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MOTOR SKILLS

Motor Skill Assessment in Autism Spectrum Disorder: A Case Study

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Abstract

Without proper motor assessment, children with autism spectrum disorder may be placed in educational settings that are inappropriate for their motor abilities. However, many practitioners find it challenging to choose which assessment to use to assess these children, especially with the number of instruments available. The purpose of this study was to present findings from a case study that compared and contrasted four widely used developmental instruments (i.e., Bruininks–Oseretsky Test of Motor Proficiency-2, BOT-2; Movement Assessment Battery for Children-2, MABC-2; Peabody Developmental Motor Scales-2, PDMS-2; and Test of Gross Motor Development-Second Edition, TGMD-2) that were designed for motor skill assessment for children. A 5-year-old boy with autism participated in the study and completed all four motor skill assessments. The child completed all gross motor skills included on the four assessments, within the gymnasium of the local elementary school, and fine motor skills were assessed in a quiet room. Results revealed that the child performed better on the PDMS-2 and the BOT-2 out of the four instruments. In conclusion, each motor assessment instrument has strengths and limitations. Practitioners and researchers should consider their assessment goal when selecting a testing instrument. If the goal is to increase time engaged in

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on-task behavior, a quantitative approach such as the MABC-2 and the BOT-2 may be best. If the goal is to describe qualitative changes, the TGMD-2 may be best. If the goal is to assess qualitative and quantitative performance, the PDMS-2 may be best.

Motor skill development is important for the health and well-being of children of all abilities. Children who are able to perform fundamental motor skills such as running, jumping, galloping, throwing, kicking, or catching at high levels of proficiency are also more physically fit, less obese, and less at risk for hypokinetic disease (Stodden, Gao, Goodway, & Langendorfer, 2014).

Researchers can assess motor skill development in children using qualitative and quantitative approaches. Qualitative assessment provides information about the process of a movement and describes how an individual moves. This detailed information is valuable to therapists and researchers, but it is not without cost. This type of assessment is often resource intensive, as it takes more time to complete and often requires researchers to have extensive training to produce valid and reliable analysis of performance exhibited during the assessment. Quantitative approaches provide numeric measurements of the outcome (e.g., distance ran), and qualitative approaches describe how the outcome was produced. Although this approach is usually less taxing on the researcher's resources, it can omit important information regarding skill performance. Researchers report that children with disabilities, including autism spectrum disorder (ASD), sometimes use a movement strategy that is not congruent with the approach for the assessment, to achieve the task required during the assessment (Berkeley, Zittel, Pitney, & Nichols, 2001; Breslin & Buchanan, 2014; Breslin & Rudisill, 2011; Green, Baird, & Barnett, 2002; Staples & Reid, 2010; Yun & Shapiro, 2004). Therefore, with a quantitative approach, a child may earn a high score for performance because of an ability to complete many repetitions, when in fact the child uses improper form.

Some assessments (e.g., the Test of Gross Motor Development-Second Edition, TGMD-2) have two approaches, with a numerical value being assigned to the presence or absence of an aspect of skill performance. However, this approach may cause confusion as well. For example, the TGMD-2 jumping task includes four performance criteria that must be met for "successful" jumping performance. However, the success of the jumping task on the Movement Assessment Battery for Children-2 (MABC-2) is based on the number of consecutive jumps a child performs. The main criterion of success for the MABC-2 jumping task is that children must jump within the boundaries of the mats and perform one jump per mat. Thus, the maturity of the jumping movement is not measured, and a child who can only complete one jump could earn the same numerical scores on both assessments, even if the quality of the movement is very different (Logan, Robinson, & Getchell, 2011; Ulrich, 2000). The jumping tasks in the Peabody Developmental Motor Scales-2 (PDMS-2) and the Bruininks–Oseretsky Test of Motor Proficiency-2 (BOT-2) are measured via the distance where jumping from the start point (the line) to the point where the back of the nearest heel touches the floor. The score given to the child is based on the distance without attention to the qualitative criterion used to perform the jump.

The increasing prevalence of ASD has made the use of motor assessment in understanding the motor skill performance of children with ASD a high priority for researchers and practitioners. Because many motor assessment instruments are available for testing, there is not one gold standard instrument to investigate motor skill performance of children with ASD, especially because none are designed exclusively for this population (Piek, Hands, & Licari, 2012). However, researchers must choose the assessment for a particular study based on the purpose of that study, rather than based on reasons of convenience (Logan et al., 2011; Staples, 2013; Yoon, Scott, Hill, Levitt, & Lambert, 2006). Thus, the purpose of this study was to compare and contrast four instruments designed for motor skills assessments, the MABC-2, TGMD-2, PDMS-2, and BOT-2, using a case study approach.

Method

Participants

The participant was a 5-year-old boy with high functioning autism, who was diagnosed at 4-years-old. The child completed all gross motor skills included on the four assessments, within the gymnasium of the local elementary school, and fine motor skills were assessed in a quiet room. The principal investigator conducted all four assessments and obtained the most up-to-date information regarding the child's diagnosis, behavioral and sensory preferences, and social communication skills from the school psychologist, who based these on the results of the child's performance on the Preschool Language Scales-Fifth Edition (PLS-5) and the Developmental Profile-Second Edition (DP-2). Specifically, the child exhibited difficulty with the tasks included on the PLS-5, scoring at or below the 5th percentile for auditory comprehension, expressive communication, and total language. Furthermore, the child had poor performance on the DP-2, earning below average scores on the subtests of physical, adaptive behavior, and social-emotional skills. The school psychologist also reported that the child exhibited impulsive behaviors and a preference for interaction with adults and some children, and it is possible that the difficulties with language and adaptive skills reported on the DP-2 and PLS-5 could have influenced performance on other assessments, including those in the motor domain.

The principal investigator has a doctorate in motor behavior and over 15 years of experience in conducting motor assessment experiments on children. She had extensive trainings on administrating the four instruments when she was a master student, and she completed motor assessment data collection on over 1,000 children.

Instrumentation

The child's motor performance was assessed using four motor skill assessments. Beyond following the directions in the instruction manual for each of these assessments, the investigator used additional empirically proven strategies for improving understanding during motor skill assessments. Specifically, demonstrations and pictures were displayed to convey the essence of the skill to the child, and simple, short verbal instructions were provided alongside these demonstrations and pictures (Breslin & Rudisill, 2011; Liu & Breslin, 2013a).

Bruininks-Oseretsky Test of Motor Proficiency-Second Edition. The BOT-2 (Bruininks & Bruininks, 2005) measures a combination of gross and fine motor proficiency in children aged 4 to 21 years old. When administered in short form (14 items), it takes between 15 and 20 min to finish. The complete form with 53 items takes about 45 to 60 min. The BOT-2 short form is used as a screening tool for children with ASD, and the complete form must be used for detailed assessment for children who had problems on the short form. The BOT-2 evaluates skills in eight subtests: fine motor precision, fine motor integration, manual dexterity, upper limb coordination, bilateral coordination, balance, running speed/agility, and strength. The BOT-2 has been used with children with ASD (Gabriels et al., 2012; Hilton et al., 2014; Pan, 2014; Vivanti, Nadig, Ozonoff, & Rogers, 2008).

Movement Assessment Battery for Children-Second Edition. The MABC-2 (Henderson, Sugden, & Barnett, 2007) assesses fine and gross motor skills of children aged 3–16 years in developmentally appropriate activities that vary across three age bands (3–6 years, 7–10 years, 11–16 years) in a valid and reliable way in under 30 min. Thus, older children are provided more challenging activities accounting for their improved manual dexterity as a function of typical motor development. It has been successfully used to assess the motor skillfulness of children with ASD (Brown & Lalor, 2009; Green et al., 2002; Green et al., 2009; Henderson et al., 2007; Liu & Breslin, 2013a, 2013b).

Peabody Developmental Motor Scales-Second Edition. The PDMS-2 (Folio & Fewell, 2000) is a valid and reliable instrument appropriate for children from birth to 5 years of age. It contains six subscales, albeit one (reflexes) is only used for children less than 1 year old. Thus, children of school age can be assessed using subscales measuring stationary action, object manipulation, visual–motor integration, grasping, and locomotion. It has been used to assess children with ASD (Lloyd, MacDonald, & Lord, 2011; Provost, Heimerl, & Lopez, 2007; Provost, Lopez, & Heimerl, 2007; Vanvuchelen, Roeyers, & De Weerdt, 2007; Zachor, IIanit, & Itzchak, 2010)

Test of Gross Motor Development-Second Edition. The TGMD-2 (Ulrich, 2000) assesses the gross motor skills of children aged 3–10 years using two subtests comprising six locomotor skills (run, gallop, hop, leap, jump, and slide) and six object control skills (strike a stationary object, dribble, catch, kick, overhand throw, and underhand roll). It is a valid and reliable tool used in many physical education classes in the United States to determine if a child qualifies for adaptive physical education (Ulrich, 2000). Given its evaluative purpose and that it takes less than 30 min to administer, it has also been popular for use with children with ASD (Berkeley et al., 2001; Breslin & Rudisill, 2011, 2013; Liu, Hamilton, Davis, & ElGarhy, 2014; MacDonald, Lord, & Ulrich, 2013; Pan, Tsai, & Chu, 2009; Staples & Reid, 2010).

Procedures

The child's gross motor skills on four instruments were completed in the gymnasium, and fine motor skills were assessed in a quiet room. The child entered the testing environment and was provided the instructions for the assessment items; instructions came from the instruction manuals for each assessment. The principal investigator administered all the assessment items and provided demonstrations to the child. No other children or research assistants were present during testing. Besides following the assessment directions in the instruction manual for each test, the investigator used additional strategies for improving the child's understanding of each skill performance. Specifically, the investigator gave demonstrations and displayed pictures to convey the essence of the skill to the child. The investigator also provided simple and short verbal instructions with the demonstrations and pictures (Breslin & Rudisill, 2011; Liu & Breslin, 2013a). The assessment was performed over a short time. That is, a break was given between each subtest to keep the child focused on tasks, and reinforcements were used (e.g., playing with a tennis ball or other favorite activities after each task) to motivate him to complete the assessments.

Results

The results of the study suggest variations in the level of delay reported as a function of the assessment used. The child earned scores in the 5th percentile for the MABC-2, with his performance classified as significant movement difficulty compared to his peers. On the PDMS-2 and TGMD-2, his performance was classified as below average, as he performed his motor skills in the 16th percentile on both assessments. However, his performance on the BOT-2 yielded higher scores, earning him a classification of average skill level (21st percentile). Specifically, based on his BOT-2 scores on fine motor precision, fine motor integration, and manual dexterity, he was classified as average.

Exploring the results on the different subtests for each assessment yields a more distinct picture. Full results of performance on these subtests are shown in Table 1. To summarize, the child's score on the manual dexterity test on the MABC-2 suggested below average performance, whereas performance on the fine motor precision, fine motor integration, and manual dexterity subtests on the BOT-2 suggested average motor skill performance. Disparity between the BOT-2 and the MABC-2 balance subtests also existed. On the MABC-2, the boy's scores again suggested below average performance, whereas on the BOT-2 his performance was average. Disparity also existed between the PDMS-2, MABC-2, BOT-2, and TGMD-2 scores. For the object manipulation subtest in the PDMS-2 and aiming and catching subtest in the MABC-2, the child scored average in comparison to the norms, with performance at the 25th percentile and 50th percentile. However, he was classified in the 9th percentile for the object control skills subtest on the TGMD-2 and in the 12th percentile for the upper limb coordination subtest on the BOT-2, earning him the classification of below average.

Discussion

Results of the study were consistent with the literature suggesting children with ASD had delayed motor performance in some or all subtests in four motor assessments (Chen, 2013; Stodden, True, Langendorfer, & Gao, 2013; Stodden et al., 2014; Williams et al., 2008). Because this study was intended to be descriptive in nature, no hypotheses were made with respect to the consistency of classification of the child's skill performance across the four motor assessments included in this study. Furthermore, the child's performance on each assessment was consistent with the data collected prior to testing. That is, he scored below average on the PDMS-2 in physical behavior, adaptive behavior, and social-emotional behavior. However, differences in the level of observed delays in motor performance among assessments may be related to differences in criteria used for each testing instrument. The child's performance was similar on the PDMS-2, BOT-2, and TGMD-2, which may indicate that certain subtests (e.g., locomotion or object control or object manipulation) measure similar motor skill performance constructs. The PDMS-2 and the BOT-2 are designed to assess motor proficiency in a more detailed manner than the MABC-2 and the TGMD-2. The MABC-2 is a screening tool to identify children at risk of movement difficulty and to describe general motor competence. The TGMD-2 is based on the qualitative assessment of gross motor skills. Many gross motor skills tested in the TGMD-2 are more related to sport.

Table 1

Participant Scores on the Assessment Instruments and Time Spent in Each Assessment

	MABC-2	PDMS- 2	TGMD-2	BOT- 2
Time spent in testing	25 min	75 min (2 testing sessions)	27 min	120 min for the complete form
Subtests Standard Scores (SS) **Percentile (Descriptive Category)**	**Manual Dexterity** SS: 7 Percentile: 16th (Below average) **Aiming & Catching** SS: 10 Percentile: 50th (Average) **Balance** SS: 3 Percentile: 1st (Below average)	**Reflexes:** NA **Stationary** SS: 7 Percentile: 16th (Below average) **Locomotion** SS: 7 Percentile: 16th (Below average) **Object Manipulation** SS: 8 Percentile: 25th (Average) **Grasping** SS: 8 Percentile: 25th (Average) **Visual–Motor Integration** SS: 9 Percentile: 37th (Average)	**Locomotor** SS: 9 Percentile: 37th (Average) **Object Control** SS: 6 Percentile: 9th (Below average)	**Fine Motor Precision:** 13 (Average) **Fine Motor Integration:** 15 (Average) **Manual Dexterity:** 16 (Average) **Upper Limb Coordination:** 12 (Below average) **Bilateral Coordination:** 12 (Below average) **Balance:** 10 (Average) **Running Speed & Agility:** 13 (Average) **Strength:** 11 (Well below average)

Table 1 (cont.)

	MABC-2	PDMS- 2	TGMD-2	BOT- 2
Quotients, SS, Percentile, or Total Motor Composite (Descriptive Category)	**Total Test Score**: 54 SS: 5 Percentile: 5th (Significant movement difficulty)	**Gross Motor Quotient:** 83 Percentile: 13th (Below average) **Fine Motor Quotient:** 91 Percentile: 27th (Average) **Total Motor Quotient:** 85 Percentile: 16th (Below average)	**Gross Motor Quotient:** 85 Percentile: 16th (Below average)	**Strength and Agility:** Percentile: 24th (Average) **Manual Coordination:** Percentile: 42th (Average) **Body Coordination:** Percentile: 14th (Below average) **Fine Manual Control:** Percentile: 38th (Below average) **Total Motor Composite**: Percentile: 21st (Average) **Short Form Composite**: Percentile: 21st (Average)

The differences in performance between assessments may be related to differences in criteria for performance on specific items. For example, tasks exploring fine motor skills on the BOT-2 require a different kind of performance than do tasks exploring fine motor skills on the MABC-2. The MABC-2 has a larger performance target size than does the BOT-2. An implication of Fitts' Law, which states that movement time is a function of the target size (Fitts, 1954), is that the child may have felt more relaxed on the MABC-2 because the target size was larger. Anecdotally, the researchers believe this to be true because successful performance on the extremely precise items on the PDMS-2 require a level of stillness not observed during data collection. The researchers recommend that the PDMS-2 is the assessment to select if the goal is to obtain the highest scores, because of repetition of classes of actions. For example, in the PDMS-2 stationary subtest, the child earned a total score of 5 on three standing-on-one-foot tests. He scored 2 on Item 20 for standing on one foot for 3 s (i.e., quantitative assessment item), 2 on Item 21 for standing on one foot for 5 s, 1 on Item 23 for standing for 3 s on one foot with hands on hips and without swaying more than 20 degrees (i.e., qualitative item), and 0 on Item 27 because he could not stand on one foot without swaying more than 20 degrees for 5–10 s.

The PDMS-2 is designed according to motor developmental stages; therefore, some items are repeated. In addition, chronological age is used to determine the test start point. The PDMS-2 also uses a basal and ceiling level, making the time spent on testing shorter. The PDMS-2 provides comprehensive assessment on a child's motor performance. For example, the PDMS-2 includes 16 quantitative and qualitative testing items to assess jumping performance. Each testing item evaluates a different aspect of jumping (Table 2).

Table 2
Item Number, Jumping Position, and Description for 16 Jumping Tests in PDMS-2

Item number	Jumping position	Description
49, 61, 67, 76, 81	Jumping forward	Jumping forward using 2-footed takeoff and landing.
51, 58, 62	Jumping down	Standing on stable object, jumps down without assistance using 2-footed takeoff and landing.
63, 84	Jumping hurdles	Jumps over string without tripping using 2-footed takeoff and landing.
72	Jumping forward on one foot	Jump forward on 1 foot without letting other foot touch floor.
50, 55, 73	Jumping up	Jumps up with feet together and touches line.
82	Turning jump	With body not deviating more than 20 degrees from vertical, jump and turn 180 degrees. Land with feet opposite original position.
87	Jumping sideways	With feet together and without pausing, jump back and forth (sideways) over line.

Because the PDMS-2 is appropriate for children from birth to 5 years, the researchers recommend the BOT-2 as a detailed motor assessment for children older than 5 years of age. The BOT-2 assesses motor proficiency of prekindergarten children, adolescents, and young adults. Some BOT-2 test items assess different aspects of motor proficiency using similar task. For example, in the balance subtest, the child scored 3 on Item 3 (standing on one leg on a line with opened eyes for 9 s), 2 on Item 6 (standing on one leg on a line with closed eyes for 3 s), 1 on Item 7 (standing on one leg on a balance beam with opened eyes for 2.07 s), and 1 on Item 9 (standing on one leg on a balance beam with closed eyes for 1 s).

Future researchers should consider completing case studies like this one on children of various ages (with matching PLS-5 and DP-2 scores) to determine if there is an age effect with the assessments rather than a communication effect. Even though these assessments are designed for use with people of a range of ages (e.g., MABC-2 for those aged 3–16 years, TGMD-2 for those aged 3–10 years, BOT-2 for those aged 4–21 years, and PDMS-2 for children from birth–5 years old), it is possible that there are age effects that must be explored. Thus, replicating this study with 3- and 4-year-old children might yield further clarification as to which motor assessment is most useful in determining the motor abilities of children with ASD.

Conclusion

Each motor assessment instrument has strengths and limitations. Practitioners and researchers should consider their assessment goal when selecting a testing instrument. If the end goal of conducting an assessment is to compare performance to specific criterion (and/or to the performance of gender and age-matched peers), the TGMD-2 or the PDMS-2 might be the most appropriate assessment instrument. When comparing scores on these assessments to normative data for age and gender, researchers can assess a child's achievements during the assessment using a performance orientation (as opposed to a mastery orientation). If the goal is to assess the ability to perform repetitive actions, it is possible that the MABC-2 (or other assessment that measures success by the quantity of a certain skill that can be performed) would be most appropriate. The PDMS-2 and the BOT-2 both measure the distance a child covers while performing certain motor skills, so these might be appropriate if measuring or assessing endurance measures.

Therefore, when determining which of these assessments to use, researchers need to consider the goal of the assessment and intervention. A combination of assessments may yield the most detailed picture of the nature of motor performance in this population (Staples, 2013). If the goal is to increase time engaged in on-task behavior, a quantitative approach may be best such as the MABC-2 and the BOT-2. If the goal is to describe qualitative changes in motor performance, the TGMD-2 may be the best assessment instrument to use. If the goal is to assess both qualitative and quantitative performance, the PDMS-2 may be the best assessment instrument to use.

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