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Original Research Article

The Dépistage Cognitif de Québec: A New Clinician's Tool for Early Recognition of Atypical Dementia

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Keywords
Atypical dementia · Alzheimer's disease · Alzheimer's variants · Posterior cortical atrophy · Frontotemporal dementia · Frontotemporal lobar degeneration spectrum · Primary progressive aphasia · Logopenic primary progressive aphasia · Neurocognitive disorders · Cognitive assessment · Screening tools · Neurocognitive testing

Abstract
Introduction: Early recognition of atypical dementia remains challenging partly because of lack of cognitive screening instruments precisely tailored for this purpose. ***Methods:*** We assessed the validity and reliability of the Dépistage Cognitif de Québec (DCQ; www.dcqtest.org), a newly developed cognitive screening test, to detect atypical dementia using a multicenter cohort of 628 participants. Sensitivity and specificity were compared to the Montreal Cognitive Assessment (MoCA). A predictive diagnostic algorithm for atypical dementia was determined using classification tree analysis. ***Results:*** The DCQ showed excellent psychometric properties. It was significantly more accurate than the MoCA to detect atypical dementia. All correlations between DCQ indexes and standard neuropsychological measures were significant. A statistical model distinguished typical from atypical dementia with a predictive power of 79%. ***Discussion:*** The DCQ is a better tool to detect atypical dementia than standard cognitive screening tests. Expanding the clinician's tool kit with the DCQ could reduce missed/delayed identification of atypical dementia and accelerate therapeutic intervention.

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Background

Over the past decade, successful efforts have been made to train first-line physicians to better recognize typical dementia such as the amnestic variant of Alzheimer's disease (aAD) [1–3]. New diagnostic criteria for atypical dementias such as primary progressive aphasia (PPA) subtypes [4], AD variants (behavioral/dysexecutive AD [b/dAD], the logopenic variant of PPA [lvPPA], posterior cortical atrophy [PCA]) [5, 6], and the behavioral variant of frontotemporal dementia (bvFTD) [7] have emerged, allowing better recognition of these complex conditions. This wave of renewed interest is associated with recent data suggesting that atypical dementia is not uncommon [8], and that AD variants compose about 11% of AD cases [9].

Early diagnosis and therapeutic intervention for these conditions begins with an accurate clinical assessment. In day-to-day practice, however, early identification of atypical syndromes remains challenging. Factors contributing to the delay between care seeking and accurate diagnosis include the lack of screening instruments specifically tailored towards early identification of atypical dementias [10, 11]. None of the commonly used cognitive screening tools (Mini-Mental State Examination [MMSE] [12] or Montreal Cognitive Assessment [MoCA] [13]) were designed for this purpose, none include behavioral measures, and none have been updated for recent diagnostic criteria.

To address this issue, we have recently developed a new cognitive screening tool, the Dépistage Cognitif de Québec (DCQ; www.dcqtest.org), based on revised criteria for AD variants and the FTD spectrum [4, 5, 7]. The DCQ was validated with 410 cognitively healthy individuals and has demonstrated excellent psychometric properties [14]. The aim of this study was thus to validate the DCQ in patients with a wide range of typical and atypical dementias, assess its accuracy compared to cognitive screening tools used in current practice, and determine its ability to predict atypical dementia.

Methods

Participants

Dementia Group

Patients were recruited from three centers in Quebec City, QC, Canada: (1) a tertiary-care memory clinic, the Clinique Interdisciplinaire de Mémoire (CIME) [15], CHU de Québec, Université Laval, (2) Hôtel-Dieu de Québec, and (3) CIUSSS de la Capitale Nationale. Patients were assessed according to the "Recommendations of the 4th Canadian consensus conference on the diagnosis and treatment of dementia" [16] and the consensus criteria for AD [5], PPA [4], bvFTD [7], Lewy body dementia [17], progressive supranuclear palsy [18], and corticobasal syndrome [19], either by behavioral neurologists, a neuropsychiatrist, or geriatricians. All patients underwent a detailed tertiary-care diagnostic workup including clinical assessment, cognitive screening (MMSE and MoCA), magnetic resonance imaging using a "dementia protocol" (which includes an axial and coronal T2-weighted/FLAIR, axial susceptibility-weighted imaging and diffusion, 3-dimensional T1-weighted sequences, measurement of hippocampal atrophy using the Scheltens scale [20], and grading of white matter changes using the Fazekas scale [21]), and blood tests (complete blood count, ions, TSH, B_{12}, Ca/Mg/Ph, RPR/VDRL for screening of syphilis). When the initial assessment remained inconclusive, supplementary investigations were performed, such as detailed neuropsychological testing, ^{18}F-fluorodeoxyglucose positron emission tomography (FDG-PET), CSF biomarkers (including the quantification of total tau, tau phosphorylated at threonine 181, and amyloid β 1–42 peptide), amyloid PET imaging, and genetic analysis in some selected cases. Disease severity was assessed using the Clinical Dementia Rating scale [22].

Prospective recruitment of patients took place over a year between December 2016 and December 2017. We included patients with a diagnosis of mild cognitive impairment or neurodegenerative dementia, at a mild to moderate stage of the disease (Clinical Dementia Rating scale ≤2). Consensus criteria were used to classify dementia subgroups [4, 5, 7, 17–19, 23]. Exclusion criteria consisted of dementia with significant vascular brain lesions (stroke, Fazekas score >2), concomitant and unstable psychiatric disorder, history of traumatic brain injury, brain surgery, active alcoholism, or drug use.

Control Group

A community-based sample of cognitively healthy controls was recruited between April 2014 and May 2016 in Québec City, via public advertisements and among patients' relatives. The local Ethics Committee approved the study protocol, and all participants provided written informed consent.

Materials and Procedure

The DCQ was designed by a group of behavioral neurologists (R.L., R.W.B.), clinical neuropsychologists (R.L., C.H.), and a speech-language pathologist (J.M.) to target five relevant cognitive domains referred to as DCQ indexes: Memory index (30 points), Visuospatial index (7 points), Executive index (10 points), Language index (33 points), and Behavioral index (20 points, a low score on this index indicates more behavioral issues), with a maximum combined DCQ score of 100 [14]. The DCQ's questionnaire, administration guidelines, and normative data are available free of charge at www.dcqtest.org. The DCQ was administered by trained psychometricians, blind to clinical diagnosis. Patient administration took 40 min versus 25 min in healthy controls. The behavioral index was completed face to face or by telephone with the main caregiver. A MoCA [13] was also administered within 3 months of the DCQ. Accuracy of the DCQ was tested using clinical diagnosis as the standard, which was concurred by pathophysiological biomarkers when available.

Statistical Analyses

Descriptive analyses included medians (interquartile range, 25th–75th percentile) and percentages. Reliability was tested for internal consistency using standardized Cronbach's alpha coefficient for all DCQ items; a value ≥0.70 was considered appropriate. A principal component analysis was performed to assess internal validity, using the patient's data to examine the internal structure of the 21 subindexes of the DCQ. The number of components retained was defined by those with eigenvalues >1; a Varimax rotation was used. Correlations were calculated with Spearman's rank coefficient (rS) to determine the DCQ concurrent validity. To assess discriminative validity, the DCQ scores were compared using the Mann-Whitney U test for two-group comparison or the Kruskall-Wallis test for multiple group comparison, followed by Bonferroni post hoc tests. The discriminant performance of the DCQ and its indexes was assessed by a receiver-operating characteristic (ROC) curve analysis. Results are expressed as areas under the ROC curves (AUC; with 95% CI). The Youden index was calculated to determine the optimal cut-point value, and sensitivity, specificity, negative and positive predictive values were calculated for each cut point. The ROC curves were compared using contrasts as suggested by DeLong et al. [24]. To take into account age and education, we sought to validate the results using *z*-transformed raw scores. Finally, a classification tree analysis was used to determine which indexes and which cut point resulted in the best patients' classification into typical (aAD including prodromal AD) versus atypical/unclear dementia (including PCA, b/dAD, PPA variants, Parkinson-plus syndromes, and mild cognitive impairment). A further classification according to the common underlying pathology was conducted into amyloid-related dementia, namely AD variants (aAD, PCA, lvPPA, and b/dAD), and non-amyloid-related dementia (bvFTD, semantic variant of PPA, nonfluent variant of PPA, Lewy body dementia, progressive supranuclear palsy and corticobasal syndrome). Pruning allowed to prevent overfitting of the model. Statistical analyses were performed using SAS version 9.4 and R version 3.2.4 software; a p value of 0.05 was required for statistical significance.

Results

Participant Characteristics

A total of 195 patients, aged 46–88 years, were included in the study. These data were compared to 433 healthy controls, aged 50–94 years. Demographics and clinical characteristics of our participants are shown in Table 1. All patients underwent a standard dementia tertiary-care workup. FDG-PET was performed in 67 cases. Pathophysiological biomarkers were assessed in 20% of patients (CSF biomarkers in 29 cases and amyloid PET imaging in 10 cases) and were consistent with AD pathology in 11% of all patients. Two patients had causative mutations for AD and bvFTD (*APP* duplication and *TARDP* mutation, respectively). The 195 patients fit either one of the following diagnostic groups: aAD (n = 72; including 9 prodromal AD), PCA (n = 9), b/dAD (n = 7), lvPPA (n = 29), semantic variant of PPA (n = 11),

Table 1. Demographics and clinical characteristics of the dementia group and healthy controls

Characteristics	Healthy controls (*n* = 433)	Dementia group (*n* = 195)	*p*
Age, years	66 (60–75)	71 (65–76)	<0.0001
Education, years	15 (12–18)	12 (10–15)	<0.0001
Gender, female	273 (55%)	90 (46%)	0.05
z-scores			
DCQ total	0.16 (–0.52; 0.67)	–2.45 (–4.00; –1.37)	<0.0001
Memory index	0.20 (–0.42; 0.77)	–2.79 (–5.11; –0.43)	<0.0001
Visuospatial index	0.49 (–0.66; 0.70)	–0.82 (–2.03; 0.43)	<0.0001
Executive index	0.01 (–0.67; 0.80)	–1.63 (–2.55; –0.62)	<0.0001
Language index	0.26 (–0.46; 0.71)	–1.55 (–3.32; –0.48)	<0.0001
Behavior index	0.59 (–0.40; 0.68)	–0.90 (–1.71; 0.24)	<0.0001
CDR	n.a.	1 (0.5–1)	
MoCA	27 (24–28)	20 (16–23)[1]	<0.0001

Data are numbers (percentage) or medians (interquartile range, 25th–75th percentile). n.a., not applicable; DCQ, Dépistage Cognitif de Québec; MoCA, Montreal Cognitive Assessment; CDR, Clinical Dementia Rating scale. [1] The MoCA was available for180 patients.

nonfluent variant of PPA (*n* = 5), bvFTD (*n* = 10), Parkinson-plus syndromes (*n* = 27; including 13 Lewy body dementia, 5 progressive supranuclear palsy, 9 corticobasal syndrome), vascular cognitive impairment (*n* = 4), and mild cognitive impairment (*n* = 21).

Validity and Reliability

The DCQ was found to have excellent internal reliability (Cronbach's α = 0.87). Significant correlations were observed in the dementia group between the DCQ and MoCA (rS = 0.67, $p < 0.0001$), MMSE (rS = 0.68, $p < 0.0001$), and Clinical Dementia Rating scale (rS = –0.54, $p < 0.0001$), indicating excellent concurrent validity. Correlations between DCQ indexes and standard neuropsychological measures in a subsample of patients (*n* = 15) were significant (Table 2). There were no significant differences in terms of demographics between the dementia group and this subsample of 15 patients (age = 74 years, range = 62–79; education = 14 years, range = 9–18; $p = 0.27$ and $p = 0.46$, respectively). Factor analysis showed that 5 components explained 59% of the total variance. The rotated loadings matrix showed that most items of the Language index are together in the 1st component; the 2nd component contains 3/4 items from the Memory index. The 3rd component contains items from the Visuospatial and the Executive indexes. The 4th component contains items from the rest of the Memory and Executive indexes. The last component is the Behavioral index.

Sensitivity, Specificity, and Diagnostic Accuracy

The ROC curve analysis indicated that the DCQ significantly distinguished patients with dementia from controls. The AUC was estimated to be 0.95 (95% CI = 0.93–0.96, $p < 0.001$). A cutoff of 81/100 yielded the best sensitivity/specificity trade-off: sensitivity = 90% and specificity = 87%. Diagnostic accuracy was 87%. Negative predictive value and positive predictive value were 95 and 73%, respectively. Analyses using *z*-converted scores have shown similar diagnostic accuracy. As demonstrated by the comparison of ROC curves in

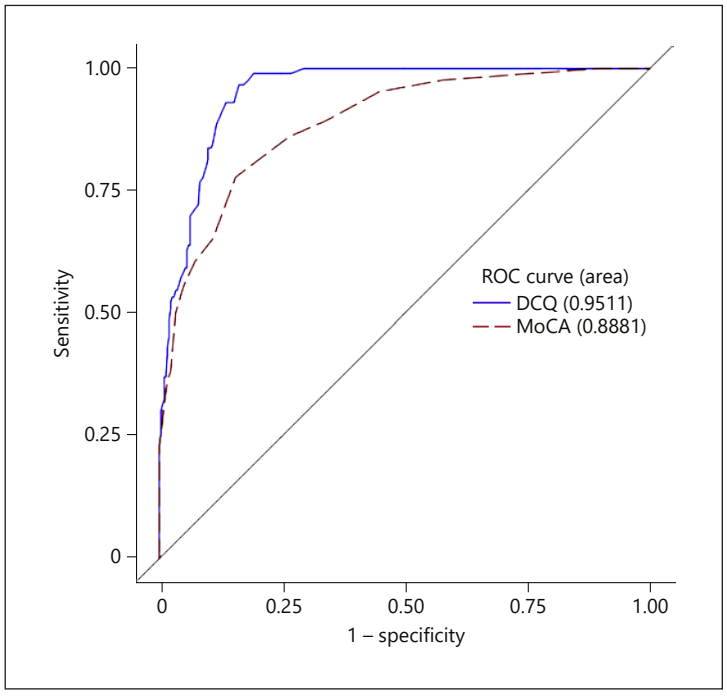

Fig. 1. Comparison of ROC curves between the DCQ and MoCA in atypical dementia. ROC, receiver-operating characteristic; DCQ, Dépistage Cognitif de Québec; MoCA, Montreal Cognitive Assessment.

Figure 1, the DCQ (AUC = 0.95, 95% CI = 0.94–0.97) was significantly more accurate than the MoCA (AUC = 0.88, 95% CI = 0.85–0.93) for detecting atypical dementia (PCA, PPA, b/dAD, bvFTD, and Parkinson-plus syndromes pooled together) from healthy controls ($p = 0.0002$). Furthermore, ROC curve analyses showed that individual DCQ indexes have excellent accuracy to identify specific dementia subtypes from healthy controls.

DCQ Profiles across Dementia Subtypes

The DCQ demonstrated excellent discriminative validity. Indeed, comparisons of the DCQ indexes showed significant differences across dementia subtypes (Table 3). Given the age difference between groups, *z*-score conversion was performed and revealed similar results. As expected, the aAD group was the most impaired on the Memory index. The visuospatial domain was significantly lower in the PCA subgroup compared to other subgroups. The lower scores on the Language index were found in the PPA and PCA subgroups. The behavioral domain was significantly impaired in both bvFTD and b/dAD compared to other subgroups, but there was no significant difference between these two subgroups when compared to each other, neither for the behavioral nor executive indexes. The pattern of cognitive impairment on the DCQ indexes across AD variants is illustrated in Figure 2. We found significant differences between the four AD variants within the Visuospatial index ($p < 0.0001$), Executive index ($p = 0.004$), Language index ($p < 0.0001$), and Behavioral index ($p < 0.0001$). There was no significant difference in the Memory index between groups ($p = 0.36$), although aAD performed the lowest. AD patients with nonamnestic presentations were significantly younger than those with typical AD. Taking into account this finding, *z*-score conversion was performed, and a comparison between groups showed similar results. We also performed a subanalysis in pathophysiological biomarker-characterized AD patients ($n = 21$). The Visuospatial index (4.5 [2.6–5.5] vs. 6 [5–7], $p = 0.008$), Language index (24.5 [22.7–25.1] vs. 29.5 [25.5–30.5], $p = 0.001$), and Executive index (3 [2.5–5.1] vs. 5.5 [3.5–8], $p = 0.025$) were found to be significantly lower in the nonamnestic AD versus aAD

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Table 2. Correlation on *z*-scores between the DCQ indexes and standard neuropsychological measures in a subsample of patients (*n* = 15)

DCQ indexes	Standard neuropsychological measures	Spearman's correlation coefficient	*p*
Memory index	Digit span forward (WAIS-IV) + RL/RI 16, CVLT-II, or HVLT-R	0.56	0.03
Visuospatial index	ROCF or Block design test subtest (WAIS-IV)	0.54	0.04
Executive index	Phonemic fluency + Digit span backward (WAIS-IV) + Stroop test color-word interference (D-KEFS)	0.82	<0.001
Language index	Semantic fluency + DO-80, TDQ-60, or Boston Naming Test	0.72	0.004

WAIS-IV, Wechsler Adult Intelligence Scale – fourth edition [37]; RL/RI 16, Rappel libre/Rappel indicé à 16 items [38]; CVLT, California Verbal Learning Test [39]; HVLT-R, Hopkins Verbal Learning Test, revised [40]; ROCF, Rey Complex Figure Test [41]; D-KEFS, Delis-Kaplan Executive Function System [42]; DO-80, Test de dénomination orale d'images [43]; TDQ-60, Test de dénomination de Québec – 60 images [44]; Boston Naming Test [45].

Table 3. Performance on the DCQ according to dementia subtype

	aAD (*n* = 72)	PCA (*n* = 9)	PPA (*n* = 45)	b/dAD (*n* = 7)	bvFTD (*n* = 10)	PARK+ (*n* = 27)	MCI (*n* = 21)	*p*
Age, years	74 (68.5–79)	60 (56–65)	68 (62–74)	66 (58–73)	64.5 (57–72)	72 (67–74)	73 (67–75)	<0.0001
Education, years	12 (10–15)	12 (10–12)	12 (10–15)	12 (10–15)	13 (11–15)	12 (8–17)	13 (10–17)	0.8
DCQ total, *n*/100	65.7 (59.5–74)	69 (58.5–71)	64.5 (54–75.5)	63.5 (49.5–69)	75 (56.5–76.5)	73 (65.5–80.5)	85.2 (81–90.2)	<0.0001
Memory, *n*/30	15 (12–20)*	20 (18–26)	18 (11–25)	19 (13–25)	26.5 (23–29)	25 (22–28)	26 (24–29)	<0.0001
Visuospatial, *n*/7	5 (3.7–6.5)	1 (0–2)†	4.5 (3–6)	5 (3–6)	6.7 (4–7)	4.5 (4–6)	6 (5.5–7)	<0.0001
Executive, *n*/10	4.5 (3–6.7)	3 (2–4.5)	3.5 (2–5)	3 (1–6)	5 (3–7)	3.5 (2.5–4.5)	6 (5.5–7)	<0.0001
Language, *n*/33	26.5 (23.5–29.5)	24 (16.5–24.5)	22 (16–25)‡	25.5 (21–29.5)	27.7 (26–29.5)	25 (22–27.5)	28.5 (26.5–31)	<0.0001
Behavior, *n*/20	14 (14–18)	18 (16–10)	18 (12–20)	10 (8–10)§	8 (6–10)¶	14 (12–18)	18 (18–20)	<0.0001

Data are medians (interquartile range, 25th–75th percentile). Relevant and significant Bonferroni post hoc analyses are indicated by a symbol. * Significant difference relative to bvFTD and PARK+. † Significant difference relative to aAD, PPA, bvFTD, and PARK+. ‡ Significant difference relative to aAD, bvFTD, and PARK+. § Significant difference relative to aAD, PCA, PPA, and PARK+. ¶ Significant difference relative to aAD, PCA, PARK+, and PPA. DCQ, Dépistage Cognitif de Québec; aAD, amnestic Alzheimer's disease; PCA, posterior cortical atrophy; PPA, primary progressive aphasia; bvFTD, behavioral variant of frontotemporal dementia; b/dAD, behavioral/dysexecutive Alzheimer's disease; PARK+, Parkinson-plus syndromes; MCI, mild cognitive impairment.

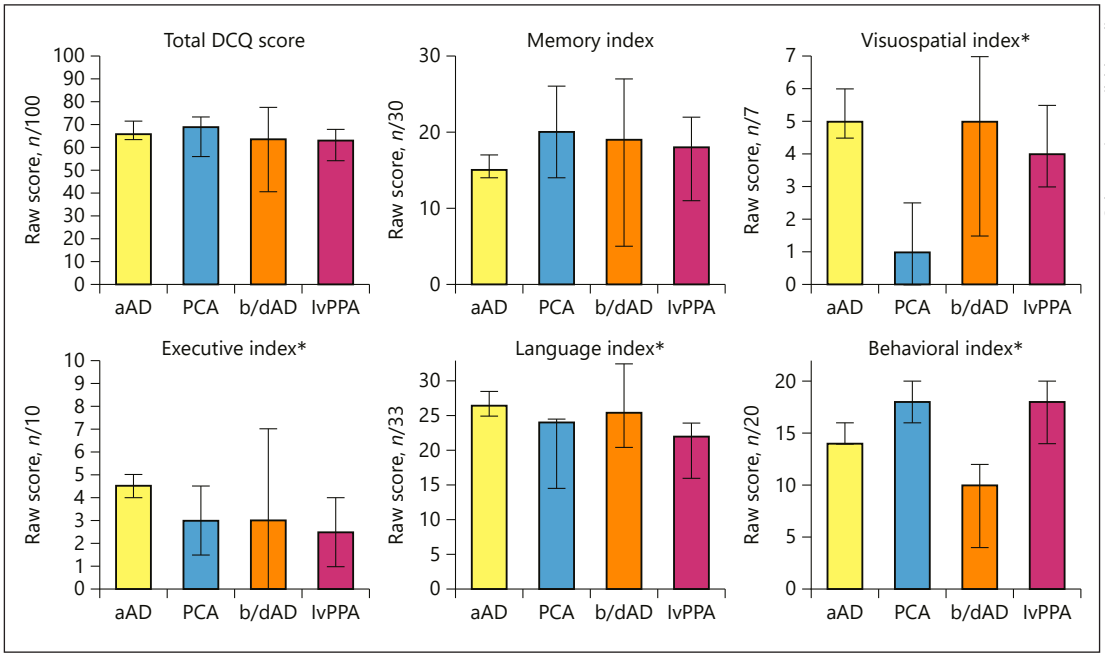

Fig. 2. Performance of the four AD variants on the five DCQ indexes. Asterisks indicate intergroup *p* values <0.05. aAD, amnestic Alzheimer's disease, *n* = 72; PCA, posterior cortical atrophy, *n* = 9; lvPPA, logopenic variant of primary progressive aphasia, *n* = 29; b/dAD, behavioral/dysexecutive Alzheimer's disease, *n* = 7.

groups, respectively. The Memory index was lower but nonsignificantly so in aAD versus nonamnestic AD.

There were no significant differences neither in age ($p = 0.64$) nor education ($p = 0.21$) between the three PPA groups. We observed significant differences between the three PPA variants for oral scene description ($p = 0.02$), word-picture matching ($p = 0.03$), and repetition ($p = 0.04$). The confrontation naming score was lowest in the semantic variant of PPA without reaching statistical significance ($p = 0.12$).

Predictive Diagnostic Algorithm

A predictive model was obtained using a classification tree analysis. For the distinction between typical and atypical/unclear dementia, three indexes (Memory, Language, Executive) and four splits were retained, with a predictive power of 79% (Fig. 3). For amyloid- versus non-amyloid-related dementia, four indexes (Memory, Behavioral, Executive, Language) and four splits were retained, with a predictive power of 79%.

Discussion

In the current study, we validated a newly developed cognitive tool, the DCQ, within a wide range of dementing syndromes. The DCQ showed excellent psychometric properties in clinical populations, as previously established in cognitively healthy individuals [14], indicating that it is a valid and reliable tool for cognitive screening in clinical settings. Its diagnostic accuracy in detecting dementia was high (sensitivity = 90%, specificity = 87%). Furthermore, when considering DCQ and MoCA performances in the same patients, the DCQ demonstrated higher accuracy than the MoCA for identifying atypical dementia. The DCQ

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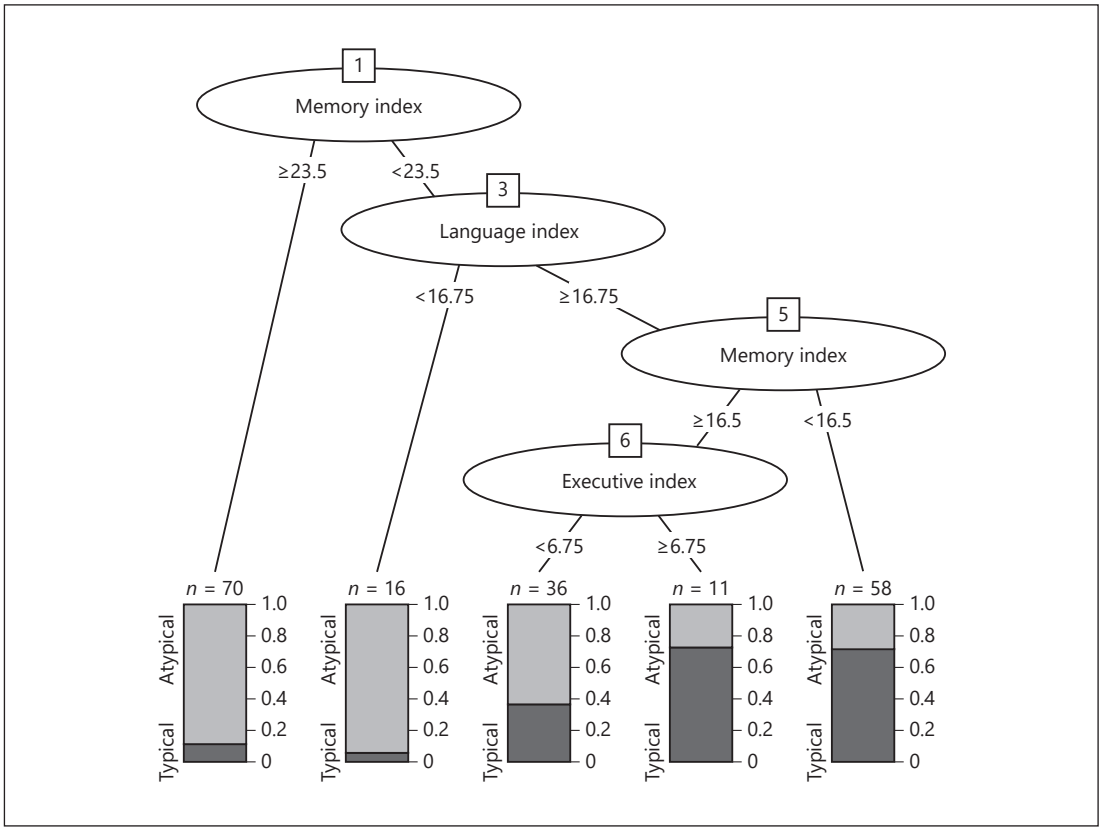

Fig. 3. Predictive diagnostic algorithm for atypical dementia. This classification tree is an algorithm that determines which indexes and cut points result in the best patient classification. The process starts with a binary split for a particular index and continues to optimize the combination of indexes to achieve the higher predictive power for the distinction between typical and atypical dementia.

enabled to draw out distinct cognitive patterns across dementia subtypes (for example, between AD variants, PPA variants, or the frontal variant of AD and bvFTD).

Despite their shortcomings reported in the cognitive screening literature [25], brief cognitive screening tests such as the MMSE and MoCA have considerable utility in discriminating individuals with dementia from healthy elderly subjects and tracking cognitive decline over follow-up [26]. However, both MMSE and MoCA failed to keep pace with evolving concepts regarding atypical presentations of dementia and, more specifically, with the flourishing of diagnostic criteria since 2011 [4, 5, 7]. Indeed, these tests have proven insufficient to discriminate dementia profiles since performance on their individual subtests yields limited information about specific cognitive domains [27, 28]. Addenbrooke's Cognitive Examination is notable for having been developed originally as an expanded version of the MMSE, with the purpose to improve the differential diagnosis of dementia [29]. Several limitations have been identified however, as it has a low sensitivity for detecting specific disorders such as bvFTD, because of insufficient measures of behavior and executive functions [30].

Other tests have been developed to assess specific domains such as the Sydney Language Battery [31] and the Detection Test for Language Impairments in Adults and the Aged [32], which were designed to assess language disorders in adults and elderly individuals. However, these tests were specifically developed for language variants of dementia and are therefore not appropriate to reveal all cognitive aspects of atypical dementias.

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The DCQ stands out by the fact that it has been precisely developed using updated diagnostic criteria for AD variants and the FTD spectrum in mind, with the goal of filling the gap between brief existing screening tools and extensive neuropsychological testing, and of widening the scope of cognitive assessment to atypical presentations of dementia. A key strength of the DCQ is that it has proven efficient to refine the differential diagnosis and delineate the dementia subtypes. Our results, indeed, suggest that performance across the five indexes draw out distinct cognitive-behavioral patterns, in accordance with our current understanding of the clinical phenotype related to each dementia subtype. For example, the DCQ revealed the expected significant differences among the various indexes in AD variants with the language variant scoring lower on the Language index, the visual variant scoring lower on the Visuospatial index, the classic amnestic AD variant scoring lower on the Memory index and the behavioral/dysexecutive variant performing worse on the Behavioral index. The differences in cognitive profiles on the DCQ between aAD and nonamnestic AD were also confirmed in the subgroup of pathophysiological biomarker-characterized AD patients.

Some peculiarities are worth noting, such as low scores on the Language index in the PCA group, approaching PPA performance. This finding may reflect the impact of visual stimuli of the Language index, as well as alexia and agraphia, which have been incorporated into core features of the PCA syndrome [33]. Overlap in the linguistic profiles of PCA and lvPPA have previously been reported by Crutch et al. [34]. With regard to the differential diagnosis between b/dAD and bvFTD, we did not find any significant difference neither on executive-behavioral domains nor on the Memory index, although previous findings have suggested that b/dAD was characterized by a milder and more restricted behavioral profile than bvFTD [35]. With respect to PPA, some hallmark language features were elicited across PPA subtypes. For instance, word-finding difficulties in spontaneous speech and prominent repetition deficits in lvPPA were found, impairments in confrontation naming and word-picture matching in the semantic variant of PPA were noted, in line with consensus criteria for PPA variants. It may also be noted that deficits in the PPA syndromes extended beyond the language domain to involve other cognitive functions (e.g. executive skills), reflecting the distributed neural network basis of the underlying pathological process [36].

Another strength of this study is its statistical model which, based on the DCQ indexes, allows to account for the interaction between different cognitive domains, optimize their combination, and provide an algorithm for decision-making with a high predictive power for identifying atypical dementia and distinguishing amyloid-related syndromes from others. This model offers a practical approach to help clinical reasoning, in conjunction with history-taking and standard dementia workup. We understand that a challenge remains to achieve the optimal compromise between accuracy of cognitive testing and short administration time, particularly in primary-care settings [10]. An alternative approach to address the time pressure issue is to use the DCQ *à la carte*, by targeting cognitive domains according to the clinician's judgment or particular focus of examination (for example, a clinician who is not satisfied with the language assessment provided by the MoCA may decide to expand strictly on language using the DCQ Language index). Our findings suggest that this strategy is reliable since the DCQ indexes, taken individually, showed excellent diagnostic accuracy for specific dementia subtypes and have correlated significantly with gold standard neuropsychological measures.

Altogether, the added value of the DCQ is to capture an overview of key cognitive domains in a brief consultation, beyond the single cutoff score of global cognitive screening tests. Thus, the DCQ may find a useful place as a complement to existing screening tools but is not intended to substitute a full neuropsychological evaluation. We propose that the DCQ be used for earlier detection of atypical dementia, by providing a more detailed description of patients'

cognitive pattern and formulating a more accurate differential diagnosis of dementing syndromes.

Among the limitations of this study, we recognize its small sample size in some diagnostic subgroups reflecting the rarity of these conditions and the lack of pathophysiological biomarker characterization in some cases. Replication in larger, biomarker-characterized cohorts within different clinical and cultural settings is needed. Moreover, the validity of the DCQ among atypical dementia presentations with mixed etiology and vascular dementia is yet to be determined.

In conclusion, the DCQ is a new 40-min cognitive screening test available for free (www.dcqtest.org) and based on the most recent criteria for AD variants and the FTD spectrum, which proved to be a valid and reliable cognitive screening tool for detecting atypical dementing disorders. Based on patterns of deficits across four key cognitive domains and a behavioral index, it showed superiority over the MoCA in detecting atypical dementias. The expansion of the clinician's cognitive screening tool kit could reduce missed/delayed diagnosis and improve early therapeutic intervention for atypical presentations of dementia.

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Disclosure Statement

The authors declare that there is no conflict of interest.

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