Brain & Development 41 (2019) 483–489

BRAIN & DEVELOPMENT
Official Journal of the Japanese Society of Child Neurology

www.elsevier.com/locate/braindev

Original article

Is the motor skills checklist appropriate for assessing children in Japan?

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Received 16 January 2019; received in revised form 13 February 2019; accepted 25 February 2019

Abstract

Purpose: Motor skill screening tools are essential for the early detection of developmental coordination disorder (DCD). The present study aimed to examine any cultural and rater effects on these tools. This then enabled us to judge the validity of the original cut-off values for identifying diagnosable children.

Methods: A community sample survey was performed in Japan; 3852 children aged 6–9 years were recruited. Both parents and teachers evaluated the motor skills of their children using the Movement Assessment Battery for Children – Second Edition Checklist. The psychometric properties were evaluated and the scoring characteristics examined based on the type of rater and country of origin, as compared to data originally sampled in the UK.

Results: High reliability and validity of the Japanese samples were confirmed. The Japanese adults evaluated their children's motor skills more rigorously than the Europeans. Additionally, there was a large disagreement between parent and teacher rating scores; the degree of agreement varied depending on the severity of motor deficits in the child.

Conclusion: The first findings from a Japanese sample suggest that the assessment of motor skills in children is significantly affected by culture and rater. These cultural characteristics and rater biases strongly suggest that new cut-off values, reflecting country and rater type, be introduced for identifying children at risk of DCD.

Keywords: Motor skills; Children; Screening; Developmental coordination disorder; Movement Assessment Battery for Children – Second Edition Checklist

1. Introduction

Deficits in motor coordination strongly impact a child's life. DCD is a neurodevelopmental disorder characterized by poor motor performance, without mental retardation or neurological/psychiatric disease [1]. Prevalence estimates for DCD range from 1.4% to 19.0% depending on country and age [2,3]. Children with DCD show severe difficulties in making coordinated movements from an early age, such as throwing a ball or tying a shoelace. Early detection and intervention can improve motor skills and enhance quality of life [4]. Thus, reliable screening tools are essential to identify children at risk of DCD.

Several screening questionnaires have been developed. The Developmental Coordination Disorder Questionnaire (DCDQ) is used as a scale for evaluating DCD-related motor skills in children [5,6]. It enables the assessment of three subcategories of skill: control during movement, fine motor, and general coordination.

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https://doi.org/10.1016/j.braindev.2019.02.012
0387-7604/

Using the age-related cut-off values, children at risk of DCD can be identified and referred for further examination and diagnostic confirmation. Although the psychometric properties, such as reliability and validity, were confirmed in translated versions of the DCDQ, average scores and score distributions are different between countries [7–9]. As such, the original cut-off values cannot be applied. We need to consider cultural characteristics when developing and introducing motor skill screening questionnaires.

The Movement Assessment Battery for Children – Second Edition (MABC-2) Checklist is another screening questionnaire [10]. The Checklist (i.e., the MABC-2 Checklist) is designed for both parents and professionals (e.g. doctors, teachers, and therapists) to evaluate a child's motor skills. This differs to the DCDQ, which is used only by parents. The Checklist asks the rater to assess motor skills in different daily situations, such as the classroom and playground, and asks for more detail than the DCDQ. The Checklist has adequate reliability and validity in a European country [11]. However, the average scores were slightly higher than those in the original version. Given the differences in motor performance between European and Asian countries [12], the score gaps from this checklist would be significant.

Rater biases should also be considered when investigating the score characteristics of the Checklist. There are often moderate score differences between parent and teacher ratings on neurodevelopmental disorder questionnaires [13–15]. This might be because parents and teachers observe different aspects of a child's behavior; motor skills displayed by children are not always the same at home and school. For example, handwriting is important at school, where it is strictly assessed by teachers, but it is less important at home. This means a child suspected of having a disorder by teachers might be seen as being unaffected by parents. Thus, the score characteristics and cut-off values should be examined differently depending on the rater.

The present study aimed to examine the cultural characteristics of the checklist, and to investigate whether or not the original cut-off values could be used for screening at risk children in Japan. Additionally, the rater biases for the checklist were evaluated using both teacher and parent rating scales. Previous studies have not revealed these cultural effects and rater biases, so the present findings should be highly informative for assessing children with motor coordination deficits.

2. Methods

2.1. Participants

Participants were recruited from a community with a population of 3852 children aged 6–9 years. The total community population (approx. 148,000) was almost equal to the average population of a city in Japan (approx. 142,000). Age distribution was also similar to average Japanese distributions. The community had 16 elementary schools, all of which had regular classes from grades one through six. We delivered the checklist to parents and teachers via the schools. We obtained 2461 and 866 responses from parents and teachers, respectively (response rate = 63.9% and 22.5%). Prior to engagement in the study, we provided sufficient explanation about the study to the school principals, children, and their parents. We then obtained school approval from all schools on behalf of their teachers, and informed consent from all the parents. The research protocol was approved by the ethics committee at the National Center of Neurology and Psychiatry (Tokyo, Japan; approval number A2015-004) and as such was deemed to be in accordance with the 1964 Helsinki declaration, and its later amendments, or comparable ethical standards.

2.2. Measures

The children's motor skills were evaluated using the Checklist originally attached to the MABC-2. The MABC-2 is an individual test battery used to assess DCD-related motor skills in children, and has been used widely in several countries, including Japan [12,16,17]. However, the Checklist had not previously been translated or standardized to Japanese samples. Thus, we purchased the Checklist from the publisher (Pearson Assessment, Oxford, UK) and translated it from English to Japanese. Five examiners and researchers verified the accuracy and reliability of the translated Checklist prior to the study [12].

The Checklist is a 30-item questionnaire that comprises two sections: Section A (movement in a static and/or predictable environment) and Section B (movement in a dynamic and/or unpredictable environment). Each section is further divided into three subcategories: Section A comprises self-care skills (A1, five items), classroom skills (A2, five items) and PE/recreational skills (A3, five items); Section B comprises self-care/classroom skills (B1, five items), ball skills (B2, five items), and PE/recreational skills (B3, five items). Raters were asked to respond to each item using a four-point Likert scale ranging from 0 (“very well”) to 3 (“not true”). Total and section scores were calculated by summing the item scores (maximum total score = 90, maximum section score = 45). Higher scores reflect more severe movement difficulties. We used the original cut-off points for identifying children suspected of having DCD; these were established using samples from the UK [10].

Both parents and teachers were asked to complete the Checklist. Parents resided with their children and observed their children daily behavior. Classroom teach-

ers, who spend more than 30 h per week with the children, also evaluated behavior. We excluded any sample data that had one or more missing values from the Checklist and did not perform any data imputation (i.e. pairwise deletion). The number of valid responses was 2242 and 484 from parents and teachers, respectively (valid response rates = 91.1% and 55.9%).

2.3. Data analyses

Since no previous studies had collected Japanese samples, we had to confirm the Checklist's basic psychometric properties before investigating cultural effects and rater biases. Internal consistency and scale homogeneity were assessed for each rather type by using Item-Total correlations and Cronbach's α coefficients. Then, confirmatory factor analysis was performed to examine the Checklist's factorial validity. We evaluated the appropriateness of the original factorial structure (i.e. two sections, 15 items per section) by using structural equation modeling (SEM) with maximum likelihood estimation techniques. Multiple fit indices were used to evaluate model fit: chi square to degree of freedom ratio (χ^2/df), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). We set the statistical criteria for a good fit between the model and data as follows: $\chi^2/df < 5$, GFI > 0.95, AGFI > 0.95, CFI > 0.95, and RMSEA < 0.05 [18,19]. We examined each path in the model using the Wald test and a *p*-value of 0.05.

We examined cultural characteristics of the Checklist by using original data sampled in the UK [10]. Differences between the total scores (i.e. original (UK), parent rating (Japan), teacher rating (Japan)) were tested via one-way ANOVA and *post hoc* analysis with the Bonferroni adjustment, depending on age. We also calculated the percentage of children with scores above the original UK cut-off values as described in the MABC-2 manual. These two analyses enabled us to judge whether or not the original score criteria could be used in other countries.

Finally, the rater biases of parents and teachers were examined using samples comprising children who had all had both parent and teacher assessments. We calculated indices of agreement between the two raters, such as κ coefficients and a prevalence-adjusted and bias-adjusted kappa (PABAK) [20]. Bland-Altman plots were generated to assess and compare rater trends. Using the present sample, we plotted new 5th percentile Checklist scores for child age and rater type. This was carried out because the 5th percentile was previously defined as the best cut-off value for identifying children suspected of having DCD. Statistical analyses were conducted using R version 3.3.3 [21] and IBM SPSS Amos 19 (SPSS Japan Inc., Tokyo).

3. Results

3.1. Basic psychometric properties

Table 1 presents Cronbach's α coefficients. The coefficients ranged from 0.927 to 0.973, indicating quite high

Table 1
Internal consistency and scale homogeneity.

Section A					Section B				
Items	Parent rating		Teacher rating		Items	Parent rating		Teacher rating	
	Item-Total correlations	Cronbach's α coefficients if item deleted	Item-total correlations	Cronbach's α coefficients if item deleted		Item-Total correlations	Cronbach's α coefficients if item deleted	Item-total correlations	Cronbach's α coefficients if item deleted
A1.1	0.644	0.930	0.824	0.971	B1.1	0.723	0.922	0.864	0.971
A1.2	0.614	0.930	0.826	0.971	B1.2	0.751	0.921	0.840	0.972
A1.3	0.698	0.927	0.846	0.971	B1.3	0.764	0.921	0.859	0.971
A1.4	0.690	0.928	0.795	0.972	B1.4	0.688	0.923	0.849	0.972
A1.5	0.740	0.927	0.872	0.971	B1.5	0.699	0.923	0.861	0.971
A2.1	0.748	0.926	0.868	0.971	B2.1	0.781	0.920	0.867	0.971
A2.2	0.748	0.926	0.843	0.971	B2.2	0.789	0.921	0.872	0.971
A2.3	0.722	0.926	0.860	0.971	B2.3	0.816	0.919	0.857	0.972
A2.4	0.743	0.926	0.888	0.970	B2.4	0.811	0.919	0.908	0.970
A2.5	0.779	0.925	0.878	0.970	B2.5	0.779	0.921	0.876	0.971
A3.1	0.773	0.926	0.890	0.970	B3.1	0.425	0.933	0.769	0.973
A3.2	0.784	0.925	0.864	0.971	B3.2	0.662	0.924	0.840	0.972
A3.3	0.707	0.930	0.840	0.971	B3.3	0.604	0.925	0.806	0.972
A3.4	0.718	0.927	0.832	0.971	B3.4	0.697	0.923	0.882	0.971
A3.5	0.772	0.925	0.870	0.971	B3.5	0.758	0.921	0.888	0.971
Cronbach's αcoefficients-all item		0.931		0.973	Cronbach's αcoefficients-all item		0.927		0.973

internal consistency. These coefficients would not be significantly decreased even if each item were removed individually. Table 1 also shows the item-total correlations between each item and section score. Each item score was significantly correlated with the section score for both parent and teacher rating scales ($p < 0.001$ for all), this verifies the Checklist's scale homogeneity. As for factorial validity, the results of confirmatory factor analysis are shown in Fig. 1. SEM based on the parent rating scales indicated a good fit between the model and data ($\chi^2/df = 6.510$; GFI = 0.957; AGFI = 0.920; CFI = 0.972; RMSEA = 0.050). The adequate fit indices for the teacher rating scales also indicated a good fit between the model and data ($\chi^2/df = 2.355$; GFI = 0.941; AGFI = 0.870, CFI = 0.987; RMSEA = 0.049). All paths in both models were significant according to the Wald test ($p < 0.05$ for all). These results demonstrate adequate factorial validity of the checklist and non-original sample.

3.2. Cultural characteristics

We tested for significant differences between the three types of total score (original, parent rating, and teacher rating) using a one-way ANOVA (Fig. 2). The main effects are significant in all age groups (6 yr: F (2, 92.65) = 42.75, p < 0.001; 7 yr: F (2, 137.56) = 45.32, p < 0.001; 8 yr: F (2, 140.49) = 16.43, p < 0.001). Post hoc analyses indicated that the original total scores were significantly lower than both the total scores of parent and teacher rating scales; this was confirmed in all age groups ($p < 0.01$ for all). The number of children suspected of having DCD according to the original cut-off values (i.e. 5th percentile) was 714 and 242 children as identified by parents and teachers, respectively (per-

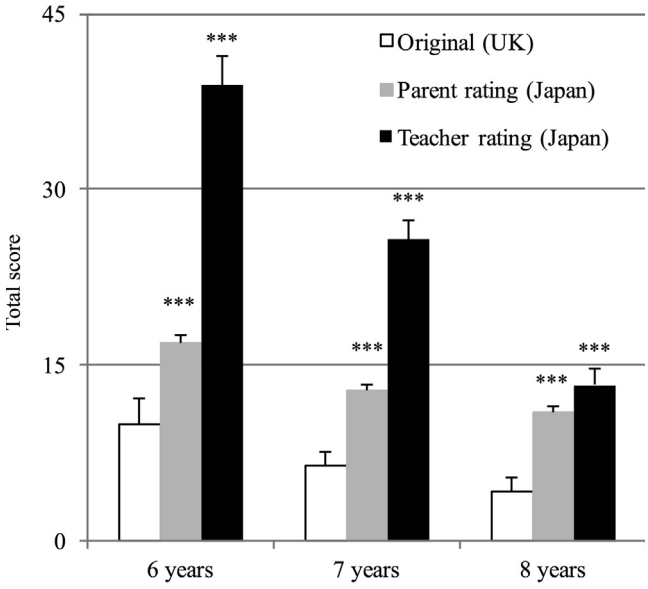

Fig. 2. Total Checklist scores. The bars and error bars show the mean and standard error, respectively (***: $p < 0.001$, **: $p < 0.001$, *: $p < 0.05$).

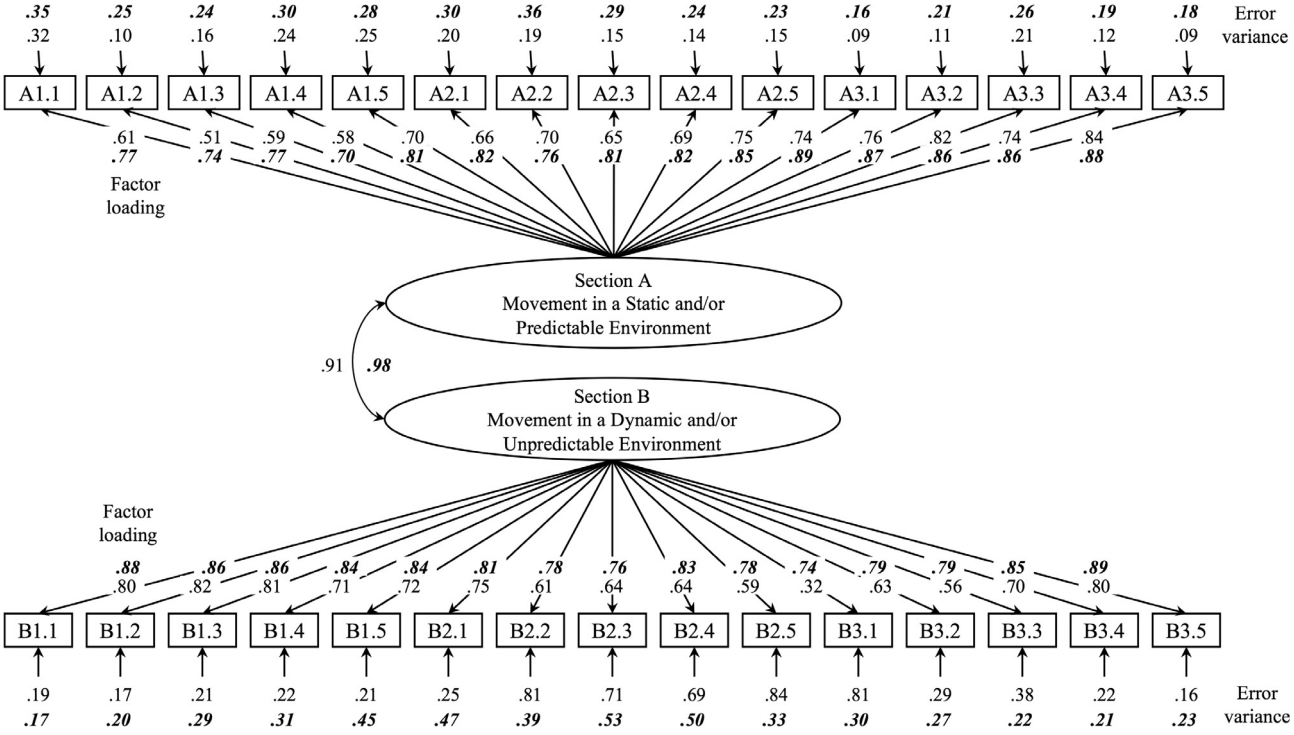

Fig. 1. Checklist factor structure and standardized parameters. Numbers in normal font: parameters based on parent rating scales. Numbers in bold italic font: parameters based on teacher rating scales.

Table 2
Agreement between parent and teacher rating scales.

	Agreement values
κ	0.27
PABAK	0.29
N (suspected)	190
by parents	45
by teacher	70
by both	75
N (normal)	136

centage (95% confidence interval) = 31.8% (22.9–33.8) and 50.0% (45.5–54.5), respectively).

3.3. Rater biases

Table 2 shows agreement between the parent and teacher rating scales. The κ coefficient was low ($\kappa = 0.27$). The coefficient remained low even when the prevalence and bias indices were considered (PABAK = 0.29). Some 190 children were identified as at risk either by parents or teachers; only 75 children were identified by both parents and teachers (agreement rate = 39.5%). Fig. 3 represents the Bland-Altman plots generated by the average and difference scores between parent and teacher rating scales. We did not find a strong fixed bias because the difference score between the raters (teacher rating scores minus parent rating scores) was almost 0. However, the proportional bias was significant (Pearson's $r = 0.33$, $p < 0.0001$). This indicates that when a child's motor impairments are severe (i.e. high averaged scores of teacher and parents), teachers considered the impairments to be more severe, and parents considered the impairments to be less severe (i.e. the score gaps between raters got wider). Fig. 4 indicates the 5th percentile scores of the Checklist for each age and rater type. New 5th percentile cut-off values, calculated with the current sample, were much higher than the original cut-off values for all age groups.

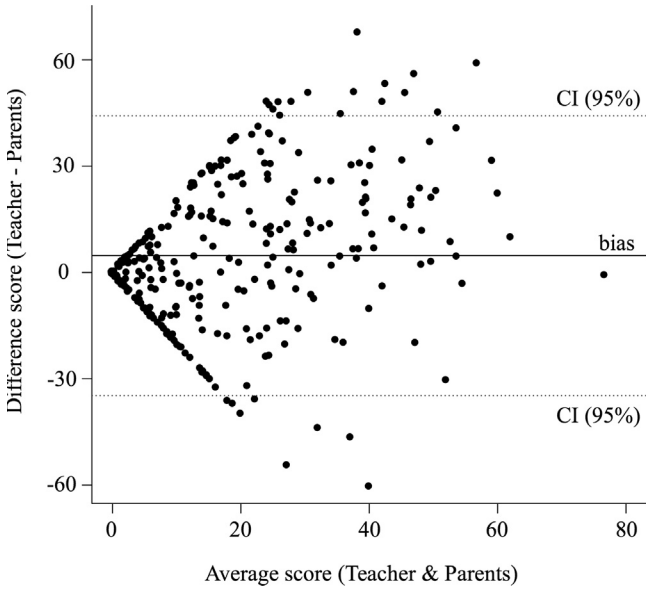

Fig. 3. Bland-Altman plots generated from parent and teacher rating scales.

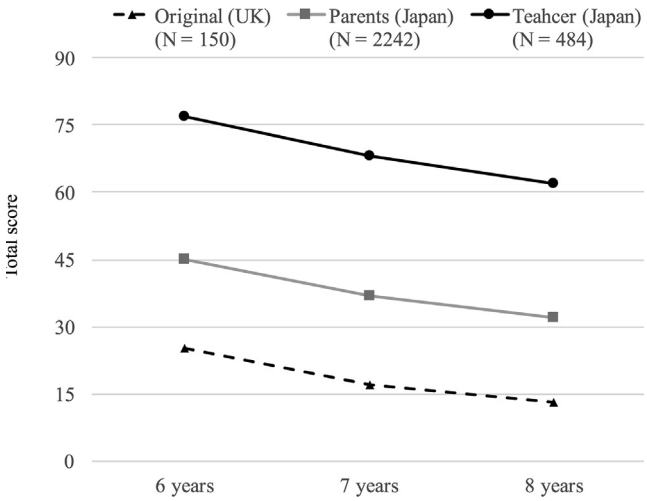

Fig. 4. Checklist 5th percentile scores. The original scores were cited from the MABC-2 manual.

4. Discussion

The present study was a first trial of the MABC-2 Checklist in Japan, collecting larger samples than those in the original UK study. This Japanese survey highlighted the existence of cultural differences in evaluating children's motor skills. In addition, both parents and teachers assessed the motor skills in their children, enabling us to reveal rater characteristics; these were not examined in previous questionnaires [7–9,11]. These findings demonstrate the significance of cultural and rater effects when assessing DCD-related motor skills in children.

Internal consistency and scale homogeneity were confirmed in both the parent- and teacher-rating Checklists. The original, and one previous study had both reported high internal consistency for the teacher-rating Checklist [10,11]. These present findings indicate that all 30 questions were appropriately designed to evaluate motor skills, regardless of rater type. Moreover, the SEM analysis showed adequate factorial validity of the Checklist with the non-original samples. The validity was not disrupted when we analyzed one-group samples from either the parent or teacher rating scales. However, a previous study reported validity based on a different factorial structure, since exploratory factor analysis was employed to find another structure [11]. Based on the present and previous findings, the Checklist can be used to evaluate a broad range of skills in children, and has

adequate factorial validity when considering the original structure (two sections, 15 items per section). Thus, basic psychometric properties of the Checklist were confirmed in countries outside the UK

Culture had a significant effect on the evaluation of children's motor skills. The total Checklist scores in the present study were much higher than those in the original UK report [10]. The score gaps between the present study and others conducted outside the UK were also shown [11]. The score gaps between countries are likely due to cultural characteristics. In Asian countries, particularly Japan, some motor skills of children are better than those in the UK and USA [12,22]. A previous study using the MABC-2 reported higher scores in the manual dexterity and balance subcategories for Japanese children compared with those from the UK [12]. Asian children having generally high motor skill levels would affect the assessment viewpoints of Asian adults. For example, Japanese teachers might evaluate a child's motor skills much more strictly than a UK teacher. If a child exhibits a poor movement performance, a teacher might evaluate their performance more harshly, because most other children perform very well. These strict motor skill expectations might affect the total Checklist scores, and cause the large scores gaps between Asian and European countries.

We also found rater biases for parents and teachers. Agreement rates between the raters were quite low. The Bland-Altman plots provided a possible explanation for this disagreement. Score gaps between parents and teachers increased when movement difficulties became more severe. In other words, parents would overestimate small difficulties in coordinated movement and underestimate severe, diagnosable difficulties. Teachers have to assess motor skills in both daily and lesson situations (e.g. PE) and therefore might gain a greater understanding of the seriousness of any difficulties. On the other hand, parents seemed to consider their child's difficulties more severe than teachers when the difficulties were small, such that the average scores were approximately lower than 20 (Fig. 3). These suggested that some parents worried so much about the slightest movement clumsiness even when their children were typically developing, and did not have severe problems related to the development. No previous studies have reported these disagreements and rater biases for motor skill assessment [7–9,11], though several studies have revealed biases regarding other neurodevelopmental disorders, such as attention deficit/hyperactivity disorder [13–15].

The clear existence of cultural characteristics and rater biases means new cut-off values for identifying children at risk of DCD must be set. Using the original cut-off values with the teacher-rating Checklist [10], half of the sampled Japanese children were considered as having DCD. This is not in line with the prevalence estimates of DCD shown in previous epidemiological studies and the general diagnostic manual [1]. This suggests that the original cut-off values are not suitable for Japanese samples. It should be noted that the 5th percentile scores of the present study checklist were completely different to the original study. The 5th percentile scores are defined as the cut-off values for identifying children who might have DCD. Moreover, as described above, the score gaps were also cleared between the parents and teachers. Therefore, when using this DCD screening questionnaire, we should introduce different cut-off values, depending on the country and rater.

This present study has several limitations. First, we did not perform individual motor skill assessments on the children using a test battery such as the MABC-2 [10]. This was because the cultural characteristics and rater biases were the main purpose of the study. However, we could not investigate the concurrent validity of the Checklist for a Japanese sample without individual assessments. It is also difficult to judge whether or not the children with scores above the 5th percentile cut-off values would be diagnosed as having DCD. Further studies need to use the individual assessment tools and examine the relationship between the Checklist scores and the assessment tool. A second limitation is that we only collected samples from children aged 6 to 9 years. Although our sample was larger than the original [10], and other previous studies [11], the Checklist was originally designed for children aged 5–11 years. According to the manual [1], the total scores of the Checklist and the cut-off values decrease with age. We should investigate these developmental changes in non-European countries and offer new cut-off values as required. Additionally, the present findings can be affected by non-response bias [23]. The response rates were clearly different between the parent and teacher rating questionnaires. These differences were partly attributed to teacher's workload stress to answer the questionnaire because they were requested to evaluate 10–35 children by themselves. Thus, some of the teachers decided to answer it only for specific children without evaluating whole children in their classes, which could lead to the biased results. Further studies should improve the response rates and adjust non-response bias [23].

In conclusion, the present study revealed cultural characteristics and rater biases when using a motor skills screening questionnaire for children. A large sample study in Japan highlighted the necessity of new cut-off values that reflected country and rater type when identifying children at risk of DCD. These novel findings are therefore highly informative for future research regarding children with motor coordination deficits.

Funding

This work was supported in part by a Grant-in-Aid for Young Scientists (B) (grant number 26780524 to YK); Intramural Research Grant for Neurological and Psychiatric Disorders of NCNP (grant number 29-6 to YK and MI); SENSHIN Medical Research Foundation (H27 to MI).

Acknowledgements

We would like to thank Dr. Tasuku Miyajima, Ms. Midori Inagaki, Ms. Hoko Ohyama, Ms. Sayuri Inoue, and Ms. Maiko Suto for their faithful assistance.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.braindev.2019.02.012.

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