



# The MOVES (Motor tic, Obsessions and compulsions, Vocal tic Evaluation Survey): cross-cultural evaluation of the French version and additional psychometric assessment

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## Abstract

**Introduction** The Motor tic, Obsessions and compulsions, Vocal tic Evaluation Survey (MOVES) is a self-report scale suggested as a severity scale for tics and related sensory phenomena observed in Gilles de la Tourette syndrome (GTS) and recommended as a screening instrument by the Committee on Rating Scale Development of the International Parkinson's Disease and Movement Disorder Society.

**Objectives** To cross-culturally adapt a French version of the MOVES and to evaluate its psychometric properties.

**Methods** After the cross-cultural adaptation of the MOVES, we assessed its psychometric properties in 53 patients aged 12–16 years and in 54 patients aged 16 years and above: reliability and construct validity (relationships between items and scales), internal consistency and concurrent validity with the Yale Global Tic Severity Scale (YGTSS) and the Children's Yale–Brown Obsessive–Compulsive Scale (CY–BOCS) or the auto-Yale–Brown scale.

**Results** The results showed very good acceptability with response rates greater than 92%, good internal consistency (Cronbach's alpha ranging from 0.62 and 0.89) and good test–retest reliability (ICCs ranging from 0.59 to 0.91). Concurrent validity with the YGTSS, CY–BOCS and auto-Yale–Brown scales showed strong expected correlations. The cut-off points tested for diagnostic performance gave satisfactory values of sensitivity, specificity, and positive and negative predictive values.

**Discussion** Our study provides evidence of the good psychometric properties of the French version of the MOVES. The cross-cultural adaptation of this specific instrument will allow investigators to include French-speaking persons with GTS aged 12 years and over in national and international collaboration research projects.

**Keywords** Gilles de la Tourette syndrome · MOVES · French · Cross-cultural · Validation

## Introduction

Gilles de la Tourette syndrome (GTS) is a chronic, childhood-onset neurodevelopmental disorder, characterized by multiple motor and one or more vocal tics that may wax and

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wane in frequency but have persisted for more than 1 year since first tic onset [1]. The prevalence of GTS is estimated between 0.3 and 0.9% in school-aged children [2]. Many adults with GTS experience diminished symptoms but a small percentage have persistently severe or worsening symptoms.

European clinical guidelines for Tourette syndrome and other tic disorders [3] have recommended screening instruments that can adequately capture symptoms at various ages. The standardized assessment tools should include validated psychometric instruments [4]. A self-rating scale that captures both tics and behavioural features in GTS is helpful in documenting patients' impressions [5, 6]. The Motor tic, Obsessions and compulsions, Vocal tic Evaluation Survey (MOVES) [5] is a self-report scale measuring the past weeks' severity of five phenomena observed in GTS and comprises 20 items grouped into five subscales: Motor tics, Vocal tics, Obsessions, compulsions and Associated Symptoms (echolalia, echopraxia, coprolalia, copropraxia). The MOVES has been validated in English in children, adolescents and adults. It is available publicly from the original article by Gaffney et al. [5]. The MOVES is suggested as a severity scale for tics and related sensory phenomena and recommended as a screening instrument by the Committee on Rating Scale Development of the International Parkinson's Disease and Movement Disorder Society [6]. We decided, therefore, to perform a study to validate a French version of the MOVES among subjects with GTS by evaluating its psychometric properties as a severity and screening tool for both tics and obsessive–compulsive symptoms.

## Methods

### Study design

The study received approval from the Ethical Review Board (Comité de Protection des Personnes Sud-Est I, reference 2012-18/2012-A01003-40, 27 August 2012). The aims and procedures were explained to participants, who all gave written informed consent. Consent for minor patients was obtained from their parents.

To assess the test–retest reliability of the MOVES, the questionnaire was mailed to all persons with GTS 15 days after a first assessment. Only respondents answering no change in their symptoms during that time were retained for this analysis.

### Participants

All outpatients with diagnosis of GTS who were consecutively admitted to a GTS Reference Centre (Paris) or a GTS Competence Centre (Clermont-Ferrand) between

January 2013 and December 2014 were included in the study. They were divided into groups of 12- to 16-year-olds and those aged 16 years and above, which correspond to the two main age categories in the French health care system. The psychometric properties of the self-report scale were evaluated in each group according to Gaffney et al. [5].

Inclusion criteria were diagnosis of GTS according to DSM IV-TR and age  $\geq 12$  years to ensure that children understood all the items of the questionnaire. Exclusion criteria were mental retardation, delirium, dementia and other cognitive disorders, vulnerable adults, participation in a clinical trial that may influence the evolution of GST and inability to complete questionnaires alone.

For comparison with patients aged 16 years and above, 30 psychiatric controls without GTS and 30 healthy controls were recruited. For comparison with patients aged between 12 and 16 years, only psychiatric controls without GTS were included as French law is reluctant to allow healthy minors to take part in research protocols. All controls were matched for gender and age (maximum difference of 2 years).

Psychiatric controls were recruited in the general psychiatric department of a teaching hospital in Clermont-Ferrand. They suffered from depressive disorder (25%), attention deficit hyperactivity disorder (18%), conduct disorder (12%), learning disorder (11%), psychological difficulties (10%), anxiety disorder (7%), bipolar disorder (6%), psychotic disorder (6%), alcohol dependence (5%), anorexia nervosa (4%) and sleep disorder (1%) according to DSM-IV-TR. Exclusion criteria were similar to those of patients except for the addition of no tics and no obsessive–compulsive disorder.

Healthy control subjects were recruited among volunteers from a clinical research centre. Exclusion criteria were current or past psychiatric disorders, tics or other neurological disorders, vulnerable adults and inability to complete questionnaires alone.

### The MOVES instrument

Each of the five subscales of the MOVES comprises four items describing symptoms [5], rated on 0–3 anchor points according to the frequency of the symptoms in the previous 4 weeks ('never', 'sometimes', 'often', 'always'). For each subscale, a score is obtained by adding the scores of the items listed in the subscale. A total MOVES score is calculated by adding the scores of these five subscales, with a range from 0 (no symptom) to 60 (the worst condition). For clinical scoring, the Motor tics and Vocal tics subscale scores are added to form a Tic subscale. The Obsessions and compulsions subscale scores are added to form an Obsessive–Compulsive subscale. The MOVES can be easily completed in less than 5 min.

## Instrument translation

The MOVES was cross-culturally adapted from English into French following guidelines for the cross-cultural adaptation of self-administered instruments [7]. Forward translations were independently made by three informed bilingual translators fluent in English (2 psychiatrists and 1 neurologist experienced in GTS research), and one bilingual translator, naïve to the outcome measure, all of them with French as mother tongue. A native English translator fluent in French, blinded to the original English version and with medical background, then made a backward translation. A multidisciplinary expert committee (composed of methodologists, health and language professionals, and the translators) reviewed the process, compared source and target versions, and resolved discrepancies, asking patients for their opinion if necessary. Item translation, semantic, idiomatic, experiential, and conceptual equivalents were discussed. After pre-testing on a sample of seven patients (mean age 35 years, SD 22 years, three men), the consensus target version was adopted by the committee as the pre-final cross-cultural adaptation (free distribution on request to authors).

We then made an evaluation of the psychometric properties of MOVES, given in detail below. We addressed the acceptability of the screening instrument, floor and ceiling effects, internal consistency, convergent validity, test–retest reliability and diagnostic performance, as recommended by guidelines for the pre-final cross-cultural adaptation [7–10].

## Assessments

The sociodemographic and medical characteristics of all participants were collected. The questionnaire was self-completed by patients and controls.

For participants aged between 12 and 16 years, the Yale Global Tic Severity Scale (YGTSS) [11] and the Children's Yale–Brown Obsessive–Compulsive Scale (CY–BOCS) [12] were administered by clinicians (neurologists and psychiatrists, respectively) to assess the severity of tics and Obsessive–Compulsive disorder, respectively.

For participants aged 16 years and above, the YGTSS was administered by clinicians and the auto-Yale–Brown scale [13, 14] self-administered to assess Obsessive–Compulsive disorder. In addition, the Symptom Check-List 90 Revised (SCL-90R) [15, 16] was self-completed by healthy controls to exclude those with possible psychiatric disorders.

The questionnaires were filled in during a routine consultation.

## Statistical analyses

Statistical analyses were performed with SAS v9.4 software and conducted at a two-sided  $\alpha = 0.05$  significance level with Bonferroni correction for multiple comparisons.

The psychometric evaluation of MOVES consisted of:

1. *Data completeness* The respondent acceptability of the questionnaire was assessed by looking at response rates.
2. *Descriptive statistics and score distributions* Mean, standard deviation, and range were used. The variability of the MOVES scores was investigated for each subscale using floor and ceiling effect. These effects were considered to be present if more than 15% of the subjects obtained the lowest or highest possible score [17].
3. *Internal consistency* Cronbach's  $\alpha$  coefficient was used to evaluate the internal consistency of each subscale [18]. The minimum required for the coefficient was 0.70, following the standard for group comparisons [19].
4. *Item–total correlations* Item–total consistency was analysed to evaluate the extent of the linear relationship between an item and the total MOVES scale, corrected for overlap (the item which is to be correlated with the scale was omitted from the scale total) [9]. A minimum correlation coefficient of 0.40 was considered indicative of good item–total consistency [20].
5. *Convergent validity* Validity was measured, calculating Spearman  $\rho$  correlation coefficients, by comparing (1) MOVES and YGTSS scores for both age groups, (2) MOVES and CY–BOCS scores for 12- to 16-year-old group, and (3) MOVES and auto-Yale–Brown scores for those aged 16 years and above. We hypothesized a significant positive correlation between the following subscales: Motor tics of MOVES and YGTSS, Vocal tics of MOVES and YGTSS, tics of MOVES and YGTSS, Obsessions of MOVES and Obsessions of CY–BOCS or auto-Yale–Brown, compulsions of MOVES and compulsions of CY–BOCS or auto-Yale–Brown, Obsessive–Compulsive of MOVES and total CY–BOCS or auto-Yale–Brown scores.
6. *Reliability* Stability over time was assessed by the test–retest method. Reliability of the subscales was estimated by intraclass correlation coefficient (ICC), based on the two-way random effect model [21]. The following categories were selected to interpret the agreement levels: 0–0.2 small, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 substantial and 0.81–1 almost perfect [22].
7. The diagnostic performance of the MOVES was explored to assess its validity as a method of screening for GTS. First, the MOVES subscale scores and the total scale score were compared in patients with GTS and in controls by nonparametric Kruskal–Wallis tests. To test the properties of the MOVES as a diagnostic test, receiver operating characteristic (ROC) curves and area under the curve (AUC) were calculated. The ROC curve is a representation of the ability of the scale to discriminate between cases of GTS and non-cases. For the 12- to 16-year-old group, non-cases were the psy-

chiatric controls. For the 16-year-old and above group, three ROCs were performed with psychiatric controls, healthy controls and all controls as non-cases. Different cut-off points of the MOVES total score were selected by ROC curves and tested by calculating the sensitivity, specificity, and positive and negative predictive values of each one.

## Results

### Participants

The participants are described in Table 1. One hundred and seven subjects with GTS were included, 53 between the age of 12 and 16 years, and 54 aged 16 years and above. The subjects were mainly male (84.9% in the 12- to 16-year-old group and 70.4% in the 16-year-old and above group), with a mean age of 13.9 (SD 1.2;

**Table 1** Sociodemographic and clinical characteristics of the participants

	12- to 16-year-olds		16-year-old and above		
	GTS ( <i>n</i> = 53)	Psychiatric controls ( <i>n</i> = 53)	GTS ( <i>n</i> = 54)	Psychiatric controls ( <i>n</i> = 30)	Healthy controls ( <i>n</i> = 30)
Sex, <i>n</i> (%)					
Male	45 (85)	45 (85)	38 (70)	19 (63)	19 (63)
Age (years), mean (SD)	13.9 (1.2)	14.0 (1.3)	25.6 (11.7)	30.4 (12.5)	28.1 (11.5)
Time since the first symptoms (years), mean (SD)	7.1 (3.2)	–	18.2 (11.4)	–	–
Psychotropic treatment, <i>n</i> (%)					
Neuroleptic	39 (74)	2 (4)	23 (55)	11 (36.7)	–
Antiepileptic	4 (8)	1 (2)	1 (2.4)	0 (0)	–
Antidepressant	9 (17)	3 (57)	13 (31.0)	16 (53.3)	–
Anxiolytic	5 (9)	7 (13)	3 (7.1)	19 (63.3)	–
Hypnotic	0 (0)	1 (2)	2 (4.8)	5 (16.7)	–
Mood stabilizer	0 (0)	2 (4)	3 (7.1)	7 (23.3)	–
Deep brain stimulation	0 (0)	0 (0)	3 (7.1)	0 (0)	–
Other					
Methylphenidate	4 (8)	10 (18.9)	0 (0)	0 (0)	–
Melatonin	2 (4)	0 (0)	0 (0)	0 (0)	–
None	11 (21)	32 (60)	12 (30)	1 (3.3)	30 (100)
Medical monitoring, <i>n</i> (%)					
General practitioner	37 (71.2)	48 (92.3)	29 (54.7)	24 (92.3)	28 (100)
Paediatrician	2 (3.8)	3 (5.8)	0 (0)	0 (0)	0 (0)
Neurologist	30 (57.7)	0 (0)	43 (81.1)	0 (0)	0 (0)
Psychiatrist	25 (48.1)	38 (73.1)	19 (36.5)	20 (76.9)	0 (0)
Psychologist	18 (34.6)	20 (38.5)	10 (19.2)	2 (7.7)	0 (0)
None	0 (0)	0 (0)	1 (1.9)	0 (0)	0 (0)
YGTSS, mean (SD)					
Motor tics	13.3 (4.6)	0	12.8 (4.5)	0	0
Vocal tics	9.3 (6.2)	0	8.5 (6.1)	0	0
Tics	22.6 (9.9)	0	21.3 (9.2)	0	0
Overall impairment	10.0 (13.1)	0	18.4 (12.2)	0	0
Global severity	32.6 (18.7)	0	39.7 (18.8)	0	0
CY–BOCS/auto-Yale–Brown <sup>a</sup> , mean (SD)					
Obsessions	2.5 (4.6)	0.3 (1.3)	4.7 (5.2)	0.8 (2.8)	0
Compulsions	3.5 (5.1)	0.3 (1.2)	4.5 (5.1)	0.6 (1.8)	0
Total CY–BOCS/auto-Yale–Brown	6.0 (9.1)	0.5 (1.8)	9.2 (9.7)	1.4 (3.5)	0

<sup>a</sup>CY–BOCS for 12- to 16-year-old group and auto-Yale–Brown for 16-year-old and above group

range 12.0–15.9 years) and 25.6 years (SD 11.7; range 16.0–59.0 years old), respectively.

In both age groups, psychiatric controls had all YGTSS scores equal to zero and very low scores for the CY-BOCS (Table 1). In the 16-year-old and above group, healthy controls had zero YGTSS and auto-Yale–Brown scores.

### Data completeness, score distribution, floor and ceiling effect

The descriptive statistics and score distributions for the subscales of the MOVES are given in Table 2. Data completeness was excellent with a response rate greater than 90% in both age groups. No ceiling effect was found. Floor effects were observed in both age groups for Vocal tics, Obsessions and Other Associated Symptoms subscales. More than 50% of subjects with GTS reported no symptom of echolalia, echopraxia, coprolalia or copropraxia.

### Internal consistency

Cronbach's  $\alpha$  coefficients ranged from 0.62 to 0.88 in the 12- to 16-year-old group and from 0.69 to 0.89 in the 16-year-old and above group (Table 3). Only the Obsessions subscale in the two age groups did not reach the required minimum  $\alpha$  coefficient of 0.70, indicating good internal consistency for all other subscales and total MOVES score.

**Table 3** Internal consistency and test–retest reliability of the MOVES in GTS patients

MOVES subscales	Cronbach's $\alpha$	ICC [95% CI]
12- to 16-year-olds		
Motor tics	0.77	0.78 [0.64–0.87]
Vocal tics	0.81	0.86 [0.76–0.92]
Tics	0.81	0.85 [0.74–0.92]
Obsessions	0.74	0.65 [0.44–0.79]
Compulsions	0.62	0.59 [0.37–0.75]
Obsessive–compulsive	0.82	0.68 [0.48–0.81]
Other associated symptoms	0.75	0.76 [0.61–0.86]
Total MOVES	0.88	0.82 [0.69–0.90]
16-year-old and above		
Motor tics	0.73	0.75 [0.59–0.86]
Vocal tics	0.76	0.77 [0.63–0.87]
Tics	0.79	0.78 [0.63–0.88]
Obsessions	0.70	0.88 [0.80–0.94]
Compulsions	0.69	0.86 [0.75–0.93]
Obsessive–compulsive	0.79	0.91 [0.83–0.95]
Other associated symptoms	0.79	0.75 [0.59–0.86]
Total MOVES	0.89	0.88 [0.79–0.94]

ICC [95% CI] intraclass correlation coefficient [95% confidence interval]

### Item–total correlations

Corrected item–total correlations ranged from 0.24 to 0.70 in the 12- to 16-year-old group, from 0.27 to 0.65 in

**Table 2** Descriptive statistics and score distributions of the MOVES in GTS patients

MOVES subscales	Response rate (%)	Mean (SD)	Range	Floor effect (%)	Ceiling effect (%)
12- to 16-year-olds					
Motor tics	98.1	5.4 (2.8)	0–12	3.8	1.9
Vocal tics	98.1	2.9 (3.0)	0–11	21.2	0
Tics	96.2	8.2 (4.8)	0–20	2.0	0
Obsessions	98.1	2.1 (2.5)	0–11	30.8	0
Compulsions	100	3.0 (2.4)	0–10	15.1	0
Obsessive–compulsive	98.1	5.1 (4.6)	0–20	13.5	0
Other associated symptoms	98.1	1.2 (2.0)	0–8	55.8	0
Total MOVES	92.5	14.2 (9.3)	0–42	2.0	0
16-year-old and above					
Motor tics	98.1	5.8 (2.9)	1–12	0	1.9
Vocal tics	100	2.8 (2.7)	0–10	16.7	0
Tics	98.1	8.7 (4.7)	1–22	0	0
Obsessions	100	1.9 (2.0)	0–8	29.6	0
Compulsions	94.4	3.8 (2.7)	0–10	9.8	0
Obsessive–compulsive	94.4	5.6 (4.1)	0–16	5.9	0
Other associated symptoms	100	1.6 (2.5)	0–9	55.6	0
Total MOVES	92.6	15.8 (9.6)	2–39	0	0

the 16-year-old and above group and were all significant (Table 4). Correlations were higher than the required 0.40, indicating good item–total consistency, except for three items (items 1, 4 and 9) in the 12- to 16-year-old group and two items (items 1 and 14) in the 16-year-old and above group.

### Convergent validity

In the 12- to 16-year-old group, the correlations hypothesized between MOVES, YGTSS and auto-Yale–Brown subscales were all significant: MOVES Motor tics versus YGTSS Motor tics,  $r = 0.53$ ,  $p < 0.0001$ ; MOVES Vocal tics versus YGTSS Vocal tics,  $r = 0.68$ ,  $p < 0.0001$ ; MOVES tics versus YGTSS tics,  $r = 0.62$ ,  $p < 0.0001$ ; MOVES Obsessions versus CY–BOCS Obsessions,  $r = 0.61$ ,  $p < 0.0001$ ; MOVES compulsions versus CY–BOCS compulsions,  $r = 0.49$ ,  $p = 0.0002$ ; MOVES Obsessive–Compulsive versus CY–BOCS Total score,  $r = 0.60$ ,  $p < 0.0001$ .

In the 16-year-old and above group, the correlations hypothesized between MOVES, YGTSS and auto-Yale–Brown subscales were all significant: MOVES Motor tics versus YGTSS Motor tics,  $r = 0.42$ ,  $p = 0.0019$ ; MOVES Vocal tics versus YGTSS Vocal tics,  $r = 0.61$ ,  $p < 0.0001$ ; MOVES tics versus YGTSS tics,  $r = 0.55$ ,  $p < 0.0001$ ; MOVES Obsessions versus auto-Yale–Brown obsessions,  $r = 0.67$ ,  $p < 0.0001$ ; MOVES compulsions versus auto-Yale–Brown compulsions,  $r = 0.52$ ,  $p = 0.0001$ ; MOVES

Obsessive–Compulsive versus auto-Yale–Brown total score,  $r = 0.58$ ,  $p < 0.0001$ .

### Reliability

The retest questionnaire was returned by all the 53 subjects with GTS in the 12- to 16-year-old group and by 49 (90.7%) in the 16-year-old and above group. No subject declared any change in health status.

The ICC ranged from 0.59 to 0.86 in the 12- to 16-year-old group and from 0.75 to 0.91 in the 16-year-old and above group (Table 3). These results indicate substantial to perfect reliability for total MOVES score and all subscales except for the Obsessions subscale in the 12- to 16-year-old group, which had moderate reliability with an ICC of 0.59, close to the substantial reliability category.

### Diagnostic performance

In the 12- to 16-year-old group, the MOVES subscale scores were significantly higher in subjects with GTS than in psychiatric controls (Table 5). In the 16-year-old and above group, the MOVES subscale scores, except for the Obsessions subscale scores, were significantly different across subjects with GTS and psychiatric and healthy controls, with the subjects scoring significantly higher than controls in the total MOVES score and in all subscales except the Obsessions and Obsessive–Compulsive subscales.

**Table 4** Corrected item–total correlations of the MOVES

MOVES items	12- to 16-year-olds	16-year-old and above
1. I make noises (like grunts) that I can't stop	0.38	0.27
2. Parts of my body jerk again and again, that I can't control	0.48	0.41
3. I have bad ideas over and over, that I can't stop	0.45	0.56
4. I have to do things in certain order or certain ways (like touching things)	0.34	0.51
5. Words come out that I can't stop or control	0.53	0.64
6. At times I have the same jerk or twitch over and over	0.40	0.41
7. Certain bad words or thoughts keep going through my mind	0.58	0.55
8. I have to do exactly the opposite of what I'm told	0.56	0.56
9. The same unpleasant or silly thought or picture goes through my mind	0.24	0.41
10. I can't control all my movements	0.60	0.54
11. I have to do several movements over and over again, in the same order	0.49	0.51
12. Bad or swear words come out that I don't mean to say	0.70	0.48
13. I feel pressure to talk, shout or scream	0.58	0.58
14. I have ideas that bother me (like germs or like cutting myself)	0.49	0.36
15. I do certain things (like jumping or clapping) over and over	0.49	0.56
16. I have habits or movements that come out more when I'm nervous	0.47	0.44
17. I have to repeat things that I hear other people say	0.46	0.62
18. I have to do things I see other people do	0.50	0.63
19. I have to make bad gestures (like the finger)	0.56	0.44
20. I have to repeat words or phrases over and over	0.51	0.65

**Table 5** MOVES subscale scores for GTS patients and control groups

MOVES subscales	GTS	Psychiatric controls	Healthy controls	<i>P</i> value GTS vs psychiatric controls vs healthy controls	<i>P</i> value <sup>a</sup> GTS vs psychiatric controls	<i>P</i> value <sup>a</sup> GTS vs healthy controls
12- to 16-year-olds						
Motor tics	5.4 (2.8)	0.5 (0.8)	–	–	< 0.0001	–
Vocal tics	2.9 (3.0)	1.0 (1.4)	–	–	0.0001	–
Tics	8.2 (4.8)	1.5 (1.9)	–	–	< 0.0001	–
Obsessions	2.1 (2.5)	1.1 (1.3)	–	–	0.0054	–
Compulsions	3.0 (2.4)	1.1 (1.0)	–	–	< 0.0001	–
Obsessive–compulsive	5.1 (4.6)	2.2 (1.9)	–	–	< 0.0001	–
Other associated symptoms	1.2 (2.0)	0.5 (1.0)	–	–	0.0251	–
Total MOVES	14.2 (9.3)	4.2 (3.5)	–	–	< 0.0001	–
16-year-old and above						
Motor tics	5.8 (2.9)	0.8 (1.3)	0.1 (0.3)	< 0.0001	< 0.0001	< 0.0001
Vocal tics	2.8 (2.7)	0.5 (0.9)	0.3 (0.7)	< 0.0001	< 0.0001	< 0.0001
Tics	8.7 (4.7)	1.3 (1.8)	0.4 (0.7)	< 0.0001	< 0.0001	< 0.0001
Obsessions	1.9 (2.0)	2.0 (1.8)	1.1 (1.4)	0.0676	0.6934	0.0588
Compulsions	3.8 (2.7)	1.6 (1.4)	0.7 (0.9)	< 0.0001	0.0005	< 0.0001
Obsessive–compulsive	5.6 (4.1)	3.6 (2.8)	1.8 (2.2)	< 0.0001	0.0432	< 0.0001
Other associated symptoms	1.6 (2.5)	0.1 (0.3)	0.2 (0.5)	< 0.0001	0.0004	0.0023
Total MOVES	15.8 (9.6)	5.0 (4.3)	2.3 (2.6)	< 0.0001	< 0.0001	< 0.0001

<sup>a</sup>In the 16-year-old and above group post hoc analysis with Bonferroni correction (corrected significant *p* value of 0.0170)

For the Obsessive–Compulsive subscale, the difference between subjects with GTS and psychiatric controls was not significant.

Table 6 shows the results of the diagnostic performance of the total MOVES score, with different definitions of non-cases and different cut-off points as threshold values for the diagnosis of GTS. The area under the ROC curve shows that the total MOVES score discriminated well between persons with GTS and controls, with AUC greater than 0.85 in both age groups. The cut-off points tested yielded similar results and gave satisfactory values of sensitivity, specificity, and positive and negative predictive values.

## Discussion

The present study describes the cross-cultural evaluation of the French version of the MOVES, including assessment of the floor and ceiling effects and of internal consistency, which was not explored in the original American study [5, 6].

A large sample of persons with GTS aged 12 years and over were recruited and compared with psychiatric, and healthy controls (in the 16-year-old and above group only) matched for age and sex.

We deliberately elected to study two groups to cover an age range from adolescence to adulthood, as recommended by the European clinical guidelines for Tourette syndrome and other tic disorders [3] and also because the evaluation scales for Obsessive–Compulsive symptoms differ between adolescents and adults. Our GTS populations can be considered as fully representative since they were similar to GTS populations described elsewhere in terms of male–female ratio and age at first symptoms [1, 23, 24]. Our GTS subjects were recruited from a Reference Centre and a Competence Centre and were thus more representative of the different levels of tic severity in GTS than cases recruited solely in tertiary centres [25–28]. Medical treatment of the cases was consistent with guidelines on pharmacotherapy in GTS including for behavioural disturbances [29–31]. Lastly, trained physicians evaluated both subjects with GTS and controls.

The French version of the MOVES had very good acceptability with excellent response rates and good response distribution, all of which indicate that the questionnaire was adapted to the population studied. Floor effects were observed for most subscales except, of course, for motor tics, owing to the absence of certain symptoms in our patients.

Internal consistency was good. As expected, the French version had good concurrent validity across all ages, similar to that of the original study, when compared to the

**Table 6** Diagnostic performance of the MOVES

	AUC [95% CI]	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Total MOVES cut-off score					
12- to 16-year-olds					
Non-cases of GTS: psychiatric controls <sup>a</sup>	0.89 [0.82–0.96]				
7		89.8	75.5	77.2	88.9
8		79.6	79.2	78.0	80.8
9		71.4	86.8	83.3	76.7
Total MOVES cut-off score					
16-year-old and above					
Non-cases of GTS: psychiatric controls <sup>a</sup>	0.86 [0.78–0.94]				
7		80.0	73.3	83.3	68.8
8		74.0	73.3	82.2	62.9
9		70.0	83.3	87.5	62.5
Non-cases of GTS: healthy controls <sup>b</sup>	0.95 [0.90–0.99]				
6		86.0	86.7	91.5	78.8
7		80.0	90.0	93.0	73.0
Non-cases of GTS: all controls <sup>c</sup>	0.91 [0.85–0.96]				
6		86.0	73.3	72.9	86.3
7		80.0	81.7	78.4	83.1
8		74.0	81.7	77.1	79.0

For each group of non-cases of GTS (psychiatric controls<sup>a</sup>, healthy controls<sup>b</sup> or all<sup>c</sup>), diagnostic performance was studied for various total MOVES cut-off scores

AUC [95% CI] area under curve [95% CONFIDENCE INTERVAL]

CY–BOCS or auto-Yale–Brown scales and YGTSS. It also had substantial to perfect reliability, with a better result than that of the original study for all subscales [5].

The diagnostic performance of the MOVES was assessed by AUC. In both subject and control groups, the threshold value varied from 6 to 9 with adequate sensitivity, specificity, and positive and negative predictive values. These thresholds were lower than those observed in the study of Gaffney et al., who reported a better diagnostic performance for a threshold score of 10 (specificity: 94%, sensitivity: 87%) [5]. This discrepancy could be explained by certain differences between the two studies. For example, differences between subjects with GTS and psychiatric controls: a notably smaller number of subjects with GTS in the study of Gaffney; a control group with chronic motor tic and a control group with obsessive compulsive disorder in the study of Gaffney, whereas our controls had neither one nor the other; and changes in criteria between the DSM III version used by Gaffney and the DSM IV-TR that we used.

Our study shows that the MOVES scale has adequate sensitivity, specificity, and positive and negative predictive values to be used as a screening instrument for GTS. However, to specify a threshold value, our preliminary study needs to be supplemented by a complementary study of diagnostic

performance with larger sample sizes and different samples of control subjects.

The limitations of our study include the lack of non-psychiatric controls for comparison with patients aged 12–16 years, and the lack of comparison with patients across all ages suffering from chronic motor tic or obsessive compulsive disorder.

In conclusion, our study provides evidence of the good psychometric properties of the French version of the MOVES self-report questionnaire as a severity and screening tool. Further studies on divergent validity, diagnostic performance and responsiveness to change are needed before it can be recommended as a severity scale and as a screening instrument for GTS. The cross-cultural adaptation of this specific instrument will nevertheless allow investigators as of now to propose French-speaking persons with GTS aged 12 years and over as participants in national and international collaboration research projects using this scale.

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## Compliance with ethical standards

**Ethical standards** The study was approved by the Ethical Review Board (Comité de Protection des Personnes Sud-Est I, reference 2012-18/2012-A01003-40, 27 August 2012).

**Informed consent** The aims and procedures were explained to participants, who all gave written informed consent. Consent for minor patients was obtained from their parents.

**Conflicts of interest** The authors declare that they have no conflict of interest.

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