysis. For the tests in the resulting multivariate logistic regression model, the diagnostic accuracy was investigated by plotting a receiver operating characteristic (ROC) curve and calculating the area under the curve and the cutoff value with optimal sensitivity and specificity.

Two additional analyses were performed. First, a logistic regression analysis was done to investigate whether the best diagnostic test was still associated with diagnosis when controlling for the Ekman Faces Test, a discriminator found in a previous study.[22] Second, the main analyses were repeated without the diagnoses subjective complaints and relationship problems in the psychiatric group.

The Benjamini and Hochberg procedure was used to correct for multiple comparisons, with a false discovery

Table 1. Characteristics of the Study Sample

	bvFTD, n = 32	Psychiatric or Psychological Diagnosis, n = 53	t/χ²(df)/U	P
Male, n (%)	18 (56)	43 (81)	6.10 (1)	.014
Age, mean (SD), y	63 (6.9)	60 (6.5)	−2.14 (83)	.035
Education in years, median (IQR)	10 (5)	10 (4)	831.0	.88
NART estimated IQ, median (IQR)	99 (22)	100 (21)	536.0	.27
MMSE score, median (IQR)	26 (4)	27 (3)	754.0	.39
FAB score, median (IQR)	16 (4)	16 (5)	777.0	.78

Abbreviations: bvFTD = behavioral variant frontotemporal dementia, FAB = Frontal Assessment Battery, IQR = interquartile range, MMSE = Mini-Mental State Examination, NART = National Adult Reading Test, SD = standard deviation.

Table 2. Neuropsychological Test Scores per Diagnostic Group, Between-Group Comparisons and Logistic Regression per Test[a]

Test	N	bvFTD, n = 32 (24–32)	Psychiatric or Psychological Diagnosis, n = 53 (43–53)	Group Comparison t (df)/U	P	Effect Size d/r	Logistic Regression With Age and Gender as Covariate OR (95% CI)	P
Attention and processing speed								
Digit Span Forward, median max span (IQR)	78	5 (1)	5 (1)	721.0	.94	0.01	1.24 (0.77–1.99)	.38
TMT-A, mean time in sec (SD)	84	62 (39)	48 (22)	−1.79 (44)	.08	0.44	1.01 (0.99–1.03)	.27
Stroop-1, median time in sec (IQR)	81	50 (11)	48 (14)	741.5	.82	0.03	1.01 (0.98–1.04)	.49
Stroop-2, median time in sec (IQR)	81	67 (22)	66 (22)	723.5	.69	0.05	1.01 (0.99–1.02)	.42
Executive function								
Digit Span Backward, median max span (IQR)	78	4 (1)	4 (2)	660.5	.47	0.08	1.08 (0.64–1.83)	.77
TMT-B, mean time in sec (SD)	75	155 (91)	128 (78)	−1.36 (73)	.18	0.32	1.00 (1.00–1.01)	.30
Stroop-3, median time in sec (IQR)	79	130 (49)	116 (49)	613.5	.30	0.12	1.00 (1.00–1.01)	.79
Key Search Test score, mean (SD)	77	9 (4)	12 (4)	3.38 (75)	.001*	0.75	0.85 (0.73–0.98)	.02
Rule Shift, median errors (IQR)	77	2 (8)	2 (3)	619.0	.54	0.07	1.10 (0.95–1.29)	.21
Cognitive Estimation Test, median errors (IQR)	66	3 (4)	2 (3)	437.0	.43	0.10	1.03 (0.83–1.28)	.80
Mazes Test, median time in sec (IQR)	77	190 (122)	183 (114)	668.5	.85	0.02	1.00 (0.99–1.01)	.68
Mazes Test, median errors (IQR)	78	4 (2)	3 (3)	677.5	.81	0.03	0.91 (0.74–1.12)	.36
Clock drawing, median errors (IQR)	72	1 (2)	1 (0)	523.0	.20	0.15	1.35 (0.80–2.25)	.26
Meander score, median (IQR)	78	4 (1)	4 (0)	649.5	.46	0.08	0.76 (0.39–1.49)	.42
Phonemic fluency score, mean (SD)	79	25 (13)	28 (14)	1.04 (77)	.30	0.22	0.99 (0.95–1.03)	.61
Memory								
VAT-A, median score trial 1 + 2 (IQR)	84	12 (2)	12 (2)	829.0	.98	0.00	0.94 (0.76–1.17)	.61
VAT-B, median score trial 1 + 2 (IQR)	78	11 (4)	11 (3)	700.5	.92	0.01	1.08 (0.88–1.33)	.46
15-WT immediate total score, mean (SD)	79	32 (11)	34 (10)	0.83 (77)	.41	0.19	0.99 (0.94–1.04)	.69
15-WT delayed score, mean (SD)	80	5 (4)	6 (3)	0.86 (78)	.39	0.28	0.96 (0.84–1.11)	.59
Language								
Semantic fluency, score, mean (SD)	83	15 (7)	19 (7)	2.01 (81)	.048	0.57	0.95 (0.88–1.02)	.14
Boston Naming Test, score, mean (SD)	75	58 (16)	74 (11)	4.62 (35)	<.001*	1.17	0.91 (0.87–0.96)	<.001*
Similarities, median score (IQR)	68	17 (15)	23 (12)	272.0	.001*	0.40	0.88 (0.82–0.96)	.003*
Visuospatial								
Rey Complex Figure—copy, mean score (SD)	78	31 (4)	31 (6)	0.12 (76)	.90	0.00	1.03 (0.93–1.14)	.54
Figure discovery, mean score (SD)	67	8 (5)	11 (3)	3.26 (65)	.002*	0.73	0.76 (0.62–0.92)	.005*
Social cognition								
Ekman Faces Test, mean score (SD)	68	31 (10)	40 (8)	3.88 (66)	<.001*	0.99	0.85 (0.78–0.93)	<.001*

*Significant P value after correction for multiple comparisons with the Benjamini-Hochberg procedure.
[a]Coding logistic regression: 0 = psychiatric condition, 1 = bvFTD.
Abbreviations: 15-WT = 15-word test, bvFTD = behavioral variant frontotemporal dementia, IQR = interquartile range, max = maximum, SD = standard deviation, TMT = Trail Making Test, VAT = Visual Association Test.

Figure 1. Group Scores on Boston Naming Test[a]
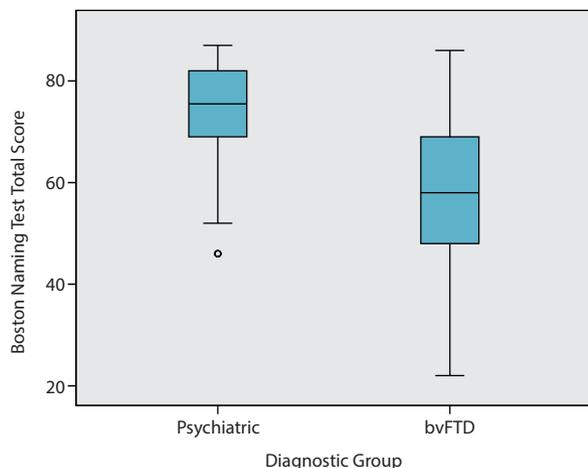
[a]Median scores with interquartile range. Circle represents 2 outliers.
Abbreviation: bvFTD = behavioral variant frontotemporal dementia.

Figure 2. ROC Curve for the Boston Naming Test[a]

[a]Diagonal segments are produced by ties.
Abbreviation: ROC = receiver operating characteristic.

rate of 0.10.[44] A $P < .05$ was used in comparing group characteristics to select possible confounders. Missing values were not included in the analyses. Most missing values were caused by organizational factors and were not related to patient characteristics. Missing values due to patient refusal or inability were evenly distributed among the diagnostic groups.

RESULTS

Table 1 shows the characteristics of the study sample. Patients with a psychiatric or psychological diagnosis were slightly younger and more often male compared to bvFTD patients. No significant differences were found in years of education, estimated IQ, MMSE scores, or FAB scores.

Table 2 shows the average or median test scores on each neuropsychological test for each diagnostic group. Compared to cutoff scores used in clinical practice, both groups scored average to below average on most tests, but the bvFTD group scored very low on the Boston Naming Test (z-score < 2)[31] When the 2 patient groups were compared directly, the bvFTD group had significantly lower scores than the psychiatric group on the following tests: Similarities, Key Search Test, Boston Naming Test, and Figure Discovery (Table 2).

For all neuropsychological tests, a univariate logistic regression was performed with the test as independent variable and diagnostic group as dichotomous dependent variable (Table 2). After adjustment for age and gender, the tests Similarities, Figure Discovery, and Boston Naming Test were still significantly associated with diagnostic group, where a lower test score was associated with a higher probability of a bvFTD diagnosis.

Subsequently, these neuropsychological tests were combined in a multivariate logistic regression analysis. After backward selection, a model remained with the Boston Naming Test as the only independent variable significantly
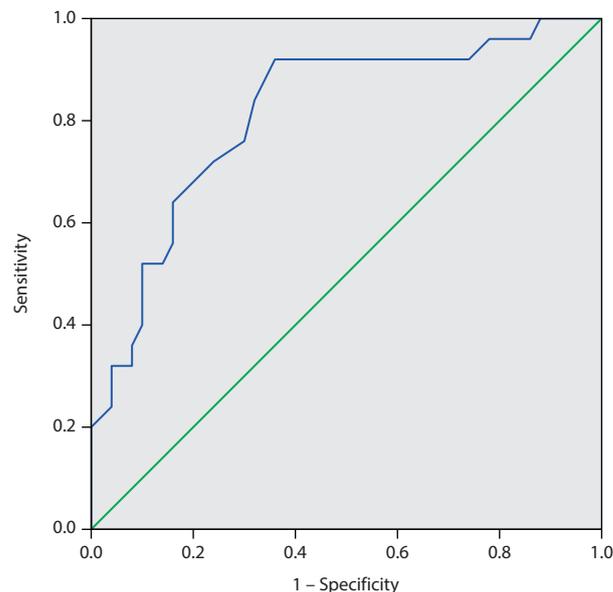
associated with diagnosis (B = −0.094, SE = 0.024, $P < .001$). This finding indicates that a lower score on the Boston Naming Test at baseline corresponds with a higher probability of a bvFTD diagnosis at year 2. The median group scores on the Boston Naming Test are shown in Figure 1.

Diagnostic Value

To explore the diagnostic value of the Boston Naming Test, a ROC curve was calculated that showed an area under the curve of 0.81 (95% CI = 0.71–0.92, $P < .001$; Figure 2), indicating a good ability of the test to differentiate the bvFTD and the psychiatric groups. The scoring of the Boston Naming Test is based on a 0–3 score for 29 items, with a maximum score of 87. A cutoff score of < 72 gives an optimal combination of a sensitivity of 92% and a specificity of 64%. However, in differential diagnosis, high specificity is more desirable than high sensitivity. Specificity for bvFTD is 90% at a cutoff score of < 60 (sensitivity = 48%), whereas the specificity of a psychiatric or psychological disorder is 90% at a cutoff score of > 71 (sensitivity = 64%). Thus, a score of 60 or lower corresponds to a high probability of bvFTD, and a score of 71 or higher corresponds to a high probability of a psychiatric disorder. Test scores between those values do not allow for reliable differentiation.

Additional Analyses

Previously, we found that an emotion recognition test, the Ekman Faces Test, discriminated between bvFTD and psychiatric disorders.[22] Therefore, we performed an additional logistic regression analysis with the Boston Naming Test and Ekman Faces Test as covariates. The Boston Naming Test was still significantly associated to diagnostic

group (Boston Naming Test: B = −0.095, SE = 0.032, P = .003), and the Ekman Faces Test was of borderline significance (Ekman Faces Test: B = −0.091, SE = 0.047, P = .052).

In addition, the logistic regression and ROC curve analyses were repeated with the psychiatric group without the patients with relationship problems or subjective complaints. Excluding these patients led to similar results. The logistic regression with Boston Naming Test as predictor was comparable (B = −0.090, SE = 0.026, P < .001), and the ROC curve had an area under the curve of 0.81 (95% CI = 0.70–0.92, P < .001).

CONCLUSION

The aim of our study was to investigate which neuropsychological tests are of value in differentiating between bvFTD and psychiatric disorders in patients presenting with late-onset frontal behavioral changes. Our main finding is that tests with a language component can differentiate between the groups, whereas executive tests cannot. Worse performance on a confrontational picture naming test (Boston Naming Test), a combined gestalt completion and naming test (Figure Discovery Test), and a verbal abstraction test (Similarities) corresponded to a higher probability of bvFTD diagnosis. Of these tests, the Boston Naming Test was most strongly associated to diagnostic group and could discriminate between the groups with good diagnostic accuracy. There were no differences between the groups on tests for attention, memory, and executive functions.

It is striking that all discriminative tests have a semantic language component. This corresponds with the deterioration of the anterior temporal lobe in bvFTD. The patients showed no apparent language disabilities yet, as this was an exclusion criterion. The tests might have picked up subtle language deficiencies that become more pronounced as the disease progresses. Survey questions for aphasia and amount of speech did not differ between groups, while bvFTD patients did have a higher score in literal thinking compared to psychiatric patients. This corresponds with the lower score on the verbal abstraction test.

Besides language functions, 2 of the discriminative tests (Figure Discovery and Boston Naming Test) also required visual recognition. It is unlikely that a problem in visual perception underlies the difference between the groups, as they showed no difference on another visual test (Rey Complex Figure—copy) and visuospatial functions remain intact in the early phase of bvFTD.[16] Other required cognitive abilities were reasoning (Similarities Test) and looking in an exploratory, goal-directed way (Figure Discovery).

The results conflict with literature showing executive impairments in bvFTD patients compared to healthy controls. It should be noted that this study included only patients with unclear diagnoses at baseline. These patients might differ in severity from the general groups of bvFTD and psychiatric patients. More complex executive tests might show more impairments.[45]

This study is the first to compare extensive neuropsychological assessment of patients with bvFTD and psychiatric disorders presenting with similar frontal behavioral symptoms. As the inclusion process was symptom-based and prospective, the study sample is a heterogeneous, highly clinically representative group of patients. In addition, the diagnoses are based on a multidisciplinary, extensive diagnostic process and a follow-up period of 2 years.

A few limitations also apply. First, the heterogeneous nature of the psychiatric group does not allow translation of the findings to general groups of psychiatric patients, since the subsamples of the various diagnoses are small. However, the focus of the study was mainly on differentiating the neurodegenerative (bvFTD) from the non-neurodegenerative diagnoses (psychiatric). Second, although the diagnosis after 2 years of follow-up gives a fair diagnostic certainty, ideally, autopsy-proven diagnoses would be used. Furthermore, one might argue that there is circular reasoning because the neuropsychological assessment at baseline was used in the diagnostic procedure. However, the final diagnoses were based mainly on the progression in clinical symptoms and brain atrophy during the 2-year follow-up period. A final consideration is that the sample size was relatively small. Replication of these results in other cohorts would strengthen the diagnostic validity. A recommendation for future studies is the addition of more basic visual perception tests and a description-based verbal naming test to better differentiate between components of visual perception and naming in picture naming tests.

In conclusion, although executive tests are able to differentiate bvFTD from healthy controls, they are not useful in differentiating bvFTD from psychiatric disorders. We recommend administering language tests, especially an extensive confrontational naming test, to aid differentiation between bvFTD and a psychiatric disorder in patients presenting with late-onset frontal behavioral changes.

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POSTTEST

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1. **One of the international consensus criteria for behavioral variant FTD (bvFTD) is a specific neuropsychological profile, which is the following:**

   a. Deficits in attention and executive functions with relative sparing of memory

   b. Executive and memory deficits with relative sparing of visuospatial functions

   c. Executive deficits with relative sparing of memory and visuospatial functions

   d. Deficits in memory and attention with relative sparing of executive functions

2. **The official neuropsychological criteria for bvFTD are not useful in distinguishing between bvFTD and psychiatric disorders. To make this distinction, which tests would be useful to include in the neuropsychological examination?**

   a. Emotion recognition and processing speed

   b. Naming and emotion recognition

   c. Sustained attention and processing speed

   d. Naming and sustained attention

3. **Pablo, who is 65 years old, has developed uncharacteristic behavior over the last few years: he takes less initiative, shows less empathy and interest in others, and has reduced self-care. He stopped doing daily activities like reading the newspaper and doing chores around the house. However, Pablo says he feels good and has no problem with the changes. There is no family history of dementia or psychiatric disorders. Which of the following diagnostic tests is the least useful in your assessment of Pablo?**

   a. Neuropsychological examination

   b. Structural brain imaging

   c. Functional brain imaging

   d. Genetic screening