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PSYCHOMETRIC PROPERTIES OF THE POLISH VERSION OF THE MOTOR OBSERVATION QUESTIONNAIRE FOR TEACHERS (MOQ-T)

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ABSTRACT

Purpose. Developmental Coordination Disorder (DCD) is a neurodevelopmental condition affecting 6–10% of school-aged children. DCD causes chronic motor impairments which distinguish children from their developmentally typical peers. To adapt and evaluate the psychometric properties of the Motor Observation Questionnaire for Teachers (MOQ-T) for use in a Polish child population.

Methods. Physical education teachers assessed a normative sample of 348 children using the MOQ-T. Internal consistency was evaluated by calculating Cronbach's alpha. Factor analysis was performed to investigate construct validity. A clinic-referred sample (n = 31) and a control group (n = 33) were recruited and concurrent validity was assessed by calculating correlations between the MOQ-T and the Körperkoordinationstest für Kinder (KTK). Receiver Operating Characteristic curve analysis assessed discriminative validity.

Results. Cronbach's alpha for the total MOQ-T score was 0.962. Factor analysis identified three factors: gross motor skills, fine motor skills, and general motor coordination. A negative correlation between the MOQ-T and KTK scores was found in both the control and clinic-referred groups. The AUC metric for the sample was 0.96 (CI: 0.90–1.00). Sensitivity was 0.80 for total MOQ-T scores at or above 44.5 with a specificity of 94%.

Conclusions. The psychometric properties of the MOQ-T as a DCD screening instrument in Polish school-aged children are promising. Further investigation warrants the inclusion of larger population samples and additional validity comparisons such as with the commonly used Movement Assessment Battery for Children (Second Edition).

Key words: teacher questionnaire, developmental coordination disorder, cross-cultural translation, reliability, validity

Introduction

Developmental Coordination Disorder (DCD) is a highly prevalent neurodevelopmental condition affecting 6–10% of school-aged children [1]. DCD is equally common among boys and girls [2, 3], although some epidemiological studies have indicated a male to female prevalence ratio of 2:1 [4]. The etiology of DCD is multi-faceted and complex. The literature most commonly identifies abnormalities present during the prenatal and perinatal periods [5] and genetic influences [6]. Detailed neuropathological analyses have yet to identify the specific deficiencies in a child's central nervous system which are responsible for DCD although a number of theories have been proposed involving numerous heterogeneous factors [7]. The onset of DCD occurs during early childhood and persists into adulthood, affecting activities of daily living both at home and school [8]. The symptoms of DCD most commonly manifest as chronic motor impairments which distinguish children from their developmentally typical peers [9]. DCD is diagnosed when the motor impairment is not related to other identifiable neurological problems such as cerebral palsy, intellectual disability, or other developmental disorders that may cause motor difficulties [10, 11].

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Assessments for DCD typically involve a developmental history analyzing deficits in three core areas: gross motor skills, fine motor skills, and psychosocial development [7]. The severity of functional deficits caused by DCD depends upon the combination of symptoms present. Common gross motor symptoms include difficulties learning and reproducing complex movement patterns such as catching and throwing a ball, riding a bicycle, skiing, maintaining balance, or combining movements into coordinated sequences [6]. The most prevalent hindrances in fine motor skills affect manipulative activities such as tying shoelaces, fastening buttons and zippers, or handwriting and drawing [12, 13]. Psychosocial symptoms include learning disabilities and behavioral disorders such as low self-esteem, anxiety, and interpersonal difficulties [3, 14, 15].

The wide variety of symptoms and underlying complexity of DCD impedes both diagnosis and classification of children [16], necessitating a multi-stage diagnostic process involving various specialists and a wide variety of diagnostic instruments. For these reasons, recommendations have been made in the literature that the first stage of a DCD diagnosis should involve an easy-to-administer screening questionnaire [6]. This initial step would only need to identify DCD-suspect children, who would then undergo formal confirmatory diagnosis. The questionnaire format is particularly attractive as it can assess a large child population in a short period of time with minimal staff training and negate the use of specialized equipment. Furthermore, questionnaires completed by individuals familiar with the child (parents, teachers, or caregivers) could negate artifacts that may be encountered in a clinical setting. Such individuals are able to assess motor function in a variety of environments and situations and discern subtle coordination difficulties. This would limit misdiagnosis of a child's motor development via false negatives or false positives [17].

One instrument developed to fulfill this goal is the Motor Observation Questionnaire for Teachers (MOQ-T), previously known as the Groninger Motor Observation Scale [18]. Teachers can observe and compare motor function across a wide population gradient. Their experience can greatly enhance the accuracy of a DCD screening questionnaire. The original Dutch version of the MOQ-T was confirmed as a valid and reliable DCD screening instrument [18] and has been translated into Japanese [19], Italian [20], and Finnish [21].

In Poland, knowledge of DCD is severely limited in both academic research and clinical and educational practice. In addition, the number of tools available to assess DCD is limited, hampering early identification. For this reason, the aim of present study was evaluate the cross-cultural translation of the MOQ-T for a Polish child population aged 5–11 years and to confirm the psychometric properties of the instrument. In particular, the internal consistency and factor structure were assessed and compared to data reported in previous research [18]. In addition, correlations between MOQ-T scores and the Körperkoordinationtest für Kinder, a standardized motor behavior test [22], were investigated to assess concurrent validity. Lastly, the discriminative validity of the MOQ-T was assessed by investigating the ability of the MOQ-T to discriminate typically developing children from those referred to a therapy center presenting with motor difficulties.

Material and methods

Participants

A normative sample of 384 children aged 5–11 years was selected from two different primary schools in the city of Wroclaw, Poland. This normative sample was comprised of healthy, typically developing (TD) children with no previous diagnoses of any developmental disorder and free of motor impairments. Health status was individually confirmed by the child's teacher who had access to health records which were corroborated with the child's family during regular parent–teacher meetings. Thirty-three children from the normative sample were randomly extracted to form a control sample with no inclusion or exclusion criteria. A clinic-referred sample of 31 children from local private therapy centers was also recruited. This clinic-referred group included only children who showed impaired motor function (difficulties with fine and gross motor control) while free of clinically relevant comorbidities such as cerebral palsy, muscular dystrophy, or mental disability. The parents or guardians of the participating children were informed about the purpose and procedures of the study and provided their written informed consent. Parents of the clinic-referred and control samples were also informed that a test battery assessing gross motor skills would be administered and that they would be notified of the results.

Measures

Motor Observation Questionnaire for Teachers (MOQ-T)

The original MOQ-T was designed to assess motor performance in activities of daily living as defined

by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5 criterion B). This questionnaire is designed to be carried out by teachers as they are able to observe a variety of motor tasks performed in a variety of situations. The MOQ-T contains 18 items assessing the fine and gross motor control of the child under investigation compared with his or her peers. Each item is rated on a four-point scale in which one point is assigned for statements that are never true and four points for statements that are always true. The questionnaire responses (level of agreement/disagreement) are summed to determine a total MOQ-T score which is adjusted for age and sex. A higher score denotes degraded motor performance and therefore a child who may have DCD [18]. This instrument has been revalidated on multiple occasions as having excellent psychometric properties. Internal consistency is high (Cronbach's alpha = 0.95) as is the sensitivity and specificity [18]. The Polish adaptation of the MOQ-T used in the present study was translated by an experienced translator whose native language was Polish. Expert opinion was obtained from educators, physical education teachers, and physiotherapists to validate the cross-cultural translation including terminology and syntax.

Körperkoordinationstest für Kinder (KTK)

The KTK was adopted as a reference standard as it is a highly recommended tool in the diagnosis of DCD [6] although it assesses only gross motor skills [22]. As a test battery, the KTK consists of four motor subtests with clearly specified protocols. Performance of each subtest results in a raw score. The raw performance scores are then summed and adjusted for age and sex. This standardized value is treated as a motor quotient (MQ), which classifies motor coordination into five different levels ranging from "high" to "motor-impaired" [22]. The KTK is frequently used in research to validate other diagnostic and screening tools. It has high validity and reliability in assessing motor coordination in children aged 5–11 years with and without developmental problems. The instrument was revalidated in 2007 confirming its high psychometric properties, although the reference norms were not updated and have been critiqued as obsolete [6, 23].

Procedures

The normative sample was evaluated by two physical education (PE) teachers who taught the children at their respective schools. The teachers were not blinded to the purpose of the study and were provided with general background information on DCD prior to completing the MOQ-T. Training was provided on how to complete the questionnaire. Each child was assessed only once by one of the teachers. For participants in the clinic-referred group their respective therapists completed the MOQ-T. The KTK was then administered by certified personnel according to published guidelines using equipment which was standardized in both groups.

Data analysis

Basic descriptive statistics were calculated for test results. As the data distribution for the clinic-referred group was significantly different from a normal distribution (Shapiro–Wilk test), non-parametric methods were used to analyze data from this group. The relationship between age and sex in both the clinic-referred and control groups were assessed using the Mann–Whitney U test and ρ-Spearman's rank correlation coefficients. Internal consistency of the MOQ-T was examined by calculating Cronbach's alpha for the normative sample. MOQ-T inter-item correlations were confirmed with Spearman's rank correlation. Construct validity was estimated via exploratory factor analysis using normative sample data (principal component with varimax rotation). The concurrent validity of the MOQ-T was assessed by calculating Spearman's rank correlation coefficients between the MOQ-T and KTK tests for both the control group and the clinic-referred group.

A Receiver Operator Characteristic (ROC) curve was composed in order to investigate the ability of the MOQ-T to discriminate between the clinic-referred sample of children with motor impairment and the control sample of TD children (discriminative validity). The area under the ROC curve (AUC) was calculated as a measure of the diagnostic potential of the MOQ-T. The AUC reflects the probability that a child with motor impairment would have attained a worse score on the MOQ-T than a TD child (a value between 0.50 and 0.70 is low, between 0.70 and 0.90 is moderate, and over 0.90 is high) [24]. Using the ROC analysis, the sensitivity and specificity of the MOQ-T was determined where sensitivity is the percentage of children with movement problems that are correctly detected by the MOQ-T whereas specificity is the percentage of children correctly identified to be without motor deficits. A sensitivity of approximately 80% and specificity of 90% is preferred based on the norms of the American Psychological Association [25].

Ethical approval

The research related to human use has been complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the authors' institutional review board or an equivalent committee.

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

The mean MOQ-T score in the normative group was 29.4 (*SD* = 10.9), where boys were rated significantly higher than girls (p = 0.001) (Table 1). Scores in this group were not dependent on age (p = 0.33). The mean MOQ-T score in the clinic-referred group was 57.8 (*SD* = 11.3). Although boys scored higher than girls this difference was not statistically significant. Similarly, no effects for age were found in the control sample (Table 2).

Table 1. Age and gender distribution of the different samples

Sample	Gender	*n*	Mean Age
Clinic-referred sample	Girls	10	9.3 (*SD* 1.3; range: 7–11)
	Boys	21	7.0 (*SD* 2.0; range: 5–11)
	Total	31	7.8 (*SD* 2.1; range: 5–11)
Control sample	Girls	19	9.8 (*SD* 0.6; range: 9–11)
	Boys	14	10.4 (*SD* 0.8; range: 9–11)
	Total	33	10.1 (*SD* 1.9; range: 9–11)
Normative sample	Girls	191	8.1 (*SD* 1.9; range: 5–11)
	Boys	193	8.9 (*SD* 2.1; range: 5–11)
	Total	384	8.1 (*SD* 1.9; range: 5–11)

Internal consistency: A Cronbach's alpha of 0.962 was found indicating high internal consistency. Satisfactory inter-correlations were also found between questionnaire items. Cronbach's alpha for the total score could be minimally enhanced by deleting items 3 (0.963), 7 (0.963), or 18 (0.963).

Construct validity: Factor analysis identified three first-order factors: gross motor skills (explaining 62.5% of variance), fine motor skills (explaining 9.4% of variance), and general motor coordination (explaining 6% of variance) (Table 3). Cronbach's alpha was 0.969 for the first factor (gross motor skills), 0.857for the second factor (fine motor skills), and 0.746 for the third factor (general motor coordination).

Concurrent validity: Results indicated a significant negative correlation between MOQ-T scores (where a high score suggests a higher probability of DCD) and KTK MQ (in which a high score indicates low probability of DCD) in the control group (ρ = –0.789; p < 0.001) and clinic-referred group (ρ = –0.691; p < 0.001), implying that children with poor scores on the MOQ-T also score poorly on the KTK.

Discriminant validity: The AUC metric for the sample was 0.96 (CI: 0.90–1.00). Sensitivity was 0.80 for a MOQ-T total score at or above 44.5, and specificity was 94%.

Discussion

The aim of the present study was to explore the psychometric properties of the Polish version of the MOQ-T as a screening tool for DCD. The internal consistency of the MOQ-T was high and comparable with not only the original Dutch version but also the Italian and Finnish adaptations [18, 20, 21]. In contrast to the original version and previous cross-cultural adaptations, factor analysis of the structure of the questionnaire

Table 2. Total MOQ-T scores of the samples by gender

Sample	Sex	*n*	MOQ-T score			
			Mean (SD)	Median	Min	Max
Normative sample	Girls	191	27.3 (9,8)	23.0	18	61
	Boys	193	31.4 (11,7)	29.0	18	60
	Total	384	29.4 (11,6)	26.0	18	61
Clinic-referred sample	Girls	10	55.2 (13,4)	50.5	42	71
	Boys	21	59.0 (10,3)	59.0	38	72
	Total	31	57.8 (11,2)	58.0	38	72
Control sample	Girls	19	26.9 (14,7)	20.0	18	68
	Boys	14	21.6 (5,5)	20.0	18	37
	Total	33	24.6 (11,9)	20.0	18	68

Table 3. *Factor* loading for the MOQ-T

Item	Factor 1: general motor factor	Factor 2: fine motor skills	Factor 3: coordination
1.	**0.84**[a]	0.26	0.23
2.	**0.90**	0.15	0.19
4.	**0.82**	0.21	0.36
8.	**0.80**	0.32	0.11
9.	**0.82**	0.36	0.23
10.	**0.86**	0.25	0.20
11.	**0.73**	0.39	0.30
13.	**0.86**	0.26	0.18
14.	**0.87**	0.13	0.18
15.	**0.87**	0.19	0.21
17.	**0.61**	0.25	0.52
3.	0.20	**0.85**	0.15
6.	0.50	**0.67**	0.28
12.	0.24	**0.84**	0.19
16.	0.44	**0.49**	0.39
5.	0.52	0.08	**0.68**
7.	0.06	0.40	**0.71**
18	0.22	0.15	**0.85**
% explained variance	62.5%	9.4%	6.0%
Eigenvalue	11.255	1.686	1.079

[a]Items that load on a particular factor are printed in bold

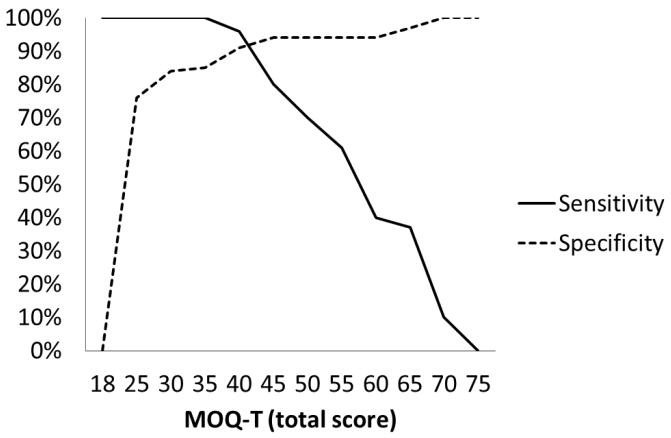

Figure 1. Sensitivity and specificity in relation to total MOQ-T scores

identified three factors. The first factor, explaining 62.5% of the total variance, is partly similar to that described in other studies validating the MOQ-T (termed in those studies as the *general motor factor*) [18]. However, three items which are encompassed in the general motor factor in previous studies formed a separate factor (factor 3) in the Polish version. This third factor has been termed '*coordination*' and it is unclear why the original general motor factor was split into two factors in the Polish version. A difference between the present study and previous studies is that physical education teachers filled out the questionnaire in the present study, whereas classroom teachers filled out the MOQ-T in the Dutch and Italian studies [18, 20]. Also, in the Finnish study, the majority of the questionnaires were filled out by classroom teachers with approximately 10% filled out by physical education teachers [21]. Whether the difference in factor structure is due to the fact that physical education teachers filled out the MOQ-T in the present study needs to be investigated in a future study. Obviously, physical education teachers are better trained to observe motor behavior than classroom teachers. However, inspection of the items that are part of factors 1 and 3 revealed that both involve either the assessment of gross motor skills or the assessment of the quality of movement performance in general. Therefore, from a practical point of view, the division of these items into two factors does not seem to be logical.

The other factor found in the original MOQ-T and cross-cultural adaptations (termed *handwriting*) was also identified in the Polish version, but with one additional fine motor item 'fastening buttons and tying shoelaces'. Therefore, this factor was labelled '*fine motor skills*' in the current study. A second difference with the Italian and Finnish adaptations was that item 9 'problems with eye-hand coordination' did was not a component of the fine motor factor but was instead

included in the first factor 'general motor coordination'. Eye-hand coordination is relevant for many fine motor tasks, but it also plays a role in gross-motor tasks such as ball catching. As physical education teachers are better trained to observe gross motor skills it may be that they are more likely to notice problems with eye-hand coordination in relation to gross motor skills. This may explain the difference between the results of the present study and previous studies regarding this item.

The concurrent validity was examined by calculating the correlations between the MOQ-T and KTK scores. A significant correlation was found between MOQ-T total scores and the KTK MQ in both the control and clinic-referred samples, indicating satisfactory concurrent validity between the two instruments. The correlations between the MOQ-T and the KTK in the present study are somewhat higher than those between the MOQ-T and the Movement Assessment Battery for Children Second Edition (MABC-2) in its original language version and Finnish cross-cultural adaptation [18, 21]. This is surprising as the KTK evaluates only gross motor skills whereas the MOQ-T and MABC-2 assess both fine and gross motor skills. The strong correlations between the KTK and MOQ-T may be best explained by the clinic-referred group involving children with poor general motor competence, with only few children presenting with difficulties with handwriting or graphomotor control. Hence, future research with the MOQ-T should involve a larger population sample with more careful selection of those included in a clinically-based group.

The Polish translation of the MOQ-T was found to have a sensitivity of 80% and a specificity of 94% which was the highest attained specificity among the other cross-cultural adaptations of the MOQ-T. These values are in accordance with the norms specified by the American Psychological Association (1985). However, these results need to be interpreted with caution as the MOQ-T scores for the clinic-referred group were determined not by teachers but by therapists trained to observe differences in motor performance who were very familiar with their respective child's movement impairments. The present study needs to be repeated with teachers completing the MOQ-T in a clinically referred sample in order to confirm the efficacy of questionnaire as a screening instrument in Poland.

Additionally, differences in the specificity of the cross-cultural adaptations may result from disparities in the applied reference instrument used to diagnose DCD. Many of the studies cited herein have assessed the validity of DCD screening protocols adopted the MABC-2 as a reference standard [6]. As the MABC-2 has not been standardized for a Polish population, research on motor impairments typically employs the KTK although its largest limitation is that is that it can only verify gross motor performance [6, 26, 27, 28]. Moreover, the relatively high psychometric properties of the MOQ-T may have been an effect of the combined normative and clinical sample, as above cited works studies only involved a normative sample. Another aspect that may explain the relatively high sensitivity and specificity of the MOQ-T may lie in the fact that the questionnaire was completed by physical education teachers (normative sample) and by therapists (clinic-referred group). Their knowledge and competency in evaluating child motor development and motor function may have had an enhanced effect on the psychometric properties of the MOQ-T. Future research should verify whether physical education teachers are more capable in rating motor performance than classroom teachers.

Despite the fact that affirmative outcomes were obtained, these result should be considered as preliminary findings and interpreted with caution. First, the normative sample was not stratified across different areas in Poland as only children from two schools within one city were included. The second limitation of the present study was that the clinic-referred sample was composed of children only suspected of DCD who presented with impaired motor function but without a confirmed diagnosis. Hence, additional research is warranted that includes not only DCD-afflicted children but also cohorts presenting with a variety of motor difficulties so as to ultimately verify the psychometric properties of the Polish MOQ-T. Third, only two teachers evaluated the motor skills of children in the normative sample which may have affected the results. Lastly, only the internal consistency was investigated as an aspect of reliability. In future studies, test-retest reliability and inter-rater reliability need also be addressed.

Conclusions

The results of the present study are promising. Despite the aforementioned limitations the Polish adaptation of the MOQ-T was found to present similar psychometric properties to the original MOQ-T. Further research is warranted before the MOQ-T can be recommended. This includes the inclusion of larger and more varied population samples and analysis of inter-rater reliability among different teacher cohorts. Additional comparisons are also necessary with the

more frequently used MABC-2 to further confirm the validity of the Polish adaptation of the MOQ-T.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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