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Reliability and validity of the Finnish version of the Motor Observation Questionnaire for Teachers

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## Abstract

### Objectives

Observational screening instruments are often used as an effective, economical first step in the identification of children with Developmental Coordination Disorder (DCD). The aim was to investigate the psychometric properties of the Finnish version of the Motor Observation Questionnaire for Teachers (MOQ-T-FI).

### Methods

The psychometric properties were tested using two separate samples (S1: age range 6–12, M 9y 5mo, females 101, males 92; S2: age range 6–9, M 7y 7mo, females 404, males 446). Teachers completed the MOQ-T-FI in both samples, and in sample 2 teachers' ratings were compared to student's performance on the Movement Assessment Battery for Children-Second Edition (MABC-2). Internal consistency was investigated by using Cronbach's alpha, predictive validity by receiver operating characteristic (ROC) analysis, concurrent validity by correlation analysis, and construct validity by factor analysis.

### Results

The MOQ-T-FI behaves consistently with its original Dutch version. The internal consistency was excellent ( $\alpha=.97$ ). The bifactor model, with one general factor and two specific factors, fit the data significantly better than the first-order model. The concurrent validity with the MABC-2 was moderate ( $r=.37$   $p<.001$ ). Sensitivity was 82.5% and specificity 44.5%, respectively.

### Conclusion

Notwithstanding the low specificity the MOQ-T-FI can be considered as a promising screening tool in the school environment for Finnish children at risk of motor learning problems.

*Keywords:* DCD, MOQ-T, validity, reliability, psychometric properties, screening

Muotoiltu: Ei Korosta

## 1. Introduction

Developmental coordination disorder (DCD) is a common neurodevelopmental disorder affecting approximately 5–6% of school-aged children. It is characterized by an inability to execute movement skills, with a significant negative impact on the child's performance in activities of daily living or academic skills (APA, 2013). The identification of children with DCD is complicated. A general lack of awareness, DCD's variability in presentation and comorbidity are the main reasons why identification is often delayed (Kennedy-Behr, Wilson, Rodger, & Mickan, 2013; Kirby, Davies, & Bryant, 2005; Wilson, Ruddock, Smits-Engelsman, Polatajko, & Blank, 2013), or even ignored. However, early identification is recommended to avoid commonly occurring secondary problems, such as social and emotional difficulties (Kirby, Sugden, & Purcell, 2014; Rigoli, Piek, Kane, & Oosterlaan, 2012; Wagner, Bös, Jascenoka, Jekauc, & Petermann, 2012; Viholainen, Aro, Purtsi, Tolvanen, & Cantell, 2014), health problems and inactivity (Hendrix, Prins, & Dekkers, 2014; Joshi et al., 2015; Rivilis et al., 2011), or academic problems (Cantell, Smyth, & Ahonen, 2003; Kantomaa et al., 2013).

The question, however, is how to best recognize those children who need support for their motor development. Standardized tests are time consuming and expensive (Cools, De Martelaer, Samaey, & Andries, 2009). Furthermore, there is disagreement on what might be the most accurate test in diagnosing DCD (Piek, Hands, & Licari, 2012; Watter et al., 2008), because commonly used standardized tests measure only discrete aspects of movement competency (Lane & Brown, 2015; Rudd et al., 2015). Observational questionnaires could reconcile the discrepancy between motor tests and give information about more diverse aspects of motor development (Doderer & Miyahara, 2013). Consequently, in order to measure movement competence, it is suggested to use a wider range of test batteries (Rudd et al., 2015). Therefore, a multilevel approach for testing and evaluation in different environments is recommended (APA, 2013; Cools et al., 2009; Wilson, 2005). Observational screening instruments are often used as an effective, economical first step in the identification of children with motor learning difficulties (Green et al., 2005; Cairney et al., 2007). Several questionnaires for parents (Wilson et al., 2009; Rosenblum, 2006), teachers (Rosenblum, 2006; Faught et al., 2008; Henderson, Sugden, & Barnett, 2007; Schoemaker, Flapper, Reinders-Messelink, & Kloet, 2008) and children (Cairney et al., 2007; Barnett, Robinson, Webster, & Ridgers, 2014) have been developed for that purpose, though it should be noted that questionnaires are subjective (Schoemaker & Wilson, 2014). Nevertheless, the questionnaires do provide useful information about functional motor abilities and how motor problems interfere with academic achievement or activities of daily living (Netelenbos, 2005; Schoemaker & Wilson, 2014).

In Finland, there are no observational questionnaires available for motor screening purposes. This lack notwithstanding, the new national school curriculum (which came into effect in August 2016) expects teachers to recognize motor learning difficulties in 6–9-year-old children. The Finnish National Core Curriculum focuses on earliest possible support in order to prevent the emergence and accumulation of problems. Support for growth and learning are provided in three stages: general support, intensified support and special support. General support provided by the classroom teacher is available for everyone as part of everyday teaching. If general support is not enough, then pedagogical assessment is required.

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Intensified and special supports are based on precise and careful assessment. (FNBE 2016). Therefore, an observational screening tool is needed to help teachers to recognize all children who need support in motor learning.

Cultural translation was chosen instead of developing a new questionnaire because it ensures comparability across international populations. (EACD, 2011; Rihtman, Wilson, & Parush, 2011). On the basis of a large systematic review, the Motor Observation Questionnaire for Teachers (MOQ-T) was chosen for culture and language adaptation in Finland (Asunta, Viholainen, Ahonen, Westerholm, & Rintala, 2014). This study aims to determine the psychometric properties of the Motor Observation Questionnaire for Teachers (MOQ-T-FI), and to investigate if the questionnaire can be used as a screening tool for motor learning difficulties in Finland. So far, sensitivity and specificity in motor observation questionnaires are usually lower in population-based screenings than they are in clinical populations. The sensitivity and specificity of MOQ-T have been investigated in a combined clinic-control sample only. This study is the first one to investigate the sensitivity and specificity of MOQ-T in a population-based sample.

## 2. Methods

### 2.1 Participants

Reliability and validity analyses were based on two community-based data sets: the first data set (S1; teachers  $n=27$ , children  $n=193$ , 6–12 years,  $M_{\text{age}}=9\text{y } 5\text{mo}$ ; females 52.3%, males 47.7%) and the second data set (S2; children  $n=850$ , 6–9 years,  $M_{\text{age}}=7\text{y } 7\text{mo}$ ; females 47.5%, males 52.5%). All children were without neurological, physical or intellectual disabilities. In S1, eight pre- and elementary schools in central Finland were selected. These were geographically distributed and included urban, suburban and rural areas. In most cases, all children from each class were tested. The exceptions included those cases in which the class size and the amount of consents received were large. For these, every second child was selected alphabetically. In S2, which serves as the reference data, the children were selected comprehensively from pre- and elementary schools in five different territories in Finland (north, south, west, east, and southwest), proportionally to the number of inhabitants. Each territory was divided further into three different municipalities (urban, suburban and rural). From each included class, three girls and three boys were selected by a specific system: every second child in alphabetical order. For pragmatic reasons, some classes were included as a whole. Ethical approval was obtained from the University of Jyväskylä Ethical Committee. Parents provided written, and children oral, consent.

### 2.2 Procedure

The first data set (S1) was designed to investigate concurrent validity, discriminative validity and predictive validity. All children were assessed with two instruments: the Movement Assessment Battery for Children – Second Edition, administered at school by a trained physical education teacher (adapted physical activity specialist); and the Motor Observation Questionnaire for Teachers (MOQ-T-FI), which was filled out by the classroom teacher (81.3%), physical education teacher (9.8%), preschool teacher (3.1%), special education teacher (4.1%) or other education professionals (1.6%). In 12.9% of the cases, two raters filled out the MOQ-T form. The second data set (S2) was used to calculate the Finnish

standards and to study internal consistency and construct validity. The reference value data consisted of MOQ-T-FI forms filled out by classroom teachers (82.5%), preschool teachers (11.2%), special education teachers (2.1%) and other education professionals (4.2%). In 20.2% of the cases, two adults filled out the questionnaire.

### 2.3 Instruments

**The Motor Observation Questionnaire for Teachers (MOQ-T).** The MOQ-T is an observational questionnaire for teachers to assess children aged 5–11 years. The MOQ-T is intended to assess teacher ratings of fine, gross and perceptual motor behavior performed in daily situations. It has been developed in the Netherlands by Van Dellen, Vaessen and Schoemaker (1990) and adapted by Schoemaker et al. (2008). The MOQ-T is an 18-item, 4-point scale, which is scored such that higher scores reflect greater risk for motor problems. Total points range from 18 to 72 (Schoemaker et al., 2008). The MOQ-T-FI is the Finnish version and it is a web-based questionnaire to help teachers recognize motor learning problems in the age range of 6–9 years. It has been culturally adapted and pretested for Finnish culture and language (Asunta et al., 2014). The cultural adaptation and translation were carried out according to international guidelines proposed by Beaton, Bombardier, Guillemin, & Ferraz (2000). Contact with the developer of the original MOQ-T was close during all six stages of the adaptation process. The initial validation and translation succeeded well (Asunta et al., 2014). Teachers completed the MOQ-T-FI forms electronically.

**The Movement Assessment Battery for Children (MABC-2).** The MABC-2 is a norm-referenced test which assesses motor functioning: fine motor tasks, balance and ball skills for children aged 3–16 years (Henderson, et al., 2007). The MABC-2 test is one of the most commonly used tests for detecting motor learning problems (Slater, Hillier, & Civetta, 2010).

### 2.4 Statistical analysis

Construct validity was established through principal component analysis. Previous factor analysis has revealed two factors contributing to motor problems: motor function and handwriting / fine motor control (Asunta et al., 2014; Giofre, Cornoldi, & Schoemaker, 2014; Schoemaker et al., 2008). Principal component analysis (PCA) with varimax rotation and confirmatory factor analysis (CFA) was used to analyze the fit of the hypothesized factor structure. To assess the CFA models, the following goodness of fit indexes by Hu and Bentler (1991) were used:  $\chi^2$ , comparative fit index (CFI;  $>.95$ ), Tucker-Lewis index (TLI;  $>.95$ ), root mean square error of approximation (RMSEA;  $<.06$ ), and standardized root mean square residual (SRMR;  $<.08$ ). In addition, the sample-size adjusted Bayesian information criterion (ABIC) was used in order to compare modified models to each other. The lower a model's ABIC is, the better the model is. The CFA models were compared using a Satorra-Bentler scaled chi-square difference test (Satorra & Bentler, 2001) and  $\Delta$ CFI criterion.  $\Delta$ CFI  $\leq$  -0.01 indicates that the null hypothesis of invariance should not be rejected (Cheung & Rensvold, 2002).

Internal consistency was calculated using Cronbach's coefficient alpha as a measure of reliability. It examines how well all the items (18) measure the same construct. The minimum acceptable value is 0.70 (Terwee et al., 2007). Average variance extracted (AVE;  $>0.5$ ), and

composite reliability (CR;  $> 0.7$ ) were calculated to measure construct reliability and convergent validity (Fornell & Larcker, 1981).

For establishing concurrent validity, Spearman's rho was calculated between the total score for the MOQ-T-FI and the total score on the MABC-2 test. A nonparametric test was used because of non-normally distributed data. Predictive validity was tested using a Receiver operating characteristic (ROC) curve.

Analyses were carried out using the Statistical Package for Social Science 20.0 (SPSS, Inc., Chicago, IL) and MPLUS 7.3 versions (Muthen & Muthen, 1998–2012). All statistical tests with  $p$  values less than .05 were considered significant. The effects of gender and age were analyzed with nonparametric tests and the effect sizes ( $r$ ) were evaluated by the recommendations of Cohen (1992), where  $.1 \leq r < .3$  represents small effect,  $.3 \leq r < .5$  medium effect, and  $.5 \leq r$  large effect. Missing values did not exist, because the data was collected electronically.

### 3. Results

A small but significant gender difference in S2 was found (Mann Whitney  $U=112513$ ,  $z=6.31$ ,  $p<.001$ ,  $r=.216$ ). Boys had a higher mean rank score for the MOQ-T-FI total score ( $Mdn=25$ ) than girls did ( $Mdn=21$ ). There were also age differences, measured with the Kruskal-Wallis nonparametric test ( $H(3)=19.754$ ,  $p<.001$ ). A more detailed comparison between the age groups revealed that the differences were significant between 6- and 7-year-olds ( $z=-94.70$ ,  $p=.002$ ,  $r=.277$ ) and also between 7- and 9-year-olds ( $z=97.53$ ,  $p<.001$ ,  $r=.243$ ), respectively. In both cases the effects were small. The computer program also counted the completion times for the electronic version of MOQ-T-FI. The average completion time was 3.3 minutes.

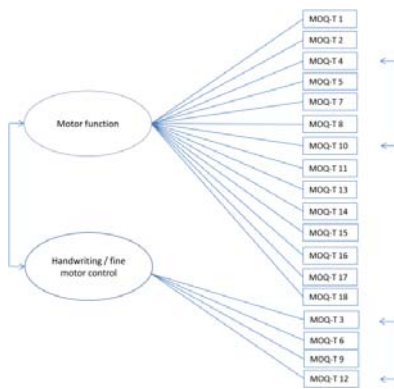
#### 3.1 Construct validity

The factorial structure of the MOQ-T-FI was estimated in two steps. Initially, the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO=.968) and Bartlett's test of sphericity ( $\chi^2=13763.56$  (153),  $p<.001$ ) were reviewed and the correlation matrix was shown to be suitable for factor analyses. In the first phase, principal component analysis (PCA) with a varimax rotation, where the estimated components are orthogonal, was used. The first two largest components, motor function and handwriting / fine motor control, were found, which together explained 70.5% of the variance. Almost the same two-factor structure was found in the original version (Schoemaker et al., 2008). In the second step, based on the structure of the PCA, we calculated a confirmatory factor analysis (CFA). The parameters of the CFA model were estimated by using the maximum likelihood robust (MLR) estimation method. The best model was received after some modifications were made. The largest modification index was between items 4 and 10 (mod=71.65) and between items 3 and 12 (mod=62.98), in which residual errors were allowed to correlate freely. Theory supported these modifications.

The first-order factor pattern of the MOQ-T-FI (Model 1, Figure 1) was equal to that of the original MOQ-T. Only one item, item 9, loaded MOQ-T-FI more on the handwriting factor than on general motor functioning (Schoemaker et al., 2008). However, exactly the same factor structure was found with the Italian adaptation of the MOQ-T (Giofre et al., 2014)

The correlation between the two factors, motor functioning and handwriting / fine motor control ( $r=.728, p<.001$ ), suggest that there might exist a general factor as well, which has been found in a previous study on the MOQ-T (Giofre et al., 2014). To test this finding we used a bifactorial model, which is not restricted by the number of first order factors. Furthermore, the advantage of the bifactor model is that it distinguishes the variances explained by the general factor and the independent specific factors, which are not allowed to correlate with each other. The general factor accounts for significant covariance of all the observed items, whereas the specific factors account for variance over and beyond the general factor (Chen, West, & Sousa, 2006; Chen, Hayes, Carver, Laurenceau, & Zhang, 2012). Both CFA models had the same error covariance structure. Both models, the first-order factor model and bifactor model, are illustrated in Figure 1.

### Model 1: The first-order factor model



### Model 2: Bifactor model

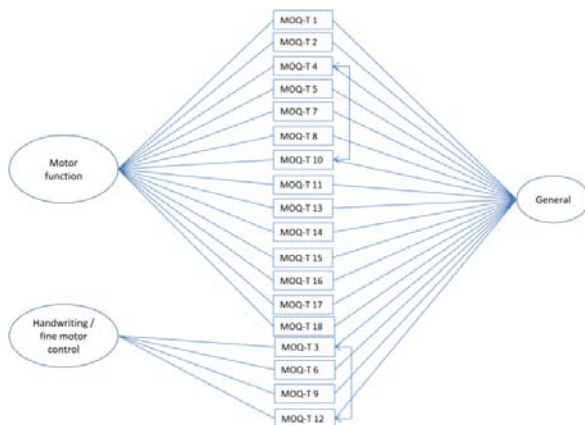




Figure 1. Structures of CFA models for the MOQ-T-FI.

Based on goodness-of-fit indexes, both models fit the data well (Table 1). The Satorra-Bentler scaled chi-square difference test demonstrated that the bifactor model fit the data significantly better than the first-order model did. In addition, the fit indexes and the change in ABIC criterion support this conclusion. All factor loadings were significant. The AVE values indicated good convergent validity for both factors in M1 and for the general factor in M2. The coefficients and estimates for both models can be seen in Table 2.

**Table 1. Fit indexes for CFA models**

Model	$\chi^2$ (df)	RMSEA	SRMR	CFI	TLI	ABIC
M1	530.90 (132) *	.060	.038	.951	.943	21850.503
M2	333.38 (115) *	.047	.020	.973	.964	21576.337

Model	$\Delta \chi^2$ ( $\Delta df$ )	$\Delta CFI$
M1-M2	175.50 (17) *	-.022

\*  $p < .001$ ;

Table 2. Factor coefficients and estimates for bifactor and first order factor models.-  
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### 3.2 Internal consistency

The internal consistency of the MOQ-T-FI was excellent for the total score ( $\alpha=.96$ ) and for two components (motor functioning,  $\alpha=.96$ ; handwriting / fine motor control  $\alpha=.90$ ). This reflects the fact that the items are closely interrelated. The item-total correlation coefficients ranged from .59 to .84. Cronbach's alpha did not increase significantly if any of the items were deleted (variation .957-.961). The CR values supported good internal consistency for both factors in M1 (.96/.89). In M2, the general factor (.96) and motor function (.89) showed excellent internal consistency, but handwriting/ fine motor control (.63) did not reach the minimum standard of .70.

### 3.3 Concurrent validity

The correlation between the total score on the MOQ-T-FI and the sum of the raw scores on all items (8) of the MABC-2 was assessed. Concurrent validity with MABC-2 was moderate, but statistically significant ( $r=.368, p<.001$ ).

### 3.4 Predictive validity

The sensitivity of the MOQ-T-FI was 82.0% and its specificity was 44.4% for the whole age range with a cut-off value of 36. In the age range of 6–9-year-old children, the sensitivity was 85.9% and specificity 50.0%, with a cut-off value of 37, and for 10–12-year-old children the sensitivity was 80.8%, and specificity was 52.6% with a cut-off value of 25. The estimated area under the receiver operating characteristic curve (AUC) for the whole age range was moderate: .73 (CI 95%, .64–.82). This indicates the likelihood that a child with motor problems receives a higher total score on the MOQ-T-FI than a child without motor problems does. (Figure 2)

Muotoiltu: Ei Korosta

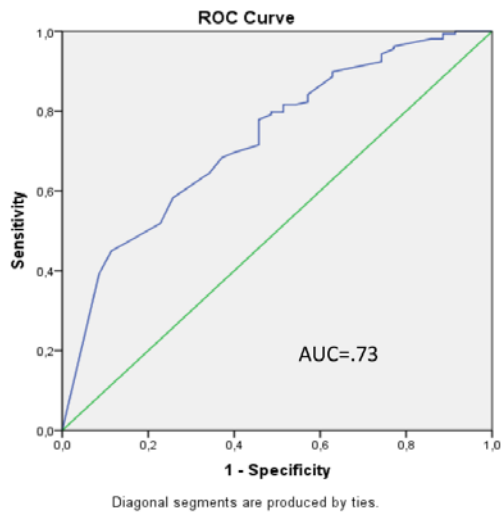


Figure 2. A receiver operating characteristic (ROC) model and area under curve (AUC)

Table 2. Factor coefficients for bifactor and first-order factor models.

Item	bifactor model (M2)				first order model (M1)	
	General	Motor function	Handwriting / fine motor	$R^2$	Motor function	Handwriting / fine motor
	$\lambda$ (s.e.)	$\lambda$ (s.e.)	$\lambda$ (s.e.)		$\lambda$ (s.e.)	$\lambda$ (s.e.)
1. The child's movements are very similar to the movements a younger child would make	.512 (.380)	.364 (.044)		.395	.629	
2. The child has difficulty performing activities involving whole-body movements (e.g., getting dressed, catching a ball)	.675 (.360)	.529 (.045)		.736	.855	
4. The child's movements are discontinuous; they lack fluency and feature stops and starts	.600 (.038)	.511 (.052)		.750	.866	
5. The child easily loses its balance	.630 (.044)	.527 (.053)		.676	.819	
7. When the child performs movements with the right or left hand, the other side of the body shows similar movements	.702 (.040)	.211 (.070)		.537	.701	
8. The child makes situationally correct movements but the timing is off	.723 (.039)	.385 (.064)		.672	.817	
10. The child's movements look rigid and stiff	.662 (.040)	.550 (.049)		.740	.856	
11. The child has difficulty making rhythmical movements	.766 (.027)	.312 (.049)		.684	.808	
13. The child's handwriting is more irregular than that of same-age peers	.627 (.048)	.500 (.058)		.643	.801	
14. The child needs to consciously plan movements that same-age peers perform automatically	.607 (.039)	.597 (.039)		.725	.832	
15. The child is unable to timely react to an approaching ball	.715 (.038)	.396 (.058)		.668	.815	
16. When pressed for time, the child quickly loses control over its movements	.742 (.030)	.213 (.050)		.595	.733	
17. The child shows impeded agility in dexterity games	.652 (.038)	.620 (.038)		.810	.882	
18. The child is clumsy, it drops things continuously	.694 (.041)	.507 (.054)		.738	.860	
3. When spelling or content require attention, the child writes less well than usual for a child of that age	.632 (.036)		.367 (.063)	.534		.721
6. The child has difficulty performing activities requiring fine movements (e.g., handicrafts, writing)	.769 (.039)		.483 (.080)	.825		.872
9. The child has problems with tasks requiring eye-hand coordination	.863 (.030)		.226 (.077)	.796		.893
12. The child has difficulty fastening buttons and tying shoelaces	.652 (.038)		.402 (.073)	.587		.757
Variances	*	*	*			
AVE <sup>a</sup>	.59	.39	.32		.65	.66
CR <sup>b</sup>	.96	.89	.63		.96	.89

Note: Standardized solution (STDYX);  $\lambda$  factor loadings; (s.e.) standard errors;  $R^2$ =R squared, (1- item error variance); \*Factor variances were constrained to be 1.00; <sup>a</sup>AVE=average variance extracted ( $\sum \lambda_i^2 / [(\sum \lambda_i^2) + \sum \text{Var}(\epsilon)]$ ), >.50 (Fornell & Larcker, 1981)<sup>28</sup>; <sup>b</sup>CR=Composite reliability, ( $\sum \lambda_i^2 / [(\sum \lambda_i^2) + \sum \text{Var}(\epsilon)]$ ), >.70 (Fornell & Larcker, 1981)<sup>28</sup>;

#### 4. Discussion

Our aim was to study validity and reliability of the MOQ-T in the Finnish context as an observational tool for teachers to recognize motor learning difficulties. An observational screening tool is needed to help teachers to recognize children who need support in motor learning. The need for this kind of tool is a topical issue in Finland because of the Core curricular change which emphasizes the early prevention of problems and support of learning in the problematic skill areas. Our results showed that the ability of the MOQT-FI to identify children with DCD is inadequate for health care screening purposes (APA, 1985) in which low specificity is unacceptable due to over-referral and for cost-effectiveness (Schoemaker & Wilson, 2014). However, low specificity is not a concern in the school context, where assessment and support are closely tied to each other, and therefore, the strength and extent of support is based on frequent assessment. Besides in the school context when the support is given by class or PE teachers, extra physical activity and support for a relatively large number of false positives does not cause any harm. For the identified children, no further assessment is necessary unless the support in the school environment has not been helpful, and the pupil has still major challenges in motor coordination and learning. Therefore we suggest that high sensitivity is the most important issue when the aim is to identify those children who could benefit from extra support in physical education and motor learning. Consequently we followed the aim of the original MOQ-T and were able to identify children with motor learning problems in order to offer extra support in motor learning within the school.

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Sensitivity did reach the required standard of >80%, which consequently meets international standards (APA, 1985). In addition, sensitivity and specificity in motor observation questionnaires are also usually lower in population-based screening than they are in clinical populations. Furthermore, the results regarding sensitivity are mixed (Schoemaker & Wilson, 2014). However, we believe that sensitivity and specificity could be further improved by better informing the teachers about motor learning problems and by training the teachers to administer the MOQ-T (Giofre et al., 2014).

The results provide support for the Finnish translation and cultural adaptation of the MOQ-T. Specificity and predictive validity were slightly better in the original Dutch version, but the original Dutch study consisted of a clinic sample of children, whereas community-based samples were included in the present Finnish sample. In other words, this study demonstrated the Finnish adaptation to be compatible with the original MOQ-T. MOQ-T-FI can be used as a fast, initial screening tool for identifying motor learning problems, like DCD, particularly in the school context in Finland. This is true despite the fact that the original MOQ-T was not developed for use as a population-based screening.

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Separate norms and cut-off scores for different age groups and for girls and boys will be needed in Finland, because gender and age significantly influenced the MOQ-T-FI total score. A closer look at the bifactor model loadings reveals that loadings are higher on the general motor factor than on the two underlying specific factors, that is, on motor functioning and handwriting. Accordingly, when children are identified by teachers as having motor problems, the interventions and support could be set for all areas of motor functioning.

It is known that teacher ratings of gross motor skills suffer from low concurrent validity (Netelenbos, 2005), which was also apparent in this study. The low concurrent validity might be due to a difference in the nature of the activities assessed by the MOQ-T and the MABC-2. Standardized motor tests such as the MABC-2 include a limited number of motor activities

that are only partly related to the daily activities children encounter at home or at school. Questionnaires have an advantage over standardized tests because they assess a broader area of motor function. In particular, they assess the functional skills and limitations across a variety of tasks and settings in daily living (Green et al., 2005).

Despite some limitations, as described above, the MOQ-T-FI could help teachers to recognize motor learning difficulties, including the DCD, in 6–9 year old children. This finding is timely due to the forthcoming national school curriculum requirements in Finland. This study shows that MOQ-T-FI is an easy-to-use, inexpensive questionnaire, which provides valid and reliable information for teachers. The usability in a school context is excellent, especially compared to most standardized tests. A professionally performed motor competence assessment takes 30 to 40 minutes, whereas MOQ-T-FI takes approximately 3 minutes of a teacher's time. Nevertheless, if the child's motor difficulties are severe and more support in motor learning is needed than the teacher can give, a standardized motor test is essential to confirm the range and degree of motor learning problems. If it is likely that a child has such serious problems in motor learning that the activities of daily living are limited, a teacher can, in these situations, guide the child and the parents to further discuss the situation with a school nurse or, if available, a school doctor, who can make a referral to additional motor assessment. In such a situation, the MOQT-FI results can provide important information about functional limitations across a variety of tasks related to daily living and academic skills in the school environment. MOQ-T-FI results could also be utilized this way in clinical settings. However, it is recommended to first conduct a study which aims to investigate the psychometric properties in a referred clinic sample.

## 5. Conclusion

In spite of the low specificity and concurrent validity with MABC-2, MOQ-T-FI can be considered as a quick and promising screening tool for early identification of motor learning problems in schools in Finland. It is likely that this kind of a feasible observational tool would (1) increase teacher awareness of motor learning problems among their pupils, (2) help teachers to recognize children at risk of DCD, and (3) give important information about the functional limitations across a variety of tasks and settings in daily living. However, further research is required to more specifically evaluate the validity and the inter-rater and test-retest reliability of the Finnish adaptation of the MOQ-T in both clinic-referred and population-based samples. In the future, it would be also interesting to explore the cultural validity and make comparisons between countries.

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## References

Muotoiltu: Ei Korosta

- APA (1985). *Standards for educational and psychological testing*. American Psychological Association. Washington, DC, USA.
- APA (2013). *Diagnostic and Statistical Manual of Mental Disorders, 5<sup>th</sup> ed.* American Psychiatric Association. Washington, DC, USA.
- Asunta, P., Viholainen, H., Ahonen, T., Westerholm, J. & Rintala, P. (2014). Motoriikan Havainnointilomake suomalaisille opettajille-Motor Observation Questionnaire for Teachers lomakkeen kulttuurinen kääntäminen [Cultural Adaptation of Motor Observation Questionnaire for Teachers – development of Finnish version (MOQ-T-FI)]. *Liikunta ja Tiede, 52*, 78–86.
- Barnett, L., Robinson, L.E., Webster, E.K. & Ridgers, N.D. (2015). Reliability of the Pictorial Scale of Perceived Movement Skill Competence in Two Diverse Samples of Young Children. *Journal Physical Activity and Health, 12*(8), 1045-1051. <http://dx.doi.org/10.1123/jpah.2014-0141>
- Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine, 25*(24), 3186-3191.
- Cairney, J., Veidhuizen, S., Kurdyak, P., Missiuna, C., Faight, B. E., & Hay, J. (2007). Evaluating the CSAPPA subscales as potential screening instruments for developmental coordination disorder. *Archives of Disease in Childhood, 92*(11), 987-991. <http://dx.doi.org/10.1136/adc.2006.115097>
- Cantell, M. H., Smyth, M. M., & Ahonen, T. P. (2003). Two distinct pathways for developmental coordination disorder: Persistence and resolution. *Human Movement Science, 22*(4), 413-431.
- Chen, F.F., West, S.G., & Sousa, K.H. (2006). A comparison of bifactor and second-order models of quality of life. *Multivariate Behavioral Research, 41*, 189–225.
- Chen, F.F., Hayes, A., Carver, C.S., Laurenceau, J-P., & Zhang, Z. (2012). Modeling general and specific variance in multifaceted constructs: a comparison of the bifactor model to other approaches. *Journal of Personality and Social Psychology, 80*, 219–251.
- Cheung, G.W., Rensvold, R.B. (2002). Evaluating Goodness-of-FitIndexes for Testing Measurement Invariance. *Structural Equation Modeling, 9*, 233-255.
- Cohen, J. (1992). A power primer. *Psychology Bulletin, 112*: 155.
- Cools, W., De Martelaer, K., Samaey, C., & Andries, C. (2009). Movement skill assessment of typically developing preschool children: A review of seven movement skill assessment tools. *Journal of Sports Science & Medicine, 8*(2), 154.
- Doderer, L., & Miyahara, M. (2013). Critical triangulation of a movement test, questionnaires, and observational assessment for children with DCD. *International Journal of Therapy and Rehabilitation, 20*(9), 435-442.

- EACD, European Academy of Childhood Disability. (2011). EACD Recommendations, long version. Definition, diagnosis, assessment and intervention of Developmental Coordination Disorder, 1–115.
- Faught, B. E., Cairney, J., Hay, J., Veldhuizen, S., Missiuna, C., & Spironello, C. A. (2008). Screening for motor coordination challenges in children using teacher ratings of physical ability and activity. *Human Movement Science, 27*(2), 177-189.
- FNBE, Finnish National Board of Education. (2016). The National Core Curriculum for Basic Education 2014. Porvoo: Kirjakeskus Oy, Finland. Digital publication, ISBN 978-952-13-6259-0.
- Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50.
- Giofre, D., Cornoldi, C., & Schoemaker, M. M. (2014). Identifying developmental coordination disorder: MOQ-T validity as a fast screening instrument based on teachers' ratings and its relationship with praxic and visuospatial working memory deficits. *Research in Developmental Disabilities, 35*(12), 3518-3525.
- Green, D., Bishop, T., Wilson, B. N., Crawford, S., Hooper, R., Kaplan, B., et al. (2005). Is questionnaire-based screening part of the solution to waiting lists for children with developmental coordination disorder? *The British Journal of Occupational Therapy, 68*(1), 2-10.
- Henderson, S. E., Sugden, D. A., & Barnett, A. L. (2007). *Movement assessment battery for children-2: Movement ABC-2: Examiner's manual* Pearson.
- Hendrix, C., Prins, M., & Dekkers, H. (2014). Developmental coordination disorder and overweight and obesity in children: A systematic review. *Obesity Reviews, 15*(5), 408-423.
- Hu, L., & Bentler, P. (1991). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.
- Joshi, D., Missiuna, C., Hanna, S., Hay, J., Faught, B. E., & Cairney, J. (2015). Reprint of "Relationship between BMI, waist circumference, physical activity and probable developmental coordination disorder over time". *Human Movement Science, 42*, 307-317.
- Kantomaa, M. T., Stamatakis, E., Kankaanpää, A., Kaakinen, M., Rodriguez, A., Taanila, A., ... Tammelin, T. (2013). Physical activity and obesity mediate the association between childhood motor function and adolescents' academic achievement. *Proceedings of the National Academy of Sciences of the United States of America, 110*(5), 1917-1922.
- Kennedy-Behr, A., Wilson, B. N., Rodger, S., & Mickan, S. (2013). Cross-cultural adaptation of the developmental coordination disorder questionnaire 2007 for German-speaking countries: DCDQ-G. *Neuropediatrics, 44*(5), 245-251.

- Kirby, A., Davies, R., & Bryant, A. (2005). Do teachers know more about specific learning difficulties than general practitioners? *British Journal of Special Education*, 32(3), 122-126.
- Kirby, A., Sugden, D., & Purcell, C. (2014). Diagnosing developmental coordination disorders. *Archives of Disease in Childhood*, 99(3), 292-296.
- Lane, H., & Brown, T. (2015). Convergent validity of two motor skill tests used to assess school-age children. *Scandinavian Journal of Occupational Therapy*, 22(3), 161-172.
- Muthen, L. K., & Muthen, B. (2012). 1998-2012. Mplus User's Guide (7th ed.). Los Angeles, CA: Muthen & Muthen.
- Netelenbos, J. B. (2005). Teachers' ratings of gross motor skills suffer from low concurrent validity. *Human Movement Science*, 24(1), 116-137.  
<http://doi:10.1016/j.humov.2005.02.001>
- Piek, J. P., Hands, B., & Licari, M. K. (2012). Assessment of motor functioning in the preschool period. *Neuropsychology Review*, 22(4), 402-13.
- Rigoli, D., Piek, J. P., Kane, R., & Oosterlaan, J. (2012). An examination of the relationship between motor coordination and executive functions in adolescents. *Developmental Medicine & Child Neurology*, 54(11), 1025-1031.
- Rihtman, T., Wilson, B. N., & Parush, S. (2011). Development of the little developmental coordination disorder questionnaire for preschoolers and preliminary evidence of its psychometric properties in israel. *Research in Developmental Disabilities: A Multidisciplinary Journal*, 32(4), 1378-1387.
- Rivilis, I., Hay, J., Cairney, J., Klentrou, P., Liu, J., & Faight, B. E. (2011). Physical activity and fitness in children with developmental coordination disorder: A systematic review. *Research in Developmental Disabilities*, 32(3), 894-910.
- Rosenblum, S. (2006). The development and standardization of the children activity scales (ChAS-P/T) for the early identification of children with developmental coordination disorders. *Child: Care, Health and Development*, 32(6), 619-632.
- Rudd, J., Butson, M., Barnett, L., Farrow, D., Berry, J., Borkoles, E., et al.(2015). A holistic measurement model of movement competency in children. *Journal of Sports Sciences*, (ahead-of-print), 1-9.
- Satorra, A., & Bentler, P. (2001). A scaled difference chi-square test statistic for momentstructure analysis. *Psychometrika* 66, 507-514.
- Schoemaker, M. & Wilson, B. (2014). Screening for Developmental Coordination Disorder in school-age children. In J. Cairney (Eds.). *Developmental coordination disorder and its consequences* (pp. 196-191).University of Toronto Press.
- Schoemaker, M. M., Flapper, B. C. T., Reinders-Messelink, H., & Kloet, A. d. (2008). Validity of the motor observation questionnaire for teachers as a screening instrument



for children at risk for developmental coordination disorder. *Human Movement Science*, 27(2), 190-199.

Slater, L. M., Hillier, S. L., & Civetta, L. R. (2010). The clinimetric properties of performance-based gross motor tests used for children with developmental coordination disorder: A systematic review. *Pediatric Physical Therapy*, 22(2), 170-179.

Terwee, C.B., Bot, S.D.M., Boer, M.R., Van der Windt, D.A., Knoll, D.L., Dekker, J., et al. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of Clinical Epidemiology*, 60, 34-42.

Van Dellen, T., Vaessen, W., & Schoemaker, M. M. (1990). Clumsiness Definition and Selection of Subjects. In A. F. Kalverboer (Ed.), *Developmental Biopsychology: Experimental and Observational Studies in Children at Risk*. (8 ed., Vol. International Academy for Research in Learning Disabilities monograph series, (pp. 135-153). Ann Arbor, Michigan: University of Michigan Press.

Kentän koodi muuttunut

Viholainen, H., Aro, T., Purtsi, J., Tolvanen, A., & Cantell, M. (2014). Adolescents' school-related self-concept mediates motor skills and psychosocial well-being. *British Journal of Educational Psychology*, 84(2), 268-280.

Wagner, M. O., Bös, K., Jascenoka, J., Jekauc, D., & Petermann, F. (2012). Peer problems mediate the relationship between developmental coordination disorder and behavioral problems in school-aged children. *Research in Developmental Disabilities*, 33(6), 2072-2079.

Watter, P., Rodger, S., Marinac, J, Woodyatt, G, Ziviani, J, & Ozanne, A. (2008) Multidisciplinary assessment of children with developmental coordination disorder: using the ICF framework to inform assessment. *Physical & Occupational Therapy in Pediatrics*, 28: 331-352.

Wilson, P. (2005). Practitioner review: Approaches to assessment and treatment of children with DCD: an evaluative review. *Journal of Child Psychology and Psychiatry*, 46(8), 806-823.

Wilson, B. N., Crawford, S. G., Green, D., Roberts, G., Aylott, A., & Kaplan, B. J. (2009). Psychometric properties of the revised developmental coordination disorder questionnaire. *Physical & Occupational Therapy in Pediatrics*, 29(2), 182-202.

Wilson, P., Ruddock, S., Smits-Engelsman, B., Polatajko, H., & Blank, R. (2013). Understanding performance deficits in developmental coordination disorder: A meta-analysis of recent research. *Developmental Medicine & Child Neurology*, 55(3), 217-228.