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Validation of the *Dépistage Cognitif de Québec*: A New Cognitive Screening Tool for Atypical Dementias

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Abstract

Objective: This study aimed to validate and provide normative data for the *Dépistage Cognitif de Québec* (DCQ; www.dcqtest.org), a new cognitive screening tool for atypical dementias.
Method: The DCQ was developed by expert behavioral neurologists and clinical neuropsychologists based on updated criteria for Alzheimer's disease, primary progressive aphasia, and behavioral variant frontotemporal dementia. It targets five relevant domains: Memory, Visuospatial, Executive, Language, and Behavior. Validation was performed in a population-based sample of 410 healthy French-speaking Canadians aged between 50 and 89 years old. Normative data were derived from a subsample of 285 participants.
Results: Mean DCQ total score (out of 100) was 89.17 ($SD = 7.36$). Pearson's correlation coefficient showed a strong and significant correlation ($r = .71$, $p < .001$) with the Montreal Cognitive Assessment. Internal consistency for the cognitive domains assessed by Cronbach's alpha was satisfactory (.74). Test–retest reliability was adequate (Pearson's coefficient = . 70, $p < .001$) and interrater reliability, excellent (intraclass correlation = .99, $p < .001$). Normative data shown in percentiles were stratified by age and education.
Conclusions: This study suggests that the DCQ is a valid and reliable cognitive screening test. Application of the DCQ on populations with atypical dementias is underway to derive sensitivity and specificity values for various dementias.

Keywords: Dementia; Alzheimer's disease; Frontotemporal dementia; Norms/normative studies; Test construction

Introduction

Dramatic increase in dementia prevalence (Sosa-Ortiz, Acosta-Castillo, & Prince, 2012) has made cognitive screening highly valuable for early detection of cognitive impairment (Yokomizo, Simon, & Bottino, 2014). Screening tests such as the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975), the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005), and the Addenbrooke's Cognitive Examination-Revised (Mioshi, Dawson, Mitchell, Arnold, & Hodges, 2006) have served as the main instruments used in practice. Other tests have been developed to assess specific domains such as the Sydney

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Language Battery (Savage et al., 2013) for the assessment of language skills, and the DAPHNE (Disinhibition, Apathy, Perseverations, Hyperorality, personal Neglect and loss of Empathy) which focuses on the assessment of behavioral symptoms in the behavioral variant frontotemporal dementia (bvFTD) (Boutoleau-Bretonnière et al., 2015).

Unfortunately, a number of shortcomings have been reported with screening instruments (Appels & Scherder, 2010; Coen, Robertson, Kenny, & King-Kallimanis, 2016; Votruba, Persad, & Giordani, 2016). Moreover, dementia classifications have flourished and several updated diagnostic criteria were published in 2011. For example, Alzheimer's disease (AD) has been reconceptualized as a spectrum with distinct clinical phenotypes (i.e. amnestic, visual, language, and frontal/dysexecutive variants) (McKhann et al., 2011). The Primary Progressive Aphasias (PPA) have been classified into three main subtypes (i.e. nonfluent/agrammatic, semantic, and logopenic) (Gorno-Tempini et al., 2011) and improved criteria for the diagnosis of bvFTD have been published (Rascovsky et al., 2011). None of the major cognitive screening tests currently available have kept pace with these clinical and nosological changes. In addition, none have integrated behavioral aspects of dementia in their screening format, making them less relevant for the detection of atypical presentations of AD, PPA or the frontotemporal lobar degeneration (FTLD) spectrum.

The goal of the current study was therefore to validate the *Dépistage Cognitif de Québec* (DCQ), a newly developed cognitive screening test (Bergeron et al., 2015) based on the updated diagnostic criteria for AD, PPA, and the FTLD spectrum. We further aimed to provide normative data in a sample of French-speaking Canadians. It is our hope that the DCQ will allow better detection of typical and atypical presentations of dementia and address the current limitations of the MMSE, MoCA and other available screening tools.

Methods

Subjects

Study participants were healthy French-speaking Canadians aged between 50 and 89 years, recruited between April 2014 and May 2016 in Québec, via public advertisements and relatives of patients. The local Ethics Committee approved the study protocol and all participants provided written informed consent. Subjects were excluded if they reported a history of traumatic brain injury, delirium, brain surgery, neurological disease (e.g., multiple sclerosis, stroke), encephalitis or meningitis, untreated metabolic condition, psychiatric illness, brain oncological therapy, alcohol and drug abuse, disabling visual and hearing disorders, experimental therapy, inability, and illiteracy. A total of 410 community-dwelling individuals took part in this validation study. They had no cognitive complaints and had preserved activities of daily living according to self-reported information and interview with a support person. The total number of participants underwent the DCQ and was used as a validation sample. A subset of 285 individuals was selected to provide normative data. Stricter criteria have been applied to this subgroup: normative data were derived from participants who scored ≥26 on the MoCA, based on a recommended cutoff score of 26 as formulated by the original authors of the MoCA (Nasreddine et al., 2005). This cutoff score is a generally accepted cutoff in the literature (Larner, 2012; Smith, Gildeh, & Holmes, 2007). However, in the particular case of the oldest-old, aged 80 years and older (80+), we believe that the suggested MoCA cutoff score 26 may be too stringent and would have excluded 50% of the sample in this age group, as reported in previous studies (Malek-Ahmadi et al., 2015). Thus, in order to enhance the inclusion of the oldest-old in the normative study, we have set a MoCA cutoff of 24 for this age group, which is in line with a large normative study for the MoCA in elderly Quebec-French population (Larouche et al., 2016).

Materials and Procedure

The DCQ (available at www.dcqtest.org) was developed at *La Clinique Interdisciplinaire de Mémoire* (CIME) of the *Centre Hospitalier Universitaire de Québec*, the oldest tertiary Memory Clinic in Canada, by a group of experienced behavioral neurologists, neuropsychiatrist, geriatricians, geriatric psychiatrist, clinical neuropsychologists and a speech language pathologist (RL, LV, RWB, SP, MH, MPF, MR, JM, CH). It targets five relevant domains: Memory, Visuospatial, Executive, Language, and Behavior (see Fig. 1). The Memory Index (out of 30) assesses basic attention using the forward digit span, a short-term recall task of eight words with delayed recall after 15 min, and a recognition task. The Visuospatial Index (out of 7) tests visual recognition of overlapping figures, spatial rotation (the subject is asked to recognize an image from a scene, representing his viewing angle, which is changed throughout the task) (see Fig. 1). This index also includes a geometric figure-drawing test. The Executive Index (out of 10) includes backward digit span, months backward, an alternating graphic sequence test, a two-item verbal abstraction task, phonemic fluency (letter A, 60 s) and a modified Stroop test. The Language

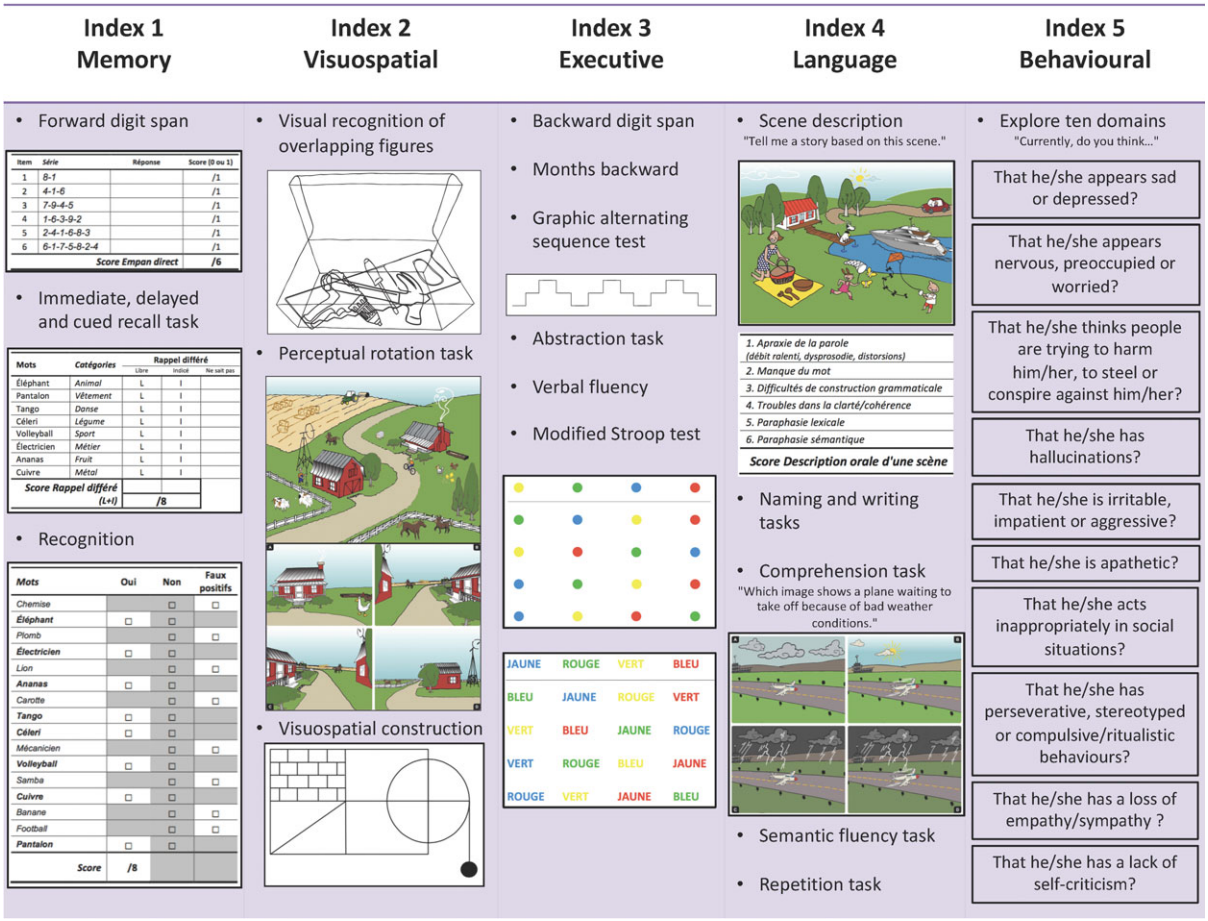

Fig. 1. Illustrative summary of the subtests composing the five DCQ indexes.

Index (out of 33) comprises a scene description task to assess spontaneous speech, a naming and single-word writing tasks, a multi-sentence writing test, assessment of comprehension through a sentence–picture matching test, a semantic verbal fluency task, and a task requiring the participant to repeat short as well as long and complex sentences. Finally, the Behavioral Index (out of 20) explores 10 domains (depression, anxiety, delusions, hallucinations, irritability and aggression, apathy, disinhibition and impaired judgment, perseverations and compulsions, loss of empathy/sympathy and self-criticism) as reported by a significant other.

All participants completed both the DCQ (25–30 min) and the MoCA in a random order, on the same day. These tests were administered by trained psychometricians. The Behavioral Index was completed face to face or by telephone with a significant other. A random sample of 45 participants was retested within 1–3 months of initial administration to examine test–retest reliability. Fifty questionnaires picked at random among the 410 participants were scored again by two blinded and independent raters to assess interrater reliability.

Statistical Analysis

Basic descriptive analyses included means and standard deviations. Student T test was used to compare means. Reliability was tested for internal consistency using Cronbach's alpha coefficient where a value > .70 was considered appropriate. Test–retest reliability was assessed using Pearson's correlation coefficient. An interrater reliability analysis using the intraclass correlation coefficient (ICC) was performed to determine consistency among raters. Validity was established through correlations between DCQ total score (out of 100) and MoCA total score (out of 30) using Pearson's correlation coefficient. Statistical analysis was performed using SPSS software (version 24.0) with the alpha level set at .05.

Results

Demographics

Demographics for the validation sample ($N = 410$) are presented in Table 1. Scores on the Behavioral Index were missing for 25 subjects, because of the non-availability of a significant other. The mean DCQ total score was 89.17 ($SD = 7.36$). The mean MoCA total score was 26.26 ($SD = 3.06$).

Participants with MoCA score <26 in the age category <80 years, and those with MoCA score <24 in the 80+ group were excluded from the normative sample, resulting in a sample size of $n = 285$. Descriptive statistics for the normative sample are shown in Table 2. The mean DCQ total score for the normative sample was 91.63 ($SD = 5.21$). There were more men than women in the normative sample (58.6% vs. 41.4%). However, there was no difference in the DCQ total score between men and women among the normative sample ($M = 91.83$, $SD = 4.99$ vs. $M = 91.32$, $SD = 5.54$ respectively, $p = .43$).

Correlations between age, years of education and DCQ score were statistically significant ($r = -.49$, $p < .001$ and $r = .44$, $p < .001$ respectively).

Normative Data

DCQ scores from the normative sample were stratified by age and education (education level was divided dichotomously into ≤12 and >12). Normative data is presented in percentiles (see Table 3). It includes percentile ranks, age ranges (50–59, 60–69, 70–79, 80+ years old), and the number of participants in each division. Percentiles for each DCQ index are provided in Table 4. To use this table, one should select the appropriate row corresponding to the patient's age range, then select the patient's education level, and finally find the patient's raw score and refer to the corresponding percentile rank. The median is the 50th percentile.

Validity and Reliability

Validity of the DCQ was assessed by correlating performance on the DCQ total score to the MoCA total score. Pearson's correlation coefficient was significantly high ($r = .71$, $p < .001$) (see Fig. 2). Correlation between the DCQ without the

Table 1. Demographics data: total sample ($N = 410$)

	Mean	Standard deviation
Age, years	66.31	9.21
Education, years	15.16	3.76
	Frequency	%
Gender		
Male	217	52.9
Female	193	47.1

Table 2. Demographics data: normative sample ($n = 285$)

	Mean	Standard deviation
Age, years	64.79	9.21
Education, years	15.84	3.45
	Frequency	%
Age groups, years		
50–59	89	31.2
60–69	119	41.8
70–79	48	16.8
80+	29	10.2
Gender		
Male	167	58.6
Female	118	41.4

Table 3. Percentile norms for the DCQ total score

Age	Education	n*	Percentiles												
			1	2	5	10	15	25	50	75	85	90	95	98	99
50–59	≤12	12	86	86	86	86	88	90	93	94	98	98	—	—	—
	>12	72	76	77	83	87	89	92	94	96	98	98	99	100	—
60–69	≤12	14	82	82	82	84	86	87	90	94	95	96	—	—	—
	>12	100	80	80	84	87	89	90	92	96	96	97	98	99	99
70–79	≤12	14	81	81	81	81	81	86	88	92	92	93	—	—	—
	>12	31	71	71	74	83	87	89	91	94	95	96	97	—	—
80+	≤12	12	72	72	72	73	74	80	86	89	90	92	—	—	—
	>12	16	71	71	71	74	79	83	86	91	92	94	—	—	—

Total $n^* = 271$, behavioral index is missing in 14 cases.

Table 4. Percentile norms for the five DCQ indexes

Index	Age	Education	n	Percentiles												
				1	2	5	10	15	25	50	75	85	90	95	98	99
Memory	50–59	≤12	12	27	27	27	27	27	28	28	29	30	30	–	–	–
		>12	77	25	25	26	27	27	28	29	30	30	30	30	30	–
	60–69	≤12	16	26	26	26	26	26	27	28	29	30	30	–	–	–
		>12	103	19	24	25	26	27	27	29	29	30	30	30	30	30
	70–79	≤12	16	26	26	26	26	27	28	28	29	29	29	–	–	–
		>12	32	21	21	22	24	25	27	27	29	29	29	30	–	–
	80+	≤12	13	24	24	24	24	24	24	27	28	29	29	–	–	–
		>12	16	19	19	19	20	21	22	26	27	28	28	–	–	–
Visuospatial	50–59	≤12	12	5	5	5	5	5	6	6	7	7	7	–	–	–
		>12	77	4	4	5	6	6	6	7	7	7	7	7	7	–
	60–69	≤12	16	3	3	3	3	4	4	6	7	7	7	–	–	–
		>12	103	4	5	5	5	6	6	7	7	7	7	7	7	7
	70–79	≤12	16	2	2	2	4	5	5	6	6	7	7	–	–	–
		>12	32	3	3	3	4	5	5	6	7	7	7	7	–	–
	80+	≤12	13	2	2	2	2	2	3	5	6	7	7	–	–	–
		>12	16	5	5	5	5	5	5	6	7	7	7	–	–	–
Executive	50–59	≤12	12	6	6	6	6	6	6	8	9	10	10	–	–	–
		>12	77	4	5	5	6	7	8	9	9	10	10	10	10	–
	60–69	≤12	16	5	5	5	5	6	6	7	8	9	10	–	–	–
		>12	103	5	5	6	6	7	7	8	9	9	10	10	10	10
	70–79	≤12	16	4	4	4	4	4	5	7	8	9	9	–	–	–
		>12	32	4	4	4	6	6	6	8	9	9	9	9	–	–
	80+	≤12	13	3	3	3	3	3	3	6	7	8	8	–	–	–
		>12	16	3	3	3	3	4	5	7	8	9	9	–	–	–
Language	50–59	≤12	12	28	28	28	28	28	29	30	31	32	32	–	–	–
		>12	77	28	28	29	30	31	31	32	32	32	33	33	33	–
	60–69	≤12	16	27	27	27	27	28	29	30	31	32	32	–	–	–
		>12	103	27	28	28	29	30	30	31	32	32	32	33	33	33
	70–79	≤12	16	26	26	26	26	26	28	29	30	31	31	–	–	–
		>12	32	25	25	26	28	29	29	31	32	32	32	32	–	–
	80+	≤12	13	21	21	21	22	25	26	28	30	31	31	–	–	–
		>12	16	21	21	21	25	27	28	30	30	30	31	–	–	–
Behavior	50–59	≤12	12	16	16	16	16	17	20	20	20	20	20	–	–	–
		>12	72	6	7	12	14	14	16	20	20	20	20	20	20	–
	60–69	≤12	14	12	12	12	14	17	18	19	20	20	20	–	–	–
		>12	100	10	12	12	14	16	16	20	20	20	20	20	20	–
	70–79	≤12	14	10	10	10	13	16	16	18	20	20	20	–	–	–
		>12	31	10	10	10	16	17	18	20	20	20	20	20	–	–
	80+	≤12	12	16	16	16	16	16	16	20	20	20	20	–	–	–
		>12	16	14	14	14	14	15	18	20	20	20	20	–	–	–

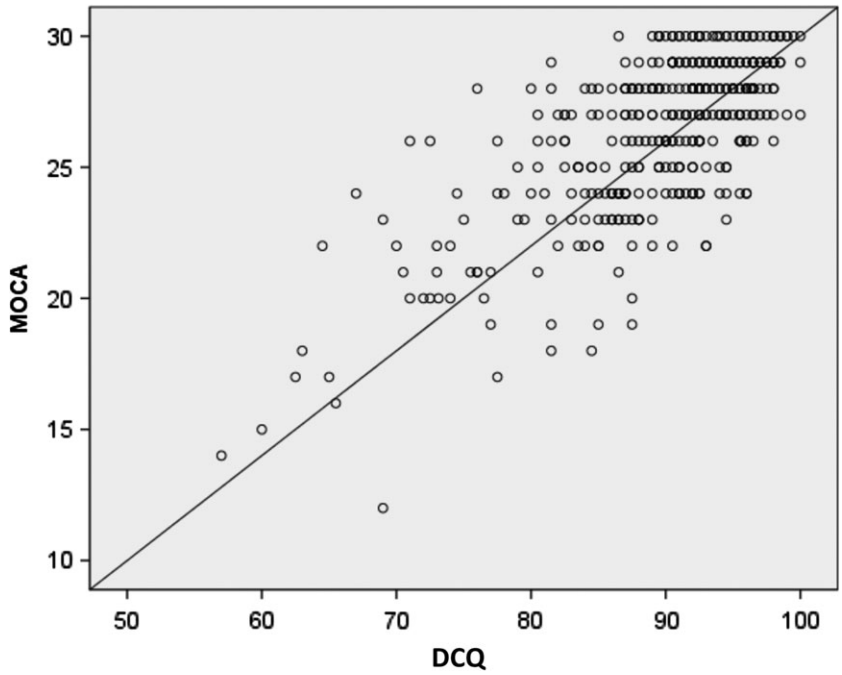

Fig. 2. Scatter plot illustrating the correlation between DCQ and MoCA total scores.

Behavioral Index and the MoCA was also high ($r = .73$, $p < .001$). Internal consistency for the four cognitive domains, as assessed by Cronbach's alpha coefficient, was .74; value $\geq .70$ was considered appropriate. Test–retest reliability was assessed in a subset of participants ($n = 45$) in an average time frame of 48.70 days ($SD = 13.90$), with a correlation value of .70 ($p < .001$). Within the test–retest sample, the mean DCQ score was 92.38 ($SD = 3.96$) at first administration and 93.24 ($SD = 3.76$) at retest ($p = .06$). Interrater reliability assessed in a random sample of 50 questionnaires was very high (ICC = .99, $p < .001$).

The acceptability of the DCQ was good. The test was well tolerated by the participants, and the behavioral questionnaire was easily understood by the significant other.

Discussion

We developed a new cognitive screening test adapted to updated dementia criteria for AD (McKhann et al., 2011), PPA (Gorno-Tempini et al., 2011) and the FTLD spectrum (Rascovsky et al., 2011) that is valid and reliable. In this process, we aimed to provide clinicians with a more advanced instrument that allows in-depth testing of various cognitive domains *à la carte* according to the clinical needs at stake.

The five DCQ indexes were specifically designed to provide advanced information on specific cognitive domains. For example, the Language Index assesses semantic knowledge through confrontation naming and comprehension tasks. It also allows the identification of surface dyslexia/surface dysgraphia through writing and spelling of irregular words. Such features can be found in the semantic variant PPA. Other salient language deficits, such as poor word retrieval and impairment in repetition of long sentences seen in the logopenic variant of PPA, agrammatism in spoken and written production seen in nonfluent variant PPA or rating of apraxia of speech in spontaneous speech (Gorno-Tempini et al., 2011) are also tested within this index. The Visuospatial Index includes subtests that explore visual orientation and space perception without interference of executive and visuoconstructive skills on pure visuospatial functions. Failure at cube drawing or clock drawing, for instance, may reflect combined executive and visuospatial impairments, therefore not allowing to probe pure visuospatial impairment (Moafmashhadi & Koski, 2013). Following this rationale, the DCQ's Visuospatial Index may allow better screening of the deficits associated with the visual variant of AD (also known as Posterior Cortical Atrophy) (Crutch et al., 2012). The Memory index includes immediate, delayed and cued recall tasks using the Dubois paradigm (Dubois et al., 2002). This method is known to better discriminate memory consolidation impairments seen in amnestic AD from other memory disorders. Finally, we believe that specific patterns of behavioral changes may help differentiate certain types of dementia (Jenner, Reali, Puopolo, & Silveri, 2006). For this reason the Behavioral Index was developed and integrated in the DCQ, and

represent a great addition to standard cognitive screening measures. This index includes, among other items, the core features of bvFTD criteria (Rascovsky et al., 2011).

The DCQ was validated on a population-based sample of 410 participants. Evidence of strong validity with existing cognitive screening instruments has been shown whereby the DCQ correlated highly with the MoCA. Cronbach's alpha coefficient reached a value of .74, which suggests appropriate internal consistency. Test–retest reliability was adequate. We found a trend towards a practice effect over an average retest period of 48.70 days, but the latter was not significant suggesting minimal (if any) practice effect. Finally, the DCQ showed excellent interrater reliability. Thus, this test has demonstrated excellent psychometric properties equivalent to those of other tests considered as gold standard in cognitive screening (Folstein et al., 1975; Nasreddine et al., 2005).

We provided normative data from a subsample of 285 cognitively healthy participants. Older age and fewer years of education were associated with lower performance on the DCQ. These results are consistent with the assertion that performance on cognitive tests is likely influenced by factors such as age and education (Ganguli et al., 2010). We therefore stratified the normative data by age and education. Finally, we present the normative data in percentiles, which provides a robust estimation of an individual's performance given his sociodemographic characteristics. The usefulness of normative data for screening tests is grounded in the refinement of interpretation of performance, taking into account factors such as age and education. Indeed, the additional use of normative data by clinicians provides a second insight on whether the patient should be referred for an extensive neuropsychological evaluation or whether a similarly normal performance is maintained over follow-up. Therefore, such additional information might help clinicians deciding whether or not more exhaustive cognitive assessment is necessary.

Some limitations can be noted in this study, however, and may be related to the incidental sampling method. Indeed, the age ranges 50–59 and 60–69 may be flawed with overrepresentation of highly educated subjects when we compare to most recent Québec demographics (Institut de la Statistique du Québec 2006, s. d.). In addition, DCQ norms were derived from a French-speaking population in Québec, and caution should be observed when using these norms in culturally, ethnically and linguistically diverse populations. The DCQ also exists in English and validation on English speaking populations is underway. In the investigative sequence of tests performed in a tertiary memory clinic, we position the DCQ as a complement to existing cognitive screening tests (see Fig. 3). We propose that this test be used *à la carte* after MMSE and MoCA performances have not helped clinicians in their diagnostic dilemma. The DCQ should be used to confirm a clinical suspicion that was unanswered by standard screening tests. This in turn may avoid exposing patients to unnecessarily lengthy neurocognitive assessment when not needed. As behavioral neurologists, neuropsychiatrist, geriatricians, geriatric psychiatrist, clinical neuropsychologists and speech language pathologist ourselves, we suggest that comprehensive neuropsychological assessment be kept for patients with complex psychiatric comorbidities, highly educated young individuals, patients with mental retardation, others suspected of malingering, etc. One must not forget, however, that our suggestion of using the DCQ test *à la carte* with the aim of exploring domain-specific deficits, has not been validated with domain-specific neuropsychological tests (we validated the DCQ using its total score against a global cognitive test with grouped sets of items). Further validation of the single DCQ indices using neuropsychological measures as criterion is already underway. Furthermore, DCQ data on a clinical sample with various types of dementia along with their neuropsychological performances on standard batteries is currently being collected prospectively, hence allowing such correlational analyses on clinical populations in the future.

In conclusion, this study introduced, validated and provided normative data for the DCQ, a new cognitive screening test adapted to the new dementia criteria for AD variants, PPAs, bvFTD and the FTLD spectrum. The DCQ items were designed specifically to detect cognitive patterns associated with atypical dementias. It demonstrated excellent psychometric properties

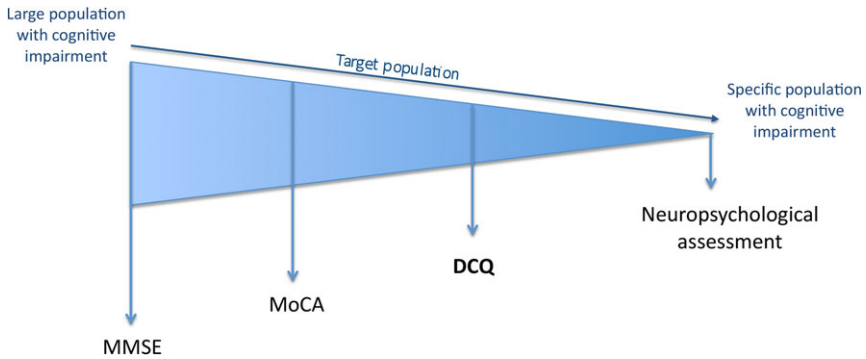

Fig. 3. Positioning the DCQ amongst other cognitive screening measures.

in healthy controls. We are confident that this instrument will be useful to expand the cognitive tool kit in the clinical setting of a memory clinic. A multicenter effort is underway in Québec City (Québec, Canada), which aims to derive sensitivity and specificity values on a wide range of clinical populations.

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Conflict of Interest

We have no conflict of interest to declare.

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