Sensory- and Perceptual-Motor Performance of Children with Learning and Behavioral Disorders Enrolled in a Learning Laboratory

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Abstract

The purpose of this study was to evaluate sensory- and perceptual-motor performance of children with learning and behavioral disorders enrolled in a learning laboratory to see if these children have specific sensory- and perceptual-motor delays. Participants were 66 children (44 boys and 22 girls; \( M \) of age = 7.61 years; \( SD \) of age = 1.75 years). Sensory- and perceptual-motor performance of these children was assessed in the Wood Motor Success Screening Tool (Wood, 1998). The results of this study indicated that 76\% (\( n = 50 \)) of the participants demonstrated the below-average overall sensory- and perceptual-motor performance with different percentages of the participants showing weaknesses on seven specific sensory- and perceptual-motor areas. These results revealed that needs for overall and specific sensory- and perceptual-motor training do exist for these children.

Key words: sensory- and perceptual-motor performance, children with learning and behavioral disorders, and adapted physical education.

Learning and behavioral disorders consist of disabilities that affect learning and/or behaviors, and in turn, performance (Horvat, Eichstaedt, Kalakian, & Croce, 2003). It is not a category of disability defined in legislation; instead, this group of disorders is categorized because of the common learning and/or behavioral problems by children for research and teaching purposes. Attention deficits disorders, leaning disabilities, mental retardation, and autism, for example, can be placed into this group because children with these disabilities usually have learning and/or behavioral difficulties, resulting in the below average motor performance (Auxter, Pyfer, & Huettig, 2005; Sherill, 2004).

Zhang (2001) conducted a pilot study focusing on the examination of basic motor performance for a total of 21 children with learning and behavioral disorders, ages 5-10 years, 12 boys and 9 girls. Based on the results of this pilot study, all the participants performed below average on all the seven locomotor skill testing items (run, gallop, hop, leap, jump, skip, slide) determined using the Test of Gross Motor Development (TGMD; Ulrich, 1985). This finding has been supported by other studies such as DiRocco, Clark, and Phillips (1987), Harvey and Reid (1997), Woodard and Surburg (1997), and Berkeley, Zittel, Pitney, and Nichols (2001).

DiRocco, Clark, and Phillips (1987) analyzed the motor performance of children with and without mild mental retardation. Among a total of 39 children with mild mental retardations from 4 to 7 years old, the results of this study found that the distance jumped by these children was 2 to 3 years behind their normal peers, implying that these children showed the below average motor performance. This finding was supported by Holland (1987) who indicated that children with mild mental retardation performed significantly worse than the age-appropriate peers without disabilities on object control and locomotor skill testing items (e.g., run and kick) examined using TGMD (Ulrich, 1985).

Harvey and Reid (1997) investigated the motor performance of 19 children with attention deficits disorders. These children were measured in TGMD (Ulrich, 1985) with a total of 12 fundamental gross motor skill testing items used in TGMD (Ulrich, 1985). Based on the averaged standard scores on locomotor and object control categories by boys and girls presented in this study, all the girls with learning disabilities performed locomotor skills at poor level and object control skills at below average, while all the boys performed locomotor skills at below average, indicating that these children showed the below-average motor performance.

Woodard and Surburg (1997) studied the motor performance of 20 children with learning disabilities. These children, including 10 boys and 10 girls, were measured using 12 fundamental gross motor skill testing items used in TGMD (Ulrich, 1985). Based on the averaged standard scores on locomotor and object control categories by boys and girls presented in this study, all the girls with learning disabilities performed locomotor skills at poor level and object control skills at below average, while all the boys performed locomotor skills at below average, indicating that these children showed the below-average motor performance.

Berkeley, Zittel, Pitney, and Nichols (2001) evaluated the motor performance of 15 children with autism. The results of this study indicated that about 73\% of these children demonstrated overall fundamental motor skill delays assessed using TGMD (Ulrich, 1985). The participants performance ranged from the poor or very poor performance categories. In addition, other studies (Orinitz, Cuthrie, & Fareley, 1977; Reid, Collier, & Morin, 1983) also reported that children with autism had significant delays in motor development compared to their peers without disabilities, and showed similar motor developmental level to their peers with mental retardation.

The results from these studies indicated that children with learning and behavioral disorders might have below average motor performance. However, these results could not be used to reveal weaknesses in sensory- and perceptual-motor areas that underlie the motor performance because of the assessment instrument these studies used. All previous investigations (DiRocco et al., 1987; Harvey & Reid, 1997; Woodard & Surburg, 1997, Berkeley et al., 2001; Zhang, 2001) used TGMD (Ulrich, 1985) to assess the participants. The use of TGMD involves the use of fundamental gross motor skill testing items only, rather than sensory-and perceptual-motor testing items.

However, the overall motor performance by children with learning and behavioral disorders is influenced not only by fundamental motor skill patterns, but also by sensory- and perceptual-motor abilities discussed in many textbooks (e.g., Sherrill, 2004). Sensory-motor ability refers to the organization of sensory information (e.g., vestibular) for use in involuntary movements (e.g., equilibrium), while perceptual-motor ability...
is the systematic use of individual-environment relationships in voluntary movements (e.g., coordination, body image, and spatial orientation; Sherrill, 2004). Since these abilities underline motor performance, children with learning and behavioral disorders have a programming need based on weaknesses in sensory- and perceptual-motor areas.

For the purpose of improving the overall fundamental motor skill performance of children with learning and behavioral disorders, we selected an assessment instrument to examine these children’s sensory- and perceptual-motor weaknesses so that a sensory-and perceptual-motor program for them could be established (Sherrill, 2004). Recently, a special physical education teacher developed a relatively new instrument for assessing children’s motor performance with sensory- and perceptual-motor testing items. This test was named as the Wood Motor Success Screening Tool (WMSST; Wood, 1998). This instrument was designed to evaluate a child’s sensory- and perceptual-motor needs for programming so that he or she can perform motor activities successfully.

The use of the WMSST (Wood, 1998) involved 17 testing items in 7 specific sensory- and perceptual-motor areas: vestibular and static balance, bilateral integration, fine motor skills, body awareness, dynamic balance, spatial orientation, and eye-hand coordination. Norms for evaluating the overall motor performance and weaknesses in individual areas were established based on local student population with and without disabilities (N = 591, ages from 4 to 10 years). Using these norms, a local child’s overall motor performance and specific sensory- and perceptual-motor areas of weakness were thus identified for designing a sensory- and perceptual-motor program.

Application of this motor test for these children outside of the geographic area of this test’s creator, however, was questionable since norms established in this test were based on the local population. We did not know whether or not this test was valid and reliable for assessing our participants since the use of a test’s norms, the validity of a test, and the reliability of a test could not be generalized to all other populations from a specified validating procedure (Yun & Ulrich, 2002). Before the assessment results obtained from this instrument could be used for designing sensory- and perceptual-motor programs for our participants, the validity and reliability of using the WMSST for assessing our participants should be documented first.

The primary purpose of this study was to evaluate sensory- and perceptual-motor performance of children with learning and behavioral disorders enrolled in our learning laboratory to see if specific sensory- and perceptual-motor needs existed for these children. This evaluation was conducted with a relatively new sensory- and perceptual-motor assessment instrument (i.e., WMSST), rather than a commonly used fundamental motor skill assessment instrument (i.e., TGMD). Since the norms of the WMSST were constructed based on the local population, we also checked the validity and reliability of this instrument for assessing children with learning and behavioral disorders enrolled in our learning laboratory.

Method

Participants

A total of 66 children, 44 boys and 22 girls, between the ages of 4 years, 6 months and 9 years, 9 months (M of age = 7.61 years; SD of age = 1.75 years), were participants. A purposive sampling technique was used to sample participants from a special physical education learning laboratory at a university. The participants were children with learning and behavioral disorders, including learning disabilities (n = 30), attention deficit disorders (n = 18), mild mental retardation (n = 11), and autistic conditions (n = 7), who enrolled in this laboratory between 2000-01 and 2003-04.

Data Collection

All participants were administered two tests: (a) the Bruininks-Oseretsky Test of Motor Proficiency-Short Form (Bruininks, 1978) and (b) the WMSST (Wood, 1998). The former test was used as the criterion measure for checking the validity of the latter test. The rationale of selecting the former test as the criterion measures was based on the fact that this test has had a long history of recognition in clinical and research areas (Tan, Parker, & Larkin, 2001). It has been frequently used for screening, diagnosis, and educational placement decisions in the field of special physical education (e.g., Wilson, Polatajko, Kaplan, & Faris, 1995). It has been often used as the criterion measure for validating other motor tests such as with children with motor impairment (Tan et al., 2001).

Each of the participants was administered both tests on the same day to evaluate the concurrent validity. In addition, each of the participants was administered the WMSST again within one week by the same tester to check the test-retest reliability. Both tests were administered by two trained testers who were graduate students in special physical education. They were trained by the laboratory director who has been a certified adapted physical educator by the National Consortium of Physical Education and Recreation for Individuals with Disabilities since 2001 (Davis, 2003). The director taught them to study and practice the test manuals and test items of both tests. They were allowed to administer those test items only after their testing results showed at least 90% agreement with the director’s testing results.

Data Analysis

The Pearson product-moment correlation, the sensitivity index, and the specificity index were employed to estimate the concurrent validity. The Pearson product-moment correlation was used to determine the relationship between two sets of scores obtained from administering two types of tests on participants (Thomas & Nelson, 2005). The sensitivity index was defined as the true-positive rate estimated by dividing the number of participants with below-average performance on both tests by the number of participants with below-average performance on the criterion measure (Burton & Miller, 1998). The specificity index was defined as the true-negative rate estimated by dividing the number of participants with average and above-average performance on both tests by the number of participants with average and above-average performance on the criterion measure (Burton & Miller, 1998).

The intraclass correlation from a one-way ANOVA (Baumgartner & Jackson, 1999) was used to estimate the test-retest reliability. To calculate the intraclass correlation coefficient, R, as an estimate of reliability, the mean square among subjects and the mean square within participants were first calculated.
through one-way ANOVA based on two sets of scores obtained from administering the WMSST twice on each participant within one week. The correlation coefficient, R, was then calculated by dividing difference between the mean square among subjects and the mean square within participants by the mean square among participants. The R indicated the reliability of the mean score for each person. There was no reliability if R equals 0. There was maximum reliability if R equals 1. The R would be lower if the person’s scores changed from trial to trial.

As long as the WMSST was confirmed as a valid and reliable instrument for the participants in this study, the raw scores obtained from this evaluation instrument were used for evaluating the participants’ sensory- and perceptual-motor performance. The overall motor ability norms developed by this instrument was used to evaluate a participant’s overall motor ability level, while the individual area norms established by this instrument was used to specify the participants’ weaknesses in individual motor areas. The overall motor ability norms classify a participant into one of the six overall motor levels: highly developed, above age level, on age level, needs practice, needs support, and needs intervention. The individual area norms classify a participant into one of the three individual motor levels: successful, age appropriate, and needs improvement, in one of the seven areas as specified before.

**Results**

A Pearson product-moment correlation coefficient of $r = .84 \ (p < .01)$ was found between two sets of scores obtained from administering two types of tests on participants. A total of 36 of the 66 participants showed below-average motor performance on both tests and 41 participants on the criterion measure, yielding a sensitivity index of .88 (36/41). A total of 16 participants showed average and above-average motor performance on both tests and 25 participants on the criterion measure, yielding a specificity index of .64 (16/25). An intraclass correlation coefficient of $R = .93$ was calculated from the one-way ANOVA.

There were approximately 76% of the participants ($n = 50$) demonstrating the below-average overall motor performance based on their assessment scores obtained from performing the sensory- and perceptual-motor testing items in the WMSST only. In the category of below average, approximately 35% of the participants ($n = 23$) performed at needs practice, 26% ($n = 17$) performed at needs support, and 15% ($n = 10$) performed at needs intervention. In the category of average and above, about 2% of the participants ($n = 1$) performed at the level of highly developed, 3% ($n = 2$) performed at above age level, and 20% ($n = 13$) performed at on age level.

The proportions of our participants showing weaknesses varied across the seven sensory- and perceptual-motor areas. More than 50% of the participants performed below average in 5 out of 7 areas, including the vestibular integration and static balance ($n = 58, 88\%$), the dynamic balance ($n = 42, 64\%$), the bilateral integration ($n = 40, 61\%$), the fine motor ($n = 39, 59\%$), and the eye-hand coordination ($n = 37, 56\%$). In other two sensory- and perceptual-motor areas, less than 50% of the participants showed the below-averaged performance, including the body awareness ($n = 27, 40\%$) and the spatial orientation ($n = 20, 30\%$).

**Discussion**

The findings of this study indicated that the WMSST was a valid assessment tool for evaluating sensory- and perceptual-motor performance of children with learning and behavioral disorders enrolled in our learning laboratory. As shown by the correlation analysis, an acceptable association ($r = .84, \ p < .01$) did exist between the Bruininks-Oseretky Test of Motor Proficiency-Short Form and the WMSST test. This association indicated that the WMSST assessed sensory- and perceptual-motor abilities in a similar way as the criterion measure did. This finding was also supported by the sensitivity index and the specificity index obtained.

The likelihood of identifying participants with below-average motor performance through the WMSST was acceptable based on the sensitivity index of .88 obtained. This index indicated that about 88% of participants were correctly identified as below-average motor performance. However, the likelihood of identifying participants with average and above-average motor performance seemed to be relatively low based on the specificity index of .64 found. This index indicated that only about 64% of participants were correctly identified without below-average motor performance.

The finding of this study indicated that the WMSST was a reliable assessment tool for evaluating sensory- and perceptual-motor performance of our children with learning and behavioral disorders as well. The result from the intraclass correlation using the one-way ANOVA revealed a high correlation coefficient ($R = .95$). This coefficient indicated that the scores of all 66 participants changed very little from the first time to the second time administering this test. This implies that this test should be a reliable tool for children with learning and behavioral disorders recruited in this study.

Because the WMSST was confirmed as a reliable and valid assessment instrument for the participants in this study, we could then use the scores found using this instrument to evaluate the sensory- and perceptual-motor performance of participants based on the overall motor ability norms and the individual area norms included in the manual of this assessment instrument. As presented in the section of results, the majority of our participants (76%) performed below average on overall motor performance, only a small part of our participants (24%) showed at average and above average.

It seems that the above finding supports that children with learning and behavioral disorders most likely demonstrate poor sensory- and perceptual-motor functions proposed in the literature. Sherrill and Pyfer (1985) reported that about 75% of children with learning disabilities scored below average on several perceptual-motor testing items. In addition, Zhang (2001) revealed that 21 children with learning and behavioral disorders performed below average on locomotor skills that require both sensory- and perceptual-motor abilities. The sensory- and perceptual-motor functions should be thus emphasized for children with learning and behavioral disorders enrolled in our learning laboratory in programming.

Across the seven sensory- and perceptual-motor areas defined in the WMSST, however, the amount of programming time should vary because the percentages of our participants performing below average across the seven areas were different. The area of vestibular
integration and static balance should be focused the most because about 88% of the participants, as presented in the section of results, scored below average in this area. Vestibular integration and static balance refers to the use of both vestibular and/or visual systems for the regulation of static positions (Wood, 1998). Such exercises as rolling forward, rocking sideward, standing with a foot, and spinning should be often used for the improvement of this area.

The next most frequently emphasized area in training the sensory- and perceptual-motor functions for children with learning and behavioral disorders should be placed on the dynamic balance. As presented in the section of results, about 64% of our participants scored below average in the area of dynamic balance, which ranked as the second largest percentage of the participants performing below average across all the seven sensory- and perceptual-motor areas. Many activities can be used to improve the dynamic balance for our children. For example, walking across a balance beam with a width of 4 inches and a height of 2 feet in a heel-to-toe fashion is good for facilitating the dynamic balance.

The bilateral integration is the third most frequently emphasized area in designing sensory- and perceptual-motor training program for children with learning and behavioral disorders. The bilateral integration refers to the smooth working together of both sides of the body or of the top and bottom halves (Sherrill, 2004). About 61% of the participants performed below average on this area, which ranked as the third largest. Such exercises as bunny hopping and crawling across the midline should be used for these children more often but less than that selected from the above areas.

The fine motor skills should be considered as the fourth area that we need to work on for children with learning and behavioral disorders. The result of this study revealed that about 59% of the participants performed below average on this area, which ranked as the fourth. All the activities using small muscles can be used to improve the fine motor ability for these children (Horvat, Eichstaedt, Kalakian, & Croce, 2003) such as building a tower using different blocks and pick up macaroni on the smooth table.

The eye-hand coordination is the fifth area that we should often emphasize on in providing children with learning and behavioral disorders with a sensory- and perceptual-motor program. The eye-hand coordination is an underlying ability for performing motor skills requiring vision. The result of this study revealed that about 56% of the participants performed below average on this area, which ranked as the fifth largest. Such exercises as catching a ball and striking a ball (Auxter, Pyfer, & Huettig, 2005) should be used for these children more often than the areas below.

The body awareness is considered as the sixth area that we need to focus on in the sensory- and perceptual-motor training program for children with learning and behavioral disorders. This area refers to a type of perceptual-motor ability of knowing different body parts (Winnick, 2005). The result of this study indicated that about 39% of the participants performed below average on this area, which ranked as the fifth in the seven areas. Such exercises as touching body parts and angles-in-the-snow-activity (Wood, 1998) should be used for these children more often than that selected from the following two areas.

The spatial orientation is also one of the seven areas that we need to work on for children with learning and behavioral disorders. The amount of time place on the spatial orientation, however, should be less than other six areas as presented above because the percentage of our participants performing below average on this area was 30%, ranking the seventh. The spatial orientation refers to the ability of understanding the relationship between the position of objects and the position of the person’s own bodies. This ability can be improved using such activities as obstacle courses (Wood, 1998).

In conclusion, the WMSST was a valid and reliable tool for assessing the sensory- and perceptual-motor performance for children with learning and behavioral disorders enrolled in our learning laboratory. The majority of our participants demonstrated the below-average overall sensory- and perceptual-motor performance. The percentages of our participants performing below average across the individual sensory- and perceptual-motor areas from the highest to lowest were the vestibular integration and static balance, the dynamic balance, the bilateral integration, the fine motor, the eye-hand coordination, the body image, and the spatial orientation.

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References


Reid, G., Collier, D., & Morin, B. (1983). The motor performance of

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autistic individuals. In R. Eason, T. Smith, & F. Caron (Eds.). *Adapted Physical Activity* (pp. 201-218). Champaign, IL: Human Kinetics.


