A Comparative Study of Children's Motor Abilities Between Brazil and the Netherlands

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Abstract

Many different motor skill instruments are used nowadays (Bardid et al., 2015). Therefore, children from different countries are rarely compared with the same assessment on their motor abilities. To contribute to cross-cultural literature, the main focus of this study was to investigate motor differences between children from the Netherlands and Brazil using the Performance and Fitness (PERF-FIT) test battery for children. Moreover, gender differences regarding motor skills were analyzed, especially in relation to power items. The sample consisted of 37 children from the Netherlands and 40 children from Brazil aged 7-12 years old. The results showed no significant difference on the total outcome of the PERF-FIT assessment between Brazilian and Dutch children. When considering every subscale and each item of the test, significant differences were found for the subscale ball skills, the items overhead throwing, bouncing and catching, and throwing and catching, whereas the Brazilian sample performed better than the Dutch sample in all listed items. While boys were faster on the ladder running task, girls outperformed boys on the throwing and catching item in both countries. No significant gender differences were found on the power items. Additionally, an interaction effect on the side jumping item showed that Brazilian boys jumped more often than girls, but in the Dutch sample the reverse was true. The findings displayed that children from countries with different socioeconomic statuses might not be as different as assumed. This study stressed the importance to further investigate cross-cultural research, also regarding gender differences.

Keywords: PERF-FIT assessment, cross-cultural comparison, gender differences, motor skills

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"A third of adults and four-fifths of adolescents do not reach public health guidelines for recommended levels of physical activity" (Hallal et al., 2012, p. 1). The public health guidelines are defined as engaging in 60 min or more of moderate to vigorous physical activity per day. Not engaging in physical activity can have negative consequences such as increasing the risk of health conditions like coronary heart disease, type 2 diabetes, breast or colon cancers, and a shortened life expectancy (Smits-Engelsman et al., 2020). However, causes of limited physical activity might differ individually and depend on the countries, regions, and environments people live in. Physical inactivity might be caused by poor gross motor skills, but also absent, or low engagement in physical activity limits the possibility to improve motor skills. As a consequence, physical activity is important to ensure a natural development of motor skills in children. Furthermore, physical endurance and fitness of children are important to perform daily life activities and to experience an independent life as an adult later on (Wouters et al., 2020). People engage in physical activities to improve their motor skills, show physical competence, get socially accepted and approved, and to experience enjoyment (Weiss, 2020). Also, more physical activity increases the interest in sustaining these levels of physical activity and this again improves self-confidence, social relationships, and motor skills (Weiss, 2020).

The mastery of gross motor skills is crucial for children to engage in play activities and develop healthy lifestyles (Valentini et al., 2017). Motor skills are defined as "the qualitative proficiency in performing a wide range of skills requiring motor coordination and control" (Pesce et al., 2018). Also, Chien et al. (2014) emphasize that specific motor abilities like hand skills are needed for self-care. Furthermore, it is important to master some motor skills in order to be more autonomous, independent and experiencing a higher quality of life (Mensch et al., 2019). Therefore, the necessity of early identification of problems with motor

skills and physical activity through standardized testing arises. The earlier the identification of motor deficits in children, the earlier those children are supported in their development of motor skills, and the less support they will need later on in life. In addition, Weiss (2020) highlights that acquiring motor competence in early childhood is crucial to master fundamental motor skills such as everyday tasks or specific types of sports later on in life.

Furthermore, Weiss (2020) explains that motor behavior develops because of the interaction of biological constraints, and environmental and life experiences. He stresses the influence and importance of social and physical environments like school, family, friends or neighborhood, for the development of motor skills and interest in physical activity. Family and peers are important for children, because they function as role models and can reinforce the development of competence by encouraging specific skills. Furthermore, a supportive social surrounding increases feelings of relatedness and enjoyment. Therefore, an encouraging climate when engaging in physical activity should facilitate the improvement of motor skills (Weiss, 2020).

According to Barnett and Goodway (2018), a lot of research regarding motor abilities and coordination has been conducted in the United States. However, not a lot of research is available from non-English speaking countries, especially literature from low- and middle-income countries is underrepresented. Thus, despite the increasing interest in children's physical health (Smits-Engelsman et al., 2020), there seems to be limited data on movement skills and physical fitness among children in low-resource settings. Also, Liutsko (2019) emphasis the lack of research on cultural differences in motor performance.

Moreover, Brain et al. (2019) addressed an inequality in physical activity between typically developing children with high socioeconomic statuses and children with disabilities or from lower socioeconomic statuses. Findings in line with this statement are presented in the research by Drenowatz et al., (2010). The researchers examined the differences in physical

activity and sedentary behavior in children with different socioeconomic statuses. The results showed that children with low socioeconomic status are more likely to engage in sedentary activities, for example watching TV, than children with higher socioeconomic statuses, resulting overall in less physical activity. Reasons for that might be that children with higher socioeconomic statuses (SES) are exposed to different socioenvironmental influences, such as the accessibility to sport facilities. Families with higher SES are also more likely to incentivize children to gain interest in physical activities. Brazil and the Netherlands are examples of countries with contrasting socioeconomic statuses. In Brazil, most of the population has a low socioeconomic status, lacks the basic need for protection and faces inequitable access to health services (de Aguiar et al., 2007). Therefore, Brazilian children living in dangerous areas cannot go outside and play with their peers, they need to stay inside the house. Higher income countries, like the Netherlands, are quite safe for children and give them many opportunities to go outside, practice their motor skills, and play with their friends (Sigelman & Rider, 2018). In line with this research, the study by Florindo et al. (2011) showed that Brazilian's engagement in physical activity, and therefore opportunities to practice motor skills, was increased by facilities less than ten minutes walking from their homes. Therefore, opportunities to practice sports are more limited in Brazil in comparison to the Netherlands. Florindo et al. (2011) also emphasized the importance of investing in public safety and facilities for the practice of sports, especially in Brazilian regions with lower socioeconomic status.

Kebbe and Vinter (2013) showed that culture and environment can influence the development of specific motor skills in children. Their study compared right-handed children, six to 10 years old, and adults from France and Syria, when drawing side views of faces, vehicles, tools and animals. The drawings of the seven- to ten-year-old French children and adults showed predominantly drawings from the left side, while the Syrian participants made

right-sided drawings on average. Therefore, there might be differences in fine motor skills between people from different countries and cultures. Since no such differences in drawings were found for six-year-old children, it could be assumed that cultural differences might have a greater impact as children get older. Maybe young children are more influenced by genes and older children more by the environment and cultural settings when developing fine motor skills.

In line with the above-mentioned findings, Feitoza et al. (2018) stated that motor abilities are influenced by different socioeconomical and cultural factors such as specific attitudes, values, believes or shared behaviors of people living in the same location. The researchers conducted a study comparing the perceived motor competence of children aged five to eight years in Brazil, Australia, Portugal and America. The results showed that American children displayed the highest perceived motor competence and Brazilian children the lowest. The authors explained that differences in a particular skill might be influenced by its existence/nonexistence within a culture, popularity/unpopularity, or the possibilities children get to practice the skill. To illustrate, Feitoza et al. (2018) measured the task object control with different conditions, one of them was the “hit” condition. This condition involved rating the own competence of hitting a ball with a bat, which is similar to baseball or softball (Estevan et. al., 2019). The American children rated themselves higher in this condition than children from the other countries of this sample (Feitoza et al., 2018). The researchers explained the findings by means of the popularity of American national sports like baseball. Additionally, the study emphasized stronger effects between older children from different countries across skills. Feitoza et al. (2018), suggested that older children perceived themselves as more competent, because they were more exposed and influenced by national sports than younger children. It is of special interest that the researchers stated that higher perceived motor competence may influence children’s engagement in physical activities and

their development of motor competence. Poitras et al. (2016) supported these findings and explained that children perceiving themselves as less competent in fundamental skills are not motivated to be active, or practice motor skills and therefore, do not learn important motor skills and improve their physical fitness.

Besides socioeconomical, environmental and cultural differences, another interesting question refers to existing differences in gender regarding motor skills. According to Pesce et al. (2018), boys tend to be more active and show on average better object control skills than girls. However, the outcomes were inconsistent in regard to locomotor skills. Hardy et al. (2010) found that girls are better than boys in locomotor skills. Bardid et al. (2016) depicted that boys and girls have equal locomotor skills. However, Robinson (2011) showed that boys have higher locomotor skills than girls. To add to the discussion of the different outcomes between girls and boys on motor skills, this paper also considers gender in the analysis of motor abilities.

This study aims to contribute to the literature regarding children and their motor abilities when comparing children from different socioeconomical and cultural background. Therefore, this paper compares motor abilities between children from Brazil and the Netherlands. The above-mentioned literature has shown that Brazilian children might have less possibilities to engage in physical activity, and as a result, train their motor skills less than children from the Netherlands. Thus, it was hypothesized that children from the Netherlands perform better than children from Brazil in all four subcategories of the PERF-FIT test battery assessment. The PERF-FIT consists of the subscales balance, ball skills, agility and power. In addition, as previously mentioned, findings regarding motor skills between boys and girls showed different outcomes. Given these studies, I further hypothesized that boys do not differ significantly from girls in the outcomes of the PERF-FIT test, except for the power subscale where boys might outperform girls in both countries.

Method

Participants

Initially, the studied sample contained 249 children from the Netherlands and Brazil, including children with learning disabilities and other disorders. Then, children diagnosed with attention-deficit/hyperactivity disorder, developmental coordination disorder, autism spectrum disorder, obsessive-compulsive disorder, and any learning disorder got excluded. Furthermore, Dutch children aged four, five, six, 11, and 12 years got excluded from the sample in order to make groups more homogeneous. The final sample consisted of 40 Brazilian and 37 Dutch children between seven and 10 years old. The Dutch sample counted 15 boys (20%) and 22 girls (28%), whereas in the Brazilian sample, 17 boys (22%) and 23 girls (30%) were included. The mean age of the Brazilian children was 10.08 years (SD 1.01). The Dutch children had a mean age of 9.02 years (SD 2.38). Hence, the Brazilian children were approximately 12 months older than the Dutch children.

The Brazilian sample presented 19 children from the Caïc and 21 children from the Pericles school in Sao Carlos. In the Dutch sample, 20 children were part of the regular school in Winschoten and 31 children attended the Mariaschool in Eelde, the Netherlands. Both, the Dutch and Brazilian schools offered two hours of physical education per week to their students. This study was approved by the Ethics Committee of Psychology (PSY-1920-S-0107).

Stimuli and Materials

Three questionnaires were presented to the Dutch sample. The first one assessed general demographics about the child such as gender, height, and weight. The second questionnaire evaluated mobility, independence, activeness, and health of the participants. The last questionnaire was given to parents to indicate the strengths and weaknesses of their

children. The Brazilian participants filled out questionnaires too, however, those questionnaires are not available.

To assess the children's motor skills, the Performance and Fitness test (PERF-FIT) was used. The test contains four subcategories, namely balance, ball skills, agility and power, which are cross culturally applicable, relevant to routines and games of the children, and easy to test in low-and high-income schools. The balance and ball exercises included bouncing and catching, throwing and catching, jumping, hopping, and balance tasks. The agility and power items assessed running, stepping, side jumps, long jumps, and overhead throws. For more details regarding each item, see Table 4 in the Appendix.

All the tasks of the PERF-FIT test got categorized into 10 different items. More specifically, for the item 1 ladder running, children were asked to run as fast as possible through a ladder. Ladder stepping, item 2, meant stepping as fast as possible with both feet in each square of a ladder. Item 3, side jumping, included jumping from left to right, and vice versa, as many times as possible for 15s. Jumping as far as possible was item 4. For item 5, overhead throw, children were instructed to throw a sandbag as far as possible. Item 6 was bouncing and catching a ball, item 7 throwing and catching a ball. Item 8 contained four jumping items of increasing difficulty. Hopping on the right leg was item 9A, and item 9B was hopping on the left leg. Static balance, item 10A, included standing on one foot for 15s and keeping balance while first holding the foot and then the knee. Dynamic balance, item 10B, consisted of knee hugging, grasping the foot while walking through the ladder and picking up cans from the floor and placing them closer or farther. Item 10A got excluded from the analyses because of inconsistent measurements between the samples.

To be able to compare the different items with their different units, raw scores were converted into standard scores based on norms from South Africa. Then, the scores of the children got transformed into quartiles. For each item, children scoring within the norm got

coded as a 1, and children scoring below the norm got coded as a 0. Therefore, the highest total possible standard score for all 10 items combined is 10 and the lowest 0.

The children in the Netherlands performed the test in a physical education room, the Brazilian children in school premises. In addition, the Appendix contains illustrations of different tasks of the PERF-FIT assessment.

Reasons for the PERF-FIT assessments' use were its excellent inter-rater and test-retest reliability (Smits-Engelsman et al., 2021), as well as excellent content and good structural validity (Smits-Engelsman et al., 2020). Moreover, this assessment test is cheap, easy to administer, and suitable to measure motor abilities in low-and high resource settings (Smits-Engelsman et al., 2020). Furthermore, the equipment needed is simple and affordable, such as a tape measure, four soda cans, rectangular foam, a water bottle, and a stepladder.

Procedure and Design

This cross-cultural study was designed to investigate the motor difference between children from Brazil and the Netherlands. The Brazilian schools Caïc and Pericles were chosen due to their location in low economic suburb areas. The regular Dutch Mariaschool and school in Winschoten were randomly selected.

Before administering the PERF-FIT test to the Dutch children, students of the Bachelor group 2122_1a_25 got a three-hour training from Dr. Jelsma in order to conduct the PERF-FIT reliably. In Brazil, testers got prepared by trained assessors for a whole day. Participation was voluntary. Written informed consent, test procedures, benefits and risks were provided to the parents in advance. Only children providing informed consent were included in the study.

Children got tested in groups of two. After explaining each task, children were allowed to practice before scores were assessed. The items jumping, hopping, bouncing, catching, throwing, and balance were constructed with increasing difficulty. Participants

started at the easiest level and stopped after two attempts if they did not reach the required score for the item. If the maximum score of the item was reached on the first attempt, no second trial was given and the child could continue with the next level of difficulty.

Due to a measurement error, three children had to be tested a second time on the hopping tasks. Overall, the children reported enjoyment of the activities and no child was injured or overly fatigued after the assessment. The assessment of two children took approximately 45-60 min. After the test, Dutch children received a bubble wand as reward for participation, Brazilian children got a medal.

Statistical Analyses

To test for motor differences between children from Brazil and the Netherlands, the assumptions for normality, equality of variance, and univariate outliers must be met. Since the sample sizes were similar and large enough, normality and equality of variance were assumed. No extreme outlier was found in the sample. Additionally, a Chi-Square test was applied to control for the assumption of independent distributed genders and number of children per country in both samples. The independent sample t-test was applied to explore whether the average age between the countries is significantly different. To test for motor differences between children from Brazil and the Netherlands, Multivariate Analysis of Variance (MANOVA) was used. The independent variable was the origin of the children (Brazil or the Netherlands), and the dependent variable the outcome of the PERF-FIT test. For the calculation of the MANOVA, the total outcome of the PERF-FIT test, its subscales, and its 10 individual items were used as variables. To examine the additional hypothesis that there is no significant difference between gender in motor abilities, except for the subscale power, another MANOVA was conducted. In the PERF-FIT test, power as a measurement was only used in combination with agility. An important aspect of agility is quickly changing directions

(Sekulic et al., 2013), which is very important for the tasks running, stepping or side jumping. Thus, overhead throw and long jumps were used as power variables.

Results

The outcome of the Chi-Square test showed no differences between gender and the two countries, X^2 (1, N = 77) = .03, p = .86. Therefore, country and gender can be compared as groups in the analysis of children's motor abilities.

Results of the independent sample t-test showed a significant difference (t(75) = -4.03, p < .001) in age for children in both counties. Thus, instead of a MANOVA a MANCOVA with the covariate age was used in the further analysis.

For more details regarding the descriptive statistics of the total outcome and the subscales of the PERF-FIT assessment, see Table 1.

Table 1

The Mean and Standard Deviation of the Total PERF-FIT and its Subscales of Children From Brazil and the Netherlands

Items	Country			
	NL (N=37)		BR (N= 40)	
	M	*SD*	*M*	*SD*
Total PERF-FIT (SS)	7.46	2.05	6.98	1.42
Sum Power and Agility (SS)	8.81	1.66	8.50	1.74
Sum Ball (SS)	6.08	4.27	8.63	2.53
Sum Hop (SS)	7.03	5.14	5.50	5.04
Sum Skills (SM)	7.46	2.05	6.98	1.42

Note. The Total PERF-FIT combines all of the 10 standardized tasks. Sum Power and Agility includes the summed standard score of the tasks running, stepping, side jump, long jump, and overhead throw; Sum Ball refers to bouncing, throwing, and catching skills with a ball; Sum Hop consists of hopping tasks and Sum Skills of the mean of the hopping tasks, balance tasks and ball tasks combined. SS refers to converted standard scores, and SM means sum of means. The maximum and therefore best score of the standard score was 10 and the minimum 0.
NL = Netherlands
BR= Brazil

The analysis showed that there was only a significant effect of age on the subscale hopping, $F(1, 72) = 6.06$, $p = .02$, not on the other subscales. After correcting for age, a significant difference between the two samples was found regarding ball skills, $F(1, 72) = 8.87$, $p = .004$, whereas Brazilian children ($M = 8.63$, $SD = 2.53$) performed better than Dutch children ($M = 6.08$, $SD = 4.27$). Significant results were also found for overhead throw, bouncing and catching, and throwing and catching. The outcomes showed that Brazilian children were better in those tasks than Dutch children. For more information see Table 2. No significant differences were found for the other subscales, individual items nor the overall outcome of the test, $F(1, 72) = .01$, $p = .941$.

Table 2

Differences on the PERF-FIT Scores Between Brazilian and Dutch Children with the Mean (SD) Values

Items	BR (*N*=40	NL (N=37)	NL (N= 37)		
	M (*SD*)	*M* (*SD*)	*F*	*p*	Partial Eta Squared
Item 1 Ladder Running (s)	6.68 (1.18)	6.61 (.67)	1.79	.19	.02
Item 2 Ladder Stepping (s)	12.89 (2.23)	12.98 (2.50)	1.07	.31	.02
Item 3 Side Jumps (#)	22.89 (6.38)	22.60 (5.91)	2.95	.09	.04
Item 4 Long Jumps (cm)	125.62 (19.91)	122.41 (15.27)	.58	.45	.01
Item 5 Overhead Throw (cm)	199.97 (38.95)	242.63 (43.05)	10.09	.002	.12
Item 6 Bouncing and Catching (#)	36.89 (14.27)	45.08 (3.99)	4.21	.04	.06
Item 7 Throwing and Catching (#)	32.13 (14.02)	46.45 (4.25)	19.23	.00	.21
Item 8 Jumping (#)	19.27 (.99)	19.40 (.84)	.78	.38	.01
Item 9A Hopping on Right Leg (#)	16.62 (4.52)	17.83 (3.25)	2.06	.16	.03
Item 9B Hopping on Left Leg (#)	15.05 (6.09)	16.78 (3.44)	1.79	.19	.02

Item 10B Dynamic Balance (# of Balanced Steps and Placed Cans)	24.03 (7.54)	26.30 (3.50)	2.67	.11	.04

Note. All listed items are raw scores of the PERF-FIT assessment. Item 10A, Static Balance, was left out intentionally. The standard deviation is presented in parenthesis.
S= Seconds
# = Number
Cm= Centimeter
NL = Netherlands
BR= Brazil

The MANCOVA analyses showed significant differences between boys and girls on the items ladder running, $F = (1, 72) = 5.12$, p=.027, and throwing and catching, $F = (1, 72) = 4.16$, p=.045. Boys in Brazil and the Netherlands were faster in the ladder running task than girls, but girls were better at throwing and catching in both countries. No significant differences on gender were found for the items overhead throw, $F = (1, 72) = 1.03$, p=.313 and long jump, $F = (1, 72) = .037$, p=.849. For more details, see Table 3.

Furthermore, the results showed an interaction effect between gender and country on item 3, side jumping ($F = (1, 72) = 4.43$, p=.039). Thus, Brazilian boys appeared to be faster at side jumping (M= 23.76, SD= 5.66) than girls (M=21,74, SD= 6.06), however, Dutch girls (M=24,23, SD= 6.97) performed more side jumps than boys (M= 20.93, SD= 5.01).

Table 3

Differences on the PERF-FIT Scores Between Boys and Girls From Brazil and the Netherlands

Items	Country						
	NL (N=37)		BR (N=40)				
	M_G (SD_G)	M_B (SD_B)	M_G (SD_G)	M_B (SD_B)	F	p	Partial Eta Squared
Item 1 Ladder Running (s)	6.78 (1.26)	6.52 (1.07)	6.80 (.76)	6.35 (.43)	5.12	.03	.07
Item 2 Ladder Stepping (s)	13.09 (1.81)	12.58 (2.77)	13.14 (3.07)	12.75 (1.48)	1.13	.29	.02
Item 3 Side Jumps (#)	24.23 (6.97)	20.93 (5.01)	21.74 (6.06)	23.76 (5.66)	.00	.97	.00
Item 4 Long Jumps (cm)	127.95 (18.03)	122.20 (18.04)	119.59 (13.07)	126.24 (17.52)	.04	.85	.00
Item 5 Overhead Throw (cm)	202.27	196.60	235.30	252.53	1.03	.31	.01

	(40.13)	(38.27)	(36.47)	(50.09)			
Item 6 Bouncing and Catching (#)	35.36	39.13	44.13	46.35	2.61	.11	.04
	(15.78)	(11.86)	(4.61)	(2.57)			
Item 7 Throwing and Catching (#)	30.36	34.73	45.06	48.06	4.16	.05	.06
	(14.84)	(12.77)	(5.06)	(2.05)			
Item 8 Jumping (#)	19.31	19.20	19.26	19.59	.19	.67	.00
	(1.04)	(.94)	(.86)	(.79)			
Item 9A Hopping on Right Leg	17.36	15.53	17.43	18.35	.25	.62	.00
(#)	(3.63)	(5.54)	(3.73)	(2.47)			
Item 9B Hopping on Left Leg (#)	16.14	13.47	16.78	16.76	1.22	.27	.02
	(5.14)	(7.14)	(3.52)	(3.44)			
Item 10B Dynamic Balance (# of	25.91	21.27	26.30	26.29	2.84	.09	.04
Balanced Steps and Placed Cans)	(6.66)	(8.11)	(3.19)	(3.98)			

Note. All listed items are raw scores of the PERF-FIT assessment. Item 10A, Static Balance, was left out intentionally. The standard deviation is presented in parenthesis.
S= Seconds
# = Number
G= Girl
B= Boy
Cm= Centimeter
NL = Netherlands
BR= Brazil

Discussion

Identifying fundamental motor deficits in children increases their opportunities to seek help from early age on and improve their motor skills (Smits-Engelsman et al., 2020). This study investigated the motor differences between children from Brazil and the Netherlands.

To my knowledge, this paper was the first one to directly compare motor abilities of children from socioeconomically different countries, namely Brazil and the Netherlands. The main hypothesis that Dutch children perform on average better than Brazilian children on the PERF-FIT assessment was not supported by the results. Furthermore, the hypothesis that there is no significant difference in motor skills between boys and girls from Brazil and the Netherlands, except for the power subscale, was also not confirmed. More specifically, no significant differences were found on the power items overhead throw and long jump.

Contrary to already available cross-cultural studies, such as the research by Bardid et al. (2015) showing a significant difference in motor performance between Australian and Belgian participants, the current research did not show an overall significant difference between the two samples. Due to the different outcomes in other studies, it might be of

importance to observe the motor performance of children in a longitudinal study over several years.

Regarding the four subscales of the PERF-FIT assessment, the analyses showed that Brazilian children were significantly better at ball skills than Dutch children. To be more specific, the analyses showed that Brazilian children seemed to be significantly better at overhead throwing, bouncing and catching, and throwing and catching than Dutch children. One possible explanation for these findings was provided by Wolney (n.d.). The author argued that Brazilian children spend a lot of time playing ball games, which are more affordable than other sport disciplines requiring more expensive equipment. Therefore, the disadvantageous financial backgrounds of Brazilian children, compared to Dutch children, might result in more training and better results in ball related skills. No significant differences between Brazilian and Dutch children on the other seven items and three subscales of the PERF-FIT assessment were found. Moreover, the effect of age was significant for the subscale hopping. According to Lloyd et al. (2012), older children have more power to hop than younger children. This might explain the effect of age on the hopping subscale.

Additionally, a significant difference between boys and girls was found on the ladder running task, where boys scored better than girls in both countries. A reason for that could be that boys have more muscle power and therefore also better sprinting abilities (Sekulic et al., 2013). Also, boys might be used to agility ladder running training since a lot of them play soccer. Additionally, a significant difference was found for the item throwing and catching, for which in both countries girls performed better. Interestingly, no significant difference for the bouncing and catching item was found on gender, even though it is similar to the throwing and catching task. These findings are in contrast to the results of Crozier et al. (2019), who showed that boys are better in throwing and catching than girls. However, my findings might be explained by the fact that throwing and catching is more difficult than bouncing and

catching, and girls seemed to be more concentrated in these tasks. Therefore, I suggest that testing for concentration during motor skill tasks could be content to future research.

Moreover, an interaction effect was found on the side jumping item. To be more specific, Brazilian boys were better than girls at side jumping, whereas Dutch girls performed better at side jumping than boys. It would be interesting to conduct more research regarding this outcome in order to explain the interaction effect.

Limitations and Future Directions

A strength of this research is that it is the first cross-cultural study to examine the difference between Dutch and Brazilian children on motor abilities. The results of this study are particularly interesting because the two countries have different cultural and socioeconomical aspects. Another strength of this paper is that different motor skills got measured, thus, the paper did not only focus on one motor ability. Furthermore, while the two samples were large in their age range, and therefore increasing representativeness, the range was also equal for both countries, which made the samples more homogeneous.

Several limitations must be mentioned in the context of the current study. Firstly, even though the Bachelor group got instructed how to assess the PERF-FIT test, the students are not trained personnel, and they conducted such a test with children for the first time. Moreover, two of the students were not native Dutch speakers, thus, children might not have understood the explanation of the tasks perfectly. Secondly, the data included schools from low socioeconomical subareas in Brazil and therefore, the outcome of the Brazilian children might not be representative for whole Brazil. Thirdly, children got tested in groups of two, which may have decreased their concentration. During the evaluation of motor abilities, the researchers noted that some children focused less on the PERF-FIT tasks but more on the other children. Fourthly, raw scores of the data got converted into standard scores based on the norms from South Africa, even though a more precise mechanism would be to use norms

from Brazil or the Netherlands as a benchmark. Lastly, the sample included only Dutch and Brazilian children. This might lead to some bias when generalizing the outcome of the two culturally and socioeconomical different countries to the population of other countries.

Thus, future research should focus more on motor abilities of children from different countries. Additionally, future research could also include older children in their cross-sectional analyses of motor abilities. Lastly, it might be interesting to understand in more depth socioeconomical and cultural influences on motor competence.

Theoretical and Practical Implications

The current study has important theoretical and practical implications. Firstly, regarding the theoretical implications, this study stressed the importance of cross-cultural evaluation of motor abilities. To illustrate, further research is needed if gross differences between countries on motor skills are found. This research might evaluate why or how those differences between countries emerge. Furthermore, research might suggest new approaches to learn from other countries to improve motor skills. To date, not a lot of research regarding motor skills takes cross-culturally different samples into account in their studies. Secondly, the results have shown that boys were faster at ladder running, whereas girls performed better at throwing and catching in both countries. However, no differences were found on the other items of the PERF-FIT assessment. This outcome is contrary to a lot of research nowadays which states that there exist significant differences for gender on motor skills (Junaid and Fellowes, 2006). Therefore, the research about influences of gender on motor skills is still inconsistent. It might be important to replicate and extend this study by assessing cultural preferences of childhood games and sports in different countries. Moreover, our results stress the importance to publish more non-significant results regarding gender differences.

Introducing the PERF-FIT assessment to more children in different schools across different countries also has some practical implications. It is of importance that more people

know about the fast, reliable and easily-conducted PERF-FIT assessment in order to detect motor deficits in children and therefore increase their chances to seek and receive help early on in their lives. This in turn might increase the chance to encounter less motor problems in adulthood due to the fact that children were able to learn and modify some specific motor skills needed later on in life. Furthermore, since the results showed that there is no significance difference on the overall motor abilities between Brazilian and Dutch children, the same treatment for motor deficits in Brazil and the Netherlands could be used. Also, it might be helpful that schools implement the PERF-FIT assessment as a regular examination to increase the awareness of motor problems.

In conclusion, the present study stressed the relevance of motor skills' assessment across different countries, indicating that after all, there is no significant difference on motor skills between Brazilian and Dutch children. Therefore, the assessment emphasized on the similarity between children from those socioeconomical and culturally different countries. As a result, similar treatments for children with motor deficits in the Netherlands might also be used in Brazil. In addition, teaching fundamental motor skills to children with motor deficits at an early age increases their abilities to participate in certain sports and everyday activities.

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Appendix

Table 4

PERF-FIT Performance Items

Performance Items	
Bouncing and Catching	Children bounce tennis ball to the floor and catch. This series involves five bouncing and catching items of increasing skill difficulty. All children start at the easiest level. This series is discontinued if the child scores less than 6 out of 10 catches.
Throwing and Catching	Children throw tennis ball in the air to at least eye level height and catch. This series involves five throwing and catching items of increasing skill difficulty. All children start at the easiest level of this series. The series is discontinued if the child scores less than 6 out of 10 catches.
Jump	Children are asked to jump inside an agility ladder. This series involves four jumping items of increasing difficulty. Two test trials are allowed if maximum score is not obtained.
Hop	Children are asked to hop inside an agility ladder. This series involves four hopping items of increasing difficulty for each leg. Two test trials are allowed if maximum score is not obtained.
Balance	Children are asked to perform two (2) static balance tasks for each leg and three (3) dynamic balance tasks. Tasks involve knee hugging, grasping the foot and picking cans from the floor at close and far distance.
Agility and Power Items	
Running	Children are asked to run (one foot per square) in 3.5m agility ladder and run around a bottle placed at a distance of 50 cm from the starting line and return the same way as fast as possible. Two test trials are given for each child. The time taken (in seconds) to complete this task and number of mistakes made are recorded.
Stepping	Children are made to step with two feet in each square of a 3.5m agility ladder and run around a bottle placed at a distance of 50 cm from the starting line and return the same place as fast as possible. Two test trials are given for each child. The time taken (in seconds) to complete this
Side Jump	Children are required to jump sideways on their feet. One foot per square, in the same three squares of the agility ladder. The total number of correct landings in 15 s is recorded for each of the two test

	trials.
Long Jump	Children are asked to jump forward as far as possible and land on their feet in a controlled manner (i.e. balanced landing). The distance between the starting line and the heel of the foot that landed closest to the starting line is measured in centimeters. Two test trials are given.
Overhead Throw	Children kneel just behind a starting line and throw a sandbag (2 kg) forward as far as possible. The bag is held over the head and thrown from a starting position behind the head. The distance between the starting line and the part of the sandbag closest to the starting line is measured in centimeters. Two test trials are performed.

Note. From "Inter-rater reliability and test-retest reliability of the performance and fitness (perf-fit) test battery for children: a test for motor skill related fitness," by B. C. M. Smits-Engelsman, E. Smit, R. X. Doe-Asinyo, S. E. Lawerteh, W. Aertssen, G. Ferguson, and D. L. Jelsma, 2021, *Bmc Pediatrics*, *21*(1) (https://doi.org/10.1186/s12887-021-02589-0). Copyright 2021 by B. C. M. Smits-Engelsman.

Figure 1

Ladderstepping

Figure 2

Hopping Task

Figure 3

Ball Throwing Task

Figure 4

Balance Task