

ASSESSMENT OF DEVELOPMENTAL COORDINATION DISORDER IN SPANISH CHILDREN

CROSS-CULTURAL ADAPTATION, PSYCHOMETRIC VALIDATION AND
REFERENCE NORMS FOR THE EUROPEAN SPANISH DCD-QUESTIONNAIRE

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Assessment of Developmental Coordination Disorder in Spanish Children. Cross-Cultural Adaptation, Psychometric Validation and Reference Norms for the European Spanish DCD-Questionnaire

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La presente memoria de tesis titulada “*Assessment of Developmental Coordination Disorder in Spanish Children. Cross-Cultural Adaptation, Psychometric Validation and Reference Norms for the European Spanish DCD-Questionnaire*” presentada por Doña Rebeca Montes Montes, graduada en Terapia Ocupacional por la Universidad de Oviedo, ha sido realizada bajo nuestra dirección y reúne todas las condiciones necesarias de originalidad, calidad y rigor científico para ser defendida públicamente y optar al Grado de Doctora con Mención Internacional en Ciencias de la Salud por la Universidade da Coruña.

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ABSTRACT

Developmental Coordination Disorder (DCD) affects 5-6% of school-aged children. Still, DCD is a highly underdiagnosed disorder in the Spanish context. Providing cross-culturally adapted, reliable and accessible diagnostic instruments is a necessary first step to improve the quick identification of children at risk of DCD and to raise awareness of this disorder in the Spanish context. The aims of this thesis were (1) to translate and cross-culturally adapt the Developmental Coordination Disorder Questionnaire (DCDQ) into European Spanish, (2) to test its psychometric properties in the Spanish population, and (3) to develop country-adjusted reference norms of the DCDQ for Spanish children. The DCDQ was cross-culturally adapted into European Spanish following international guidelines (DCDQ-ES), and it was standardized using a sample of 570 Spanish children. After a multi-step process involving a multidisciplinary team, the DCDQ-ES achieved good cross-cultural equivalence. Internal consistency values were excellent, and construct, concurrent and discriminant validity of the DCDQ-ES were adequate. Finally, age-specific reference norms were developed for Spanish children. In conclusion, the DCDQ-ES shows cross-cultural equivalence with the original version, and it shows good psychometric properties in the Spanish context. The DDCDQ-ES is a reliable and valid instrument to assist in the quick identification of DCD in Spanish children.

RESUMEN

El Trastorno del Desarrollo de la Coordinación (TDC) afecta al 5-6% de la población escolar. Sin embargo, el TDC es altamente desconocido en España. Disponer de instrumentos diagnósticos de fácil acceso, adaptados transculturalmente, fiables y válidos, es un necesario primer paso para mejorar la rápida identificación de riesgo de TDC y para aumentar la visibilidad de esta condición de salud en nuestro contexto. Los objetivos de esta tesis fueron (1) adaptar transculturalmente a castellano el Developmental Coordination Disorder Questionnaire (DCDQ), (2) examinar sus propiedades psicométricas en el contexto español, y (3) desarrollar normas de referencia del DCDQ específicas para población infantil española. El DCDQ fue traducido y adaptado transculturalmente a castellano según las recomendaciones y guías internacionales (DCDQ-ES), y se estandarizó con una muestra de 570 escolares españoles. Tras un proceso multidisciplinar, el DCDQ-ES alcanzó buena equivalencia transcultural. Los valores de consistencia interna fueron excelentes, y la validez estructural, concurrente y discriminante fueron adecuadas. Por último, se desarrollaron normas de referencias españolas específicas por edad. En conclusión, el DCDQ-ES es transculturalmente equivalente a la versión original, y tiene buenas propiedades psicométricas. El DCDQ-ES un instrumento válido y fiable para evaluar rápidamente riesgo de TDC en población infantil española.

RESUMO

O Trastorno do Desenvolvemento da Coordinación (TDC) afecta ao 5-6% da poboación escolar. Con todo, o TDC é moi descoñecido en España. Dispoñer de instrumentos diagnósticos de fácil acceso, adaptados transculturalmente, fiables e válidos, é un primeiro paso necesario para mellorar a rápida identificación de risco de TDC e para aumentar a visibilidade desta condición de saúde no noso contexto. Os obxectivos desta tese foron (1) adaptar transculturalmente ao castelán o Developmental Coordination Disorder Questionnaire (DCDQ), (2) examinar as súas propiedades psicométricas no contexto español, e (3) desenvolver normas de referencia do DCDQ específicas para poboación infantil española. O DCDQ foi traducido e adaptado transculturalmente a castelán segundo as recomendacións e guías internacionais (DCDQ-ES), e estandarizouse cunha mostra de 570 escolares españois. Tras un proceso multidisciplinar, o DCDQ-ES alcanzou unha boa equivalencia transcultural. Os valores da consistencia interna foron excelentes, e a validez estrutural, concorrente e discriminante foron axeitados. Por último, desenvolvéronse normas de referencias españolas específicas por idade. En conclusión, o DCDQ-ES é transculturalmente equivalente á versión orixinal, e ten unhas boas propiedades psicométricas. O DCDQ-ES é un instrumento válido e fiable para avaliar rapidamente o risco de TDC en poboación infantil española.

OUTLINE OF THIS THESIS

This doctoral thesis is a compendium of three scientific publications that cover the cross-cultural adaptation, psychometric validation and development of reference norms for the Developmental Coordination Disorder Questionnaire (DCDQ) into Spanish context.

Chapter 1 of this thesis provides context of the definition and diagnosis of Developmental Coordination Disorder (DCD). This chapter also includes an overview of the DCD assessment in Spanish context, and describes the process of cross-cultural adaptation and psychometric validations of health condition assessment tools into new contexts. *Chapter 1* ends by stating the aims of this thesis.

Chapter 2 describes (a) the comprehensive cross-cultural adaptation process of the DCD into European Spanish based on international recommendations, and (b) the preliminary validation of the DCDQ in Spanish children. Once the final version of the European Spanish DCDQ was obtained, the further validation and development of country-adjusted percentiles are described in *Chapters 3* and *4*.

In *Chapter 3*, the concurrent validity of the DCDQ in Spanish children was investigated by examining its correlation and agreement with the Spanish version of the DCDDaily-Q. This chapter also provides the Spanish age- and sex-specific percentiles for the DCDDaily-Q.

Chapter 4 describes (a) the further psychometric validation of the DCDQ in the Spanish population, including its construct and discriminant validity, sensibility and specificity, and (b) the Spanish age-specific percentiles and cut-off scores for the DCDQ.

Finally, *Chapter 5* provides a summary, overall discussion and final conclusions of the work presented in this thesis. Implications and relevance of this thesis for Spanish professionals in research and clinical settings are discussed, and limitations and directions for future research are suggested. This chapter is also available in Spanish.

Supplementary information of this thesis is included in *Appendix*, after general references. *Appendix* contain (1) output of the thesis, (2) certificate of ethics committee approval, (3) the European Spanish version of the DCDQ, (4) quality indicators of the publications, and (5) first and last pages of the published studies.

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CHAPTER 1

GENERAL INTRODUCTION



DEVELOPMENTAL COORDINATION DISORDER

Children with Developmental Coordination Disorder (DCD) present deficits in their motor coordination ability, which has persistent and significant consequences for daily functioning¹. This disorder is characterized by a deficit in the acquisition and performance of motor coordination skills according to the child's chronological age and opportunity for skill learning and use, that cannot be better explained by the presence of a developmental or neurological condition affecting movement^{1,2}.

The impact of DCD on daily functioning has been persistently reported in the literature. Participation in meaningful activities of daily living (ADL), also defined as involvement in a life situation, is considered a main health component by the International Classification of Functioning, Disability and Health (ICF)³ and it is severely compromised in children with DCD. Several studies have shown that children and adolescents with DCD encounter activity limitations and participation restrictions in those occupational domains that are most relevant for children, i.e., “self-care”, “education” and “play and leisure”⁴⁻⁷. In addition, children with DCD often face associated difficulties apart from poor motor coordination. For instance, physical and psychosocial issues are highly prevalent among these children, such as obesity and poor physical fitness, low self-esteem, poor perceived efficacy and internalizing problems⁸⁻¹³.

DCD in the Spanish context

It is estimated that DCD has a worldwide prevalence rate of 5-6% in school-aged children, making it one of the most prevalent neurodevelopmental disorders in childhood^{1,2}; this equates to more than 200,000 Spanish children¹⁴. Prevalence estimates for DCD highly vary according to country and selection criteria¹⁵, and thus it is important to investigate the presence of DCD in each context. However, research on DCD in the Spanish context is extremely scarce, as it is still a highly unknown disorder among Spanish professionals in research and clinical settings¹⁶. At the beginning of this thesis, only one study had roughly explored the prevalence of potential DCD in the Spanish context, founding a prevalence of risk of DCD of 17.4% in preschool children¹⁷. Still, only 1% of Spanish school-aged children seek care in Paediatric Primary Care for motor coordination issues¹⁸. Overall, the Spanish health system is not identifying children with DCD¹⁶.

It is possible that lack of available screening tools that are easy to access and to use contributes to the low knowledge and identification of this disorder in Spain^{16,19,20}. Improving DCD identification, screening and diagnosis is considered to be a main priority of healthcare professionals²⁰. Early assessment and identification of children at risk of DCD are key factors to promoting a further comprehensive diagnosis of DCD and to accessing services that support these children and their families^{20,21}. Therefore, providing accessible, reliable and valid screening tools may improve the healthcare professionals' ability to accurately identify and assess DCD, and it will contribute to raise awareness of this disorder in the Spanish context.

IDENTIFICATION AND DIAGNOSIS

There is international consensus on the diagnosis and assessment of DCD. The Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) provides clear diagnostic criteria for DCD¹ (see Table 1). These criteria have been confirmed by the European Academy of Childhood Disability (EACD) with only some minor changes², and are very similar to the International Classification of Diseases-11 (ICD-11) description of DCD²² (see Table 1).

Table 1. Diagnostic criteria for Developmental Coordination Disorder

Diagnostic criteria (DSM-5) ¹	Diagnostic criteria (EACD) ²	Description (ICD-11) ²²
A. The acquisition and execution of coordinated motor skills is substantially below that expected given the individual's chronological age and opportunity for skill learning and use. Difficulties are manifested as clumsiness as well as slowness and inaccuracy of performance of motor skills.	I. The acquisition and execution of coordinated motor skills is substantially below that expected given the individual's chronological age and sufficient opportunities to acquire age-appropriate motor skills.	1. Significant delay in the acquisition of gross and fine motor skills and impairment in the execution of coordinated motor skills that manifest in clumsiness, slowness, or inaccuracy of motor performance. Coordinated motor skills are markedly below that expected given the individual's chronological age and level of intellectual functioning.
B. The motor skills deficit in Criterion A significantly and persistently interferes with activities of daily living appropriate to chronological age and impacts academic/school productivity, prevocational and vocational activities, leisure, and play.	II. The motor skills deficit described in criterion I significantly and persistently interferes with the activities of everyday living appropriate to chronological age and impacts upon academic/school productivity, prevocational and vocational activities, leisure, and play.	3. Coordinated motor skills difficulties cause significant and persistent limitations in functioning (e.g. in activities of daily living, school work, and vocational and leisure activities). **

* The order of criteria C and D (DSM-5) is inverted in the EACD recommendations (criteria IV and III).

** The order of criteria B and C (DSM-5) is inverted in the ICD-11 description.

Table 1 (cont). Diagnostic criteria for Developmental Coordination Disorder

Diagnostic criteria (DSM-5) ¹	Diagnostic criteria (EACD) ²	Description (ICD-11) ²²
C. Onset of symptoms is in the early developmental period.	IV. Onset of symptoms in childhood (although not always identified until adolescence or adulthood). *	2. Onset of coordinated motor skills difficulties occurs during the developmental period and is typically apparent from early childhood. **
D. The motor skills deficits are not better explained by intellectual disability or visual impairment and are not attributable to a neurological condition affecting movement.	III. The motor skills deficits are not better accounted for by any other medical, neurodevelopmental, psychological, social condition, or cultural background. *	4. Difficulties with coordinated motor skills are not solely attributable to a Disease of the Nervous System, Disease of the Musculoskeletal System or Connective Tissue, sensory impairment, and not better explained by a Disorder of Intellectual Development.

* The order of criteria C and D (DSM-5) is inverted in the EACD recommendations (criteria IV and III).

** The order of criteria B and C (DSM-5) is inverted in the ICD-11 description.

Diagnosis assessment

The diagnosis of DCD should be made by a multi-professional team that evaluates the specified criteria². The team should include a physician (i.e., child psychiatrist, developmental paediatrician or child neurologist) and an occupational therapist trained in the standardized motor tests and the observational tools used to assess the motor capacity and daily performance and participation²³. Other professionals may also contribute to the process of diagnosis (i.e., physical therapist, speech therapist, ophthalmologist, psychologist or educational psychologist)².

In order to provide a unified process of diagnosis assessment, the EACD international clinical practice recommendations on the definition, diagnosis and assessment of DCD proposed a pathway to accurately diagnose DCD². Although the recommendation is designed to first operationalize criterion C/IV, a preliminary assessment of criterion B/II through parental screening questionnaires may be a relevant starting point as well²⁴, as difficulties in motor-based ADL often account for the first signal of potential underlying motor issues^{2,19,25} (see Figure 1).

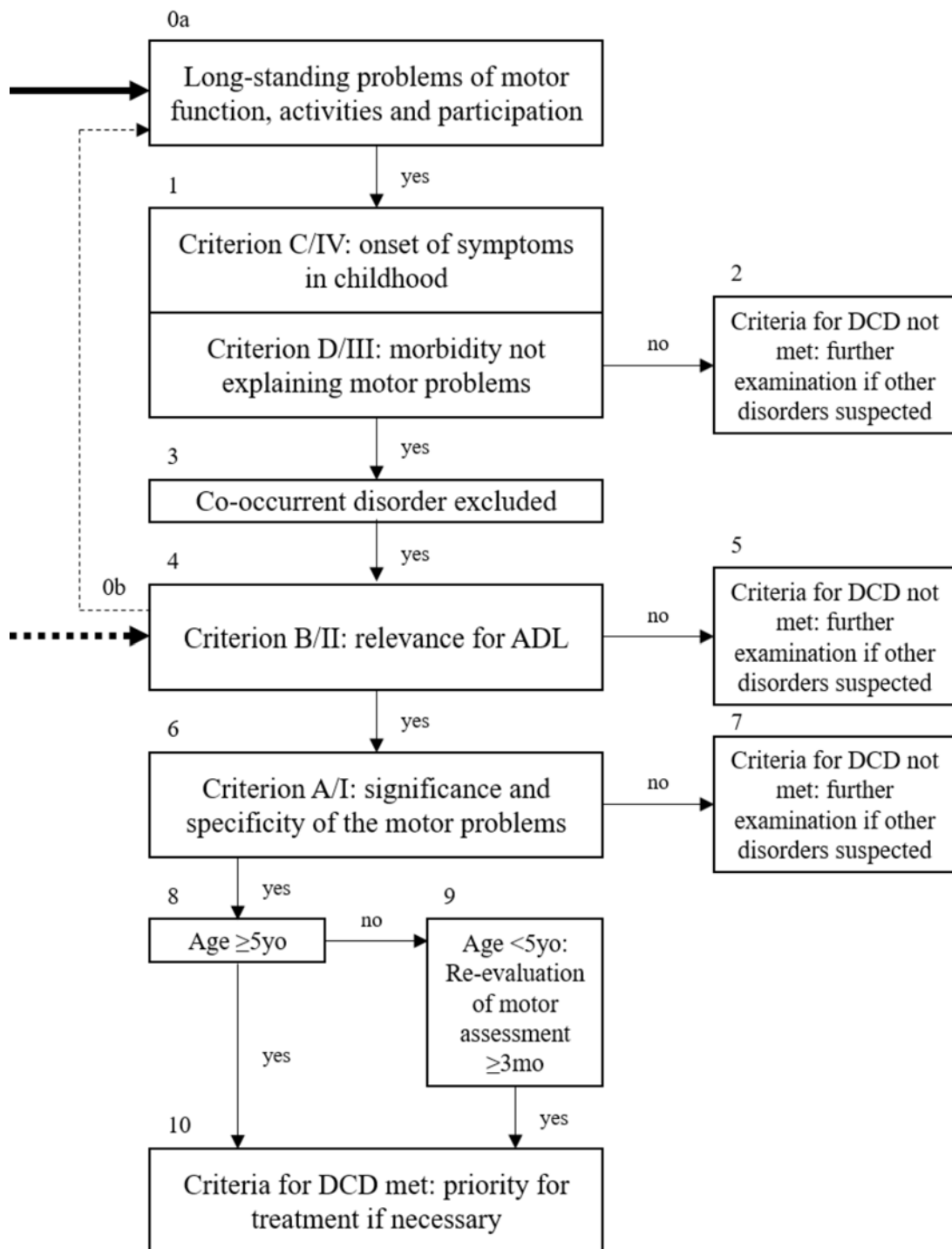


Figure 1. Flow chart assessment of DCD diagnosis. Adapted from Blank et al.²

As there is no existing “gold standard” capable of simultaneously evaluate the discriminative criteria (i.e., motor capacity and daily performance), several recommendations on the assessment and operationalization of the diagnostic criteria A/I and B/II have been made^{2,21,24-25} (see Table 2).

Table 2. Diagnostic assessment and recommendations for Developmental Coordination Disorder

Criterion A/I. Deficits in coordinated motor skills

A score below the 16th percentile (1SD) on a standardized motor test that measures different areas of motor competence and that has good reliability and validity and population-based norm references.

The MABC-2 or the BOT-2 are the two standardized motor tests that are recommended to assess criterion A/I, if a cross-culturally adapted and standardized version exist in the target group. The DCDDaily is a new instrument that covers the child's motor capacity in a broad range of ADL with promising results²⁷, but more research is needed to confirm its psychometric properties². The MABC-2 has been cross-culturally adapted and standardized in Spanish children²⁸.

If the child's score on the motor test is above the specified cut-off criteria but there are clear indications of increased risk for DCD (i.e., criteria B/II, C/IV and D/III are met), it is recommended to use a second standardized motor test or to perform a second examination by another therapist.

Criterion B/II. Relevance for activities of daily living, academic productivity and leisure and play

Motor-based performance in self-care, school-related and play activities of daily living (i.e., dressing and undressing, drawing, playing) should be informed and reported by people that are significant in the child's life (i.e., the child himself/herself, parents or teachers).

The measure or measures used to inform the performance of motor-based activities should be cross-culturally relevant and standardized in the target population.

There are several questionnaires and observation forms aimed to specifically assess performance in motor-based activities in the context of DCD (e.g., DCDQ, MACB-2-C, DCDDaily and DCDDaily-Q).

The DCDDaily-Q is a new tool that provides a comprehensive evaluation of the child's learning, performance and participation in a broad range of motor-based everyday activities²⁹. While its psychometric properties are promising, there is a clear need for research that further evaluates the reliability and validity of the DCDDaily-Q^{2,21}. At the beginning of this thesis, the European Spanish cross-cultural adaptation and psychometric validation of the DCDDaily-Q was in progress, but its concurrent validity with the DCDQ in the Spanish context was yet to be tested.

Because of its extensively studied psychometric properties, the DCDQ is currently the most recommended measure to assess criterion B/II.

MABC-2 = Movement Assessment Battery for Children – Second Edition; BOT-2 = Bruininks-Oseretsky Test of Motor Proficiency-2; DCDQ = Developmental Coordination Disorder; MACB-2-C = Movement ABC-2 Checklist.

Overall, both the child's motor capacity (i.e., what the child can do in a standardized environment) and performance (i.e., what the child actually does in his/her everyday life) need to be examined. While the first criterion is better to be addressed using an objective motor test, the latter should be evaluated through parental reports or questionnaires that reflect the child's performance in his/her daily environment^{2,30}. In addition, parental instruments may provide a useful starting-point to quickly identify those children who are at risk of DCD^{19,25}. The current international consensus is to use the Developmental Coordination Disorder Questionnaire to assess the impact of motor coordination issues on daily performance^{2,25}.

The Developmental Coordination Disorder Questionnaire

The Developmental Coordination Disorder Questionnaire (DCDQ) is a questionnaire for parents designed to identify motor coordination problems during daily activities in children ages 5-15 years³¹. The current version is a revision of the original first developed DCDQ in the late 1990s³², which has been replaced by the version published in 2009³¹ that is used worldwide in the present. The DCDQ comprises 15 items covering control during movement, fine motor/handwriting and general coordination. Following the ICF model, the DCDQ focuses on the child's activity level as it evaluates the child's *performance* and not the child's *capacity*. Items include self-care activities (e.g., tidying up, putting on shoes), productivity and school work activities (e.g., writing, drawing, cutting out pictures and shapes) and leisure and play activities (e.g., jumping in garden or play environment, throwing and catching a ball, enjoying sports or active games).

Several studies have reported that the DCDQ is a reliable and valid measure to operationalize criterion B of DCD and to quickly identify children at risk of DCD^{23,26,33}, with an age-specific sensitivity and specificity of 85% and 71%, respectively³¹. An important additional advantage of this instrument is that the DCDQ is freely available to clinicians and researchers on the DCDQ website³⁴.

Currently, the DCDQ is the most studied and used tool to assess criterion B/II and to quickly identify children at risk of DCD^{2,21,25}. The DCDQ has been successfully cross-culturally adapted for several languages and cultural contexts, and research has proved that these adaptations retain good psychometric properties for screening for DCD in children worldwide³⁵⁻⁴⁵. In 2012, a Latin American Spanish cross-cultural adaptation of the DCDQ was completed by Salamanca et al.⁴⁶. However, there are linguistic and cultural characteristics of the Latin American Spanish that differ from European Spanish idioms or the social and cultural context of Spanish children in word meaning, morphology, phonology and cultural expressions^{47,48}.

When using a health-related assessment instrument in a different culture, language or country, it is necessary to use a proper and systematic method to reach conceptual, semantic and experiential equivalence between the original and target versions of the questionnaire^{49,50}. Thus, a properly cross-culturally adjusted and psychometric validated version of the DCDQ for Spanish children was lacking.

CROSS-CULTURAL ADAPTATION OF ASSESSMENT MEASURES

Cross-cultural adaptation

The term “cross-cultural adaptation” describes a process that comprises both language (translation) and cultural adaptation issues to satisfactorily prepare an instrument for use in another setting⁵⁰. A cross-cultural adaptation is needed when there is a change in culture, language or country of use between the original and the target contexts⁴⁹. The main purpose of a cross-cultural adaptation is to reach cross-cultural equivalence between the original and the adapted instruments (see Table 3).

Table 3. Definitions of cross-cultural equivalence⁵⁰⁻⁵².

Equivalence	Definition	Example
Conceptual equivalence	The instrument is measuring the same theoretical construct and concept in the source and target cultures.	If asked for difficulties writing neatly, the instrument should measure the legibility of the writing and not the clarity of its content.
Semantic (and linguistic) equivalence	The meaning of the item is the same in the source and target languages and cultures, including colloquialisms or idioms.	The expression “bull in a china shop” (used to describe a clumsy child that may bump into things unintentionally) may have to be replaced by a more culturally appropriate expression with similar meaning.
Content or experiential equivalence	The content of each item of the measure is relevant and pertinent to the experience of daily life of each culture	Hitting an approaching ball with a <i>bat</i> may not be a relevant or significant experience of daily life in Spanish children, but hitting an approaching ball with a <i>tennis racket</i> is.

There is no consensus for cross-cultural adaptation guidelines⁵³, but most of the proposed methods include (1) translation, (2) synthesis or reconciliation, (3) back translation, (4) expert committee review, (5) pretesting, and (6) submission to the developers for appraisal of the adaptation process^{50,52,53}. Most authors recommend finishing the process by performing a preliminary study of the reliability properties of the cross-culturally adapted version^{50,52,53}.

Psychometric properties

Once a cross-cultural adaptation has been successfully completed, it is necessary to establish the initial full psychometric properties of the measure with a sample of the target population^{50,52}.

The psychometric properties that are most recommended to test when exploring a cross-cultural version of an existing questionnaire are reliability and validity^{52,54,55}. If the measure aims to diagnose a health condition, it is necessary to determine its sensitivity and specificity as well⁵⁶. In addition, it is recommended to develop country-specific percentiles and cut-off scores, moreover if the measure explores performance in daily situations that may differ among cultural contexts, like the DCDQ²⁵.

Reliability

Reliability refers to the stability, consistency or accuracy of an instrument. A reliable measure will reproduce a consistent result in time and space within the same population and under similar conditions^{55,57,58}. The three more important reliability criteria are (1) internal consistency and homogeneity, (2) test-retest reliability, and (3) inter-rater reliability^{52,54,55}, being internal consistency the most assessed and more often reported criterion of reliability in health-related questionnaires⁵⁴.

Internal consistency and homogeneity indicate whether the different items of an instrument measure the same construct⁵⁹. For instance, all the items in the subscale “fine motor/handwriting” of the DCDQ should measure this construct, and not a different construct such as “general coordination”. If a questionnaire has different subscales or domains, such as the DCDQ, the internal consistency should be explored for each subscale and for the total scale⁶⁰. The Cronbach’s alpha coefficient is the most used measure to assess internal consistency⁵⁵. Values higher than 0.7 are often considered indication of good internal consistency⁵⁷.

Test-retest reliability refers to the degree of stability of the measure throughout time, while ***inter-rater reliability*** refers to the concordance degree between two or more observers regarding the measure scores^{55,58}. Test-retest and inter-rater reliability are estimated with the intraclass correlation coefficient and the Kappa coefficient, respectively⁵⁵.

Validity

Validity refers to the degree to which an instrument actually measures what it aims to measure⁶¹. There are several types of validity. The main ones are (1) content validity, (2) criterion validity, and (3) construct validity⁵⁵, being criterion validity and construct validity the most often reported and recommended criteria of validity in cross-cultural adaptation processes^{50,52}.

Content validity indicates whether the instrument completely reflects the construct that intends to be measured⁵⁵. Content validity is assessed during the design and development of the instrument using a combination of qualitative and quantitative approaches⁶¹.

Criterion validity refers to the degree to which the instrument correlates with an existing and valid measure that evaluates the same construct (i.e., a “gold standard”)⁶². If the criterion validity of two instruments is measured simultaneously, it is called *concurrent validity*⁵⁵. The main disadvantage of the criterion validity is that gold standard instruments may not be available⁶¹. The criterion validity is usually measured with a correlation coefficient, where higher values indicate higher correlation between the instruments⁵⁵.

Construct validity refers to the degree to which an instrument measures the intended construct⁶². This type of validity is the most complex to establish, and therefore several methods are recommended. One of the most common strategies for confirming construct validity is by measuring the *discriminant validity*, i.e., measuring the degree to which two constructs that should be distinct are in fact distinct⁵⁴. For example, the DCDQ should be able to satisfactorily discriminate between children with and without actual DCD.

Another aspect of construct validity can be measured through the *structural validity*, that evaluates how well the structure of a multi-item instrument reflects the multidimensionality of the construct that intends to be measured⁶³. For example, how well the items of the DCDQ represent the proposed constructs of the DCDQ (i.e., control during movement, fine motor/handwriting and general coordination). While some authors include the structural validity as a type of construct validity^{55,61,63}, other authors consider structural validity and dimensionality as a separate type of validity⁵⁴. Structural validity is recommended to be evaluated by using a confirmatory factor analysis, which is a more strict and restrictive method than the exploratory factor analysis^{62,64}.

Sensitivity and specificity

Another two aspects that are relevant if the measure aims to diagnose a health condition are sensitivity and specificity⁵⁶. Sensitivity refers to the ability to detect someone with a health condition (i.e., a child with DCD), while specificity refers to the ability to correctly detect those individuals without a condition (i.e., typically developing children). Ideally, sensitivity and specificity values of DCD-related instruments should be above 80% and 90%, respectively^{1,2}. A high sensitivity may be interesting if an instrument is intended to detect children at risk of DCD for a further, more comprehensive evaluation¹⁹, while high specificity is particularly relevant if an instrument is intended to confirm a diagnosis.

Reference norms and cut-off scores

The standardization of the reference norms of an instrument is the final step of the cross-cultural adaptation and validation in a new context^{50,54}. Cut-off scores require customization to specific population and countries, especially if the instrument measures a construct that may differ across contexts. This is particularly relevant in the evaluation of daily motor performance, which is highly influenced by cultural environment^{37,39}. Thus, it has been recommended to develop country-specific cut-off scores for DCD-related instruments²⁵.

In conclusion, DCD is a prevalent disorder that has significant impact in everyday functioning and participation. Clinical management of children with DCD is scarce in the Spanish context, as most children with DCD are not identified, nor are they referred for treatment. In order to improve DCD identification in Spanish children, more accessible, reliable and useful instruments are needed. The DCDQ is a parental questionnaire used worldwide to quickly identify children at risk of DCD and to assess diagnostic criteria for DCD. Providing a cross-culturally adapted, reliable and adjusted European Spanish version of the DCDQ would contribute to the much-needed clinical assessment and research practice of DCD in the Spanish context.

AIMS OF THIS THESIS

The main aims of this thesis were (1) to translate and cross-culturally adapt the DCDQ into European Spanish, (2) to test the psychometric properties of the DCDQ in the Spanish population, and (3) to develop country-adjusted percentiles and cut-off scores of the DCDQ for Spanish children.

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CHAPTER 2

CROSS-CULTURAL ADAPTATION AND PRELIMINARY VALIDATION OF THE EUROPEAN-SPANISH VERSION OF THE DEVELOPMENTAL COORDINATION DISORDER QUESTIONNAIRE

Montes-Montes R, Delgado-Lobete L, Pereira J, Pousada T. Cross-Cultural Adaptation and Preliminary Validation of the European Spanish Version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES). *Am J Occup Ther* 2020;74(4): 7404205060.

ABSTRACT

The Developmental Coordination Disorder Questionnaire (DCDQ) is the most widely used measure of difficulties with activities of daily living and academic performance in children with developmental coordination disorder, but this tool has not been adapted for use in Spain.

The aim of this study was to translate and cross-culturally adapt the Developmental Coordination Disorder Questionnaire into European Spanish (DCDQ-ES) for use in evaluating motor coordination. The English version was translated and cross-culturally adapted into European Spanish following international guidelines. The preliminary evaluation of the DCDQ-ES reliability was tested using a randomly selected sample of 35 children aged 6 to 12. Cultural relevance and equivalence, as well as idiomatic differences of the English and European Spanish versions were noted and assessed. Cognitive debriefing interviews led to additional minor modifications that facilitated comprehension and interpretation. Internal consistency and homogeneity of the DCDQ-ES were good (Cronbach alpha = 0.857; corrected item-total correlations = 0.268 - 0.692). To conclude, the DCDQ-ES is conceptually and semantically equivalent to its English version and it is successfully cross-culturally adapted into a European Spanish context. Preliminary data suggests that the DCDQ-ES is a reliable measure of motor coordination in Spanish children. DCD.

INTRODUCTION

Developmental Coordination Disorder (DCD) is a motor neurodevelopmental disorder that affects about 5% to 6% of school-aged children^{1,2}. This disorder has a significant impact on executive function, daily life activities, and academic achievement throughout adolescence and adulthood. Therefore, DCD should be addressed as soon as motor coordination difficulties are identified during development³⁻⁷.

One of the most widely recognized and validated tools used in screening for and assessing children with DCD is the Developmental Coordination Disorder Questionnaire (DCDQ)^{2,8}. This 15-item parent-report questionnaire is designed to assess motor coordination in children ages 5–15 years. The DCDQ has been successfully cross-culturally adapted for several languages and contexts, and studies have demonstrated that these adaptations are reliable and valid for screening for DCD in children⁹⁻¹⁵.

A Latin American Spanish version of the DCDQ is available¹⁶, but its linguistic and cultural characteristics may not match European Spanish idioms or the social context of Spanish children. Latin American Spanish differs from European Spanish in many ways in terms of word meaning, morphology, phonology, and cultural expressions¹⁷. When cross-culturally adapting a measure for a different context, it is necessary to consider both semantic and contextual aspects to ensure equivalence of results; a European Spanish adaptation of the DCDQ (DCDQ–ES) that fits the context of Spanish children is therefore necessary. The aims of this study were to translate and cross-culturally adapt the DCDQ for use in Spain and conduct a preliminary assessment of reliability with a Spanish population.

METHODS

Translation

We obtained approval to develop a translation and cross-cultural adaptation of the DCDQ from the developer, Brenda Wilson. Approval for this study was granted by the Autonomic Research Ethics Committee of Galicia (Code 2017/167). We followed the same six-stage process proposed by Beaton et al.¹⁸ (Figure 1) that was used for other cross-cultural adaptations of this questionnaire.

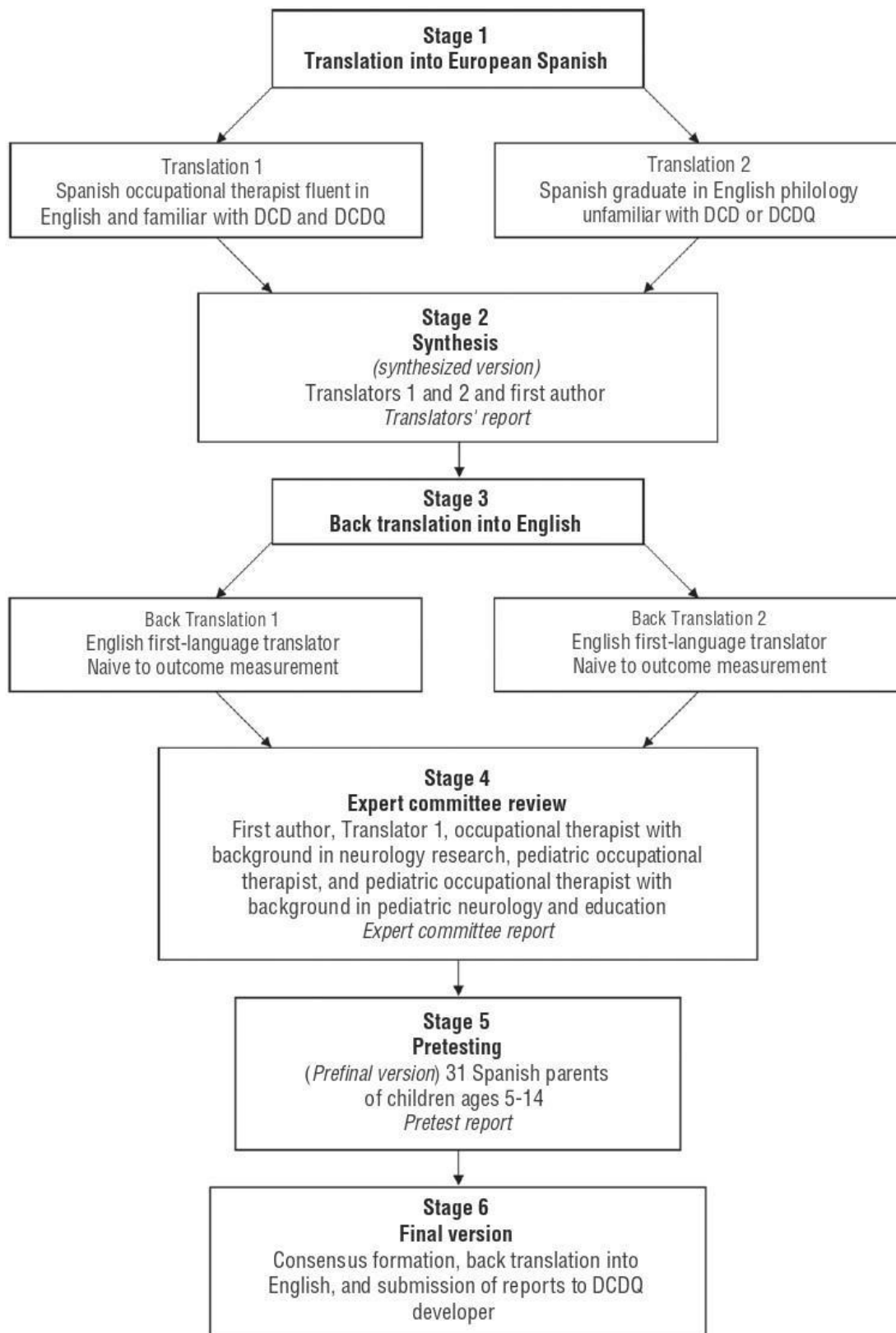


Figure 1. Cross-cultural adaptation process of the DCDQ-ES.

The DCDQ was independently translated by a Spanish occupational therapist and a professional translator with a background in English literature and education. The Spanish occupational therapist was familiar with the DCDQ and had a background in research on DCD (Translator 1), whereas the professional translator was unfamiliar with the DCDQ and with DCD (Translator 2). The two translators and the main researcher compared the two translations, T1 and T2, and produced a version of the DCDQ that synthesized elements of both translations. This version was independently back translated into English by two bilingual translators who were unfamiliar with the DCDQ and whose first language was English, to produce BT1 and BT2.

Expert Committee Review and Pretest of Cultural Relevance, Equivalence, and Comprehensibility

An expert committee reviewed and compared T1, T2, the synthesized version, BT1, and BT2 to determine cultural and idiomatic equivalence between the synthesized translation and the original English DCDQ. This committee included the main researcher, Translator 1, a paediatric occupational therapist, an occupational therapist with a background in neurology research, and an occupational therapist with a background in paediatric neurology and education. A modified, prefinal version of the DCDQ–ES was produced after the expert committee review.

The prefinal version was tested with a community-based convenience sample of 31 parents of children ages 5–14 years. The parents were recruited from previously contacted schools located in four different regions of Spain, and they had varied educational and occupational backgrounds. One participant had a child diagnosed with attention deficit hyperactivity disorder, and the rest had children who were considered typically developing. All parents were informed about the purpose of the study and provided informed consent.

To evaluate the cultural relevance, equivalence, and comprehensibility of the prefinal version of the DCDQ–ES, we used the Three-Step Test–Interview (TSTI), a cognitive interview approach consisting of three consecutive phases: think aloud, follow-up, and validation¹⁹. The interviews were not transcribed because any potential issues were addressed during the interview. The main researcher led the interviews and wrote down any difficulties expressed by the participants, as well as any nonverbal expression

suggesting that some aspects of the DCD–ES were unclear in order to clarify or discuss any potential issues. We used inquiry, paraphrase, exposition, and exemplification to detect difficulties with semantics and grammar (semantic equivalence), interpretation of colloquialisms (idiomatic equivalence), and familiarity with the activities described in the prefinal version (experimental equivalence). As recommended, if 20% (i.e., ≥ 6) of the participants found an item difficult to interpret or understand, we revised and reworded that item²⁰.

After rewording the problematic items, we produced the final version of the DCDQ–ES and recorded all stages of the cross-cultural adaptation process. This final version was back translated into English and submitted to the DCDQ’s original developer (Wilson), who analysed the written report of the cross-cultural adaptation process and approved the final version of the DCDQ–ES.

Preliminary Reliability Evaluation

A second randomly selected sample of Spanish parents was used to evaluate the reliability of the DCDQ–ES. Thirty-five parents of typically developing children ages 6–12 years attending a randomly selected mainstream school in A Coruña (a city in northern Spain) completed the DCDQ–ES (mothers = 80.0%; children’s average age = 9.00 ± 2.03 years; girls = 51.4%). All parents answered the questionnaire anonymously in their home and sent it back to the school, where the first author collected them. Reliability was determined through analysis of the internal consistency and homogeneity of the completed questionnaires.

Data Analysis

The first author analysed the cognitive interviews conducted for the prefinal version of the DCDQ–ES to determine whether participants’ comments reflected semantic, idiomatic, or experimental difficulties. Chi-square tests were used to explore differences in equivalence between translations. Internal consistency was estimated using Cronbach’s α , with values >0.80 considered good. Homogeneity of the items was assessed using corrected item–total correlations, with values >0.20 considered acceptable²¹. All statistical analyses were conducted using IBM SPSS Statistics Version 20 (IBM Corp., Armonk, NY) and EPIDAT 3.1²².

RESULTS

Initial Equivalence Evaluation

Both translators evaluated the semantic and conceptual equivalence of the two independent and synthesized translations of the DCDQ–ES; results are summarized in Table 1. The translators agreed on the equivalence of 66.7% of items across the two translations.

After reviewing the synthesized translation, the translators considered all items to be either totally (86.7%, 95% confidence interval [CI] [69.3-96.2]) or conceptually (13.3%, 95% CI [3.8-30.7]) equivalent. The two translators' equivalence evaluations did not differ significantly ($\chi^2 = 0.27, p = 0.605$).

Pretest Evaluation of Cultural Relevance, Equivalence, and Comprehensibility

During the expert committee review, six items were extensively discussed and modified. In Item 4, the Spanish term *zona de juegos* was modified to *zona de juego* to include every possible play area. Items 6, 7, 8, 9, and 15 described motor planning–related activities and were challenging to reword in a way that accurately retained the original meaning. Brief examples were added to these five items to facilitate understanding and interpretation. In addition, Items 14 and 15 were reworded with positive phrasing to avoid possible misunderstandings.

In testing the prefinal version of the DCDQ–ES, all 31 parents (Table 2) displayed good understanding of the items, but they reported difficulties with or made recommendations for eight of the items (results are summarized in Table 1). Most of the comments referred to minor semantic or idiomatic concerns. However, one parent reported difficulty with experimental equivalence for Item 3, which addresses children's performance while playing sports (this issue is explored in the Discussion). According to the participants, the instructions were easy to understand, and the activities were familiar and easy to recall.

Table 1. Equivalence evaluation of the independent and synthesized translations of the DCDQ to European Spanish

	Translation and Synthesis				Test of the Pre-final DCDQ-ES			
	Independent translations equivalence		Synthesized translation equivalence		Comments	N(%)	Difficulty in Understanding	Led to rewording in the final version
	Translator 1	Translator 2	Translator 1	Translator 2				
Item 1	A	A	A	A	SE	6 (19.4)	No	No
Item 2	B	A	A	A	-	-	-	-
Item 3	B	B	A	A	IE EE	5 (16.1) 1 (3.2)	No	No
Item 4	B	B	A	A	IE	12 (38.7)	No	Yes
Item 5	A	A	A	A	-	-	-	-
Item 6	C	B	B	A	-	-	-	-
Item 7	A	A	A	A	-	-	-	-
Item 8	B	A	B	A	-	-	-	-
Item 9	B	A	B	A	SE	5 (16.1)	Yes	Yes
Item 10	A	A	A	A	-	-	-	-
Item 11	A	A	A	A	-	-	-	-
Item 12	A	B	A	B	SE	5 (16.1)	No	No
Item 13	A	A	A	A	SE	2 (6.5)	No	No
Item 14	B	B	A	A	SE	6 (19.4)	Yes	Yes
Item 15	B	B	A	A	SE	3 (9.7)	Yes	Yes

Note: A=the item is conceptually and semantically equivalent; B=the item is conceptually equivalent; C=the item is not equivalent; N=number of comments on the item; (%)=proportion of comments on the item; SE=comments on semantic equivalence; IE=comments on idiomatic equivalence; EE=comments on experimental equivalence.

Results from the TSTI evaluation of the pretest led to additional changes in four items. Items 9, 14, and 15 underwent structural changes, and brief examples were included using terms selected to better capture the original meaning of the items rather than the direct Spanish translations. Although Item 4 was easy to understand and interpret, participants reported that it would sound more natural if it were expressed in the indicative mood instead of the subjunctive mood. No differences in reported cultural equivalence or comments were found according to parents' region, indicating that items reflect common activities for the majority of participants from northern and central Spain.

Table 2. Socio-demographic characteristics of the parent participants in the cross-cultural adaptation of the DCDQ-ES.

	N (%) / Mean ± SD
Child age	8.2 ± 2.2
Role	
Mother	18 (58.1)
Father	13 (41.9)
Region	
A Coruna (northwestern)	5 (16.1)
Asturias (northern)	22 (71.0)
Valladolid (central)	2 (6.5)
Madrid (central)	2 (6.5)
Education level	
First stage of high school	1 (3.2)
High school	8 (25.8)
Technical/Community college	13 (41.9)
University studies	9 (29.0)

Note: N=number of participants; (%)=proportion of participants; SD=standard deviation.

Reliability

The DCDQ-ES showed good internal consistency, with a Cronbach's α of .857 (Table 3). The α coefficient did not significantly increase when items were individually removed, indicating that no single item was problematic. Corrected item-total correlations were good (range = 0.268–0.692).

Table 3. Internal consistency and homogeneity of the DCDQ-ES

	Cronbach's alpha	Cronbach's alpha if item is deleted	Corrected item-total correlation
DCDQ-ES	0.857		
Item 1		0.849	0.482
Item 2		0.854	0.377
Item 3		0.854	0.370
Item 4		0.849	0.485
Item 5		0.857	0.310
Item 6		0.859	0.268
Item 7		0.849	0.476
Item 8		0.850	0.461
Item 9		0.845	0.561
Item 10		0.838	0.692
Item 11		0.840	0.632
Item 12		0.846	0.532
Item 13		0.840	0.627
Item 14		0.837	0.692
Item 15		0.853	0.435

DISCUSSION

The aim of this study was to translate and culturally adapt the DCDQ into European Spanish and evaluate its cultural relevance, equivalence, and comprehensibility with Spanish parents of children ages 5–15 years. We produced the translation by synthesizing two independent Spanish translations into a prefinal version, testing the prefinal version, and incorporating the results into the final version. We then evaluated the reliability of the final version in assessing motor coordination of Spanish children.

Translation Process

The translators agreed that the synthesized version better preserved the intent of the original DCDQ than the individual translations and that it reflected the linguistic and cultural characteristics of the European Spanish context. Most processes recommended for translating and cross-culturally adapting questionnaires incorporate generating a synthesized translation from independent translations. However, many studies do not use this procedure and instead use a single translation, likely because it involves less time and fewer resources^{18,20}. In our study, analysis of the two translations provided an opportunity

for the translators and reviewers to engage in debate to uncover relevant information and challenges that would otherwise have gone unnoticed. The high degree of agreement among the translators and reviewers on the equivalence of the synthesized version reflects improvements in the overall quality of the DCDQ–ES. Thus, this study supports the use of two or more independent translations in the cross-cultural adaptation of questionnaires.

We modified Items 14 and 15, which were negatively worded in the original, to use positive phrasing. As a result, the parents reported that the items were more comprehensible and enabled them to provide more accurate information. Difficulty in comprehending these two items was reported in studies for other European adaptations of the DCDQ, in which it was necessary to reword the items to facilitate interpretation^{10,15}.

Cultural Relevance and Equivalence

Overall, the parents were familiar with the activities described in the DCDQ–ES. Slight modifications were made to some items to better fit the Spanish context; for instance, the expression “bull in a china shop” was replaced with the Spanish equivalent “elefante en una cacharrería,” [*“elephant in a glassware shop”*]. Other cross-cultural adaptations of the DCDQ have made modifications to reflect cultural differences in common, everyday activities^{15,23}. Although the parents were familiar with the activities described in the DCDQ–ES, some reported difficulty recalling their children’s performance in sports-related activities for Item 3. Working parents in particular reported that they rarely had the opportunity to watch their children play outside; most families in Spain have two working parents, and parent–child time is influenced by Spanish family traditions and child-unfriendly work schedules^{24,25}. Parents are usually more involved in children’s academic activities during the week and are able to watch them play outdoor sports only on weekends²⁴. Minor difficulties in cross-cultural adaptation of Item 3 were previously reported in the literature, but overall the parents in our sample reported adequate cultural equivalence of this item^{14,16}.

Idiomatic Difficulties

Many of the semantic modifications during the expert committee review and pretest process were made to ensure that the items were in line with the original intended meaning in English. Items assessing motor planning actions involving organized and precise activities had to be reworded and brief examples added to facilitate an interpretation

closer to the original one (e.g., separating stroke pressure from grasp tightness when writing or drawing for Item 9). Other cross-cultural adaptations of the DCDQ also found minor issues regarding unexpected meanings of motor precision on these items^{15,16}. The think-aloud phase during the TSTI process revealed that some parents found Items 9, 14, and 15 to be oddly expressed and difficult to interpret. Item 15 was the most discussed item during the expert committee review because the direct translations of slouch and fall out did not adequately reflect the intended meaning of these terms. Although most parents were able to give an adequate example of the activities described in these items, we decided to reword them and provide additional information to facilitate comprehension and interpretation. Idiomatic difficulties were also found in development of the Latin American Spanish version of the DCDQ; Items 14 and 15 were especially challenging to adapt because of the difficulty in translating them to Latin American Spanish, and the items were reworded to positive phrasing and adjusted to the Colombian context (e.g., “bull in a china shop” was deleted from Item 14)¹⁶.

Reliability

The preliminary data on reliability of the DCDQ–ES suggest good internal consistency and homogeneity. All of the DCDQ cross-cultural adaptations have demonstrated excellent psychometric properties, including internal consistency and homogeneity similar to those of the present study^{9-14,26}.

Limitations and Future Research

The main limitation of this study is that all participants came from northwestern and central regions of Spain, and thus it may be possible that a few minor linguistic and cultural aspects of the questionnaire were not addressed. Some southern, northeastern, and northwestern regions of Spain speak different Spanish dialects, but all Spaniards are taught standard (Castilian) Spanish as the main language. When adapting questionnaires for use in Spain, researchers typically translate them into standard Spanish because it is the main language in Spain and is understood and spoken in the entire country. Therefore, the DCDQ–ES is usable in all of Spain. Another limitation is the small sample used to evaluate the reliability of the DCDQ–ES. Some authors have suggested that a sample size of 15–30 is sufficient to provide preliminary evidence for internal consistency in health status questionnaires²¹, and this study provided preliminary data from 35 participants. However, additional studies should use larger samples.

IMPLICATIONS FOR OCCUPATIONAL THERAPY PRACTICE

The findings of this study have the following implications for occupational therapy practice:

- Motor coordination skills are closely associated with occupational performance and participation. A well-validated and cross-culturally adapted tool such as the DCDQ–ES can enable early detection of motor coordination difficulties in children with potential DCD.
- Occupational therapy practitioners working in clinical practice or schools in Spain or with clients from Spain can use the DCDQ–ES to assess a broad range of daily activities in children with motor coordination difficulties.
- This study provides preliminary evidence of reliability of the DCDQ–ES for use with children ages 6–12 years. The DCDQ–ES is the first cross-culturally adapted tool available in European Spanish for assessing children’s motor coordination during everyday activities.


CONCLUSION

Our results show that the European Spanish version of the DCDQ is equivalent to the original English DCDQ and is culturally appropriate for use with the Spanish population. This study highlights the need for a rigorous and thorough process in adapting measures for new cultural contexts and populations. Preliminary data suggest that the DCDQ–ES has good reliability, and further testing is required to establish its validity in assessing Spanish children.

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CHAPTER 3

CONCURRENT VALIDITY BETWEEN THE DCDQ-ES AND THE DCDDAILY-Q-ES AND REFERENCE NORMS FOR THE DCDDAILY-Q-ES

Montes-Montes R, Delgado-Lobete L, Pereira J, Schoemaker MM, Santos-del-Riego S, Pousada T. Identifying Children with Developmental Coordination Disorder via Parental Questionnaires. Spanish Reference Norms for the DCDDaily-Q-ES and Correlation with the DCDQ-ES. *Int J Environ Res Public Health*. 2020;17(2):555.

ABSTRACT

Developmental Coordination Disorder (DCD) is one of the most prevalent neurodevelopmental disorders in school-aged children, with major consequences in psychosocial and physical health. Adequate identification of this disorder is necessary to prompt effective interventions. The aims of this study were to develop the Spanish adjusted reference norms for the DCDDaily-Q and to test the correlation and agreement between the Spanish versions of the DCDDaily-Q (DCDDaily-Q-ES) and the Developmental Coordination Disorder Questionnaire (DCDQ-ES), two reliable instruments to assess motor performance and DCD. Clinically relevant percentiles were calculated for the DCDDaily-Q-ES using a representative sample of Spanish children aged 5 to 10 years ($n=356$; $M=7.3$ years, $SD=1.8$; boys=50%). Pearson's correlation coefficient and intraclass correlation coefficient (ICC) were used to determine correlation and agreement between questionnaires, respectively. A moderate and significant correlation and agreement between DCDDaily-Q-ES and DCDQ-ES was found ($r=0.406$; $ICC=0.381$; $p<0.001$). Differences in daily participation and performance were found between age groups, but not between boys and girls. Spanish age-adjusted percentiles and cutoff scores for DCDDaily-Q-ES are provided. This study offers further validation and relevant information regarding assessment of DCD and has practical implications for clinical practice and research.

INTRODUCTION

Developmental Coordination Disorder (DCD) is one of the most prevalent neurodevelopmental disorders in school-aged children, and it is considered one of the major health concerns in this population¹⁻⁴. Consequences of DCD often span across psychosocial, occupational, and physical health dimensions, and usually persist into adulthood^{2,5-7}.

In addition to motor coordination difficulties, children and adolescents with DCD have an increased risk for mental and psychosocial health issues, such as depression and anxiety and other internalizing problems⁸⁻¹¹, problems with social interactions and victimization^{2,12-14}, emotional and behavioral issues^{11,13}, and lower self-worth and self-esteem than children without motor coordination difficulties¹⁵. Regarding physical problems, children with DCD are at higher risk for obesity, higher waist circumference and body fat percentage^{16,17}, poorer cardiorespiratory fitness, and lower flexibility, muscle strength, and muscle endurance^{6,18-20}. Overall, children and adolescents with DCD suffer lower health-related quality of life than their typically developing peers^{14,15,21}.

Despite this disorder being highly underdiagnosed in Spain, a recent study suggests that 12% of Spanish children aged 6 to 12 years have probable DCD^{22,23}. To get a diagnosis of DCD, the child must present a motor deficit (criterion A) that affects performance during activities of daily living (ADL) (criterion B). This motor deficit must be present since early development (criterion C) and cannot be better explained by other medical conditions (criterion D)¹. Early detection and identification are recommended as they lead to prompt intervention and guide efforts and resources towards a reliable and definite diagnosis. The Developmental Coordination Disorder Questionnaire (DCDQ)²⁴ is recommended to evaluate criterion B² and it has been recently cross-culturally adapted and preliminarily validated in Spanish children²⁵. Even though the DCDQ addresses motor performance during ADL, a comprehensive evaluation of self-care activities is lacking²⁵. Self-care and self-maintenance activities should be systematically assessed as self-care participation and performance are severely affected in children with DCD²⁷⁻³¹. Some studies have reported that DCD has a greater impact on self-care functioning than on gross motor or fine motor performance^{27,28}. Moreover, both children with DCD and parents of children with DCD perceive difficulties in self-care functioning as one of their main concerns^{14,32,33}. Specific self-care activities that children with DCD struggle with

include dressing (managing buttons and zippers, orientating and manipulating socks, tying shoelaces), eating (using a knife and fork, pouring liquids, opening wrapper/package, noticing quantity of food in mouth or fork), and toileting (drying oneself after bathing or showering, brushing teeth or hair, managing toothpaste, wiping oneself clean)^{27,29-31}.

The DCDDaily-Q³⁴ is a newly developed instrument to comprehensively assess ADL, especially focusing on self-care, fine motor and gross motor performance, and participation. Research suggests that it has an extraordinary discriminant capacity and it can effectively identify children at risk of DCD, but more studies are needed^{2,34}. The DCDDaily-Q was recently cross-culturally adapted and psychometrically validated in Spain, showing an excellent construct validity and discriminant capacity to identify children with neurodevelopmental disorders (to be published). However, due to limitations in sample size, reference norms for Spanish children were not developed, and its concurrent validity with the Spanish version of the DCDQ (DCDQ-ES) has yet to be tested. Previous research shows that population-adjusted reference norms should always be operated when assessing motor performance³⁵⁻³⁷. To date, the original Dutch cutoffs are the only available criteria to identify children at risk of DCD when using the DCDDaily-Q, so it is unknown if these cutoffs are also suitable for children within different contexts or regions. The aims of this study are (1) to develop the Spanish adjusted reference norms for the DCDDaily-Q using a representative sample of Spanish children, and (2) to test the correlation and agreement between the DCDDaily-Q-ES and the DCDQ-ES in Spanish context.

METHODS

Participants and procedures

Data from 356 children aged 5 to 10 years were collected between January and December 2019. Participants came from 17 randomly selected mainstream schools located in eight geographic locations in northwest, north, and central Spain. Geographic location selection was made by convenience and considering different sociodemographic factors, such as rural or urban settings and family educational background. None of the participants had an existing or previous diagnosis of any learning or developmental disorder as reported by schools and parents.

The DCDDaily-Q-ES was sent to the parents via school intermediation, and returned to the researchers after completion. Additionally, 266 parents also completed the DCDQ-ES. This study was carried out following the rules of the Declaration of Helsinki and it was approved by the Research Ethics Committee of Galicia in Spain (code 2018-606, date of approval: December 2018). Data were collected anonymously. All participants consented to take part in the study anonymously and confidentially.

Measurements

Spanish Version of the DCDDaily-Q

The DCDDaily-Q is a 23-item parental questionnaire that addresses children's participation and performance in a broad range of ADL, including self-care (10 items), fine motor (7 items), and gross motor activities (6 items)³⁴. Parents are asked to rate their children's performance for each item in comparison to a given description of what is considered the right way to perform the activity (1=good, 2=medium, 3=poor). The DCDDaily-Q total performance score ranges from 23 to 69, where higher scores indicate poorer performance. Apart from performance, the DCDDaily-Q also evaluates participation in ADL on a four-point scale (1=regularly, 2=sometimes, 3=seldom, 4=not yet/never). The total participation score ranges from 23 to 92, and higher scores indicate less participation.

The DCDDaily-Q has excellent psychometric properties and discriminant capacity to identify children with DCD (Cronbach alfa=0.85; sensitivity=88%; specificity=92%)³⁴. The Spanish cross-cultural adaptation (DCDDaily-Q-ES) was successfully undertaken following the international guidelines^{38,39} and shows excellent fit to the three-factors structure and good reliability (Cronbach alfa = 0.82).

Spanish Version of the DCDQ

The DCDQ was designed to identify motor problems and probable DCD in 5- to 15-year-old children²⁴, and it is the most used measurement to operationalize criterion B of the diagnostic criteria for DCD². The DCDQ is a parental questionnaire consisting of 15 items covering three subscales: Control during movement (6 items), fine motor/handwriting (4 items), and general coordination (5 items). Parents are asked to rate their children's performance on a five-point scale. The DCDQ total score ranges from 15 to 75, where higher scores indicate better performance.

The DCDQ shows good psychometric properties (Cronbach alfa=0.94; overall sensitivity=85%; overall specificity=71%)²⁴. This instrument has been successfully cross-culturally adapted to European Spanish (DCDQ-ES), and its psychometric validation proved that it is a reliable and valid measure to assess motor coordination in Spanish children (Cronbach alfa=0.86)²⁵.

Data Analysis

Statistical analysis was performed with SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). A value of $p < 0.05$ was considered statistically significant. One-way ANOVA analyses were conducted to calculate the effect of age on the DCDDaily-Q-ES participation and performance total and subscale scores. Bonferroni post hoc tests were used to examine differences between age groups. An independent samples t-test was conducted to analyse sex differences in DCDDaily-Q-ES participation and performance total and subscale scores.

Several percentiles for participation and performance total and subscales were calculated. The 85th and 95th percentiles are usually recommended to serve as cutoffs to determine the presence of DCD in clinical practice and research, respectively^{40,41}. As additional percentiles may be useful for clinical practice and research, the 80th, 90th, and 96–99th percentiles were also considered.

The correlation between the DCDDaily-Q-ES performance total and subscale scores and the DCDQ-ES total and subscale scores was determined calculating Pearson correlation coefficients. The intraclass correlation coefficient (ICC) was used to determine agreement between the DCDDaily-Q-ES performance scale and the DCDQ-ES. ICC estimates and their 95% confidence intervals were calculated based on a one-way random model. In order to determine agreement between the DCDDaily-Q-ES and DCDQ-ES using ICC, the DCDQ-ES total scale score was recalculated reversing DCDQ-ES item scores from 5 (worst performance) to 1 (better performance) so that both DCDDaily-Q-ES performance and DCDQ-ES scale scores went in the same direction. Raw DCDDaily-Q-ES performance and reversed DCDQ-ES total scores were then transformed to the 0–100 range to enable ICC calculation and estimation of differences between both measurements.

RESULTS

Sociodemographic characteristics of the sample are shown in Table 1. All age groups were balanced by sex (boys and girls=50.0% in each group).

Table 1. Sociodemographic characteristics of the sample (n = 356).

Sociodemographic Factors	Participants	Mean ± SD or %
Age (in years)	356	7.3 ± 1.8
Age group 1 (5-6 years)	136	38.2
Age group 2 (7-8 years)	106	29.8
Age group 3 (9-10 years)	114	32.0
Boys	178	50.0
Girls	178	50.0
Northwest Spain	191	53.7
North Spain	147	41.3
Central Spain	18	5.1
Urban setting	281	78.9
Rural setting	75	21.1
High family educational level (university studies)	182	57.1
Medium-low family educational level (nonuniversity studies)	137	42.9

Note: SD=standard deviation.

Using the Bonferroni post hoc test, ANOVA showed no differences in general participation or performance between children aged 7 or 8 years and children aged 9 or 10 years as measured by the DCDDaily-Q-ES (Table 2). Children aged 7 years and older scored significantly lower than children aged 5 or 6 years in self-care, fine motor, and gross motor participation and performance subscales of the DCDDaily-Q-ES. According to their parents, boys participated more often in gross motor ADL than girls, and girls performed fine motor ADL significantly better than boys, but overall, there were no sex differences in total performance or participation scores (Table 3). Therefore, percentiles for all subscales, total participation, and total performance scales of the DCDDaily-Q-ES were calculated separately for children aged 5 to 6 years and for children aged 7 years and older (Table 4).

Table 2. Differences in DCDDaily-Q-ES subscales and total scores for participation and performance in activities of daily living (ADL) across age groups ($n = 356$).

DCDDaily-Q-ES Subscales	Age group 1 n = 136	Age group 2 n = 106	Age group 3 n = 114	<i>p</i> Value within groups
	Mean ± SD	Mean ± SD	Mean ± SD	
Participation				
Self-care ADL	16.8 (3.8)	13.9 (2.6)	13.3 (2.5)	<0.001 ^a ; <0.001 ^b ; 0.389 ^c
Fine motor ADL	9.8 (2.6)	9.0 (2.0)	9.0 (2.2)	0.015 ^a ; 0.021 ^b ; 1.000 ^c
Gross motor ADL	12.8 (2.8)	11.6 (2.8)	12.5 (3.0)	0.004 ^a ; 0.954 ^b ; 0.086 ^c
Total ADL	39.5 (7.4)	34.5 (5.9)	34.8 (6.1)	<0.001 ^a ; <0.001 ^b ; 1.000 ^c
Performance				
Self-care ADL	14.9 (3.1)	12.7 (2.5)	11.8 (1.7)	<0.001 ^a ; <0.001 ^b ; 0.023 ^c
Fine motor ADL	9.8 (2.3)	8.6 (2.0)	8.0 (1.7)	<0.001 ^a ; <0.001 ^b ; 0.133 ^c
Gross motor ADL	10.4 (2.4)	8.7 (2.2)	8.8 (2.3)	<0.001 ^a ; <0.001 ^b ; 1.000 ^c
Total ADL	35.1 (6.2)	30.0 (5.2)	28.6 (4.6)	<0.001 ^a ; <0.001 ^b ; 0.203 ^c

Note: ADL=activities of daily living; SD=standard deviation; a = between group 1 and group 2; b = between group 1 and group 3; c = between group 2 and group 3.

Table 3. Differences in DCDDaily-Q-ES subscales and total scores for participation and performance in activities of daily living (ADL) across sex ($n = 356$).

DCDDaily-Q-ES Subscales	Boys n = 178 M = 7.33 Years (1.83)	Girls n = 178 M = 7.33 Years (1.78)	<i>p</i> Value
	Mean ± SD	Mean ± SD	
Participation			
Self-care ADL	15.0 (3.6)	14.6 (3.3)	0.294
Fine motor ADL	9.4 (2.5)	9.3 (2.2)	0.664
Gross motor ADL	12.0 (3.1)	12.7 (2.7)	0.013
Total ADL	36.4 (7.3)	36.7 (6.5)	0.708
Performance			
Self-care ADL	13.4 (3.0)	13.1 (2.8)	0.251
Fine motor ADL	9.3 (2.3)	8.5 (1.9)	<0.001
Gross motor ADL	9.2 (2.4)	9.6 (2.4)	0.095
Total ADL	31.9 (6.4)	31.1 (5.9)	0.261

Note: ADL=activities of daily living; SD=standard deviation.

Table 4. Percentiles for participation and performance subscales and total scores across age groups and sex ($n = 356$).

Participation and Performance Subscales	n	P80	P85	P90	P95	P96	P97	P98	P99
5-6 years old	136								
Self-care ADL participation		20	21	22	23	24	24	25	32
Fine motor ADL participation		12	13	14	14	15	16	17	18
Gross motor ADL participation		15	16	16	17	17	18	18	19
Total ADL participation		46	47	48	51	52	56	58	67
Self-care ADL performance		17	18	19	20	21	23	24	25
Fine motor ADL performance		12	12	13	14	14	15	15	17
Gross motor ADL performance		12	13	13	14	15	15	15	16
Total ADL performance		40	41	43	45	47	49	53	56
7-10 years old	220								
Self-care ADL participation		16	16	17	18	19	20	21	21
Fine motor ADL participation		11	12	12	13	13	14	15	15
Gross motor ADL participation		14	15	16	17	17	17	18	20
Total ADL participation		39	41	42	46	47	47	48	50
Self-care ADL performance		14	14	15	16	17	17	19	20
Fine motor ADL performance		10	10	11	12	13	14	14	15
Gross motor ADL performance		11	11	12	13	13	13	15	16
Total ADL performance		33	34	36	39	40	41	43	45
Boys	178								
Gross motor ADL participation		15	15	16	17	17	18	18	19
Fine motor ADL performance		11	12	13	14	14	15	15	16
Girls	178								
Gross motor ADL participation		15	15	16	17	17	18	18	19
Fine motor ADL performance		10	11	11	13	13	13	14	14

Note: In bold = recommended cut-off points for DCD indication in clinical practice (p85) and research (p95).

Interpretation guidelines for the Spanish percentile cutoffs of the DCDDaily-Q-ES are shown in Appendix A Table A1. These recommendations have been developed using the original Dutch DCDDaily-Q manual as a guideline to facilitate communication when reporting DCDDaily-Q results across contexts and studies.

Overall, moderate and significant correlations were found between the DCDDaily-Q-ES performance total and subscale scores and the DCDQ-ES total and subscale scores (Table 5). The highest correlations were found between DCDDaily-Q-ES performance total and DCDQ-ES total scales ($r=0.406$, $p<0.001$), fine motor ADL and fine motor/handwriting scales ($r=0.359$, $p<0.001$), and self-care ADL and DCDQ-ES total scales ($r=0.356$, $p<0.001$). Correlation between the DCDDaily-Q-ES and DCDQ-ES was higher in children aged 7 years and older than in younger children ($r=0.509$, $p<0.001$ vs. $r=0.273$, $p<0.01$ respectively).

Table 5. Correlations between DCDDaily-Q-ES performance total and subscale scores and DCDQ-ES total and subscales scores ($n = 266$).

DCDDaily-Q-ES Total and Subscales	DCDQ- ES	Control during movement	Fine motor/handwriting	General coordination
DCDDaily-Q-ES	0.406***	0.340***	0.330***	0.342***
Self-care ADL	0.356***	0.311***	0.280***	0.306***
Fine motor ADL	0.307***	0.202***	0.359***	0.255***
Gross motor ADL	0.351***	0.328***	0.199***	0.292***

Note: *** = $p < 0.001$.

Agreement between both measurements in the overall sample was poor to moderate and significant ($ICC=0.381$, $95\% CI=0.273-0.479$, $p<0.001$), and moderate and significant in children aged 7 years and older ($ICC=0.489$, $95\% CI=0.366-0.595$, $p<0.001$), but poor and nonsignificant in children aged 5 and 6 years ($ICC=0.154$, $95\% CI=-0.048-0.343$, $p=0.067$). Differences in DCDDaily-Q-ES performance scale and DCDQ-ES total scale were higher in younger children ($t(148.565)=4.919$, $p<0.001$).

DISCUSSION

This is the first study to develop reference norms for the DCDDaily-Q in new cultural contexts. Findings support the need to develop population-adjusted percentiles and cutoffs when assessing motor performance and daily participation. Correlations and agreement between the Spanish versions of the DCDDaily-Q and the DCDQ were moderate overall, but stronger in children aged 7 years and older.

According to parents, children younger than 7 years participated less and performed poorer than older children in all DCDDaily-Q-ES scales, which is consistent with previous research³⁴. It is to be expected that motor performance and participation improve

with age, as children get more proficient with experience, especially in self-care ADL, and therefore, they can engage in a wider range of activities as they grow older^{23,31}.

No overall differences in daily participation or performance were found between boys and girls. Results regarding the influence of sex on motor performance are inconclusive, as some studies have found differences while others have not^{23,34,42,43}. In this study, girls were reported to outperform boys in fine motor activities, but to participate less in gross motor activities, which is an often-described outcome in literature^{23,44-48}.

The Spanish cutoff scores belonging to the 85th and 95th percentiles are higher than Dutch ones, indicating an overall less frequent participation and poorer performance of ADL in Spanish children³⁴. Sample distribution may help explain this difference, as the Spanish sample is larger and better sex-balanced in each age group, but cultural factors are also to be considered. Findings from previous studies suggest differences in patterns of motor performance between children from Southern, Central, and Northern Europe, with better scores in northern regions, and thus making it necessary to develop country-specific cutoffs for the Movement Assessment Battery for Children—Second Edition (M-ABC2) or DCDQ^{35,37,49-52}. Differences in scores belonging to the 85th and 95th percentiles of the DCDDaily-Q between Spanish and Dutch children were between two and five points, demonstrating the need to develop specific cutoffs for each population and context, as evaluating the risk for DCD in Spanish children using Dutch criteria would lead to false-positive outcomes and inaccurate diagnoses. The authors recommend considering the 85th percentile of the performance scale as indicative of DCD for criterion B in a clinical context. Conversely, the 95th percentile should be considered in research works, especially in population-based studies^{40,41}. It is necessary to emphasize that a definite diagnosis of DCD should only be made after assessment of all four criteria by a multidisciplinary team, which should always include an occupational therapist.

As described in previous research, a moderate but significant correlation between the DCDDaily-Q total performance score and the DCDQ total score was found³⁴, which further shows the concurrent validity of both measurements in a Spanish context. Several reasons explain why a perfect correlation or agreement between the DCDDaily-Q and the DCDQ is not to be expected. Firstly, although both questionnaires assess motor performance during ADL, different types of ADL are evaluated in each measurement.

The DCDQ focuses on activities related to control during movement, fine motor skills, and general coordination, and includes just one item that specifically addresses self-care performance. In contrast, the DCDDaily-Q primarily evaluates self-care ADL (43.5%), apart from fine motor (30.4%) and gross motor activities (26.1%).

Secondly, parents are required to make slightly different assessments in each questionnaire. When using the DCDQ, parents are asked to compare the degree of coordination that their child has with other children of the same age, whereas the DCDDaily-Q offers a description of what is considered the right way to perform each of the 23 activities so that parents can determine how well their child does the activity.

Finally, age was a relevant factor, as correlation and agreement between DCDDaily-Q-ES and DCDQ-ES were higher in children aged 7 to 10 years. Furthermore, children aged 5 and 6 years showed higher variance in motor ADL performance than older children, especially in self-care ADL, and differences between both measurements were also greater in this age group, suggesting larger variability in motor performance during early development. This is consistent with previous research and adds to the evidence for not making a definite diagnosis of DCD in very young children². Based on these findings, it is highly recommended to assess criterion B, the impact of the motor deficit on daily life, with both the DCDDaily-Q and the DCDQ, especially in children aged 5 or 6 years, so that the clinical team can gather more comprehensive information regarding daily functioning.

Limitations and Future Research Directions

This study is subject to some limitations and future research directions. It was not possible to calculate sensitivity and specificity of the Spanish 85th and 95th percentiles to identify children with a formal diagnosis of DCD, as DCD is a highly unknown disorder in Spain, and most Spanish children with motor coordination difficulties go unnoticed in medical evaluations^{22,23}. Having two culturally adapted, valid, reliable, and accessible instruments to assess the presence of DCD may increase awareness of DCD in Spain. The sample came from three specific locations in Spain, but it included children from different settings and social backgrounds. The presented sample was larger and more balanced by sex than the Dutch sample, but additional efforts should be made in future studies to gather larger samples to test these findings in other countries or cultural contexts. Future

research should further examine potential differences in DCDDaily-Q outcomes in children from different countries. Daily participation is not only restricted in children with DCD, but also in children with other relatively common neurodevelopmental disorders, such as Attention Deficit and Hyperactivity Disorder (ADHD) and Autism Spectrum Disorders^{53,54}, and therefore, the DCDDaily-Q could be an effective measurement to assess participation issues in several neurodevelopmental difficulties. As most children with a diagnosis of ADHD encounter motor coordination problems as well^{2,55}, future research should validate whether this questionnaire can offer relevant information about motor performance of children with ADHD in specific occupational areas. The DCDDaily-Q-ES and the DCDQ-ES are suitable and accurate instruments to use in future studies aiming to identify DCD in children or to explore motor performance and participation.

CONCLUSIONS

Limitations in ADL participation and performance are core factors in DCD, and they must be adequately assessed when addressing criterion B for DCD diagnosis. The current study provides percentiles for motor performance and participation in several daily living areas and cutoff scores to identify 5- to 10-year-old children at risk of DCD in Spain using a large, representative sample of typically developing children. The DCDDaily-Q-ES and DCDQ-ES have moderate correlation and agreement, which strengthens their concurrent validity.

This study has important implications for both the clinical context and research. Health practitioners and rehabilitation professionals, such as physical and occupational therapists, can use two reliable, valid, user-friendly, and freely available tools to assess motor performance during ADL and criterion B of the diagnostic criteria for DCD. Additionally, these findings may contribute to enhance research and clinical exploration of DCD in Spain in order to improve awareness of this disorder in the Spanish population.

APPENDIX

Table A1. Spanish cut off values and interpretation for the total scores on the “Participation” and “Performance” scales of the DCDDaily-Q-ES.

Participación y Desempeño en AVD	Edades 5 y 6 Años	Edades 7 a 10 Años	Interpretación
Participación en AVD			
Percentil ≥ 95	≥ 51	≥ 45	El niño participa mucho menos que sus compañeros en las AVD de acuerdo a la valoración paterna
Percentiles 86-94	48-50	42-45	El niño participa menos que sus compañeros en las AVD de acuerdo a la valoración paterna
Percentil ≤ 85	≤ 47	≤ 41	El niño participa lo mismo que sus compañeros en las AVD de acuerdo a la valoración paterna
Desempeño en AVD			
Percentil ≥ 95	≥ 45	≥ 39	El desempeño del niño es significativamente peor que el de sus compañeros de acuerdo a la valoración paterna.
Percentiles 86-94	42-44	35-38	El desempeño del niño es algo peor que el de sus compañeros de acuerdo a la valoración paterna
Percentil ≤ 85	≤ 41	≤ 34	El niño no tiene dificultades de desempeño de acuerdo a la valoración paterna

Note: AVD=actividades de la vida diaria.

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CHAPTER 4

PSYCHOMETRIC VALIDATION AND REFERENCE NORMS FOR THE EUROPEAN SPANISH DEVELOPMENTAL COORDINATION DISORDER QUESTIONNAIRE: DCDQ-ES

Montes-Montes R, Delgado-Lobete L, Pereira J, Santos-del-Riego S, Pousada T. Psychometric Validation and Reference Norms for the European Spanish Developmental Coordination Disorder Questionnaire: DCDQ-ES. *Int J Environ Res Public Health*. 2020;17(7):2425.

ABSTRACT

The Developmental Coordination Disorder Questionnaire (DCDQ) is a widely used and well-validated tool that contributes to the diagnosis of Developmental Coordination Disorder (DCD). The aim of this study was to further analyse the psychometric properties of the European Spanish cross-culturally adapted version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES) in a sample of Spanish children aged 6–11 years and to establish reference norms with respect to age groups. Parents of 540 typically developing children completed the DCDQ-ES. A second sample of 30 children with probable DCD (pDCD) was used to test its discriminant validity. Confirmatory factor analysis supported the original three-factor structure and the internal consistency was excellent (Cronbach's $\alpha=0.907$). Significant differences between age groups were found. The pDCD group scored significantly lower than the reference sample in the three subscales and DCDQ-ES total score ($p<0.001$; AUC=0.872). The DCDQ-ES is a reliable and valid tool for screening motor coordination difficulties in Spanish children and for identifying children with probable DCD. The findings of this research suggest that context-specific cut-off scores should be systematically utilized when using cross-cultural adaptations of the DCDQ. Age-specific cut-off scores for Spanish children are provided.

INTRODUCTION

It is estimated that Developmental Coordination Disorder (DCD) affects approximately 5%–10% of school-aged children, making it the most prevalent neurodevelopmental disorder in childhood¹⁻³. Children with DCD present motor coordination difficulties that significantly and persistently limit their daily functioning. As established by the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), children with DCD must show significantly poorer motor coordination performance than expected from the child's chronological age and opportunity for skill learning and use (criterion A) that significantly and persistently interferes with typical activities of daily living (criterion B), where onset occurs in the early developmental period (criterion C) and that cannot be better explained by a neurological condition affecting movement (criterion D)².

Children with DCD often struggle with associated developmental problems such as physical problems, sensory processing issues and psychosocial and anxiety difficulties in childhood and adolescence⁴⁻¹¹, and their daily participation in activities is significantly limited in comparison to their typically developing peers^{12,13}. In addition, there is a high co-occurrence between DCD and Attention Deficit Hyperactivity Disorder (ADHD) and Autism Spectrum Disorders (ASD)^{3,14}. The impact of DCD on daily functioning and participation has been widely reported. Findings from several studies, including a systematic review of 44 articles conducted by Magalhães et al.¹², show that children with DCD have serious activity and participation issues in both productive, leisure and self-care activities, especially in dressing, eating, toileting, sport and outdoor play participation and school-related activities^{1,13-17}. In addition, the impact of DCD on everyday performance usually persists during adolescence and adulthood^{8,18}.

As DCD is a chronic condition with lifelong consequences, it is necessary to identify DCD as early as possible in order to prevent further limitations and promote specific intervention^{3,19,20}. While motor coordination test batteries such as Movement Assessment Battery for Children-2 are recommended to assess criterion A, their utilization is usually too time- and resource-consuming for early identification or screening. Therefore, questionnaires aimed at parents have been developed as feasible alternatives to identify children at risk of DCD and to assess criterion B in large groups of children³. Screening methods to quickly identify children with motor difficulties in Spain are highly needed, as most of the Spanish children with probable DCD go underdiagnosed in Pediatric

Primary Care^{21,22}. There are several parent and teacher questionnaires available aimed to operationalize criterion B for DCD diagnosis, such as the Movement Assessment Battery for Children-2 checklist, the Children Activity Scales (both parent and teacher versions) or the DCDDaily-Q³. The Developmental Coordination Disorder Questionnaire (DCDQ)²³ is the most used measure to identify children with probable DCD^{2,3}.

The DCDQ is a three-dimensional, well-validated and easily accessible measure that was developed in Canada and is aimed at assessing motor performance during daily activities in children aged 5–15 years. In order to use it outside Canada, the DCDQ has been successfully cross-culturally adapted to several languages and countries, including Canadian and European French, German, Brazilian, Italian, Polish, Hindi and Latin American Spanish²⁴⁻³¹. The DCDDaily-Q³² is a newly developed parent questionnaire aimed to comprehensively evaluate motor performance in activities of daily living, including self-care and fine motor and gross motor activities. Although both the DCDQ and the DCDDaily-Q evaluate daily motor performance via parental assessment, the type of activities that are evaluated and the assessments parents are required to make differ between both measures³³. A European Spanish version of the DCDQ (DCDQ-ES) has been recently translated, cross-culturally adapted and preliminarily validated in Spanish children, but further psychometric validation is needed³⁴. Developing custom cut-off points for the Spanish population is also required and recommended, as previous studies have demonstrated that the original proposed cut-off points of the DCDQ may not adjust to South European children³⁵. The aims of this study were (1) to test the psychometric properties of the DCDQ-ES and (2) to develop country-adjusted reference norms and cut-off points for Spanish children.

METHODS

Participants, Procedure and Research Ethics

As children with DCD are usually identified at school-age, two samples of children aged 6 to 11 years were included in the study: a normative group ($n=540$, 50.0% boys, mean age=8.5, SD=1.7) and a probable DCD group (pDCD) ($n=30$, 66.7% boys, mean age=7.9, SD=1.2) (Table A1). All children in the pDCD group were identified as having probable DCD using the 95th percentile cut-off score on the Spanish version of the DCDDaily-Q (mean score=46.9, SD=7.8)³³.

The DCDDaily-Q is a parent questionnaire aimed to operationalize criterion B of the diagnosis of DCD³². This measure has demonstrated excellent psychometric properties and capacity to identify children with DCD (Cronbach alpha=0.85; sensitivity=88%; specificity=92%)³². All children in the pDCD group had been referred to two rehabilitation centers in Spain for motor performance issues, and some of them had a previous medical diagnosis of a co-occurring neurodevelopmental condition (ADHD=33.3%, ASD=13.3%, no co-occurring disorder=53.3%). None of the children in the pDCD group were receiving specific treatment for DCD.

Participants in the normative group were randomly selected from a previously recruited larger sample that came from fourteen randomly selected mainstream elementary schools located in five locations in northwest, north and center of Spain (northwest=78.1%, north=20.2%, center=1.7%)^{21,33}. Most of the children (60.6%) came from a family with high/university education level (i.e., at least one parent held a college degree). Children with a parent-reported diagnosis of a developmental disorder were excluded from this group.

A third group that included children in the normative sample was created to serve as a control group for discriminant validity analysis in order to control for age and sex distribution. Children in the control group were randomly selected from the normative group using age- and sex-stratified sampling to match for exact age and sex with the pDCD group. As the pDCD sample size was small ($n=30$), a 1:2 ratio was used for the control group ($n=60$) to increase the statistical power of the analyses^{36,37}.

This study was approved by the Autonomic Research Ethics of Galicia Committee (code 2017-167). The DCDQ-ES was sent to the parents of the participants between June 2017 and December 2019 via school or rehabilitation center intermediation, so the parents could complete the DCDQ-ES at home.

Parents also received an informative letter about the study, where it was stated that completion of the DCDQ-ES was anonymous and voluntary. The e-mail address and telephone number of the first author were included in the letter so parents could contact the research team for clarification of the items or the questionnaire. Only parents who consented to participate returned the DCDQ-ES to the schools after completion within one week. Researchers retrieved the completed questionnaires from the schools.

Measurements

European-Spanish Version of the DCDQ (DCDQ-ES)

The DCDQ-ES is a 15-item parent questionnaire designed to screen motor coordination disorders in 5–15-year-old children²³. Using a five-point Likert scale, parents are asked to evaluate how well their child performs certain motor daily activities compared with their peers (1=not at all like your child; 2=a bit like your child; 3=moderately like your child; 4=quite a bit like your child; 5=extremely like your child). Items are divided into three subscales or factors: control during movement, fine motor/handwriting and general coordination.

Total and subscale scores are calculated, where higher scores indicate better performance and the total score indicates whether a child has probable DCD with respect to three age groups (5–7 years 11 months; 8–9 years 11 months; and 10–15 years)²⁴. The DCDQ usually takes about 10–15 min to complete²³, and it is a well-validated and recommended tool for assessing criterion B of the DSM-5 for a diagnosis of DCD^{2,3}. The DCDQ was originally developed in English, and its original validation study using a large sample of Canadian children demonstrated good psychometric properties (Cronbach's alpha=0.94; sensitivity=85%; specificity=71%)²³. Translation into European Spanish, cross-cultural adaptation and preliminary psychometric validation of the DCDQ-ES have been described in a previous study, demonstrating that it is conceptually and semantically equivalent to its English version and is a reliable measure for assessing motor coordination in Spanish children³⁴. Additionally, the DCDQ-ES has a moderate and significant correlation with the Spanish version of the DCDDaily-Q ($r=0.406$; $ICC=0.381$; $p<0.001$), which contributes to demonstrating its concurrent validity³³. The DCDQ-ES is available in the Appendix of this thesis.

Statistical Analysis

Analyses were performed using SPSS version 24 (SPSS Inc., Chicago, IL, USA) and EQS 6.1 for Windows. To assess the goodness of fit, confirmatory factor analysis (CFA) was conducted using an unweighted least-squares estimation method ($n=540$)³⁸⁻⁴⁰. A root-mean-square error of approximation (RMSEA) of <0.08 , a comparative fit index (CFI) of >0.95 and a non-normed fit index (NNFI) of >0.95 were indicators that the model fitted the data adequately^{41,42}.

Reliability of the DCDQ-ES was calculated using Cronbach's alpha, with a value higher than 0.70 considered to be an indication of good internal consistency. Student's t-test, analysis of variance (ANOVA) and Bonferroni post-hoc tests were used to determine the discriminant validity of the DCDQ-ES by calculating differences between the control group and the pDCD, pDCD only, pDCD/ADHD and pDCD/ASD groups for mean item scores and mean total and subscale scores. Discriminant validity of the DCDQ-ES across age groups was also tested using Student's t-test.

Mean differences according to sex and age group were assessed with Student's t-test and ANOVA analysis. Then, the 5th, 10th, 15th and 20th percentiles of the normative group were calculated for the DCDQ-ES total and subscale scores in the overall sample and within each of the three age groups. ROC computations were conducted and DCDQ-ES total score sensitivity, specificity and predictive values were calculated.

Finally, we explored the potential research consequences of adjusting DCDQ-ES scores for the Spanish population by examining the percentage of children identified as having probable DCD using the original Canadian cut-offs (≤ 46 for ages 6–7; ≤ 55 for ages 8–9; or ≤ 57 for ages 10–11) or the Spanish-adjusted 5th percentile cut-offs for each age group.

RESULTS

Construct Validity and Internal Consistency

The original proposed three-factor model reported an overall good fit to the data (factor 1 = control during movement (items 1–6); factor 2=fine motor/handwriting (items 7–10); factor 3=general coordination (items 11–15)) ($\chi^2(87)=667.7$, $p<0.01$; CFI=0.974; NNFI=0.969; RMSEA=0.047, 95% CI=0.038–0.056). All the loadings were significant and ranged from 0.52 to 0.78 (Figure 1).

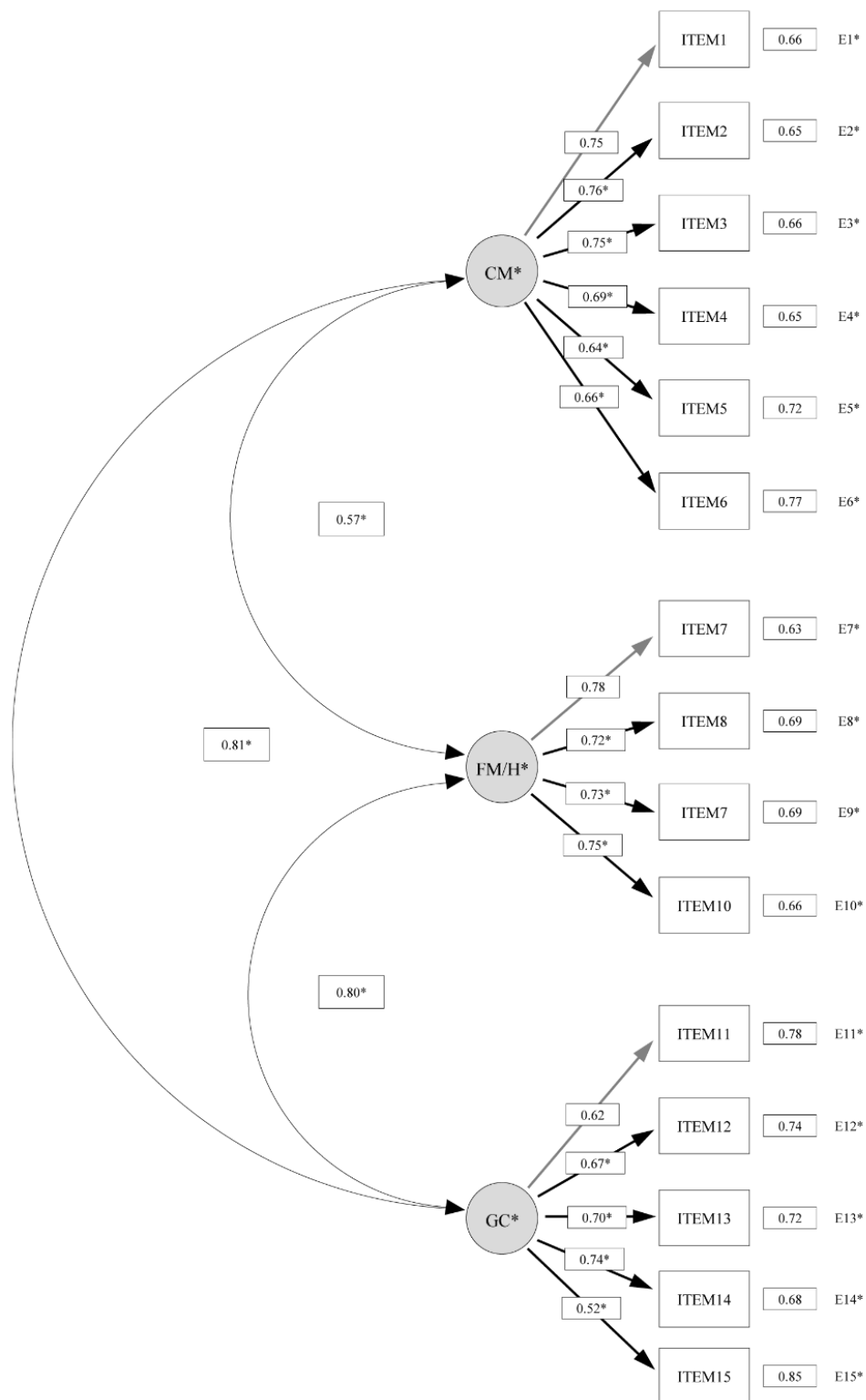


Figure 1. Confirmatory factor analysis of the Spanish version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES) three-factor model ($n=540$). Items 1, 7 and 11 fixed to 1 during estimation. CM=control during movement; FM/H=fine motor/handwriting; GC=general coordination.

Internal consistency was excellent for the DCDQ-ES total, and good for the three motor coordination factors (DCDQ-ES total, $\alpha=0.907$; control during movement, $\alpha=0.863$; fine motor/handwriting, $\alpha=0.835$; general coordination, $\alpha=0.775$). The Cronbach's alpha did not increase if any of the items were deleted, therefore indicating that no item was problematic.

Discriminant Validity

As displayed in Table 1, the total score of the DCDQ-ES showed a good discriminant capacity between typically developing children and children with probable DCD across age groups.

Table 1. DCDQ-ES total and subscale scores for pDCD and matched control group across age groups ($n=90$).

DCDQ-ES	pDCD Mean (SD)	Control Mean (SD)	<i>p</i> Value
Total ($n=90$)			
Control during movement	20.4 (6.2)	26.8 (3.3)	<0.001
Fine motor/handwriting	12.0 (5.2)	17.2 (3.0)	<0.001
General coordination	15.7 (5.5)	21.4 (3.4)	<0.001
DCDQ-ES total	48.1 (14.0)	65.5 (8.3)	<0.001
6-7 years ($n=33$)			
Control during movement	18.2 (7.3)	26.1 (3.1)	0.005
Fine motor/handwriting	10.5 (5.8)	16.3 (2.6)	0.008
General coordination	14.2 (5.7)	21.1 (3.2)	0.002
DCDQ-ES total	42.8 (15.3)	63.5 (7.7)	<0.001
8-9 years ($n=48$)			
Control during movement	21.4 (5.0)	27.2 (3.6)	<0.001
Fine motor/handwriting	13.2 (4.7)	17.8 (3.2)	0.002
General coordination	16.9 (5.3)	21.5 (3.7)	<0.001
DCDQ-ES total	51.4 (12.9)	66.4 (8.8)	<0.001
10-11 years ($n=9$)			
Control during movement	23.0 (7.8)	27.7 (2.3)	0.410
Fine motor/handwriting	11.7 (5.5)	17.7 (2.7)	0.056
General coordination	15.0 (6.6)	22.0 (3.0)	0.055
DCDQ-ES total	49.7 (12.7)	67.3 (7.2)	0.029

Note: SD=standard deviation; pDCD=probable Developmental Coordination Disorder.

The pDCD group scored significantly lower than the matched control group, both for the DCDQ-ES total and subscale scores and all items. Children with pDCD only (without ADHD or ASD) also showed significantly poorer scores on the DCDQ-ES total scale and all subscales (Table 2).

Table 2. DCDQ-ES total, subscale and item scores for pDCD and matched control group ($n=90$).

DCDQ-ES	pDCD Mean (SD) ($n=30$)	pDCD only Mean (SD) ($n=16$)	pDCD/ADHD Mean (SD) ($n=10$)	pDCD/ASD Mean (SD) ($n=4$)	Control Mean (SD) ($n=60$)	<i>p</i> Value within Groups
Item 1	3.0 (1.3)	3.4 (1.2)	2.9 (1.2)	1.8 (1.5)	4.4 (0.8)	<0.001 a; 0.002 b; <0.001 c; <0.001 d
Item 2	2.8 (1.3)	3.1 (1.1)	2.8 (1.4)	1.8 (1.5)	4.5 (0.7)	<0.001 a; <0.001 b; <0.001 c; <0.001 d
Item 3	2.7 (1.4)	2.9 (1.1)	2.7 (1.7)	2.0 (2.0)	4.1 (1.0)	0.004 a; 0.004 b; 0.004 c; <0.001 d
Item 4	4.0 (1.2)	4.3 (0.9)	4.1 (1.4)	3.0 (1.6)	4.6 (0.7)	0.033 a; 1.000 b; 0.760 c; 0.004 d
Item 5	4.0 (1.2)	4.1 (1.0)	4.3 (1.3)	2.8 (1.5)	4.6 (0.6)	0.016 a; .213 b; 1.000 c; <0.001 d
Item 6	3.8 (1.2)	4.1 (1.0)	3.8 (1.4)	3.0 (1.4)	4.8 (0.5)	<0.001 a; 0.012 b; 0.003 c; <0.001 d
Item 7	3.0 (1.5)	3.5 (1.4)	2.3 (1.1)	3.0 (2.3)	4.3 (0.8)	<0.001 a; 0.053 b; <0.001 c; 0.119 d
Item 8	3.0 (1.6)	3.6 (1.7)	2.5 (1.4)	1.8 (1.0)	4.4 (0.9)	<0.001 a; 0.082 b; <0.001 c; <0.001 d
Item 9	3.0 (1.4)	3.6 (1.3)	2.3 (1.1)	2.5 (1.7)	4.2 (1.0)	<0.001 a; 0.357 b; <0.001 c; 0.017 d
Item 10	3.0 (1.4)	3.4 (1.3)	2.6 (1.2)	2.0 (1.4)	4.3 (0.9)	<0.001 a; 0.029 b; <0.001 c; <0.001 d
Item 11	3.5 (1.5)	3.8 (1.5)	3.8 (1.1)	1.8 (1.0)	4.6 (0.7)	0.001 a; 0.011 b; 0.087 c; <0.001 d
Item 12	3.4 (1.4)	4.0 (1.2)	3.2 (1.2)	1.5 (1.0)	4.4 (0.7)	<0.001 a; 0.666 b; 0.001 c; <0.001 d
Item 13	2.7 (1.4)	3.3 (1.4)	1.8 (0.9)	2.3 (1.3)	4.3 (1.0)	<0.001 a; 0.014 b; <0.001 c; 0.003 d
Item 14	3.3 (1.5)	3.8 (1.4)	3.1 (1.4)	1.8 (1.0)	4.3 (1.0)	0.002 a; 0.793 b; 0.014 c; <0.001 d
Item 15	2.8 (1.5)	3.5 (1.5)	1.8 (0.9)	2.8 (1.7)	3.9 (1.1)	0.001 a; 1.000 b; <0.001 c; 0.388 d
Control during movement	20.4 (6.2)	21.8 (4.4)	20.6 (6.8)	14.3 (8.8)	26.8 (3.3)	<0.001 a; <0.001 b; <0.001 c; <0.001 d
Fine motor/handwriting	12.0 (5.2)	14.2 (4.9)	9.7 (4.2)	9.3 (5.6)	17.2 (3.0)	<0.001 a; 0.025 b; <0.001 c; <0.001 d
General coordination	15.7 (5.5)	18.4 (5.0)	13.7 (3.8)	10.0 (5.5)	21.4 (3.4)	<0.001 a; 0.035 b; <0.001 c; <0.001 d
DCDQ-ES total	48.1 (14.0)	54.3 (10.7)	44.0 (11.8)	33.5 (18.6)	65.5 (8.3)	<0.001 a; <0.001 b; <0.001 c; <0.001 d

Note: SD=standard deviation; pDCD=probable Developmental Coordination Disorder; ADHD=Attention Deficit and Hyperactivity Disorder; ASD=Autism Spectrum Disorder; a=between controls and pDCD; b=between controls and pDCD only; c=between controls and pDCD/ADHD; d=between controls and pDCD/ASD.

Age and Sex Differences and Age-Specific Cut-Offs

Significant differences between age groups were found in the DCDQ-ES total scale and all subscales ($p < 0.001$). Younger children scored significantly lower than their older peers in the DCDQ-ES total scale and subscales.

Differences between sex groups were found only in one subscale. In the overall normative sample, girls scored significantly higher than boys in fine motor/handwriting ($p < 0.001$), but not in control during movement ($p = 0.424$), general coordination ($p = 0.084$) or total score ($p = 0.228$).

Therefore, percentiles for all subscales and total score were calculated separately for each age group. In total, four cut-off points for each age group were calculated according to the 5th, 10th, 15th and 20th percentiles on the normative group for DCDQ-ES total and subscales (Table 3). The 15th percentile cut-off point of the DCDQ-ES for the total sample was 57 or below, with a sensitivity of 76.7% and a specificity of 83.3% (AUC=0.872, 95% CI=0.798–0.948, $n=90$) (Table 4; Figure 2).

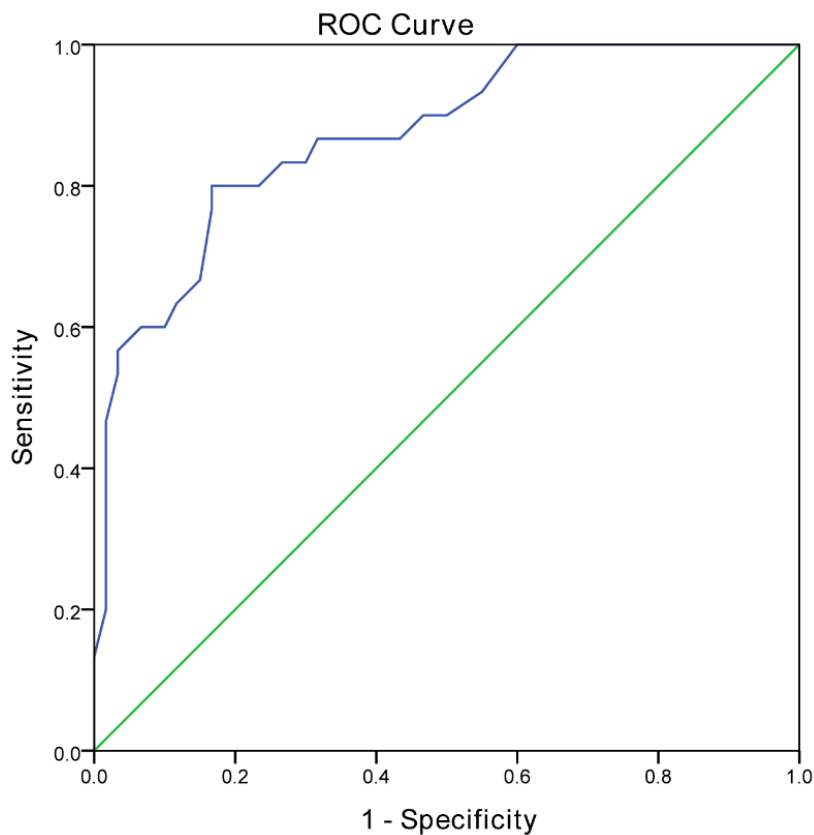


Figure 2. Receiver operating characteristic curve for the DCDQ-ES (cut-off score of 57) ($n=90$).

Table 3. Overall and age-specific cut-off points according to the 5th, 10th, 15th and 20th percentiles for the DCDQ-ES total and subscores in the normative group ($n=540$).

DCDQ-ES	p5	p10	p15	p20
Normative group ($n=540$)				
Control during movement	19	21	22	24
Fine motor/handwriting	12	14	15	16
General coordination	15	17	18	19
DCDQ-ES total	49	55	57	59
6-7 years old				
Control during movement	18	20	21	22
Fine motor/handwriting	12	13	14	15
General coordination	14	16	17	18
DCDQ-ES total	46	50	54	57
8-9 years old				
Control during movement	19	21	22	24
Fine motor/handwriting	12	14	15	16
General coordination	15	17	19	19
DCDQ-ES total	50	55	58	60
10-12 years old				
Control during movement	21	23	24	24
Fine motor/handwriting	13	15	16	16
General coordination	16	17	19	20
DCDQ-ES total	53	56	59	61

Note: In bold=recommended cut-offs for DCD indication (criterion B) in clinical practice (p15) and research (p5).

Table 4. Predictive values and Youden's index of the 5th and the 15th percentiles ($n=90$).

DCDQ-ES Total Score	FP N (%)	FN N (%)	TP N (%)	TN N (%)	PPV	NPV	Youden's Index
p15 (57)	10 (16.7)	7 (23.3)	23 (76.7)	50 (83.3)	69.7%	87.7%	0.833
p5 (49)	1 (1.7)	16 (53.3)	14 (46.7)	59 (98.3)	93.3%	78.7%	0.450

Note: FP=false positive; FN=false negative; TP=true positive; TN=true negative; PPV=positive predictive value; NPV=negative predictive value.

Table 5 displays the research consequences of using the original Canadian cut-off points for identifying Spanish children with probable DCD, which were developed using logistic regression modelling²³. As observed, 3.5% of children in the reference sample were diagnosed differently, depending on the cut-off point used. For the youngest children there is a 100% rate of agreement between both cut-off proposals, but in older groups this mismatch would result in a high rate of false-positive diagnoses. This mismatch is especially relevant in children aged 10 to 11 years, as 6.7% of Spanish children would get a false positive of probable DCD in research practice.

Table 5. Prevalence of children diagnosed with probable DCD using Canadian or Spanish cut-off points ($n=540$).

Spanish Cut-Offs	Canadian Cut-Offs	
	Probable not DCD	Probable DCD
Total sample		
Probably not DCD	90.9%	3.5%
Probable DCD	0.0%	5.6%
6-7 years old		
Probably not DCD	95.0%	0.0%
Probable DCD	0.0%	5.0%
8-9 years old		
Probably not DCD	90.5%	3.9%
Probable DCD	0.0%	5.6%
10-12 years old		
Probably not DCD	87.2%	6.7%
Probable DCD	0.0%	5.1%

Note: DCD=Developmental Coordination Disorder.

DISCUSSION

The aim of this research was to further validate the Spanish version of the DCDQ and to develop cut-off points for Spanish children using a randomly selected, sex and age-balanced sample of 540 Spanish typically developing children.

As motor coordination performance is a complex construct, different theories have been suggested and tested for its categorization when using and interpreting the DCDQ^{23,43,44}. In this study, CFA analysis confirmed the original proposed three-factor structure, which is in line with the findings from Rivard et al.⁴⁴ and the validation study of the Italian version of the DCDQ³⁵. Overall, these findings add to the evidence that motor coordination is a complex and multifactorial construct and that fine motor skills,

coordination during movement and general coordination are interrelated factors but with unique differential aspects. For instance, girls and boys tend to show different motor coordination patterns in fine and gross motor skills, even when children come from different countries and cultural environments^{21,45}, and children with DCD struggle with different areas of motor coordination^{3,13}. Therefore, it is necessary to assess each factor when exploring for DCD or coordination difficulties in daily living. Based upon the presented results, the authors recommend taking into account the specific problems in each of the three subscales in addition to interpreting the total score when using the DCDQ in a clinical context.

The DCDQ-ES has been previously cross-culturally adapted to the Spanish population, demonstrating that it is culturally and conceptually equivalent to the original DCDQ, and the preliminary validation study showed that the DCDQ-ES is a reliable tool for assessing motor performance in typically developing Spanish children³⁴. In line with previous studies, findings from this further validation work report higher internal consistency values for the DCDQ-ES total scale and for the three subscales²⁴⁻³¹. Cronbach's alpha values in other validation studies in European, Asian and Latin American populations range from 0.89 to 0.96²⁴⁻³¹, demonstrating that the DCDQ is a reliable tool for assessing motor coordination and probable DCD.

The DCDQ-ES showed a high capacity to discriminate between children with and without probable DCD. The pDCD group scored significantly lower on all of DCDQ-ES items, the total scale and each of the three subscales ($p < 0.05$). The total score of the DCDQ-ES significantly discriminated children in the pDCD group across the three age groups as well. The co-occurrence rate of other neurodevelopmental conditions within the pDCD group is in line with the high prevalence rates reported by previous research, particularly regarding ADHD and ASD^{3,14,46-48}. Children with ADHD frequently present with motor coordination difficulties and DCD^{3,49}, and it has been questioned whether ADHD and DCD may pose as a unique disorder, but research demonstrates that they show differential motor, executive functioning and sensory processing characteristics and disparities in brain underpinnings, adding to the evidence of both disorders being commonly overlapping but different conditions^{7,50,51}.

Co-occurrence between DCD and ASD has been less explored, partially because assessment of motor coordination difficulties in children with ASD is reasonably more complex. However, the DSM-5 states that co-occurrence between both disorders is possible and research suggests that it may be quite frequent^{2,3,52-54}. A recent study using a large sample of children with ASD ($n > 11,000$) estimates that prevalence of risk of DCD in this population is as high as 86.9%⁵⁵. Even if ASD commonly overlaps with DCD, research supports that both are different disorders with unique physiological and functional characteristics and intervention requirements⁵⁶. For instance, Caeyenberghs et al.⁵⁷ found that children with DCD only and ASD only showed disorder-specific neural alterations, while children with both DCD and ASD exhibited distinct topological patterns, concluding that co-occurring children have a unique neural signature.

In this study, most of the items significantly discriminated children with pDCD only, pDCD/ADHD and pDCD/ASD, although some items (i.e., item 4, 5 or 15) did not discriminate typically developing children from pDCD only children, which can be partially explained by the small sample size in this subgroup. However, the total and subscale scores of the DCDQ-ES significantly discriminated children with pDCD only, pDCD/ADHD and pDCD/ASD, thus supporting the discriminant validity of the DCDQ-ES.

As expected, significant differences between age groups were found in both the DCDQ-ES total scale and all subscales. Older children scored significantly higher than younger children, which adds to the evidence that children improve their motor skills as they grow, as has been theorized previously by several authors, thus supporting the use of age-specific cut-off points^{21,23,35,44,46}.

Findings regarding sex differences in motor performance vary highly across cultural contexts and measures of assessment^{20,33,45}. In this study, boys and girls showed a similar score on the DCDQ-ES total scale but had significant differences in the fine motor/handwriting subscale. Outcomes regarding differences in motor coordination between boys and girls are inconclusive and vary according to country and measure of assessment⁵⁸⁻⁶⁰. For instance, Rivard et al.⁴⁴ reported that Canadian typically developing and DCD girls scored better on the DCDQ total scale than typically developing and DCD boys, respectively, while Caravale et al.³⁵ found that Italian boys and girls showed similar

scores on the Italian DCDQ. Using the DCDDaily-Q, Delgado-Lobete et al.⁴⁵ found that both Spanish and Dutch girls showed better performance in fine motor activities than Spanish and Dutch boys, but differences in total performance varied according to sex and country.

These outcomes are in line with the findings from this study, and suggest that motor performance is probably influenced by cultural factors and daily activity participation. On the other side, typically developing boys are usually more proficient in gross motor skills than typically developing girls, while girls usually outperform boys in fine motor skills, but there is generally a higher proportion of males than females reported with DCD^{21,33,45,59,60}. Thereby, it is possible that impairments in gross motor skills may be more evident than difficulties in fine motor performance, which could lead to girls with coordination motor struggles to go unnoticed.

As age was significantly associated with DCDQ-ES subscales and total scores, different cut-off points were calculated following the original age categorization of the DCDQ²³. The resulting Spanish cut-offs reflected the lower mean scores found in typically developing Spanish children in comparison with the Canadian children, except for younger children. Identifying DCD in young children may be more complicated than in older children because motor performance is more variant and coordination difficulties can be overturned^{3,33}. Country-adjusted cut-off points have also been developed for other Southern American and European versions of the DCDQ, and these are usually lower than the original ones^{35,61}. The established cut-off points for Brazilian children are significantly lower than both the Canadian and the Spanish norms, indicating lower overall scores in the DCDQ for Brazilian children⁶¹. While Italian adjusted cut-off points are almost similar to the Spanish norms in younger children, they differ significantly in the 8–9 and 10–12-years-old groups³⁵, which in the Spanish situation may reflect an increasing improvement in motor performance with age²¹. This situation may be due to different motor coordination standards between North America and South America or Southern Europe, which are consistent with the different prevalence rates of probable DCD among these populations^{21,60}. Interestingly, differences between Italian and Spanish cut-off points further support that variances in motor coordination performance exist even between regions that may be perceived as similar.

The 5th percentile is often taken as the cut-off point in tools designed to identify the risk of DCD in research^{32,35,62-64}, and so it is the cut-off point recommended by the authors when using the DCDQ in Spain to operationalize criterion B of the diagnostic criteria for DCD diagnosis in research practice. Conversely, the use of the 15th percentile is recommended in clinical practice. However, as the aim of the DCDQ-ES is to identify as many children with probable DCD as possible, different percentile scores are given so that researchers and healthcare practitioners can compare a child's performance in each of the three factors and the total scale in relation to the normative sample, thereby detecting those children with mild motor coordination difficulties in order to prompt strategies to prevent further consequences. An additional recommendation for clinicians would be to not only be alert to the total DCDQ-ES score but to notice whether the child scores lower than their peers in a particular area (i.e., control during movement, fine motor/handwriting or general coordination), as children with DCD present with a variety of motor coordination issues.

As expected, the Spanish recommended cut-off score for clinical practice in the overall sample, regardless of age group, is higher than the Canadian value (57 vs. 53). It is interesting to note that although this overall cut-off resulted in quite similar sensitivity values (Spanish=77%; Canadian=81%), the specificity in the Spanish version is significantly higher (Spanish=83%; Canadian=65%).

However, sensitivity and specificity values for the clinical proposed Spanish cut-off were similar with that of the original DCDQ and other cross-cultural adaptations^{23,25-27,30,35}. For instance, sensitivity and specificity of the German version of the DCDQ for a clinic sample was 72.7% and 95%, while these values decreased to 30% and 86.7% in a community sample²⁵. The Italian-adjusted cut-off scores resulted in a sensitivity of 59% and a specificity of 65% for a community-based sample³⁵, but these values increased to 88% and 96% if using a clinical DCD sample²⁷. The sensitivity and specificity for Brazilian children is 73% and 86.6%, respectively²⁶, and the European French values are similar as well (sensitivity=85%, specificity=81.6%)³⁰.

One important finding in this study was that using the non-country-adjusted cut-off points for Spanish children resulted in a significant mismatch and a high rate of false-positive diagnoses of probable DCD, especially in children older than 7 years. As previously

discussed, the discrepancy between Canadian and Spanish norms could be explained by differences in motor coordination standards between regions, which have been reported in previous studies across European and American populations^{35,45,60,62}. It may be possible that parents from different cultural and geographical backgrounds have distinct standards on rating their child's motor performance in comparison to other children.

These findings show that it is crucial to develop and promote the use of country-adjusted norms in order to prevent misleading outcomes in clinical and research practice. Possible clinical consequences of mistakenly identifying children with probable DCD include not only economic and resource costs but also the cost of putting families and children through unnecessary stress and potentially delaying a definite diagnosis. As the DCDQ-ES aims to operationalize criterion B of the DSM-5 diagnostic criteria for DCD, a diagnosis of definite DCD only should be made after a comprehensive multidisciplinary evaluation^{3,33}. An occupational therapy evaluation of the impact of motor deficits on a child's activities in daily living has specific relevance in the diagnosis of DCD (criterion B). Therefore, it is recommended to include paediatric occupational therapists in the multidisciplinary team.

Limitations and Future Research Directions

Some limitations of this study should be addressed. One important limitation was that a definite diagnosis of DCD could not be established in the pDCD group. However, only children who scored at the most restrictive cut-off in the DCDDaily-Q were included in the pDCD group. Another limitation regarding the pDCD group is that most severe cases (i.e., children who had been referred for motor coordination difficulties in addition to another potential neurodevelopmental condition) were more likely to be recruited in this study, which may constitute a bias. A second limitation is that the sample size of the 10–11-years-old group in the pDCD group was very small. Additionally, our sample did not include children aged 12–15, therefore the norms for the older age group should be considered when assessing Spanish children older than 11 years. Finally, intra-rater reliability, test-retest reliability and concurrent validity with objective motor test batteries were not tested. Future research directions might include gathering data from children with a definite diagnosis of DCD in order to further test the sensibility and specificity of the proposed cut-off scores.

CONCLUSIONS

The present study has both research and clinical implications as it reports further information about the psychometric properties of the European Spanish version of the DCDQ and provides the reference norms for Spanish children. Findings show that the DCDQ-ES is a reliable and valid instrument for assessing motor coordination issues and for identifying children with probable DCD in Spanish context. Age-specific cut-off points adjusted to the Spanish population are provided for research and clinical purposes. The DCDQ-ES is a cost-effective, accessible and reliable measure for easy and quick assessment of motor coordination that may prompt further and comprehensive evaluation of potential DCD if needed. Health practitioners working in paediatric primary care or with children, such as occupational and physical therapists, can benefit from these findings and use the DCDQ-ES to operationalize criterion B of the diagnostic criteria for DCD.

APPENDIX

Table A1. Age and sex for all groups ($n=570$).

Participants	N	Boys (N (%))
Normative group	540	270 (50.0%)
6-7 years old	180	90 (50.0%)
8-9 years old	180	90 (50.0%)
10-12 years old	180	90 (50.0%)
pDCD group	30	20 (66.7)
6-7 years old	11	8 (72.7)
8-9 years old	16	10 (62.5)
10-11 years old	3	1 (33.3)
Control group	60	40 (66.7)
6-7 years old	32	16 (72.7)
8-9 years old	32	20 (62.5)
10-11 years old	6	2 (33.3)

Note: pDCD=probable Developmental Coordination Disorder.

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CHAPTER 5
SUMMARY AND GENERAL
DISCUSSION

BACKGROUND AND MAIN AIM OF THIS THESIS

It is estimated that more than 200,000 school-aged children in Spain present with Developmental Coordination Disorder (DCD)^{1,2}. However, most of these children are not identified, and therefore it is more difficult for them to receive treatment to limit the consequences of this disorder on daily performance and participation²⁻⁴. In addition, DCD research in Spain is extremely scarce, which further hinders the impact of this disorder in Spanish children. Providing accessible, adapted and reliable instruments to screen for DCD may contribute to raise awareness of this disorder in the Spanish context and to identify children who are at risk of DCD^{5,6}.

The main aim of this thesis was to develop a cross-culturally adapted, reliable and valid version of the Developmental Coordination Disorder Questionnaire (DCDQ) for use in a European Spanish context⁷⁻¹², and to provide country-adjusted reference norms of the DCDQ for Spanish children. As a first step, the conceptual, semantic, linguistic and experiential equivalence between the original DCDQ and the European Spanish version was investigated. The preliminary reliability of the newly produced DCDQ-ES was also examined. Results of this study were used to further establish the psychometric properties of the DCDQ-ES, including its concurrent validity with the European Spanish version of the DCDDaily-Q (DCDDaily-Q-ES). Finally, sex- and age-specific reference norms for both the DCDQ-ES and the DCDDaily-Q-ES were developed in order to provide a useful instrument to quickly identify children at risk of DCD and to support the diagnosis of DCD in Spanish children.

SUMMARY AND DISCUSSION

Reflections on the thesis

The cross-cultural adaptation and psychometric validation of the DCDQ into Spanish children gave rise to some critical reflections that may be relevant for future research. Issues regarding the methodological approach and assessment of everyday activities in DCD are examined, and implications in both research and clinical practice are discussed.

Cross-cultural equivalence of the DCDQ-ES

Cross-cultural adaptation of a medical, sociological or physiological questionnaire should be considered if the instrument is to be applied in a different culture, language and country than the ones in which it was developed^{12,13}. Only performing a forward translation into the target language does not ensure a cross-cultural equivalence between both versions, as it results in a suboptimal outcome that is not informed by rigorous conceptual, semantic, linguistic and cultural criteria, and that may lead to inaccurate conclusions¹³⁻¹⁵.

Findings in this thesis show that a systematic procedure contributes greatly to reach cultural equivalence between the original and the target versions of assessment instruments. Following international recommendations^{12,13}, two forward translations of the DCDQ into European Spanish were performed by two translators with different profiles and backgrounds. Initially, translators were asked to independently rate the conceptual and semantic equivalence of each translated item. At that stage, only 40% of the items were considered as being totally equivalent (i.e., conceptually and semantically equivalent) by both translators, and there was an overall 33.3% rate of disagreement between them. After the synthesis and reconciliation procedure, 73.3% of the reconciled items were considered totally equivalent by both translators. This is an important finding that adds to the evidence of synthesis and reconciliation process being a significant part of cross-cultural adaptation^{12,13,15}. In this thesis, analysis of the two translations provided an opportunity for the translators and the PhD candidate to critically address relevant information and equivalence issues that would otherwise have been overlooked. These findings also indicate that including both translation profiles (i.e., DCD familiar and unfamiliar translators) significantly contributes to improve the cross-cultural equivalence of DCD-related questionnaires, because it allows the research team to cover two important aspects of cross-cultural adaptation (i.e., conceptual and semantic equivalence), and to produce a semantically and linguistically appropriate translation that faithfully reflects the original intended meaning in terms of movement and performance¹⁶.

The committee review and the comprehensibility analysis also contributed to further improve the cross-cultural adaptation of the DCDQ-ES. In this thesis, a multiregional committee was used to ensure that the DCDQ-ES adaptation was appropriate regardless of the region of origin¹³. Most of the issues addressed during the expert committee review referred to motor-planning related activities, because they were challenging to reword in

a way that sounded natural in European Spanish while accurately retaining the original meaning. For example, the expression “bull in a china shop”, which is used to describe a clumsy child that may bump into things unintentionally, was replaced with the Spanish equivalent “elefante en una cacharrería” [*elephant in a glassware shop*]. These issues were further discussed during the debriefing cognitive interviews as well, which led to additional structural changes on some of these items. In some cases, adding a brief explanation of the inquired task improved the comprehensibility and interpretation of the item. In other items, the described activities were replaced with more culturally appropriate alternatives (e.g., “building a cushions *wall* or *tower*” instead of “building a cardboard or cushions *fort*”). In addition, the two items of the DCQ that were initially worded with negative phrasing, were reworded with positive phrasing in Spanish to avoid misunderstandings. As a result, the items became more comprehensible and enabled parents to provide more accurate information about their child’s performance. Overall, although all the different European Spanish translations of the DCDQ were linguistically and technically correct, the way in which the motor activity was described was the key factor that allowed parents to recall their child’s movement and performance. Rewording items, including brief examples and using cultural-specific expressions are common strategies used by other cross-cultural adaptations of the DCDQ^{8,11,17,18}, which highlight the need to conduct appropriate cross-cultural adaptation methods before applying a DCD-related questionnaire in a new cultural context.

Psychometric properties of the DCDQ-ES

It is recommended to complete the pretesting stage of the cross-cultural adaptation with the initial testing of reliability^{12,14}. Therefore, we examined the preliminary reliability of the DCDQ-ES using a randomly selected sample of 35 typically developing children ages 6-12 years. We found that the DCDQ-ES had good preliminary values of internal consistency and homogeneity, which prompted a full psychometric testing of the DCDQ-ES.

Criterion validity of the DCDQ-ES was examined in *Chapter 3* by exploring the correlation and agreement between the DCDQ-ES and the European Spanish version of the DCDDaily-Q (DCDDaily-Q-ES). It was found that both instruments had a significant and moderate correlation and agreement for the overall sample and for children aged 7 years and older. However, the agreement was poor and nonsignificant in the younger

group (i.e., children aged 5 and 6 years). It is clear that age is a relevant factor when assessing for daily motor performance in DCD. For instance, it is not recommended to give a formal diagnosis of DCD in children younger than 5 years because it is expected for children that young to have great variability in different domains of motor performance⁴. Therefore, health professionals and therapists working with young children would benefit from using complementary instruments to investigate performance in motor-based everyday activities¹⁹. Overall, it was concluded that the DCDQ-ES showed an overall adequate criterion validity with the DCDDaily-Q-ES.

Findings from *Chapter 2* and *Chapter 4* showed that internal consistency indicators of the DCDQ-ES were as good as the obtained for the overall questionnaire in the revised DCDQ²⁰. Moreover, the DCDQ-ES demonstrated good internal consistency for each of the subscales, with Cronbach's alpha values ranging from 0.78 to 0.86. These findings are in line with those reported in previous validation studies of the DCDQ in different populations and countries^{7-10,21-25}. Furthermore, this work contributes to confirm that, if cross-culturally adapted, the DCDQ is a highly reliable instrument regardless of the context of use. In addition, the confirmatory factor analysis validated the three-factor structure found for the DCDQ, which contributes to verify the construct validity of the DCDQ-ES.

Finally, the DCDQ-ES was found to effectively discriminate between children with and without significant coordination difficulties. However, this finding is subject to some sample-related limitations. It was not possible for us to gather a sample of children with an official diagnose of DCD, because it is a highly underdiagnosed and unrecognized disorder in Spain, and children with DCD get usually overlooked by the national health system^{2,3}. For instance, we assessed more than 730 Spanish school-aged children and none of them had a previous diagnosis of DCD or dyspraxia, even though a group of these children reported significant motor performance issues on the DCDQ or the DCDDailyQ.

Reference norms of the DCDQ-ES

Performance in everyday activities is influenced by both individual and environmental factors such as sex, age and cultural expectations and standards²⁶. Because of that, validation of DCD-related instruments aimed to assess performance in motor-based activities of daily living require customization of reference norms and cut-off scores²⁷. In

this thesis, the Spanish-adjusted percentiles were calculated for the DCDDaily-Q and for the DCDQ. In both cases, the standardized scores differed from those obtained in the population of original development and validation^{20,28}. This is the first time that reference norms are provided for a cross-cultural adaptation of the DCDDaily-Q, and thus it is the first step to further validate this instrument outside The Netherlands. The need of customized cut-off scores for the different cross-cultural adaptations of the DCDQ is evident, however^{8,23,25,29}. The reasons explaining the different trends of daily performance and motor capacity across countries and cultural contexts are multifactorial and complex. For instance, children evaluated with objective motor capacity tests systematically obtain different scores according to country³⁰⁻³². The distinctive cultural patterns of participation opportunities and engagement in motor-based activities contribute to explain the differences in motor capacity and performance across populations, and overall emphasize the need of developing custom cut-off points that effectively identify risk of DCD in each context.

International recommendations have been proposed to select the best cut-off points for identifying DCD. The 15th and the 5th percentile scores are the most commonly used cut-off values for DCD criteria in motor tests and performance questionnaires^{25,28,33,34}. Overall, the 15th percentile is used to describe moderate DCD, whereas children who score at or below the 5th are classified as having severe DCD^{33,34}. Additionally, the 5th percentile can be used for screening potential DCD in community-based samples to reduce bias³⁴. Finally, if the child scores at or below the 15th percentile but one or more diagnostic criteria may not have been evaluated, then a formal diagnosis of DCD cannot be given and the term probable DCD (pDCD) should be used instead³³. As previously argued, the score distribution of a motor capacity or performance measure significantly varies between populations. Therefore, it is important to use the country-specific reference norms to establish the cut-off points of DCD-related instruments.

In this thesis, the predictive values of the overall (not age-specific) DCDQ Spanish-adjusted 15th and 5th percentile values were examined using a sample of children with pDCD. The Youden's index and overall predictive values of the 15th percentile score for the overall sample were better than those of the 5th percentile, resulting in 77% sensitivity and 83% specificity. However, the 5th percentile yielded a positive predictive value of 93%, which may be of particular interest for screening purposes and for community-based

research. Some of the children included in the pDCD group had a previous diagnosis of an existing neurodevelopmental disorder (e.g., attention deficit and hyperactivity disorder or autism spectrum disorders). These particular aspects could explain the moderate values of sensitivity and specificity found for the 15th percentile of the DCDQ-ES. Still, these values are very similar with those of the original DCDQ and other cross-cultural adaptations^{7-9,20,24,25}, and close to the recommended values of 80% sensitivity and 90% specificity¹.

Applying country-specific cut-off points is important for both clinical and research practice. For instance, determining risk of DCD in Indian, Brazilian or Greek samples using the originally recommended, not country-adjusted cut-off scores resulted in abnormally high prevalence rates of pDCD^{23,30,32}. As shown in *Chapter 4*, screening for DCD in Spanish children using the Canadian cut-off scores instead of the age-specific Spanish 5th percentile scores would result in a 3.5% rate of false-positive diagnoses. Likewise, using non-customized cut-off scores in clinical practice would result in inaccurate diagnoses that would further limit the identification of Spanish children at risk of DCD.

Future research recommendations

The findings in the current thesis have also provided us some important suggestions for future directions. First, the process of cross-cultural adapting a questionnaire for a different cultural population requires an adequate and rigorous methodological strategy. Before performing a cross-cultural adaptation, a meticulous advanced planning is needed. The synthesis and reconciliation of the two independent translations has proven to be a very important step of the cross-cultural adaptation, but the assessment method of this stage is not always provided. In this thesis, we used a two-phase evaluation of the perceived equivalence of independent and synthesized translations that helped to measure the changes after reconciliation, and thus it could be of use for future research. Also, guidelines and recommendations for systematizing the process of synthesis and reconciliation exist that may assist future research on this procedure¹⁵. In addition, using different translation profiles is recommended for the cross-cultural adaptation of DCD-related instruments.

Second, assessment of reliability and validity requires using representative and large, age- and sex-balanced samples to avoid bias. The structural validity of a multi-factor instrument gives insight about the construct validity, and thus it should be verified through a confirmatory factor analysis using an adequate sample size. Simulation studies conclude that sample size requirements for structural equation models (i.e., confirmatory factor analysis) are influenced by several parameters, such as the factor number and size, factor loadings, model complexity and covariances within and between factors^{35,36}. Thus, reporting these parameters in DCD-related questionnaires validation studies will guide future research needs for sample size requirements. Once the structure of the questionnaire is confirmed, then the reliability of each subscale should be assessed as well as the overall questionnaire internal consistency. Concurrent validity needs to be evaluated with an instrument that measures the same construct, which in the case of the DCDQ it is motor performance in everyday activities. The concurrent validity of the DCDQ has traditionally been tested with the MABC-2 or the MABC-2-C, but these instruments may not be able to accurately evaluate the criterion validity of the DCDQ³⁷. The development of the DCDDaily-Q contributes to fill this gap. Despite its differences with the DCDQ, the DCDDaily-Q measures a similar construct (i.e., the child's daily performance in his/her current environment), and it also evaluates other relevant aspects for DCD such as learning and participation²⁸. The DCDDaily, a motor battery test that comprehensively evaluates the child's motor capacity in everyday activities, may complement both the DCDQ and the DCDDaily-Q²⁸, and therefore future research should expand on the relation between the three instruments in Spanish children. In those situations where it is difficult to gather a formally diagnosed DCD clinical sample, the discriminant validity of DCD-related instruments should be evaluated using a sample that has been previously identified as having pDCD with another measure.

Third, it became clear for us that developing specific percentiles for each of the subscales that comprise DCD-related questionnaires contributes to the assessment of DCD both in clinical and research practice. In order to comprehensively evaluate daily performance, the therapist or researcher needs to be able to assess a broad range of motor-based everyday activities¹⁹, especially in a disorder as heterogenous in nature as the DCD^{1,4}. A recent study shows that motor performance is influenced not only by individual and environmental factors but by type of activity as well, even within the same population³⁸.

Thus, to make reference norms available for each of the subdomains of DCD-related instruments supports a more precise identification of specific motor performance issues. Accordingly, future research on the validation or development of DCD-related instruments should not only provide reference norms for the overall or diagnostic score, but also for each of the subdomains intended to be measured.

It must be noted that diagnosis assessment of DCD requires of a comprehensive and individualized evaluation of both motor capacity and daily performance, as well as further examination of potential co-occurring disorders^{1,4}. Assessment of formal diagnosis must always include the use of a cross-culturally adapted and standardized objective motor test (i.e., criterion A/I, MABC-2) in addition to daily performance evaluation (i.e., criterion B/II, DCDQ), and supplementary medical examination of criteria C/IV and D/II. Even though the DCDQ alone is not sufficient to establish a diagnosis of DCD, DCD-related instruments provide a valuable starting point to clinicians and researchers. In most cases, occupational therapists, teachers or even physical therapists are the best-suited professionals to identify difficulties in motor coordination or risk of DCD in children, as they have more opportunities to observe the child in his or her daily environment than their pediatrician. It may be useful to use screening questionnaires, like the DCDQ, that allow for an early and quick identification of risk of DCD and that serve as an opening for further and comprehensive medical assessment, providing a cost-effective and less burdensome process for the child, family and service system^{5,27}.

Implications for Spanish research and clinical assessment of DCD

The work presented in this thesis provides the much-needed cross-cultural adaptation and psychometric validation and standardization of the DCDQ for use in the Spanish population. By making freely available an instrument that is reliable and easy to use and to analyse, this thesis supports the cost-effective, practical and quick identification of risk of DCD in Spanish children. As the DCDQ is the most frequently used measure to assess criterion B of the diagnostic criteria of DCD in both clinical and research practice, the work of this thesis further enables and promotes research and diagnostic and therapeutic management on DCD in the Spanish context. In addition, this thesis contributed to the Spanish standardization of another instrument aimed to assist in the identification and assessment of DCD, the DCDDaily-Q-ES.

During this thesis, it became clear from personal communications with several occupational and physical therapists, education professionals and parents that DCD is a present disorder in Spain, even though it is not commonly known nor recognized. Many clinicians expressed that, even though they did not know about DCD, the described symptomatology matched the profile of many of the children they were attending. It was considered by those professionals that having an instrument to quickly identify children at risk of DCD would help the clinical and diagnostic assessment of these children. Occupational and physical therapists and other professionals working with children can use the DCDQ-ES to identify those children attending intervention that show difficulties in motor coordination, and thus contributing to diagnosis and treatment of DCD in the Spanish context.

The DCDQ-ES is already being used for both clinical and research purposes in Spain. At least two additional studies have been carried out using the work of this thesis, which for the first time allowed to determine the prevalence and epidemiology of pDCD in Spanish school-aged children^{39,40}. In turn, this is increasing visibility of DCD among health practitioners and therapists in Spain, who are starting to use the DCDQ-ES and the DCDDaily-Q-ES in clinical practice. Moreover, the DCDQ-ES is included in the upcoming clinical practice recommendations on the diagnosis, assessment and intervention of DCD published by the Spanish Society of Paediatric Neurology [*Sociedad Española de Neurología Pediátrica*], which will support clinical identification, diagnosis and therapeutic assessment of DCD in Spanish children. It is expected that providing accessible, reliable and standardized DCD-related instruments, such as the DCDQ-ES, will increase awareness and support visibility of DCD in Spain, and eventually promote a more accurate and improved diagnosis of DCD in Spanish children.

CONCLUSIONS

Based on the findings in the separate studies, the following conclusions can be drawn:

- The European Spanish version of the DCDQ (DCDQ-ES) is equivalent to the original DCDQ in terms of conceptual, semantic and experiential equivalence, and it is culturally appropriate for use with the Spanish population.
- The DCDQ-ES shows adequate psychometric properties in terms of internal consistency, concurrent validity, structural validity and discriminant validity.
- The Spanish-customized reference norms are country-specific and reflect the differences between Spanish and Canadian children. The cut-off points of the DCDQ-ES are better able to predict the presence of probable DCD than the non-country-specific cut-off scores.
- Overall, the DCDQ-ES is a cost-effective, cross-culturally adapted, reliable and valid instrument to quickly identify children at risk of DCD and to assist with the diagnostic and therapeutic assessment of DCD.

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RESUMEN EXTENDIDO
EN CASTELLANO

ANTECEDENTES Y OBJETIVOS DE ESTA TESIS

Se estima que más de 200.000 niños y niñas españoles en edad escolar presentan Trastorno del Desarrollo de la Coordinación (TDC)^{1,2}. Sin embargo, la gran mayoría de los casos no se llega a diagnosticar, y, en consecuencia, es más complicado que puedan recibir el tratamiento adecuado para limitar las consecuencias que esta condición tiene en el desempeño diario y la participación²⁻⁴. Además, la investigación del TDC en España es extremadamente escasa, lo que invisibiliza el impacto del TDC en el contexto español. Disponer de herramientas de cribado de TDC accesibles, adaptadas y fiables puede contribuir a aumentar la visibilidad del TDC en España, y promover la rápida identificación de población infantil española que presente riesgo de desarrollar TDC^{5,6}.

El principal objetivo de la presente tesis fue desarrollar y validar la adaptación transcultural española del Developmental Coordination Disorder Questionnaire (DCDQ), y proveer a los profesionales del ámbito de la infancia las normas de referencia del DCDQ ajustadas a población escolar española.

SÍNTESIS DE RESULTADOS PRINCIPALES

Adaptación a castellano y validación preliminar del DCDQ

El estudio de adaptación transcultural a castellano y validación preliminar en población española del DCDQ se describe en el *Capítulo 2*. En la línea de otras adaptaciones transculturales de este instrumento⁷⁻¹¹, en la presente tesis se siguió el proceso de adaptación transcultural de seis pasos propuesto por Beaton et al.¹²: (1) dos traducciones independientes a lengua castellana, realizadas por dos traductoras diferentes con perfiles específicos; (2) síntesis y reconciliación de ambas traducciones, por las dos traductoras y un tercer perfil (doctoranda), lo que permitió obtener una única traducción sintetizada; (3) dos retro traducciones independientes a lengua inglesa, realizadas por dos traductores bilingües ajenos a la versión original del DCDQ; (4) revisión del proceso por parte de un comité de expertos constituido por la traductora 1, el tercer perfil involucrado en el paso de síntesis y reconciliación, una terapeuta ocupacional pediátrica, una terapeuta ocupacional con experiencia en investigación en ámbito neurológico, y una terapeuta ocupacional con experiencia en neurología pediátrica y educación, que examinaron las dos traducciones independientes, la traducción sintetizada, y las dos retro traducciones, para determinar la equivalencia transcultural entre la traducción sintetizada y la versión

original del DCDQ; (5) un pretest en una muestra comunitaria de 31 padres de niños y niñas españoles entre 5 y 14 años, con el objetivo de evaluar la equivalencia transcultural, relevancia y comprensibilidad de la versión pre final a través de entrevistas cognitivas, tras lo cual se obtuvo la versión final del DCDQ-ES; y (6) retro traducción del DCDQ-ES a lengua inglesa y envío del proceso documentado a la desarrolladora original del DCDQ (Brenda Wilson, TO, MSc), que revisó y aprobó el proceso y la versión final del DCDQ-ES. Por último, estudiamos la fiabilidad preliminar del DCDQ en una segunda muestra aleatoria de 35 padres de escolares con desarrollo típico entre 6 y 12 años.

Durante el proceso de adaptación transcultural, se detectaron y revisaron diferentes aspectos problemáticos relacionados con la equivalencia conceptual, semántica y experiencial, lo que, en conjunto, contribuyó a desarrollar una versión en castellano del DCDQ con mayor equivalencia cultural. Tras este proceso, el DCDQ-ES pudo alcanzar equivalencia conceptual, semántica y experiencial con la versión original del DCDQ. Las entrevistas cognitivas permitieron comprobar que los ítems del DCDQ-ES reflejan actividades de la vida diaria de autocuidado, académicas y de juego que son familiares para la mayor parte de padres y madres. Además, en el estudio descrito en el *Capítulo 2* se comprobó que el DCDQ-ES mostró buena consistencia interna y homogeneidad iniciales en escolares españoles.

Validación completa del DCDQ en población escolar española

Los prometedores resultados de fiabilidad preliminar obtenidos en el estudio del *Capítulo 2* permitieron llevar a cabo la validación completa de las propiedades psicométricas del DCDQ en población escolar española. En el estudio recogido en el *Capítulo 3* se examinó la validez concurrente del DCDQ-ES, analizando su correlación y concordancia con el DCDDaily-Q-ES en una muestra seleccionada aleatoriamente de 266 niños y niñas españoles entre 5 y 10 años. Ambos instrumentos correlacionaron significativamente entre sí, y el grado de concordancia para la muestra total fue significativo y moderado. Sin embargo, los análisis específicos por grupos de edad revelaron que el DCDQ-ES mostraba una baja concurrencia con el DCDDaily-Q-ES el grupo de 5 y 6 años. Adicionalmente, el DCDDaily-Q-ES se estandarizó por sexo y edad en una muestra española de 356 escolares, lo que, posteriormente, contribuyó a completar la validación psicométrica del DCDQ-ES.

En el *Capítulo 4* se describe el estudio de validación complementaria del DCDQ-ES, en el que se examinó la consistencia interna, validez factorial y validez discriminante del DCDQ-ES. Para ello, se incluyeron dos grupos de escolares entre 6 y 11 años: 540 niños y niñas con desarrollo típico, y 30 niños y niñas con probable TDC (pTDC) que se encontraban recibiendo tratamiento a causa de problemas en el desempeño motor y que habían obtenido puntuaciones iguales o superiores al percentil 95 en el DCDDaily-Q-ES. También se formó un tercer grupo de 60 participantes pareados por edad y sexo con el grupo pTDC, seleccionados aleatoriamente del grupo normativo, para que sirvieran de control en el análisis de validez discriminante. El grupo normativo se compuso con una distribución completamente equitativa por sexo y grupo de edad para disminuir posibles sesgos.

La estructura factorial originalmente propuesta para el DCDQ (control durante el movimiento, motricidad fina/escritura, y coordinación general) se confirmó en la población española a través de un análisis factorial confirmatorio. Los buenos valores de consistencia interna fueron corroborados tanto para el cuestionario general, como para las tres subescalas del mismo. Además, el DCDQ-ES demostró su capacidad para discriminar significativamente a población española con y sin pTDC.

Puntos de corte del DCDQ ajustados a población escolar española

Para finalizar el proceso de validación, en el *Capítulo 5* también se obtuvieron los percentiles estandarizados y los puntos de corte para el DCDQ-ES en niños y niñas españoles. Siguiendo las recomendaciones internacionales a este respecto, se calcularon los percentiles 5 y 15 de la puntuación total en población española para obtener los puntos de corte indicativos de TDC. En la muestra general, una puntuación igual o inferior a 57 puntos en la escala total del DCDQ-ES (\leq percentil 15) mostró una sensibilidad del 77% y una especificidad del 83%. Además de los percentiles 5 y 15, también se obtuvieron los percentiles 10 y 20 de la puntuación total, por su interés y usabilidad en la práctica clínica. Por último, se desarrollaron los percentiles 5, 10, 15 y 20 para cada grupo de edad y para las tres subescalas del DCDQ-ES.

DISCUSIÓN GENERAL

Reflexiones derivadas de esta tesis

La adaptación transcultural y validación psicométrica del DCDQ en población escolar española ha permitido desarrollar una serie de reflexiones críticas que pueden ser de utilidad para futuros estudios. En este apartado, se examinarán diferentes aspectos relacionados con el enfoque metodológico y la evaluación del desempeño diario en el TDC, y se discutirán las implicaciones prácticas de la presente tesis en los campos clínico e investigador.

Adaptación transcultural del DCDQ-ES

Cuando se pretende utilizar cuestionarios de evaluación médica, sociológica o psicológica en un contexto cultural, lingüístico o geográfico diferente a los contextos en los que la herramienta fue desarrollada, es necesario realizar una adaptación transcultural en la población de destino^{12,13}. La simple traducción del instrumento a la lengua de destino no asegura la equivalencia transcultural entre ambas versiones, y da lugar a un producto subóptimo en ausencia de criterios conceptuales, semánticos, lingüísticos y culturales rigurosos, lo que, en última instancia, puede llevar a conclusiones imprecisas sobre el diagnóstico¹³⁻¹⁵.

La presente tesis doctoral muestra que un proceso sistemático de adaptación transcultural contribuye significativamente a alcanzar la equivalencia cultural entre la versión original del instrumento y su versión en la población de destino. Siguiendo las recomendaciones internacionales^{12,13}, dos traductoras con diferentes perfiles realizaron dos traducciones independientes del DCDQ a lengua castellana. En un primer momento, se solicitó a ambas traductoras que evaluaran de manera independiente la equivalencia conceptual y semántica de cada uno de los ítems traducidos. En esta fase inicial, se comprobó que tan sólo el 40% de los ítems traducidos de forma independiente eran considerados totalmente equivalentes (conceptual y semánticamente equivalentes) por ambas traductoras. Tras el proceso de síntesis y reconciliación, ese porcentaje aumentó hasta un 73.3% de acuerdo. Este es un hallazgo especialmente relevante que corrobora que el proceso de síntesis y reconciliación es una parte significativa para el éxito de la adaptación transcultural^{12,14,15}. En la presente tesis, el análisis de las dos traducciones independientes proveyó un marco para que las traductoras y la doctoranda pudieran debatir críticamente información

relevante sobre determinadas problemáticas relacionadas con la equivalencia que, de otra manera, hubieran pasado desapercibidas. Estos hallazgos también indican que la inclusión de dos perfiles diferentes de traducción en el proceso de adaptación transcultural (por ejemplo, en cuanto a la previa familiaridad con el TDC), contribuye significativamente a mejorar la equivalencia transcultural de aquellos cuestionarios que aborden aspectos relacionados con esta condición, porque permite al equipo investigador cubrir dos aspectos importantes de la adaptación transcultural (la equivalencia conceptual y semántica), y facilita el desarrollo de una traducción semántica y lingüísticamente apropiada que refleje de forma precisa la intencionalidad y significado original del instrumento en términos de movimiento y desempeño¹⁶.

La revisión por parte del comité de expertos y el análisis de comprensibilidad también contribuyeron a la mejora de la adaptación transcultural del DCDQ-ES. En la presente tesis doctoral, se compuso un comité multirregional para verificar que la adaptación del DCDQ-ES resultara apropiada y equivalente independientemente de la región de origen¹³. La mayoría de aspectos que fueron tratados por el comité de expertos estaban relacionados con los ítems que describen actividades de planificación motora, debido al reto que supuso encontrar una traducción que se leyera natural en castellano y que, al mismo tiempo, reflejara con precisión la intencionalidad original. Por ejemplo, la expresión “toro en una tienda de porcelanas” [*bull in a china shop*], que en el DCDQ se emplea para describir a un niño o niña que puede chocar con objetos sin querer debido a su torpeza, fue sustituida por el equivalente en castellano “elefante en una cacharrería”. Estos aspectos también fueron objeto de debate durante las entrevistas cognitivas del pretest, lo que llevó a realizar ajustes estructurales adicionales en algunos de los ítems. En algunos casos, añadir una breve explicación de la tarea a valorar mejoró la comprensibilidad e interpretación del ítem. En otros ítems, las actividades descritas fueron sustituidas por alternativas más culturalmente apropiadas (p.ej., “construir una *muralla* o una *torre* con bloques o cojines” en lugar de “construir un *fortín* con cajas y cojines”). Por otra parte, los dos ítems que se expresan en forma negativa en la versión original del DCDQ fueron modificados y expresados de forma positiva en el DCDQ-ES para evitar confusiones en su interpretación. Como consecuencia, los ítems resultaron más fáciles de comprender por los padres y madres, lo que permitió que estos pudieran responder de forma más precisa sobre el desempeño motor de sus hijos. En conjunto,

aunque todas las traducciones previas del DCDQ eran lingüística y técnicamente correctas, el aspecto determinante que facilitó que los padres y madres pudieran responder teniendo en mente el movimiento y desempeño de sus hijos, fue la forma en la que las actividades estuvieran descritas y ejemplificadas en el cuestionario. Modificar la estructura de los ítems, incluir breves ejemplos, y utilizar expresiones específicas de cada cultura, son estrategias comunes que se han empleado en otras adaptaciones transculturales del DCDQ^{8,11,17,18}, lo que, en conjunto, señala la necesidad de emplear métodos rigurosos que garanticen la adaptación transcultural de los instrumentos relacionados con la evaluación del TDC, antes de utilizarlos en un nuevo contexto cultural.

Propiedades psicométricas del DCDQ-ES

Las propuestas sobre adaptación transcultural recomiendan completar el proceso de pretest con la evaluación inicial de la fiabilidad de la versión adaptada^{12,14}. Por lo tanto, en la presente tesis doctoral, se examinó la fiabilidad preliminar del DCDQ-ES con una muestra seleccionada aleatoriamente de 35 escolares con desarrollo típico entre 6 y 12 años. Los resultados mostraron que el DCDQ-ES presentaba buenos valores preliminares de consistencia interna y homogeneidad, lo que permitió realizar una posterior evaluación completa de sus propiedades psicométricas.

La validez de criterio del DCDQ-ES se examinó a través de la correlación y concordancia entre esta herramienta y la versión adaptada a población española del DCDDaily-Q (DCDDaily-Q-ES). Los análisis demostraron una correlación significativa y moderada entre ambos instrumentos para la muestra general y en población mayor de 6 años. Sin embargo, se encontró una concordancia baja y no significativa en el grupo más joven (5 y 6 años). Es evidente que la edad es un factor relevante para la evaluación del desempeño motor diario y el TDC. Por ejemplo, no se recomienda establecer un diagnóstico formal de TDC en población de 5 años o menor, porque se espera que los niños y niñas de edades tan tempranas muestren una gran variabilidad en los diferentes dominios del desempeño motor⁴. Por tanto, los profesionales sanitarios y terapeutas que trabajan con grupos tan jóvenes obtendrán información más fiable sobre el desempeño motor diario si emplearan instrumentos de evaluación complementarios¹⁹. En conclusión, el DCDQ-ES muestra una validez de criterio adecuada con el DCDDaily-Q-ES.

Los hallazgos de los estudios descritos en el *Capítulo 2* y *Capítulo 4* mostraron que los indicadores de consistencia interna del DCDQ-ES son tan buenos como los obtenidos en la revisión original del DCDQ²⁰. Además, el análisis de fiabilidad de las tres subescalas del DCDQ-ES también arrojó resultados positivos, con unos valores alfa de Cronbach entre 0.78 y 0.86, lo que coincide con los datos reportados en estudios previos de validación del DCDQ en diferentes países y poblaciones^{7-10,21-25}. Esta tesis contribuye a confirmar que, si se realiza una adaptación transcultural apropiada, el DCDQ es un instrumento altamente fiable, independientemente del contexto de utilización. Adicionalmente, los análisis factoriales confirmatorios corroboraron la estructura trifactorial encontrada inicialmente en el DCDQ, lo que apoya la validez de constructo del DCDQ-ES en población española.

Por último, se mostró que el DCDQ-ES es capaz de discriminar con éxito entre población escolar con y sin dificultades significativas de coordinación motora. Sin embargo, es necesario señalar que este hallazgo en concreto está sujeto a ciertas limitaciones relacionadas con la muestra. En la presente tesis doctoral no fue posible reunir una muestra de niños y niñas españoles con diagnóstico oficial de TDC, debido a que esta es una condición enormemente infradiagnosticada y desconocida en España, y, frecuentemente, las personas con TDC no son detectados por el sistema de salud^{2,3}. Por ejemplo, para la realización de esta tesis, se evaluaron a más de 730 niños y niñas españoles en edad escolar sin que ninguno de ellos reportara un diagnóstico previo de TDC o dispraxia, incluso aunque un grupo de los participantes obtuvieron valores en el DCDQ o en el DCDDailyQ indicativos de problemas significativos de desempeño motor.

Valores de referencia del DCDQ-ES

El desempeño en las actividades de la vida diaria está influido por una gran variedad de factores, tanto individuales como del entorno, que incluyen el sexo, la edad, las expectativas culturales y los estándares sociales²⁶. Debido a eso, la validación de instrumentos relacionados el TDC que se orienten a evaluar el desempeño de actividades motoras de la vida diaria, requiere de valores de referencia y puntos de corte específicos a la población de uso²⁷. En la presente tesis, se desarrollaron percentiles ajustados a la población española tanto para el DCDDaily-Q como para el DCDQ. En ambos casos, los valores estandarizados fueron diferentes a los obtenidos en las poblaciones de desarrollo y validación original^{20,28}. Esta es la primera vez en la que se desarrollan normas de

referencia para una adaptación transcultural del DCDDaily-Q, y por tanto constituye el primer paso para complementar la validación de este instrumento fuera de los Países Bajos, su país de desarrollo. Sin embargo, la necesidad de desarrollar puntos de corte específicos para las diferentes adaptaciones transculturales del DCDQ se ha evidenciado reiteradamente en la literatura^{8,23,25,29}. Las razones que subyacen a la existencia de patrones diferentes de desempeño diario y capacidad motora en función del país y el contexto cultural son multifactoriales y complejas. De esta manera, los niños y niñas de diferentes países muestran diferencias en su desempeño, pero también en sus capacidades motoras, incluso cuando se les evalúa con baterías de evaluación objetivas³⁰⁻³². Los patrones culturales distintivos de oportunidades para la participación y compromiso ocupacional en actividades motoras de la vida diaria contribuyen a explicar las diferencias en la capacidad y desempeño motores de las diferentes poblaciones, y ponen de relieve la necesidad de desarrollar puntos de corte específicos, capaces de identificar eficazmente el riesgo de TDC en cada contexto.

Existen recomendaciones internacionales que orientan la selección de los puntos de corte más adecuados para identificar TDC en los instrumentos diseñados para tal fin. Los percentiles 15 y 5 (o, en su defecto, los percentiles 85 y 95) son los valores más frecuentemente utilizados para determinar la indicación de TDC en las baterías motoras y los cuestionarios de desempeño^{25,28,33,34}. En general, el percentil 15 se utiliza para describir la existencia de TDC moderado, mientras que se considera que aquellos niños y niñas que obtienen puntuaciones iguales o inferiores al percentil 5 presentan TDC severo^{33,34}. Por otra parte, el percentil 5 puede ser utilizado para identificar TDC en muestras comunitarias y estudios poblacionales con el objetivo de reducir el riesgo de sesgo³⁴. Por último, una puntuación igual o inferior al percentil 15, en ausencia de la evaluación del resto de criterios diagnósticos del TDC, no es suficiente como para establecer un diagnóstico formal de TDC, y se debe utilizar el término “probable TDC” (pTDC) en su lugar³³. Como se ha argumentado previamente, la distribución de las puntuaciones de un instrumento de medida de la capacidad o desempeño motores difiere significativamente en función de la población estudiada. Por lo tanto, es importante utilizar normas de referencia específicas y ajustadas a cada país para establecer los puntos de corte en instrumentos relacionados con el TDC.

En la presente tesis, se examinaron los valores predictivos de los percentiles 15 y 5 ajustados a población general española en el DCDQ, utilizando para ello una muestra de escolares con pTDC. El índice de Youden y la mayor parte de los valores predictivos del percentil 15 para la muestra general resultaron superiores que los obtenidos en el percentil 5, obteniendo una sensibilidad del 77% y una especificidad del 83%. Por otra parte, el percentil 5 mostró un valor predictivo positivo del 93%, lo que es particularmente interesante para trabajos de screening o investigaciones poblacionales. Parte del grupo con pTDC reportaba un diagnóstico previo de trastorno del neurodesarrollo (trastorno por déficit de atención e hiperactividad o trastorno del espectro autista). Este aspecto concreto contribuye a explicar los valores moderados obtenidos de sensibilidad y especificidad para el percentil 15 del DCDQ-ES, que, sin embargo, son muy similares a los obtenidos en la versión original del DCDQ y en otras adaptaciones transculturales^{7-9,20,24,25}, y muy cercanos a los valores recomendados de 80% para la sensibilidad y 90% para la especificidad¹.

Utilizar los puntos de corte ajustados a la población de destino es un aspecto importante tanto para la práctica clínica como para la investigadora. Por ejemplo, estudios previos han encontrado datos de prevalencia de riesgo de TDC desproporcionadamente elevados en muestras indias, brasileñas o griegas al utilizar los puntos de corte inicialmente recomendados en los instrumentos originales, sin haber sido ajustados a las poblaciones de uso^{23,30,32}. Como se mostró en el estudio descrito en el *Capítulo 4*, si se realizara un screening de TDC en población escolar española utilizando los puntos de corte canadienses en lugar del percentil 5 español, se obtendría una prevalencia de 3.5% de falsos positivos. De la misma manera, utilizar puntos de corte no ajustados a la población española en la práctica clínica conllevaría imprecisión en el diagnóstico, lo que dificulta aún más la identificación de niños y niñas españoles en riesgo de TDC.

Recomendaciones y líneas futuras de investigación

Los resultados de la presente tesis doctoral también han permitido desarrollar algunas sugerencias relevantes para líneas futuras de investigación. En primer lugar, el proceso de adaptación transcultural de un cuestionario de evaluación, para ser utilizado en una población y contexto cultural diferente al de su origen, requiere de una estrategia metodológica adecuada y rigurosa. Antes de llevar a cabo la adaptación transcultural, es necesario realizar una planificación meticulosa del proceso. La síntesis y reconciliación

de dos traducciones independientes ha mostrado ser un paso fundamental de la adaptación transcultural, pero la literatura no siempre describe su método de evaluación. En esta tesis, se ha utilizado una evaluación en dos pasos de la equivalencia percibida de las traducciones directas y sintetizada, que facilitó la medición de los cambios tras la reconciliación, y que puede ser de utilidad para investigaciones futuras. Por otra parte, existen guías y recomendaciones para sistematizar el proceso de síntesis y reconciliación que pueden facilitar el manejo de este proceso¹⁵. De la misma manera, con la realización de esta tesis doctoral se concluye que es recomendable incluir diferentes perfiles de traducción para la adaptación transcultural de instrumentos de evaluación relacionados con el TDC.

En segundo lugar, el estudio de la fiabilidad y validación de un cuestionario debe basarse en muestras representativas, suficientemente grandes, y con similar distribución de sexo y edad, para disminuir el riesgo de sesgo. La validez estructural de instrumentos multifactoriales proporciona información relevante sobre su validez de constructo, y por lo tanto debe verificarse a través de análisis factoriales confirmatorios con tamaños de muestra adecuados. Los estudios de simulación demuestran que existen diferentes parámetros que influyen las especificaciones de tamaño de muestra para modelos de ecuaciones estructurales, como el análisis factorial confirmatorio, entre los que se incluyen el número y tamaño de los factores, las cargas factoriales, la complejidad del modelo y las covarianzas intra e inter factoriales^{35,36}. Por tanto, reportar estos parámetros en los estudios de validación de instrumentos relacionados con la evaluación del TDC permitirá guiar las necesidades de las futuras investigaciones en cuanto a la selección del tamaño muestral. Una vez la estructura del instrumento se confirma, la fiabilidad de cada subescala debe evaluarse de forma complementaria a la escala total. Por otra parte, la validez concurrente debe estudiarse utilizando un instrumento que mida el mismo constructo, que, en el caso del DCDQ, es el desempeño motor diario. Tradicionalmente, la validez concurrente del DCDQ se ha evaluado con el MABC-2 o el MABC-2-C, pero estos instrumentos podrían no estimar la validez de criterio del DCDQ de forma precisa³⁷. El desarrollo del DCDDaily-Q contribuye a cubrir esta necesidad. A pesar de sus diferencias con el DCQ, el DCDDaily-Q mide un constructo similar (el desempeño diario del niño o niña en su entorno habitual), y, complementariamente, también analiza otros aspectos relevantes para el TDC, como el aprendizaje y la participación en actividades

diarias²⁸. El DCDDaily, una batería motora que evalúa de forma integral la capacidad motora en actividades diarias, complementa la información obtenida a través del DCDQ y del DCDDaily-Q²⁸. Por tanto, investigaciones futuras pueden continuar la línea iniciada en la presente tesis doctoral, y explorar la relación entre los tres instrumentos en población escolar española. En aquellas situaciones en las que resulte complicado reunir una muestra con diagnóstico formal de TDC, la validez discriminante de instrumentos relacionados con la evaluación de TDC debe estudiarse con un grupo que haya sido previamente identificado como pTDC con otra herramienta.

En tercer lugar, durante el desarrollo de esta tesis, se ha comprobado que desarrollar percentiles específicos para cada una de las subescalas que componen los cuestionarios de evaluación del TDC contribuye a la valoración integral de esta condición, tanto en la práctica clínica, como en investigación. Para valorar de forma exhaustiva el desempeño diario, el terapeuta o investigador debe ser capaz de evaluar un abanico diverso de actividades motoras diarias¹⁹, especialmente en el caso de una condición de naturaleza tan heterogénea como el TDC^{1,4}. En este sentido, un estudio reciente muestra que en el desempeño motor no sólo influyen factores individuales y del entorno, si no, también, el tipo de actividad, incluso en una misma población³⁸. Por lo tanto, disponer de normas de referencia para cada uno de los dominios relacionados con el TDC, permitirá identificar de forma más precisa problemas específicos en el desempeño motor diario. En consecuencia, las futuras investigaciones sobre la validación o desarrollo de instrumentos de evaluación relacionados con el TDC deben desarrollar normas de referencia para cada uno de los dominios que compongan el instrumento, además de para la escala o batería general.

Es necesario señalar que el manejo diagnóstico del TDC requiere de una evaluación integral e individualizada de la capacidad y del desempeño, y complementarse con el estudio de potenciales condiciones de salud concurrentes^{1,4}. La valoración de un diagnóstico formal debe incluir siempre el uso de una batería de evaluación objetiva de la capacidad motora (criterio diagnóstico A/I, MABC-2), además de la evaluación del desempeño diario (criterio diagnóstico B/II, DCDQ), y de un examen médico complementario de los criterios C/IV y D/II. Sin embargo, incluso aunque el uso exclusivo del DCDQ no sea suficiente para establecer un diagnóstico de TDC, los instrumentos de cribado ofrecen un punto de partida valioso para el personal clínico e

investigador. En muchas ocasiones, los terapeutas ocupacionales, profesores o fisioterapeutas son los profesionales mejor posicionados para identificar dificultades de coordinación o riesgo de TDC en población infantil, ya que tienen más oportunidades de observación del niño o niña en su entorno que su pediatra de referencia. Utilizar cuestionarios de screening como el DCDQ resulta particularmente útil, ya que permite una rápida y precoz detección de riesgo de TDC, y sirve como punto inicial para una posterior evaluación clínica exhaustiva, lo que supone un proceso más efectivo en recursos para la persona, la familia y el sistema^{5,27}.

Implicaciones para la práctica investigadora y el manejo clínico del TDC en España

El trabajo presentado en esta tesis cubre la necesidad actual de herramientas de cribado de TDC adaptadas transculturalmente, validadas y estandarizadas en población española. Al facilitar de manera libre un instrumento de evaluación que es fiable y sencillo de usar, aplicar y analizar, esta tesis contribuye al proceso de detección temprana de riesgo de TDC en población escolar española. Dado que el DDCDQ es la herramienta más utilizada para medir el criterio diagnóstico B del TDC, tanto en práctica clínica como investigadora, el trabajo de la presente tesis promueve y apoya la investigación y el manejo clínico y terapéutico del TDC en el contexto español. Además, esta tesis también ha contribuido a la estandarización española de otro instrumento diseñado para contribuir a la identificación y tratamiento del TDC, el DCDDaily-Q-ES.

Durante el desarrollo de esta tesis, diferentes conversaciones personales con terapeutas ocupacionales y fisioterapeutas, profesionales de la educación, y familiares, contribuyeron a confirmar que el TDC es una condición de salud muy presente en España, incluso aunque no sea conocida ni diagnosticada. Una gran parte de los profesionales expresaron que, aunque no estuvieran familiarizados con el TDC, su sintomatología se correspondía con el perfil de muchos de los niños y niñas a los que dan atención en clínica. Además, la mayor parte de los mismos consideran que el disponer de un instrumento que permita una rápida identificación de riesgo de TDC facilitará el manejo diagnóstico y terapéutico de esta población. Los terapeutas ocupacionales, fisioterapeutas y otros profesionales del ámbito de la infancia, podrán utilizar el DCDQ-ES para identificar con herramientas estandarizadas aquellos niños y niñas que acudan a sus servicios por problemas de coordinación motora, y contribuir al diagnóstico y tratamiento del TDC en España.

Actualmente, el DCDQ-ES ya está siendo utilizado para fines clínicos e investigadores en España. Al menos dos estudios adicionales han sido realizados aplicando el trabajo derivado de esta tesis, lo que ha permitido, por primera vez, determinar la prevalencia y epidemiología de pTDC en población escolar española^{39,40}. A cambio, las nuevas líneas de investigación sobre TDC en España están contribuyendo a aumentar la visibilidad de este trastorno entre los profesionales sanitarios y terapeutas españoles, que comienzan a utilizar el DCDQ-ES y el DCDDaily-Q-ES en su práctica clínica. Además, el DCDQ-ES se incluye en el próximo monográfico sobre recomendaciones de práctica clínica para el diagnóstico, evaluación e intervención del TDC, que publicará la Sociedad Española de Neurología Pediátrica, lo que apoya la identificación clínica, diagnóstico y manejo terapéutico del TDC en niños y niñas españoles. Se espera que disponer de herramientas de evaluación del TDC que sean fácilmente accesibles, fiables y estandarizadas, como el DCDQ-ES, aumente la visibilidad del TDC en nuestro país y, eventualmente, promueva un mejor y más preciso diagnóstico del TDC en población escolar española.

CONCLUSIONES

Tomando como base los hallazgos de los diferentes estudios, se concluye:

- La versión española del DCDQ (DCDQ-ES) es equivalente a su versión original en términos de equivalencia conceptual, semántica y experiencial, y su uso es culturalmente apropiado para la población española.
- El DCDQ-ES muestra propiedades psicométricas adecuadas en cuanto a la consistencia interna, la validez concurrente, la validez estructural y la validez discriminante.
- Las normas de referencia del DCDQ-ES se ajustan a la población española y reflejan las diferencias entre el desempeño de la población escolar española y canadiense. Los puntos de corte del DCDQ-ES son capaces de predecir con más precisión la presencia de probable TDC en población española que los puntos de corte no ajustados a población española.
- En conjunto, el DCDQ-ES es un instrumento fácilmente accesible, adaptado transculturalmente, válido y fiable para identificar rápidamente aquellos niños y niñas españoles en riesgo de TDC, contribuyendo así al manejo diagnóstico y derivación terapéutica del TDC.

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APPENDIX

1. OUTPUT

Results of this doctoral thesis were published as articles in peer-reviewed journals, conference presentations and poster presentations.

Articles in peer-reviewed-journals

Montes-Montes R, Delgado-Lobete L, Pereira J, Pousada T. Cross-Cultural Adaptation and Preliminary Validation of the European Spanish Version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES). *Am J Occup Ther* 2020;74(4): 7404205060.

Montes-Montes R, Delgado-Lobete L, Pereira J, Schoemaker MM, Santos-del-Riego S, Pousada T. Identifying Children with Developmental Coordination Disorder via Parental Questionnaires. Spanish Reference Norms for the DCDDaily-Q-ES and Correlation with the DCDQ-ES. *Int J Environ Res Public Health*. 2020;17(2):555.

Montes-Montes R, Delgado-Lobete L, Pereira J, Santos-del-Riego S, Pousada T. Psychometric Validation and Reference Norms for the European Spanish Developmental Coordination Disorder Questionnaire: DCDQ-ES. *Int J Environ Res Public Health*. 2020;17(7):2425.

Conference presentations

Montes R, Pousada T. Detección del trastorno del desarrollo de la coordinación en población infantil. Research presentation at *V Workshop Internacional en Imagen Médica Captura e integración de Datos Clínicos*, 2017, A Coruña, Spain

Montes-Montes R, Delgado-Lobete L, Pousada T. Adaptación del Developmental Coordination Disorder Questionnaire a población escolar española. Research presentation at *II Congreso Mundial de Educación EDUCA*, 2019, Santiago de Compostela, Spain

Poster presentations

Montes-Montes R, Delgado-Lobete L. Concordancia entre los puntos de corte canadienses y españoles para la identificación de probable Trastorno del Desarrollo de la Coordinación. *VI Congreso Internacional en Contextos Clínicos y de la Salud*, 2020, Almería, Spain.

Workshops

Delgado-Lobete L, Montes-Montes R. Trastorno del Desarrollo de la Coordinación: identificación precoz con escalas de evaluación. *Colegio Oficial de Terapeutas Ocupacionales de Galicia*, 2020, Galicia, Spain

2. ETHICS COMMITTEE APPROVAL



Secretaría Técnica
Comité Autonómico de Ética da Investigación de Galicia
Secretaría Xeral, Consellería de Sanidade
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DICTAMEN DEL COMITÉ DE ÉTICA DE LA INVESTIGACIÓN DE A CORUÑA-FERROL

Carlos Rodríguez Moreno, Secretario del Comité de Ética de la Investigación de A Coruña-Ferrol

CERTIFICA:

Que este Comité evaluó en su reunión del día 26/04/2017 el estudio:

Título: Adaptación transcultural y validación del cuestionario Developmental Coordination Disorder Questionnaire 2007 en población española

Promotor: Rebeca Montes Montes

Tipo de estudio: Otros

Version:

Código del Promotor:

Código de Registro: 2017/167

Y, tomando en consideración las siguientes cuestiones:

- La pertinencia del estudio, teniendo en cuenta el conocimiento disponible, así como los requisitos legales aplicables, y en particular la Ley 14/2007, de investigación biomédica, el Real Decreto 1716/2011, de 18 de noviembre, por el que se establecen los requisitos básicos de autorización y funcionamiento de los biobancos con fines de investigación biomédica y del tratamiento de las muestras biológicas de origen humano, y se regula el funcionamiento y organización del Registro Nacional de Biobancos para investigación biomédica, la ORDEN SAS/3470/2009, de 16 de diciembre, por la que se publican las Directrices sobre estudios Posautorización de Tipo Observacional para medicamentos de uso humano, y el la Circular nº 07 / 2004, investigaciones clínicas con productos sanitarios.
- La idoneidad del protocolo en relación con los objetivos del estudio, justificación de los riesgos y molestias previsibles para el sujeto, así como los beneficios esperados.
- Los principios éticos de la Declaración de Helsinki vigente.
- Los Procedimientos Normalizados de Trabajo del Comité.

Emite un **INFORME FAVORABLE** para la realización del estudio **por el/la investigador/a del centro:**

Centros	Investigadores Principales
Universidade de A Coruña	Thais Pousada García

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Y hace constar que:

1. El Comité Territorial de Ética de la Investigación de A Coruña-Ferrol cumple los requisitos legales vigentes (R.D 223/2004 de ensayos clínicos, y la Ley 14/2007 de Investigación Biomédica).
2. El Comité Territorial de Ética de la Investigación de A Coruña-Ferrol tanto en su composición como en sus PNTs cumple las Normas de Buena Práctica Clínica (CPMP/ICH/135/95).
3. La composición actual del Comité Territorial de Ética de la Investigación de A Coruña-Ferrol es:

Salvador Pita Fernández (Presidente). Médico especialista en Medicina Familiar y Comunitaria. Área de Gestión Integrada A Coruña.

Lucía Fuster Sanjurjo (Vicepresidenta). Farmacéutica. Especialista en Farmacia Hospitalaria. Área de Gestión Integrada Ferrol

Carlos Rodríguez Moreno (Secretario). Médico especialista en Farmacología Clínica. Área de Gestión Integrada Santiago

Natalia Cal Purriños (Vicesecretaria). Licenciada en derecho. Fundación "Profesor Nóvoa Santos". A Coruña

Juana M^a Cruz del Río. Trabajadora social. Consellería de Sanidad

Begoña Graña Suárez. Médica especialista en Oncología Médica. Área de Gestión Integrada A Coruña

Angel Lopez-Silverrey Varela. Médico especialista en Pediatría. Área de Gestión Integrada A Coruña

Alejandro Pazos Sierra. Médico. Universidad de A Coruña

Gonzalo Peña Pérez. Médico especialista en Cardiología. Hospital de San Rafael. A Coruña

José M^a Rumbo Prieto. Diplomado en enfermería. Área de Gestión Integrada Ferrol

María Isabel Sastre Gervás. Farmacéutica Atención Primaria. Área de Gestión Integrada A Coruña

Para que conste donde proceda, y a petición del promotor / investigador, en Santiago de Compostela,

El secretario



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3. DCDQ-ES

CUESTIONARIO de COORDINACIÓN-CASTELLANO
EUROPEAN SPANISH DCDQ (DCDQ-ES)

Nombre del niño/a: _____ Fecha de hoy: _____
 Persona que completa el cuestionario: _____ Fecha de nacimiento del niño: _____
 Relación con el niño: _____ Edad del niño: _____

La mayor parte de las habilidades motoras sobre las que se pregunta en este cuestionario hacen referencia a las actividades que los niños hacen con sus manos o cuando se mueven.

La coordinación de los niños puede mejorar cada año a medida que crecen y se desarrollan. Por esta razón, le será más fácil responder las preguntas si tiene en cuenta la habilidad de otros niños que usted conozca y que tengan *la misma edad que su hijo/a*.

Al responder las preguntas, compare el grado de coordinación de su hijo/a con el de otros niños de la misma edad, y responda en función de ello teniendo en cuenta que una mayor puntuación refleja una mejor habilidad motora.

Por favor, rodee con un círculo el número que mejor describa a su hijo/a. Si desea cambiar su respuesta y rodear otro número, rodee la respuesta correcta dos veces.

Si no está seguro de entender la pregunta, o tiene dudas sobre la respuesta que mejor se adapta a la descripción de su hijo, llame a _____ a través de _____ para solicitar ayuda.

	Muy diferente a como lo hacen otros niños	Algo parecido a como lo hacen otros niños	Moderadamente parecido a como lo hacen otros niños	Muy parecido a como lo hacen otros niños	Prácticamente igual a como lo hacen otros niños
	1	2	3	4	5
1 Su hijo/a <i>lanza una pelota</i> de forma controlada y precisa.	1	2	3	4	5
2 Su hijo/a <i>atrapa una pelota</i> pequeña (p.e.: del tamaño de una pelota de tenis) lanzada desde una distancia de aproximadamente 2 metros.	1	2	3	4	5
3 Su hijo/a <i>golpea</i> de forma precisa con una raqueta una <i>pelota pequeña</i> en movimiento.	1	2	3	4	5
4 Su hijo/a <i>salta</i> sin dificultad los obstáculos que se pueden encontrar en el jardín o en una zona de juego.	1	2	3	4	5
5 Su hijo/a corre de manera <i>similar</i> y tan <i>rápido</i> como otros niños/as de su misma edad y sexo.	1	2	3	4	5

	Muy diferente a como lo hacen otros niños 1	Algo parecido a como lo hacen otros niños 2	Moderadamente parecido a como lo hacen otros niños 3	Muy parecido a como lo hacen otros niños 4	Prácticamente igual a como lo hacen otros niños 5
6	Si su hijo/a <i>se propone</i> realizar una <i>actividad</i> motora, puede dirigir sus movimientos adecuadamente para llevar a cabo la tarea y completarla de forma efectiva (p.e.: al construir una “muralla” o “torre” con bloques o cojines, al manejar los juguetes, al construir una estructura con bloques, o al usar material de manualidades).				
	1	2	3	4	5
7	En clase, su hijo/a copia, <i>escribe</i> o dibuja lo suficientemente <i>rápido</i> como para seguir el ritmo del resto de sus compañeros/as.				
	1	2	3	4	5
8	Su hijo/a copia o <i>escribe</i> números, letras o palabras de forma <i>legible</i> , precisa y correcta. Si su hijo/a aún no escribe, es capaz de <i>colorear</i> y <i>dibujar</i> de manera coordinada, y hace dibujos que se puedan reconocer.				
	1	2	3	4	5
9	Su hijo/a ejerce la <i>fuerza</i> o tensión correctas al escribir o al dibujar (es decir, no aplica excesiva <i>presión en el trazo</i> ni agarra con excesiva fuerza el lápiz, y su escritura no es ni demasiado fuerte ni demasiado suave sobre el papel).				
	1	2	3	4	5
10	Su hijo/a <i>recorta</i> dibujos y formas fácilmente y de manera precisa.				
	1	2	3	4	5
11	Su hijo/a muestra interés y le <i>gusta</i> participar en <i>deportes</i> o juegos <i>activos</i> que requieran buenas habilidades motoras.				
	1	2	3	4	5
12	Su hijo/a aprende <i>nuevas actividades motoras</i> (p.e.: nadar, patinar) fácilmente y sin necesitar más práctica o tiempo que otros niños/as para alcanzar el mismo nivel de habilidad.				
	1	2	3	4	5
13	Su hijo es <i>rápido</i> y <i>eficaz</i> al asearse o arreglarse, al ponerse y atarse los zapatos, al vestirse, etc.				
	1	2	3	4	5
14	Su hijo/a se mueve y se desplaza sin torpeza, sin chocar con objetos ni romper cosas frágiles cuando se mueve en una habitación pequeña (es decir, no se le describiría como un “niño torpe” o como un “elefante en una cacharrería”).				
	1	2	3	4	5
15	Su hijo/a es capaz de mantener la postura sin <i>cansarse</i> ni <i>desplomarse</i> o <i>deslizarse</i> por la silla, cuando se le pide que permanezca sentado durante cierto tiempo.				
	1	2	3	4	5

GRACIAS

DCDQ-ES: HOJA DE PUNTUACIÓN (exclusiva uso profesional)*

Nombre: _____ Fecha: _____

Fecha de nacimiento: _____ Edad: _____

	Control durante el movimiento	Motricidad fina/ Escritura	Coordinación global
1. Lanza una pelota			
2. Atrapa una pelota			
3. Golpea una pelota			
4. Salta			
5. Corre			
6. Planifica actividades			
7. Escribe rápido			
8. Escribe de forma legible			
9. Hace fuerza y presión			
10. Recorta			
11. Le gustan los deportes			
12. Aprende nuevas habilidades			
13. Es rápido y hábil			
14. Se desplaza con cuidado			
15. Es capaz de mantenerse sentado mucho tiempo			

$$\text{TOTAL} \quad \frac{\quad}{/ 30} + \frac{\quad}{/ 20} + \frac{\quad}{/ 25} = \frac{\quad}{/ 75} \quad \text{TOTAL}$$

Control durante el movimiento Motricidad fina/ Escritura Coordinación global

Niños con edades comprendidas entre 5 años 0 meses y 7 años 11 meses

Percentil ≤5 15-46 Indicación de TDC severo.
 Percentil 6-15 47-54 Indicación de TDC.
 Percentil >15 55-75 No hay indicación o sospecha de TDC.

Niños con edades comprendidas entre 8 años 0 meses y 9 años 11 meses

Percentil ≤5 15-50 Indicación de TDC severo.
 Percentil 6-15 51-58 Indicación de TDC.
 Percentil >15 59-75 No hay indicación o sospecha de TDC.

Niños con edades comprendidas entre 10 años 0 meses y 15 años

Percentil ≤5 15-53 Indicación de TDC severo.
 Percentil 6-15 54-59 Indicación de TDC.
 Percentil >15 60-75 No hay indicación o sospecha de TDC.

**Para establecer el diagnóstico definitivo de TDC es necesario evaluar todos los criterios incluidos en el DSM-5. Si en la evaluación sólo se emplea el DCDQ-ES, se deben utilizar los términos "indicación de TDC", "probable TDC" o "riesgo de TDC".*

Para consulta de percentiles 10 y 20 e información sobre la adaptación transcultural en castellano y validación psicométrica en población española:

- Montes-Montes R, Delgado-Lobete L, Pereira J, Pousada T. Cross-Cultural Adaptation and Preliminary Validation of the European Spanish Version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES). *Am J Occup Ther.* 2020;74(4):7404205060. <https://doi.org/10.5014/ajot.2020.038315>
- Montes-Montes R, Delgado-Lobete L, Pereira J, Santos-del-Riego S, Pousada, T. Psychometric Validation and Reference Norms for the European Spanish Developmental Coordination Disorder Questionnaire: DCDQ-ES. *Int J Environ Res Public Health.* 2020;17(7):2425. <https://doi.org/10.3390/ijerph17072425>

4. QUALITY INDICATORS OF THE PUBLICATIONS

Study 1. Montes-Montes R, Delgado-Lobete L, Pereira J, Pousada T. Cross-Cultural Adaptation and Preliminary Validation of the European Spanish Version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES). *Am J Occup Ther* 2020;74(4): 7404205060.

- **Journal:** American Journal of Occupational Therapy.
- **Online ISSN:** 1943-7676.
- **Journal Index:** Journal Citation Report (Social Sciences Edition).
- **Journal Impact Factor (2019):** 2.231.
- **5 Year Impact Factor (2019):** 2.868.

Category	Quartile (2019)	Ranking (2019)
Rehabilitation (SSCI)	Q1	3/71

Study 2. Montes-Montes R, Delgado-Lobete L, Pereira J, Schoemaker MM, Santos-del-Riego S, Pousada T. Cross-Cultural Adaptation and Preliminary Validation of the Developmental Coordination Disorder Questionnaire for European Spanish children. *International Journal of Environmental Research and Public Health*. 2020;17(2):555

AND

Study 3. Montes-Montes R, Delgado-Lobete L, Pereira J, Santos-del-Riego S, Pousada T. Psychometric Validation and Reference Norms for the European Spanish Developmental Coordination Disorder Questionnaire: DCDQ-ES. *International Journal of Environmental Research and Public Health*. 2020;17(7):2425.

- **Journal:** International Journal of Environmental Research and Public Health.
- **ISSN:** 1660-4601.
- **Journal Index:** Journal Citation Report (Social Sciences and Sciences Editions).
- **Journal Impact Factor (2019):** 2.849.
- **5 Year Impact Factor (2019):** 3.127.

Category	Quartile (2019)	Ranking (2019)
Public, Environmental & Occupational Health (SSCI)	Q1	37/170
Public, Environmental & Occupational Health (SCIE)	Q2	58/193
Environmental Sciences (SCIE)	Q2	105/265

5. FIRST AND LAST PAGES OF PUBLISHED PAPERS



Cross-Cultural Adaptation and Preliminary Validation of the European Spanish Version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES)

Rebeca Montes-Montes, Laura Delgado-Lobete, Javier Pereira, Thais Pousada

Importance: The Developmental Coordination Disorder Questionnaire (DCDQ) is the most widely used measure of difficulties with activities of daily living and academic performance in children with developmental coordination disorder, but this tool has not been adapted for use in Spain.

Objective: To translate and cross-culturally adapt the DCDQ into European Spanish (DCDQ-ES) for use in assessing motor coordination in Spanish children.

Design: Cross-cultural adaptation and preliminary validation study.

Setting: Community and mainstream schools in Spain.

Participants: A committee of five experts oversaw the cross-cultural adaptation process. A community-based convenience sample of 31 parents of children ages 5–14 yr was used to test the comprehensibility of the DCDQ-ES. Preliminary reliability was tested with 35 randomly selected parents of children ages 6–12 yr.

Outcomes and Measures: The DCDQ was translated into European Spanish and cross-culturally adapted following international guidelines. Comprehensibility was assessed using cognitive debriefing interviews. The final version of the DCDQ-ES was used for the reliability analysis.

Results: Cultural relevance and equivalence and idiomatic differences between the DCDQ and DCDQ-ES were evaluated. Comprehensibility analysis led to minor modifications that facilitated comprehension and interpretation. Internal consistency and homogeneity of the DCDQ-ES were good (Cronbach's $\alpha = .857$, corrected item-total correlations = .268–.692).

Conclusions and Relevance: The DCDQ-ES is conceptually and semantically equivalent to DCDQ and was successfully cross-culturally adapted for the European Spanish context. Preliminary data suggest that the DCDQ-ES is a reliable measure of motor coordination in Spanish children.

What This Article Adds: This study provides evidence of the cultural equivalence of the DCDQ-ES for use with Spanish children. Occupational therapists in Spain can use the DCDQ-ES to evaluate children's motor coordination difficulties in everyday activities.

Developmental coordination disorder (DCD) is a motor neurodevelopmental condition that affects an estimated 5%–6% of school-age children (American Psychiatric Association, 2013; Blank et al., 2019). This disorder has a significant impact on executive function, daily life activities, and academic achievement throughout adolescence and adulthood. Therefore, DCD should be addressed as soon as motor coordination difficulties are identified during development (Bernardi et al., 2018; Delgado-Lobete et al., 2019; Harrowell et al., 2018; Magalhães et al., 2011; Wilson et al., 2013).

One of the most widely recognized and validated tools used in screening for and assessing children with DCD is the Developmental Coordination Disorder Questionnaire (DCDQ; Blank et al., 2019; Wilson et al., 2009). This 15-item

Citation: Montes-Montes, R., Delgado-Lobete, L., Pereira, J., & Pousada, T. (2020). Cross-cultural adaptation and preliminary validation of the European Spanish version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES). *American Journal of Occupational Therapy*, 74, 7404205060. <https://doi.org/10.5014/ajot.2020.038315>



- Salamanca, L. M., Naranjo, M. M. C., & González, A. P. (2012). Traducción al español del Cuestionario para Diagnóstico de Trastorno del Desarrollo de la Coordinación [Spanish translation of the Developmental Coordination Disorder Questionnaire]. *Revista Ciencias de la Salud*, *10*, 195–206.
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- Wilson, P. H., 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 and Child Neurology*, *55*, 217–228. <https://doi.org/10.1111/j.1469-8749.2012.04436.x>

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Acknowledgments

We thank the original author of the DCDQ, Brenda Wilson, for granting permission to translate and cross-culturally adapt it into European Spanish. We also thank the translators, expert committee members, and parents who participated in this study. This research was partially supported by the Galician Innovation Agency through the Pequeña y Mediana Empresa Connect Program (3rd ed.; IN852A.2016/10), assistance for the consolidation and structuring of competitive research of the Galician University System of the Xunta de Galicia (R2014/039), and a grant for Singular Research Centers (ED431G/01) endowed by the European Union's European Regional Development Fund. The authors have no interests that might be perceived as posing a conflict or bias.



Article

Identifying Children with Developmental Coordination Disorder via Parental Questionnaires. Spanish Reference Norms for the DCDDaily-Q-ES and Correlation with the DCDQ-ES

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Marina M. Schoemaker ³, Sergio Santos-del-Riego ² and Thais Pousada ¹

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Abstract: Developmental Coordination Disorder (DCD) is one of the most prevalent neurodevelopmental disorders in school-aged children, with major consequences in psychosocial and physical health. Adequate identification of this disorder is necessary to prompt effective interventions. The aims of this study were to develop the Spanish adjusted reference norms for the DCDDaily-Q and to test the correlation and agreement between the Spanish versions of the DCDDaily-Q (DCDDaily-Q-ES) and the Developmental Coordination Disorder Questionnaire (DCDQ-ES), two reliable instruments to assess motor performance and DCD. Clinically relevant percentiles were calculated for the DCDDaily-Q-ES using a representative sample of Spanish children aged 5 to 10 years ($n = 356$; $M = 7.3$ years, $SD = 1.8$; boys = 50%). Pearson's correlation coefficient and intraclass correlation coefficient (ICC) were used to determine correlation and agreement between questionnaires, respectively. A moderate and significant correlation and agreement between DCDDaily-Q-ES and DCDQ-ES was found ($r = 0.406$; $ICC = 0.381$; $p < 0.001$). Differences in daily participation and performance were found between age groups, but not between boys and girls. Spanish age-adjusted percentiles and cutoff scores for DCDDaily-Q-ES are provided. This study offers further validation and relevant information regarding assessment of DCD and has practical implications for clinical practice and research.

Keywords: developmental coordination disorder; assessment; DCDDaily-Q; DCDQ; activities of daily living; daily participation; daily performance; occupational therapy

1. Introduction

Developmental Coordination Disorder (DCD) is one of the most prevalent neurodevelopmental disorders in school-aged children, and it is considered one of the major health concerns in this population [1–4]. Consequences of DCD often span across psychosocial, occupational, and physical health dimensions, and usually persist into adulthood [2,5–7].

In addition to motor coordination difficulties, children and adolescents with DCD have an increased risk for mental and psychosocial health issues, such as depression and anxiety and other

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Article

Psychometric Validation and Reference Norms for the European Spanish Developmental Coordination Disorder Questionnaire: DCDQ-ES

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Abstract: The Developmental Coordination Disorder Questionnaire (DCDQ) is a widely used and well-validated tool that contributes to the diagnosis of Developmental Coordination Disorder (DCD). The aim of this study was to further analyze the psychometric properties of the European Spanish cross-culturally adapted version of the Developmental Coordination Disorder Questionnaire (DCDQ-ES) in a sample of Spanish children aged 6–11 years and to establish reference norms with respect to age groups. Parents of 540 typically developing children completed the DCDQ-ES. A second sample of 30 children with probable DCD (pDCD) was used to test its discriminant validity. Confirmatory factor analysis supported the original three-factor structure and the internal consistency was excellent (Cronbach's $\alpha = 0.907$). Significant differences between age groups were found. The pDCD group scored significantly lower than the reference sample in the three subscales and DCDQ-ES total score ($p < 0.001$; AUC = 0.872). The DCDQ-ES is a reliable and valid tool for screening motor coordination difficulties in Spanish children and for identifying children with probable DCD. The findings of this research suggest that context-specific cut-off scores should be systematically utilized when using cross-cultural adaptations of the DCDQ. Age-specific cut-off scores for Spanish children are provided.

Keywords: developmental coordination disorder; validity; reliability; screening; parental questionnaire; developmental coordination disorder questionnaire

1. Introduction

It is estimated that Developmental Coordination Disorder (DCD) affects approximately 5%–10% of school-aged children, making it the most prevalent neurodevelopmental disorder in childhood [1–3]. Children with DCD present motor coordination difficulties that significantly and persistently limit their daily functioning. As established by the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), children with DCD must show significantly poorer motor coordination performance than expected from the child's chronological age and opportunity for skill learning and use (criterion A) that significantly and persistently interferes with typical activities of daily living (criterion B), where onset occurs in the early developmental period (criterion C) and that cannot be better explained by a neurological condition affecting movement (criterion D) [2].

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