Adapting and Validating a Motor Intelligence Assessment Tool for Children with Intellectual Disabilities: Prioritizing Movement and Sensory-Motor Integration

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Abstract: *Background*: Motor intelligence, which involves the integration of sensory input and motor output, plays a crucial role in the physical, cognitive, and social development of children with intellectual disabilities (ID). While validated tools exist to measure motor intelligence in typically developing children, there is a significant gap in reliable and adaptable assessments for children with ID. Assessing motor intelligence in this population is essential for identifying sensory-motor deficits and designing targeted interventions to enhance physical performance, promote participation in physical activities, and improve overall quality of life.

Objective: To evaluate the reliability, validity, and sensitivity of the adapted tool in identifying sensory-motor deficits and movement priorities specific to this population. The ultimate goal is to provide a practical and effective assessment tool that can inform targeted interventions to improve motor performance, physical activity participation, and overall developmental outcomes for children with ID.

Methods: A total of 100 children aged 9–12 years with mild-to-moderate intellectual disabilities (IQ range 50–70) were randomly selected from a special education school in Assiut province, Egypt. The study adapted an existing motor intelligence test battery, originally designed for typically developing children, to better suit the sensory-motor and cognitive abilities of children with ID. The adapted battery included tasks evaluating sensory-motor coordination, balance, motor planning, and movement prioritization. Modifications were made to simplify instructions, reduce task complexity, and incorporate visual and auditory cues to accommodate the unique needs of children with ID. Reliability and validity were assessed using Pearson's correlation coefficients and t-tests, while factor analysis was conducted to identify key dimensions of motor intelligence in this population.

Results: The motor intelligence test battery demonstrated high reliability ($r = 0.813$ to 0.999) and validity (t-values ranging from 7.98 to 9.33; $p < 0.01$). Tasks such as "Consecutive Jumps" ($r = 0.980$) and "Sound and Motion" ($r = 0.915$) showed excellent reliability, indicating their suitability for children with ID. However, tasks requiring more complex coordination, such as "Rolling Ball," exhibited moderate reliability ($r = 0.529$), suggesting the need for further refinement or alternative task designs for this population. Factor analysis revealed five distinct dimensions of motor intelligence, collectively explaining 35.65% of the variance, which aligned with the movement priorities and sensory-motor challenges specific to children with ID. Standardized score tables were developed to ensure fair and accurate interpretation of test results, accounting for the variability in motor abilities within this population.

Conclusion: The adapted motor intelligence test battery proved to be a reliable and valid tool for assessing motor intelligence in children with intellectual disabilities. The modifications made to the original test battery ensured its appropriateness for this population, enabling the identification of sensory-motor deficits and movement priorities. The study highlights the importance of tailoring assessment tools to the unique needs of children with ID, ensuring accurate measurement and meaningful interpretation of results. The researcher recommends the inclusion of the adapted motor intelligence battery and the standardized score tables in related programs within intellectual schools to support the development of targeted interventions. These interventions can enhance motor performance, promote physical activity participation, and improve overall quality of life for children with ID.

Keywords: Motor intelligence, movement primacy, motor performance for children with special needs.

1. INTRODUCTION

Individuals with special needs represent a significant and growing segment of the global population. According to the World Health Organization (WHO), approximately 16% of the world's population—about 1.3 billion people—live with disabilities, including 290 million children, most of whom reside in developing countries. Among them, 34 million individuals are deaf, with 5% of them being congenitally deaf [1]. Disabilities span a wide range of conditions, including motor, sensory, and cognitive impairments, each presenting unique challenges for individuals and their communities.

Mental disabilities often lead to reduced overall or specific intellectual abilities, while individuals with motor, visual, or auditory impairments generally possess normal cognitive abilities. However, the

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severity of their disability significantly influences their learning potential and adaptability. Without comprehensive care and support, individuals with disabilities face heightened risks of social exclusion, economic dependency, and personal challenges, increasing their reliance on families and society [2]. These findings are echoed in global reviews highlighting the critical role of targeted interventions in minimizing barriers to education, health, and economic participation [3].

A holistic approach integrating psychological, educational, physical, sports, and counseling interventions is essential to enhance the adaptability and overall well-being of individuals with disabilities. Physical education and sports, in particular, play a vital role in fostering the development of physical capabilities while simultaneously promoting social and emotional growth. Movement and play in structured environments have been shown to improve motor skills, refine behavior, and stabilize positive motives, thereby enhancing self-confidence and interpersonal interactions [4]. Evidence from systematic reviews demonstrates that participation in sports can significantly reduce challenging behaviors and improve the quality of life among individuals with disabilities [5]. Furthermore, such activities provide opportunities for children with disabilities to build resilience and enhance their emotional well-being [6].

Governments and organizations worldwide recognize the importance of addressing the unique challenges faced by individuals with disabilities, particularly those with intellectual impairments. Tailored educational and rehabilitation programs designed to match the abilities of these individuals are critical in fostering independence and participation. Public and private entities have collaborated to deliver specialized services, ranging from skill development programs to community-based rehabilitation initiatives [2]. These efforts are supported by standardized global tools, such as the International Classification of Functioning, Disability, and Health (ICF), which aim to provide consistent frameworks for assessing disability and tracking progress in inclusion efforts [7].

The role of motor intelligence in improving the quality of life for children with special needs is particularly significant. Motor intelligence, which encompasses the ability to coordinate and execute movements effectively, is foundational to many aspects of learning, independence, and social interaction. Enhancing motor skills not only contributes to physical development but also fosters cognitive and emotional growth, unlocking the potential for greater autonomy and community integration. For children with special needs, prioritizing motor skill development through structured interventions is essential to empower them to navigate their environments successfully and achieve their personal aspirations [8]. Studies have shown that well-designed motor skill programs lead to improved functional independence and overall well-being, highlighting the importance of prioritizing these interventions [9].

This study aimed to evaluate the reliability, validity, and sensitivity of an adapted motor intelligence assessment tool for children with intellectual disabilities (ID), with a focus on identifying sensory-motor deficits and movement priorities specific to this population. From a statistical standpoint, we used factor analysis to determine the fundamental aspects of motor intelligence and test-retest reliability analyses (using Fisher's z-transformation to calculate 95% confidence intervals and Pearson's r) to assess the stability of the modified assessment tool. The validity and reliability of motor intelligence tests have been assessed with the help of Pearson's r values, which provide information on test score consistency between two applications. These statistical analyses, along with the application of the Sigma Method provide tailored and statistically sound way to normalize the test results which has not been previously established for this population. Drawing on the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) [10], a widely recognized tool for assessing motor skills, the adapted tool was designed to address the unique needs of children with ID. By systematically measuring motor performance, including coordination, balance, and motor planning, this research seeks to provide a practical and effective assessment tool. The findings will inform targeted interventions aimed at improving motor performance, enhancing physical activity participation, and promoting overall developmental outcomes for children with ID. Ultimately, this work contributes to the development of inclusive practices that empower children with disabilities to achieve their full potential and lead fulfilling lives.

2. METHODS

2.1. Study Design and Population

The study adopted a descriptive-analytical approach to align with the research objectives. A cross-sectional sampling technique was used to select the study participants. The sample size was determined using the formula for cross-sectional studies:

$n = Z^2 \cdot p \cdot (1-p) / d^2$ where n is the sample size, Z is the Z-score (1.96 for a 95% confidence level), p is the estimated prevalence of sensory-motor deficits in children with intellectual disabilities (assumed to be 50% for maximum variability), and d is the margin of error (set at 10%). Based on this calculation, a sample size of 100 children was deemed appropriate to ensure statistical reliability.

The decision to aim for a sample size of 100 participants was also informed by pragmatic considerations related to feasibility and data collection constraints within the study setting.

Our focus will be on describing the motor intelligence profiles observed within our sample and exploring relevant associations within this specific group of children with intellectual disabilities.

The sample was intentionally selected from an intellectual school in one governorate in Egypt to ensure homogeneity in the study population. Inclusion criteria for participation were: (a) chronological age between 9 and 12 years, (b) an IQ score between 50 and 70 on the Stanford-Binet Intelligence Scale, and (c) the absence of any other disabilities that could interfere with participation in the program activities. Exclusion criteria included: (a) severe physical or sensory impairments that would limit motor assessment, (b) behavioral or emotional disorders that could disrupt testing procedures, and (c) incomplete or missing data on key variables. This sampling approach ensured a representative and focused evaluation of sensory-motor deficits in the target population.

2.2. Ethical Considerations

Ethical clearance for the study was obtained from the institutional review board of the ethical committee (Reference number:102023003, Faculty of sport sciences, Assiut University). Informed consent was obtained from the guardians of study participants prior to study commencement.

EXPLORATORY STUDY

In this study, an exploratory approach was employed to verify the scientific transactions of the tests used for measuring the motor intelligence of children with special needs. One Pilot study was conducted from 4th to 14th January 2024 to ensure the appropriateness of the tests and the spatial and temporal conditions of application. Other Pilot study was carried out, not related to a research study consisting of five children. The purpose was to assess the safety of the tools used, the registration form for the tests, and the procedures, conditions, and instructions for the chosen tests. Additionally, three assistants Faculty of physical Education were trained in conducting the tests accurately.

The following tools and devices were utilized for data collection: a stopwatch, measuring tape, collars, medicine balls, boxes, cones, blindfold, whistle, multiple sounds, and a ruler with several colors, Appendix A. The stopwatch is used to measure the duration of specific events or activities. The measuring tape is employed to measure distances or lengths accurately. Collars are utilized for tracking or monitoring subjects. Medicine balls are used for strength and conditioning exercises. Boxes and cones are often used as markers or props in experiments or data collection setups. A blindfold is employed to restrict visual input in certain tests or assessments. A whistle is used to signal the beginning or end of specific tasks or activities. Multiple sounds can be used to create auditory stimuli or cues in experiments. Finally, a ruler with several colors can assist in identifying higher number of successful catches indicates better reaction time. These tools and devices provide researchers with the means to collect accurate and reliable data in a variety of contexts and disciplines.

The initial exploratory studies yielded the following results:

- The first measurement of the motor intelligence tests was obtained using the test-retest method to determine the Reliability (stability) coefficient.
- The validity of the test application settings, the reliability of the tools utilized, and the suitability of the test data recording form were thoroughly verified and confirmed.
- Due to an insufficient number of assistants, additional assistants who expressed a desire to assist in the implementation of research tests were added.
- The second measurement was obtained to calculate the reliability coefficient for the designed tests using the test application and test reapplication method.
- The validity coefficient for the tests was determined using self-assessment.

According to [11], scientific transactions play a crucial role in the measurement and testing method. These transactions can be divided into two parts: basic scientific transactions (e.g., objectivity, validity, and reliability) and side scientific transactions (e.g., work economy, standards, and comparability). In this study, the focus is primarily on the basic scientific transactions due to the subjective nature of side scientific transactions, as perceived by the researchers.

2.4. Statistical Analysis

The Statistical Package for the Social Sciences (SPSS V26, IBM, USA) was used to conduct the statistical analysis. Descriptive statistics, including the mean and standard deviation, were employed to present the characteristics of the variables. Additionally, the statistical description of the IQ and anthropometric variables was performed for the study sample. Kolmogorov-Smirnov test was used to investigate the welter the data follow normal distribution. In addition to the Kolmogorov-Smirnov test, the Shapiro-Wilk test and Q-Q plots were used to further assess the normality of data distribution. The results of these additional tests align with our original findings from the Kolmogorov-Smirnov test. To determine the reliability of the motor intelligence tests, the tests were applied to an external sample consisting of 12 children within the same age group. Subsequently, the tests were reapplied after a time difference of three days. The reliability coefficient was calculated based on the results obtained. To determine the validity coefficient for the motor intelligence tests, the researchers calculated the subjective validity coefficient by taking the square root of the reliability coefficient for these tests. Pearson's correlation was used to establish correlations between two applications of the IQ test. The factorial matrix using rotation by the Varimax method was conducted for the tests related to motor intelligence for children with special needs who were under 12 years old.

The factor analysis was conducted using the Principal Component Analysis (PCA) method and orthogonal rotation via the Varimax method, as it is considered one of the most objective methods of indirect factor analysis. We chose PCA over Exploratory Factor Analysis EFA because it is generally more suitable than EFA for data reduction; PCA provides an insight into the major components of the motor intelligence assessment tool that explain maximum variance of the data. Also, PCA work without assuming presence of latent variables, which is exactly the approach we are adopting in our work.

Factor retention was determined using multiple criteria:

We kept the factors having eigenvalue greater than 1.0.The scree plot was examined for an elbow point where the curve levels off, indicating optimal number of factors.

We looked for factors to retain that would cumulatively explain at least 70% of the total variance. The retained factors were considered in terms of their theoretical meaningfulness related to the motor intelligence of children with intellectual disabilities.

A factor was considered significant if at least three tests loaded on it with loadings of 0.30 and above. This standard threshold was selected because it is greater than the standard error of factor loadings for a sample size of about 100. Orthogonal rotation should be used to interpret factors (Field, 2013). Loadings smaller than +0.30 is considered as Zero loadings. Loadings in the range of +0.30 and +0.40 are known as moderate loadings. Loadings above +0.40 are termed as High loadings.

Raw scores were converted into standardized scores using the Sigma Method, which provides normalized tables. The standardized score was calculated using the formula:

Standardized Score=Mean (X) ± Fixed Value

The fixed value was determined as: Fixed Value = standard deviation (SD) /16.67; 16.67 is derived from dividing 100 by 6 (assuming 6 standard deviations cover most of the data in a normal distribution).

We carried out a number of analyses to evaluate the Sigma Method's performance in comparison to other standardization approaches, such as:

Z-score transformation: We contrasted the standardized scores that were produced using the Sigma Method with those that were acquired using the conventional Z-score transformation. Using correlation analysis, we assessed how well the two approaches agreed. The validity of the Sigma Method as a stand-in for Z-score normalization would be supported by high correlations.

Percentile ranking: The outcomes of the Sigma Method were evaluated by contrasting them with percentile ranks. We checked to see if the Sigma Method scores matched the percentile-ranking-based expected score distribution, guaranteeing that the standardized scores appropriately represent the relative position of sample participants.

The final standardized scores were scaled to a range from 0 to 20 for each test, enabling a total score out of 100 for the entire battery. This approach was specifically designed to assess motor intelligence in children with special needs.

Furthermore, standardized and raw scores for the five tests were included in the analysis. A significance level of $p < 0.05$ was used for all statistical tests. While we recognize the potential for increased Type I error due to multiple comparisons, we chose to prioritize the detection of potentially meaningful associations for further investigation. Any statistically significant findings should be interpreted with caution and confirmed in future research."

3. RESULTS

3.1. Participant Characteristics

The study sample included 100 children with intellectual disabilities aged 9–12 years. Table **1** summarizes their demographic and anthropometric characteristics. The mean IQ of the participants was 55.00% (SD = 3.88), consistent with mild to moderate intellectual disability classifications. The mean age was 11.08 years (SD = 0.74), with participants averaging a height of 144.55 cm (SD = 8.05 cm) and a weight of 41.00 kg (SD = 7.35 kg).

3.2. Reliability and Validity of Motor Intelligence Tests

Table **2** evaluates the reliability and validity of motor intelligence tests across two applications. It includes tests like "Sound and Motion," "Numbered Circles," and "Throwing Sensation." The table reports significant Pearson correlation coefficients ($p < 0.05$) for most tests, confirming high reliability. For instance, the "Consecutive Jumps" test had a Pearson value of 0.980, indicating near-perfect reliability, which can be used to check the motor deficit. These reliable tests help in monitoring effectiveness of programs and interventions Standard deviations and means for each application are also listed, showing consistency between the first and second applications.

3.3. Factor Analysis of Motor Intelligence Tests

The scree plot in Figure **1** illustrates the eigen values for the components, with the first five factors having eigen values greater than 1.0, as indicated by the "elbow point" where the slope of the line levels off, aligning with the Kaiser criterion for factor retention.

The factor analysis identified five distinct dimensions of motor intelligence. With using PCA and Varimax rotation, collectively explaining 35.65% of the variance in test scores. Before rotation, the factorial matrix (Table **1A**, Appendix) categorized the motor intelligence tests into factors based on their eigen values and communalities. For instance, the "Dropped Ball and Eye Mask" test heavily loaded on Factor 5, reflecting its association with specific motor intelligence attributes. Factor 1 had the highest loading from the "Drop the Ball" test (loading = 0.737), representing muscle sensation and proprioceptive control, while Factor 4 had significant contributions from balance-related tests, such as "Winding Around the Circle" (loading = 0.579), emphasizing vestibular and spatial awareness. Factor 5 highlighted tests associated with auditory-motor coordination, including "Sound and Motion" (loading = 0.759). After orthogonal rotation using the Varimax method, the refined factorial matrix (Table **3**) provided clearer interpretations of the dimensions, with the rotation further emphasizing the distinctiveness of each factor.Factor 1 (8.452% of variance) showed high loadings for tests involving eye-hand coordination and proprioception, such as "Dropped ball and Eye Mask" (0.747) and "Stop the balls" (0.704).

Factor 2 (8.186% of variance) primarily captured balance and spatial awareness, with strong loadings from "Winding around the circle" tests (0.660, 0.575, 0.736).

Factor 3 (6.789% of variance) emphasized general motor planning and coordination, with high loadings from "Jumping and clapping" (0.680) and "Winding around the circle" (0.592).

Factor 4 (6.465% of variance) reflected auditory-motor integration and quick response, with notable loadings from "Sound and motion" (-0.626) and "Quick prediction" (0.579).

Factor 5 (5.765% of variance) appeared to measure fine motor skills and visual-motor integration, with high loadings from "Coloured ruler and hands" (0.759) and "The jumpers" (0.546).

The distribution of major, medium, and minor loadings across factors confirmed the robustness of this five-factor solution, providing a comprehensive framework for understanding the underlying structure of motor intelligence in children with intellectual disabilities.

3.4. Descriptive Results of Motor Intelligence Tests

The descriptive statistics for motor intelligence test performance are summarized in Table **4**. Participants exhibited a range of abilities across the motor intelligence tests. For example, in the "Drop the Ball" test, the mean raw score was 117.4 cm (SD = 28.7 cm), highlighting their overall ability to execute tasks requiring proprioception and coordination. Similarly, in the "Winding Around the Circle" test, which measures vestibular sensation and balance, the mean completion time was 37.4 seconds (SD = 5.12 seconds). The "Sound and Motion" test, which evaluates auditory-motor integration, had a mean completion time of 12.85 seconds (SD = 3.14 seconds). These results establish performance benchmarks for motor intelligence in this population, with the data highlighting strengths in simpler sensory-motor coordination tasks and challenges in complex balance and spatial awareness tasks.

Table 1: Statistical Description of IQ and Anthropometric Variables for the Sample

Variables	Sample, N=100	
	Mean value	Standard deviation
Intelligent quotient IQ (%)	55	3.88
Age (years)	11.08	0.74
Height (cm)	144.55	8.05
Weight (kg)	41	7.35

Table 2: Reliability Coefficient and Validity between Measurements of the First and the Second Application of Motor Intelligence Tests

Seq	Test name	Test Nr.	First application		Second application		Pearson's r	95% CI for r Fisher's z-transformation	Validity intrinsic $\sqrt{r}$
			Mean	SD	Mean	SD			
1	Sound and motion	1	4.97	0.64	5.05	0.71	0.915*	[0.875, 0.943]	0.957
2	Numbered circles	2	2.67	1.23	2.83	0.94	0.972*	[0.958, 0.981]	0.986
3	Quick prediction	3	1.75	0.62	1.83	0.58	0.887*	[0.837, 0.923]	0.942
4	Consecutive jumps	4	3.33	1.72	3.5	1.51	0.980*	[0.970, 0.986]	0.990
5	Pendulum throw	5	1.75	0.75	1.58	0.67	0.857*	[0.796, 0.901]	0.926
6	Varied throwing	6	1.42	0.67	1.5	0.67	0.908*	[0.865, 0.938]	0.953
7	Throwing sensation	7	1.25	0.45	1.17	0.58	0.870*	[0.814, 0.910]	0.933
8	Target throw	8	3.25	1.29	3.08	1.17	0.955*	[0.934, 0.970]	0.977
9	Stacking hoops	9	1.5	0.91	1.83	1.03	0.39	[0.209, 0.545]	0.624
10	Ball thrower	10	2.33	1.23	2.58	1	0.939*	[0.911, 0.959]	0.969
11	Rolling ball	11	25	11.68	21.67	10.3	0.529	[0.369, 0.658]	0.727
12	Ball and Eye Mask	12	17.5	9.42	15.83	10.41	0.487	[0.320, 0.624]	0.698
13	Drop the ball	13	20	14.19	19.42	13.55	0.977*	[0.966, 0.984]	0.988
14	Dropped ball and Eye Mask	14	13.08	12.7	12.83	12.54	0.993*	[0.990, 0.995]	0.996
15	Stop the balls	16	2.33	1.3	2.42	1	0.934*	[0.904, 0.955]	0.966
16	Colour and movement	17	4.82	0.58	4.74	0.59	0.945*	[0.920, 0.963]	0.972
17	Geometric shapes	18	2.25	0.45	2.33	0.49	0.816*	[0.741, 0.871]	0.903
18	Ball and line	19	1.5	1	1.42	1.17	0.429	[0.254, 0.577]	0.655
19	Rolling back and Eye Mask	20	1.33	0.89	1.58	0.67	0.868*	[0.811, 0.909]	0.932
20	Walk for the circle	21	2.08	1.17	2.08	1	0.934*	[0.904, 0.955]	0.966
21	Walking for the circle and with Eye Mask	22	47.08	27.87	45.67	27.48	0.993*	[0.990, 0.995]	0.996
22	Running for the circle	23	1.17	0.94	1.33	0.78	0.042	[-0.155, 0.236]	0.205
23	Throwing in the circle	25	1.5	1	1.75	0.87	0.892*	[0.844, 0.926]	0.944
24	Coloured ruler and hands	27	2.67	1.16	2.42	1.17	0.924*	[0.889, 0.948]	0.961
25	Colourful ruler and feet	28	3.17	0.72	3	0.95	0.930*	[0.898, 0.952]	0.964
26	The jumpers	31	13.5	3.68	13.08	4.27	0.905*	[0.861, 0.936]	0.951
27	Jumping and clapping	32	8.92	1.73	8.88	1.57	0.813*	[0.737, 0.869]	0.902
28	Winding around the circle	34	12.37	9.37	12.66	8.89	0.999*	[0.998, 0.999]	0.999

(Table 2). Continue

Seq	Test name	Test Nr.	First application		Second application		Pearson's r	95% CI for r Fisher's z-transformation	Validity intrinsic $\sqrt{r}$
			Mean	SD	Mean	SD			
29	Winding around the circle	35	12.85	1.91	12.81	1.94	0.998*	[0.997, 0.999]	0.999
30	Winding around the circle	36	8.83	1.17	8.8	1.17	0.997*	[0.995, 0.998]	0.998
31	Circle and triple	39	15.43	1.92	15.34	1.87	0.989*	[0.984, 0.993]	0.994

*Symbol and bold font means that the results is significant with P <0.05.

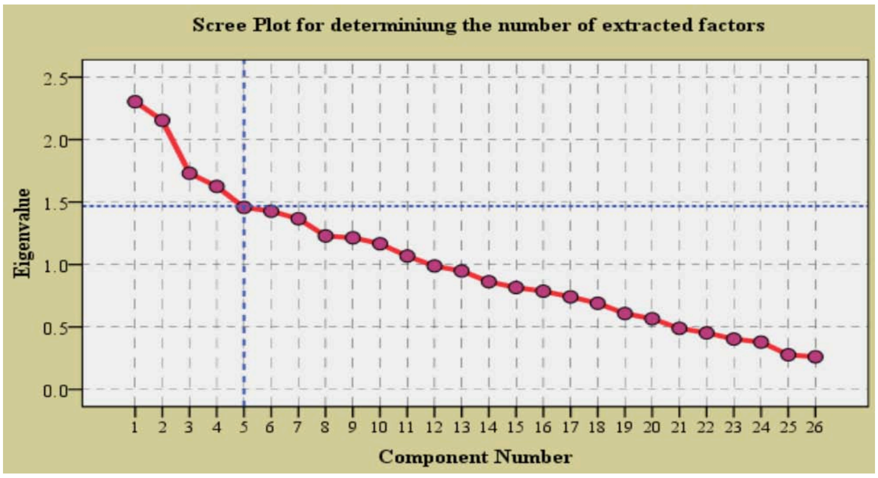

Figure 1: Scree plot for determining the number of extracted factors. The scree plot shows the eigenvalues for each component, with the first five components having eigenvalues greater than 1.0. The dashed line represents the threshold for significant factors based on the Kaiser criterion.

Table 3: The Factorial Matrix after Orthogonal Rotation by the Varimix Method for Tests

	Test Name	1	2	3	4	5	Communality
1	Sound and motion	0.091	0.32	0.055	0.626	0.044	0.507
2	Numbered circles	0.179	0.010	0.300	0.018	0.015	0.122
3	Quick prediction	0.058	0.186	0.264	0.579	0.135	0.461
4	Consecutive jumps	0.358	0.141	0.470	0.046	0.236	0.426
5	Pendulum throw	0.110	0.054	0.275	0.212	0.008	0.135
6	Varied throwing	0.044	0.111	0.07	0.037	0.233	0.074
7	Throwing sensation	0.098	0.271	0.233	0.487	0.235	0.429
8	Target throw	0.257	0.048	0.027	0.381	0.132	0.231
10	Ball thrower	0.660	0.231	0.200	0.015	0.147	0.550
13	Drop the ball	0.235	0.010	0.028	0.277	0.169	0.161
14	Dropped ball and Eye Mask	0.747	0.058	0.069	0.142	0.019	0.586
16	Stop the balls	0.704	0.067	0.034	0.032	0.136	0.520
17	Colour and movement	0.048	0.242	0.280	0.178	0.312	0.268
18	Geometric shapes	0.027	0.239	0.168	0.13	0.184	0.136
20	Throwing in the circle	0.386	0.189	0.123	0.156	0.174	0.254
21	Coloured ruler and hands	0.112	0.075	0.027	0.072	0.759	0.600
22	Colourful ruler and feet	0.097	0.015	0.368	0.075	0.181	0.183
25	The jumpers	0.348	0.028	0.054	0.058	0.546	0.426
27	Jumping and clapping	0.01	0.021	0.68	0.09	0.16	0.496

(Table 3). Continue

	Test Name	1	2	3	4	5	Communality
28	Winding around the circle	0.155	0.019	0.592	0.032	0.016	0.376
31	Winding around the circle	0.077	0.575	0.256	0.089	0.172	0.439
32	Winding around the circle	0.131	0.660	0.152	0.038	0.038	0.478
34	Circle and triple	0.135	0.221	0.172	0.027	0.152	0.120
35	Throwing in the circle	0.085	0.736	0.086	0.067	0.248	0.622
36	Coloured ruler and hands	0.141	0.551	0.001	0.367	0.077	0.464
39	Colourful ruler and feet	0.062	0.008	0.012	0.423	0.105	0.193
	Eigen value	2.197	2.128	1.765	1.68	1.499	9.271
	% of factor variance	8.452	8.186	6.789	6.465	5.765	35.658
	Major loading	3	4	3	4	2	14
	Medium loading	3	1	2	2	2	1
	Minor loading	20	21	21	20	23	11

Table 4: Descriptive Statistics for Motor Intelligence Test Results in Children with Special Needs less than 12 Years Old

	Test name	Unit	Mean value	SD	Rate
1	Drop the ball	cm	117.4	28.7	1.722
2	Winding around the circle	second	37.4	5.12	0.3072
3	Color ruler and hands	number	0.1667	0.074	
4	Sound and motion	second	12.85	3.14	0.1884
5	Walk for the circle	number	0.467	0.118	

3.5. Standardized and Raw Scores of Selected Tests

Detailed mappings of raw and standardized scores for the "Drop the Ball," "Winding Around the Circle," and "Sound and Motion" tests are presented in Appendix A (Tables **2A–4A**). These standardized scores provide a clear framework for interpreting individual and group performance in the motor intelligence battery.

Table **2A**, focused on the "Drop the Ball" test, illustrates the relationship between raw performance values and corresponding standardized scores, providing a clear method for normalizing individual results. For instance, a raw score of 31.3 cm equated to the highest standardized score of 20, while progressively higher raw scores resulted in lower standardized scores (e.g., a raw score of 201.78 cm corresponded to a standardized score of 0.2). Similarly, Table **3A** presents the standardized and raw scores for the "Rolling Around the Circle" test, which assesses internal balance and vestibular sensation. For this test, raw values such as 22.04 seconds correlated with a standardized score of 20, with longer times yielding lower standardized scores (e.g., 52.76 seconds scored as 0). This test is particularly significant, as it highlights the ability of the body to maintain balance through sensory signals transmitted to the cerebellum, reflecting vestibular function. Finally, Table **4A** emphasizes sensory integration and motor response as assessed in the "Sound and Motion" test. For example, a raw score of 3.43 seconds translated to the maximum standardized score of 20, demonstrating precise motor-sensory coordination. As with the other tests, slower performance times corresponded to progressively lower standardized scores, enabling clear comparisons of individual capabilities. Together, these tables provide a robust framework for interpreting motor intelligence across multiple sensory-motor domains, ensuring objective and standardized evaluations of performance.

4. DISCUSSION

This study aimed to evaluate the reliability, validity, and sensitivity of an adapted assessment tool in identifying sensory-motor deficits and movement priorities specific to children with intellectual disabilities (ID) aged 9–12 years. By employing a multidimensional framework, the study provides a comprehensive evaluation of the tool's effectiveness in capturing the unique motor challenges faced by this population. The findings highlight the tool's potential as a reliable and standardized instrument for guiding targeted interventions. Importantly, the study underscores the practical utility of the adapted tool in improving motor performance, enhancing physical activity participation, and promoting better developmental outcomes for children with ID. These results are significant as they not only validate the tool's effectiveness but also emphasize its role in addressing sensory-motor deficits to support the overall well-being and social integration of children with intellectual disabilities.

The participants in this study demonstrated baseline physical and cognitive characteristics that align with previous research on children with intellectual disabilities. The mean IQ of 55.00 ± 3.88, mean age of 11.08 ± 0.74 years, height of 144.55 ± 8.05 cm, and weight of 41.00 ± 7.35 kg are consistent with the mild-to-moderate intellectual disability category. Comparatively, Koutsobina *et al*. found that children with mild ID performed better in motor tasks than peers of corresponding mental age but scored lower than typically developing peers of the same chronological age [12]. Similarly, Lotfy observed a sample of children aged 10–11 years with a mean height of 143.28 cm and weight of 44.51 kg, emphasizing the need to contextualize motor performance within the specific physical and cognitive profiles of this population [13]. These baseline data highlight the importance of considering individual and group characteristics when interpreting motor intelligence outcomes and designing interventions.

The results revealed significant motor deficits in tasks requiring complex coordination and balance, such as the "Winding Around the Circle" test, where participants demonstrated a mean completion time of 37.4 seconds (SD = 5.12 seconds). This finding aligns with Jeoung, who reported that children with moderate ID scored lower in fine motor and manual dexterity tests than peers with mild ID or autism [14]. Additionally, Vuijk *et al*. found that 81.8% of children with mild ID exhibited borderline or definite motor difficulties, particularly in manual dexterity and balance, mirroring the balance-related challenges observed in our participants [15]. Notably, participants in this study performed relatively better in simpler sensory-motor tasks, such as the "Sound and Motion" test, which highlights the variability of motor competence across different sensory-motor domains. This underscores the importance of developing targeted interventions to address specific deficits while leveraging strengths in auditory-motor coordination to build confidence and skill acquisition.

The motor intelligence tests used in this study demonstrated strong reliability and validity, with Pearson's coefficients ranging from 0.813 to 0.999. Tests such as "Consecutive Jumps" (r = 0.980) and "Sound and Motion" (r = 0.915) achieved high reliability, while intrinsic validity values were similarly robust (e.g., 0.990 for "Consecutive Jumps" and 0.957 for "Sound and Motion"). These findings are consistent with Koutsobina *et al*., who reported a Cronbach's alpha of 0.90 across 32 motor tasks, confirming psychometric robustness [12]. However, weaker correlations were observed in tests like "Rolling Ball" (r = 0.529) and "Stacking Hoops" (r = 0.390), which is comparable to findings by Westendorp *et al*., who noted lower reliability in gross motor skills among children with ID [16]. Peters advocated for alternatives to traditional reliability metrics, such as omega and Greatest Lower Bound (GLB), to more precisely capture the reliability of multidimensional constructs like motor intelligence [17] . These results highlight the robustness of most tests in this study while emphasizing the need to refine assessments involving complex coordination tasks.

Factor analysis identified five distinct dimensions of motor intelligence: muscle sensation, vestibular sensation, visual integration, auditory-motor coordination, and general motor coordination, collectively explaining 35.65% of the variance. The "Drop the Ball" test loaded highly on Factor 1 (muscle sensation, loading = 0.747), reflecting its relevance to proprioceptive feedback and motor planning. Similarly, the "Winding Around the Circle" test was strongly associated with vestibular sensation (loading = 0.736), emphasizing its role in balance and spatial awareness. These findings align with Koutsobina *et al*., who identified six factors explaining 66.88% of the variance in perceptual-motor skills [12], and Galdi *et al*., who reported a strong correlation (r = 0.71) between gross motor skills and cognitive potential in young children [18]. These results support the multidimensional nature of motor intelligence and provide a framework for designing targeted interventions based on specific sensory-motor domains.

The use of the Sigma scale to convert raw scores into standardized values ensured consistent and objective assessments across the motor intelligence battery. For instance, in the "Drop the Ball" test, raw scores ranged from 31.3 cm to 201.78 cm, corresponding to standardized values from 20 to 0.2. This approach is consistent with Rintala and Loovis, who standardized TGMD-2 scores to a mean of 100 (SD = 15) and found that 96% of children with ID performed below their typically developing peers [19]. Similarly, Top highlighted the benefits of standardized motor testing for precision improvements in inclusive classrooms [4]. The development of standardized scores in this study ensures fair and replicable evaluations, facilitating comparisons across participants and motor tasks.

This study underscores the critical role of motor intelligence in identifying sensory-motor deficits and guiding targeted interventions for children with intellectual disabilities. The classification of motor intelligence into distinct dimensions highlights the interplay between sensory inputs and motor outputs, which is essential for daily functioning and participation in physical activities. Downs *et al*. emphasized the foundational role of gross motor competence in building more complex skills and promoting long-term physical activity participation [20]. The findings of this study align with these conclusions, reinforcing the importance of addressing motor deficits to improve not only physical abilities but also social, cognitive, and emotional outcomes.

Practical Implications

The findings highlight the importance of a multi-faceted approach to motor intelligence assessment, incorporating various sensory modalities such as muscular, vestibular, visual, and auditory factors. This comprehensive evaluation framework ensures that children with special needs are assessed holistically, allowing for more effective intervention planning and support. By addressing different aspects of motor intelligence, educators and therapists can better understand each child's strengths and areas needing improvement, contributing to more personalized and impactful developmental programs.

Comparison of Statistical Approach to Alternative Methods

To evaluate motor intelligence in kids with intellectual disabilities, our study used conventional statistical techniques like reliability testing and factor analysis. We recognize the new developments in disability assessment research, even though these techniques have been successful in identifying important aspects of motor skills. Bayesian techniques for adaptive testing in neurodevelopmental disorders [21] and machine learning algorithms for neurodevelopmental disorders [22] have been investigated in recent studies. These cutting-edge methods may be beneficial for managing intricate, multifaceted data and taking individual variability into account. These methods could be combined with our battery of standardized tests in future studies to improve diagnostic precision and individualized intervention design. But our present approach offers a strong basis for clinical use, striking a balance between statistical rigor and practical implementation in diverse healthcare settings.

Strengths Points of the Study

Our study offers several strengths, particularly in its comprehensive approach to assessing motor intelligence in children with intellectual disabilities (IQ 50-70). By employing a variety of motor skill tests—such as ball dropping, sound-motion coordination, and circle walking—we provided a holistic view of motor intelligence, covering sensory integration, motor perception, and vestibular balance. The sample size of 100 children aged 9-12 ensured robust statistical analysis, enhancing the reliability of our findings. Additionally, the high reliability scores (ranging from 0.813 to 0.999) across most tests demonstrated consistency, validating the study's methodology. The use of sigma scales for standardization allowed for meaningful comparisons, ensuring that the assessment tools were both rigorous and adaptable to diverse motor skills.

Limitations of the Study

Despite its strengths, the study has some limitations. Firstly, while most tests showed high reliability, tasks requiring advanced motor control, such as the "rolling ball test," exhibited lower reliability ($r = 0.529$). This suggests variability in performance for more complex motor tasks, indicating the need for refinement in these assessments. Additionally, the study's focus on a specific age range (9-12 years) and a narrow IQ range (50-70) limits the generalizability of the findings to broader populations or different age groups. The sample size was calculated on the assumption of a 50% prevalence of sensory-motor deficit to have maximum variability as precise estimates were not available on this population. This approach may be methodologically correct, but it may not truly reflect the study population. Moreover, the sample was deliberately chosen from an intellectual school in one governorate in Egypt to standardize the study population. This strategy enabled us to assess a specific cohort of children with intellectual disabilities but may limit the wider applicability of the findings to other areas or regions with more fancy socio-cultural educational contexts. Although the sample size of 100 participants was calculated to ensure sufficient statistical power for detecting significant effects, the study did not conduct a formal power analysis to estimate the minimum detectable effect size. Future studies could benefit from a priori power calculations to further strengthen the robustness of the findings.

Another limitation is the lack of longitudinal data; assessing motor intelligence over time could provide deeper insights into developmental progress and the long-term impact of interventions. Lastly, the study did not explore socio-environmental factors, such as family support or educational settings, which might influence motor intelligence outcomes.

Statistical Methodology's Wider Consequences

In particular, factor analysis, reliability testing with Pearson's r and confidence intervals, and the Sigma

Method for standardization are statistical techniques used in this study that have broad applicability outside of the particular context of evaluating motor intelligence in children with intellectual disabilities. In medical statistics, factor analysis is frequently used to create composite scores, uncover underlying constructs, and reduce the dimensionality of complex datasets. It could be used, for instance, to simplify analysis and identify important dimensions in studies of treatment response, disease severity, or quality of life. In order to validate measurement instruments used in a variety of medical specialties and guarantee that evaluations are reliable and consistent over time, reliability testing is crucial. A more complex interpretation of reliability is offered by the use of confidence intervals. In small sample studies, the use of confidence intervals offers a more nuanced interpretation of reliability, which is especially beneficial. Additionally, the Sigma Method, which offers normalized tables and streamlines score comparison, might be modified for application in other disability research domains where standardized norms are either nonexistent or unsuitable for particular populations. In summary, this study shows that a practical approach to standardization combined with strong statistical methods can be used as a model for creating and evaluating assessment instruments in a variety of medical and disability-related domains.

CONCLUSION

The study concludes that motor intelligence in children with intellectual disabilities can be effectively measured using a combination of sensory-motor tests. Our factor analysis a statistical technique used to explore the relationships between the various tests in our battery, identified five key dimensions—motor perception, vestibular sensation, auditory integration, visual perception, and general motor coordination—explaining 35.65% of the total variance. The high reliability and validity of most tests as indicated by the test-retest correlations and confidence intervals established through Pearson's r and Fisher's z-transformation, underscore the importance of comprehensive, multidimensional assessments. The findings highlight significant motor skill deficits in children with intellectual disabilities, particularly in tasks requiring sensory integration and balance. This underscores the critical role of targeted interventions to enhance motor and cognitive development, promoting better social and educational outcomes for these children.

The study offers a robust statistical framework for evaluating motor intelligence in this population in addition to these useful implications. We were able to standardize raw scores and compare test results on a consistent scale by using the Sigma Method, which is specifically important when assessing performance across various motor domains. The results of the factor analysis provide insights into the underlying structure of motor intelligence, which advances the theoretical understanding of motor abilities in children with intellectual disabilities. The high reliability coefficients (Pearson's $r > 0.80$) found for the majority of tests corroborate the consistency of the assessment tool.

Based on the findings, we recommend several practical and research-focused actions. Firstly, educational and therapeutic programs should prioritize targeted motor skills training, focusing on sensory integration and balance. Interventions such as vestibular exercises and coordination activities can address specific deficits identified in our study. Secondly, the development and refinement of motor intelligence tests, especially for complex tasks, are crucial to improving assessment reliability.

Finally, we expect that the data and statistical models presented in this study will be useful for future meta-analyses and systematic reviews examining motor intelligence in children with intellectual disabilities, given the standardized scores and the strong statistical validation of our assessment tool.

STATEMENTS AND DECLARATIONS

Ethical Considerations

The study adhered to ethical guidelines and complied with the principles of the Declaration of Helsinki. The institutional review board of Assiut University approved the study, ensuring ethical procedures (Reference number: 102023003, Faculty of sport sciences, Assiut University).

Consent to Participate

Written informed consent to participate in the study was obtained from all participants.

CONSENT FOR PUBLICATION

Not Applicable.

DECLARATION OF CONFLICTING INTEREST

The authors declare that they have no competing interests.

FUNDING STATEMENT

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DATA AVAILABILITY

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

AUTHORS' CONTRIBUTIONS

M.Z., N.S., E.S. and M. E. were equally responsible for the conceptualization, design, data collection, analysis, interpretation of the data, drafting, revising, and final approval of the manuscript. They ensured the accuracy and integrity of the work.

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APPENDIX A: SUPPLEMENTAL MATERIAL

Table 1A: Factorial Matrix before Rotation by Varimax Method for Tests

Nr.	Test Name	1	2	3	4	5	Communality
1	Sound and motion	0.246	0.412	0.296	0.429	0.070	0.506
2	Numbered circles	0.236	0.115	0.185	0.139	0.015	0.122
3	Quick prediction	0.006	0.087	0.127	0.662	0.024	0.462
4	Consecutive jumps	0.453	0.060	0.309	0.261	0.233	0.426
5	Pendulum throw	0.076	0.137	0.333	0.003	0.007	0.135
6	Varied throwing	0.087	0.072	0.029	0.147	0.199	0.074
7	Throwing sensation	0.037	0.131	0.545	0.222	0.254	0.429
8	Target throw	0.177	0.199	0.095	0.389	0.016	0.231
10	Ball thrower	0.737	0.039	0.049	0.063	0.023	0.551
13	Drop the ball	0.21	0.014	0.212	0.213	0.163	0.161
14	Dropped ball and Eye Mask	0.643	0.296	0.061	0.19	0.214	0.586
16	Stop the balls	0.613	0.260	0.2	0.188	0.049	0.521
17	Colour and movement	0.032	0.355	0.232	0.047	0.293	0.268
18	Geometric shapes	0.052	0.301	0.125	0.035	0.163	0.136
20	Throwing in the circle	0.246	0.184	0.307	0.066	0.247	0.254
21	Coloured ruler and hands	0.001	0.12	0.058	0.104	0.756	0.6
22	Colourful ruler and feet	0.136	0.134	0.307	0.16	0.164	0.183
25	The jumpers	0.392	0.106	0.178	0.187	0.44	0.425
27	Jumping and clapping	0.185	0.203	0.465	0.377	0.252	0.497
28	Winding around the circle	0.007	0.133	0.469	0.348	0.128	0.375
31	Winding around the circle	0.022	0.606	0.039	0.208	0.165	0.439
32	Winding around the circle	0.128	0.579	0.355	0.002	0.037	0.479
34	Circle and triple	0.071	0.256	0.035	0.152	0.159	0.12
35	Throwing in the circle	0.367	0.567	0.272	0.176	0.247	0.622
36	Coloured ruler and hands	0.365	0.521	0.074	0.184	0.139	0.463
39	Colourful ruler and feet	0.009	0.088	0.223	0.313	0.195	0.193
	Eigen value	2.304	2.153	1.729	1.624	1.457	9.269
	Factor variance	%8.86	%8.28	%6.65	%6.25	%5.60	%35.65

Table **2A** details standardized and raw scores for the "Drop the Ball" test, correlating specific raw performance values with corresponding standard scores. For instance, a raw value of 31.3 cm is linked to a standard score of 20, aiding in normalizing and comparing individual results.

Table 2A: Standardized and Raw Scores for the Drop Ball Test

Standard value	Raw value	Standard value	Raw value	Standard value	Raw value	Standard value	Raw value	Standard value	Raw value
20	31.3	16	65.74	12	100.18	8	134.62	4	169.06
19.8	33.02	15.8	67.46	11.8	101.9	7.8	136.34	3.8	170.78
19.6	34.74	15.6	69.18	11.6	103.62	7.6	138.06	3.6	172.5
19.4	36.47	15.4	70.91	11.4	105.35	7.4	139.79	3.4	174.23
19.2	38.19	15.2	72.63	11.2	107.07	7.2	141.51	3.2	175.95
19	39.91	15	74.35	11	108.79	7	143.23	3	177.67
18.8	41.63	14.8	76.07	10.8	110.51	6.8	144.95	2.8	179.39
18.6	43.35	14.6	77.79	10.6	112.23	6.6	146.67	2.6	181.11
18.4	45.08	14.4	79.52	10.4	113.96	6.4	148.4	2.4	182.84
18.2	46.8	14.2	81.24	10.2	115.68	6.2	150.12	2.2	184.56
18	48.52	14	82.96	10	117.4	6	151.84	2	186.28
17.8	50.24	13.8	84.68	9.8	119.12	5.8	153.56	1.8	188
17.6	51.96	13.6	86.4	9.6	120.84	5.6	155.28	1.6	189.72
17.4	53.69	13.4	88.13	9.4	122.57	5.4	157.01	1.4	191.45
17.2	55.41	13.2	89.85	9.2	124.29	5.2	158.73	1.2	193.17
17	57.13	13	91.57	9	126.01	5	160.45	1	194.89
16.8	58.85	12.8	93.29	8.8	127.73	4.8	162.17	0.8	196.61
16.6	60.57	12.6	95.01	8.6	129.45	4.6	163.89	0.6	198.33
16.4	62.3	12.4	96.74	8.4	131.18	4.4	165.62	0.4	200.06
16.2	64.02	12.2	98.46	8.2	132.9	4.2	167.34	0.2	201.78

The test of rolling around the circle appeared within the motor intelligence battery, and that the distinguishing feature of its tests is the internal balance of the body during the performance, as this test is characterized by the ability of the body to balance through the vestibular sensation. Changes in body position are reported by sensory signals that are transmitted to the cerebellum via the vestibular aqueducts of the spinal cord. Accordingly, disturbances in balance can be traced through four anatomical sites: the cerebellum, the vestibular spinal canals, the vestibular branch of the auditory nerve, and the inner ear. The sigma scale was used to extract standard scores (Table **3A**).

Table 3A: Standard and Raw Scores for the Rolling Around the Circle Test

Sta dard value	Raw value	Standard value	Raw value	Standard value	Raw value	Standard value	Raw value	Standard value	Raw value
20	22.04	16	28.18	12	34.33	8	40.47	4	46.62
19.8	22.35	15.8	28.49	11.8	34.64	7.8	40.78	3.8	46.92
19.6	22.65	15.6	28.8	11.6	34.94	7.6	41.09	3.6	47.23
19.4	22.96	15.4	29.11	11.4	35.25	7.4	41.39	3.4	47.54
19.2	23.27	15.2	29.41	11.2	35.56	7.2	41.7	3.2	47.84
19	23.58	15	29.72	11	35.86	7	42.01	3	48.15
18.8	23.88	14.8	30.03	10.8	36.17	6.8	42.32	2.8	48.46
18.6	24.19	14.6	30.33	10.6	36.48	6.6	42.62	2.6	48.77
18.4	24.5	14.4	30.64	10.4	36.79	6.4	42.93	2.4	49.07
18.2	24.8	14.2	30.95	10.2	37.09	6.2	43.24	2.2	49.38
18	25.11	14	31.26	10	37.4	6	43.54	2	49.69
17.8	25.42	13.8	31.56	9.8	37.71	5.8	43.85	1.8	50
17.6	25.73	13.6	31.87	9.6	38.01	5.6	44.16	1.6	50.3
17.4	26.03	13.4	32.18	9.4	38.32	5.4	44.47	1.4	50.61

17.2	26.34	13.2	32.48	9.2	38.63	5.2	44.77	1.2	50.92
17	26.65	13	32.79	9	38.94	5	45.08	1	51.22
16.8	26.96	12.8	33.1	8.8	39.24	4.8	45.39	0.8	51.53
16.6	27.26	12.6	33.41	8.6	39.55	4.6	45.69	0.6	51.84
16.4	27.57	12.4	33.71	8.4	39.86	4.4	46	0.4	52.15
16.2	27.88	12.2	34.02	8.2	40.16	4.2	46.31	0.2	52.45
								0	52.76

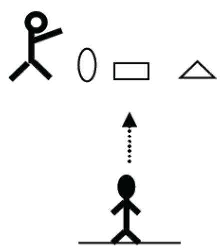
Table **4A** focuses on the "Sound and Motion" test, associating raw performance values with standardized scores. This test emphasizes sensory integration and motor response. For example, a raw score of 3.43 corresponds to a standard score of 20, reflecting precise motor-sensory coordination.

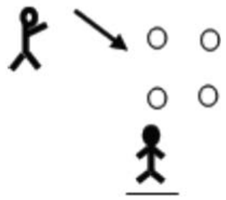
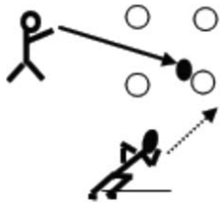
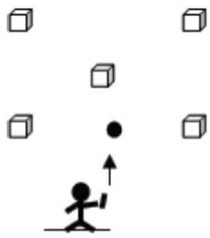
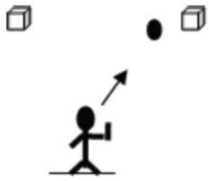
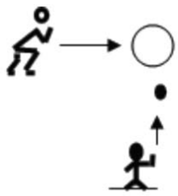
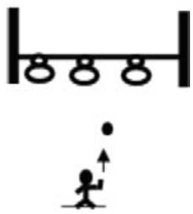
Table 4A: Standard and Raw Scores for the Sound and Motion Test

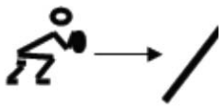
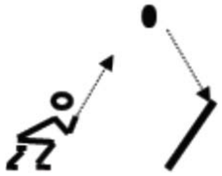
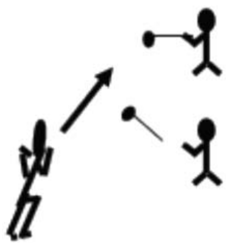
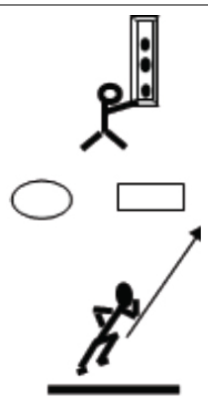
Standard value	Raw value	Standard value	Raw value	Standard value	Raw value	Standard value	Raw value	Standard value	Raw value
20	3.43	16	7.2	12	10.97	8	14.73	4	18.5
19.8	3.62	15.8	7.39	11.8	11.15	7.8	14.92	3.8	18.69
19.6	3.81	15.6	7.57	11.6	11.34	7.6	15.11	3.6	18.88
19.4	4	15.4	7.76	11.4	11.53	7.4	15.3	3.4	19.07
19.2	4.18	15.2	7.95	11.2	11.72	7.2	15.49	3.2	19.26
19	4.37	15	8.14	11	11.91	7	15.68	3	19.44
18.8	4.56	14.8	8.33	10.8	12.1	6.8	15.86	2.8	19.63
18.6	4.75	14.6	8.52	10.6	12.28	6.6	16.05	2.6	19.82
18.4	4.94	14.4	8.71	10.4	12.47	6.4	16.24	2.4	20.01
18.2	5.13	14.2	8.89	10.2	12.66	6.2	16.43	2.2	20.2
18	5.31	14	9.08	10	12.85	6	16.62	2	20.39
17.8	5.5	13.8	9.27	9.8	13.04	5.8	16.81	1.8	20.57
17.6	5.69	13.6	9.46	9.6	13.23	5.6	16.99	1.6	20.76
17.4	5.88	13.4	9.65	9.4	13.42	5.4	17.18	1.4	20.95
17.2	6.07	13.2	9.84	9.2	13.6	5.2	17.37	1.2	21.14
17	6.26	13	10.02	9	13.79	5	17.56	1	21.33
16.8	6.44	12.8	10.21	8.8	13.98	4.8	17.75	0.8	21.52
16.6	6.63	12.6	10.4	8.6	14.17	4.6	17.94	0.6	21.7
16.4	6.82	12.4	10.59	8.4	14.36	4.4	18.13	0.4	21.89
16.2	7.01	12.2	10.78	8.2	14.55	4.2	18.31	0.2	22.08

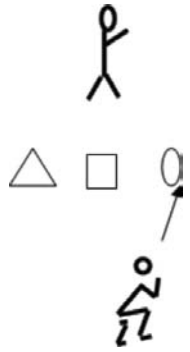
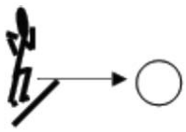
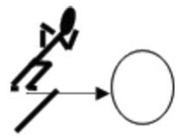
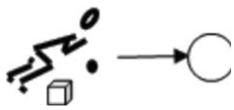
APPENDIX B:

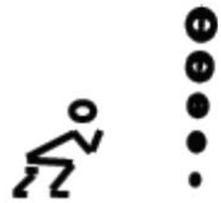
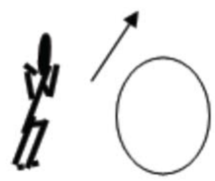
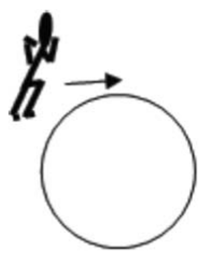
(Motor Tests Designed to Measure Motor Intelligence)

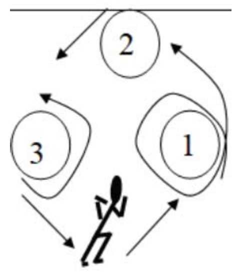
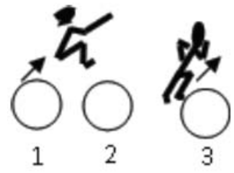
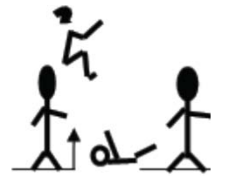
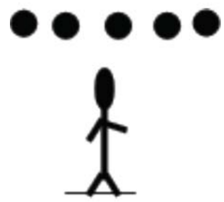
No.	Test Name	Unit of Measurement	Sensory Receptors	Tools Used	Legal Specifications of Tools	Performance Specifications	Illustration	Recording Method
1	Sound and Motion	Seconds	Hearing	- White tape. - Stopwatch. - Whistle. - Drum.	A circle with a diameter of 2m, an equilateral triangle with each side 2m, a rectangle with each side 2m, and a line for the tester 5m from the shapes.	The child stands on the tester's line. The examiner produces sounds, and the child runs around the corresponding shape.		The best time out of three attempts is recorded to the nearest decimal.

2	Numbered Circles	Number	Hearing	- White tape. - Stopwatch. - Plastic ball. - Blindfold.	Four circles with a diameter of 2m, numbered (1-4), spaced 4m apart. A line for the tester is 3m from the nearest circle.	The tester stands on the line with eyes blindfolded. The examiner throws the ball into a circle, and the tester identifies the circle number.		The number of correct identifications is recorded.
3	Quick Anticipation	Number + Seconds	Hearing + Vision	- White tape. - Stopwatch. - Plastic ball.	Four circles with a diameter of 2m, numbered (1-4). A line for the tester is 5m from the nearest circle.	The tester faces away from the circles. The examiner throws the ball into a circle, and the tester turns, runs, and catches the ball before it bounces twice.		The tester is given 5 attempts, and the number of correct catches is recorded.
4	Consecutiv e Jumps	Number	Motor Perception	- Open ground. - Blindfold. - White tape.	Six circles with a diameter of 2m, numbered (1-6).	The tester's eyes are blindfolded, and they are instructed to jump into three specified circles.		The tester is given 5 attempts, and the number of correct jumps is recorded.
5	Pendulum Throw	Number	Vision + Motor Perception	- Pole. - Rope. - Hoop. - Iron ring. - Plastic ball.	A 1.5m iron pole with a 50cm crossbar and a 7cm ring attached to a rope with a 1m hoop. A throwing line is 3m from the pole.	The examiner swings the hoop like a pendulum. The tester throws the ball through the hoop.		The tester is given 3 attempts, and the number of successful throws is recorded.
6	Varied Throwing	Number	Motor Perception	- 5 open boxes. - White tape. - 5 tennis balls.	Five open boxes, each 50cm in size, arranged in a square with the fifth box in the center. The throwing line is 2m from the nearest box.	The tester throws 5 balls, each into a different box.		The tester is given one attempt, and the number of successful throws is recorded.
7	Throwing Sensation	Number	Motor Perception	- 2 open boxes. - White tape. - 5 tennis balls. - Blindfold.	Two open boxes placed 2m apart on a horizontal line. The throwing line is 4m from the nearest box.	The tester's eyes are blindfolded, and they throw 5 balls into the boxes.		The tester is given one attempt, and the number of successful throws is recorded.
8	Targeted Throwing	Number	Motor Perception	- 5 tennis balls. - Hoop. - White tape.	A 6m line and a 2m hoop. The throwing line is 2m from the rolling line.	The tester stands at the starting line while the examiner rolls the hoop. The tester throws the ball into the hoop.		The tester is given 5 attempts, and the number of successful throws is recorded.
9	Stacked Hoops	Number	Motor Perception	- 3 tennis balls. - 3 hoops. - 2 poles. - Plastic rope. - White tape.	Two poles, each 1m tall, spaced 8m apart, connected by a plastic rope with 3 hoops (each 2m in diameter) spaced 2m apart. The throwing line is 4m from the hoops.	The tester throws the balls into the hoops.		The tester is given one attempt, and the number of successful throws is recorded.

10	Ball Launcher	Number	Vision + Motor Perception	- Ball launcher. - Box. - White tape.	A starting line 3m from the ball launcher.	The tester stands behind the starting line, holding a box. When balls are launched, the tester runs to catch them and place them in the box.		The tester is given 5 attempts, and the number of successful catches is recorded.
11	Rolling Ball	Centimeters	Motor Perception	- White tape. - Plastic balls.	A line for the tester 5m from the target line.	The tester rolls a ball to stop on the target line.		The tester is given 5 attempts, and the distance between the ball and the line is recorded.
12	Ball and Blindfold	Centimeters	Motor Perception	- White tape. - Plastic ball. - Blindfold.	A line for the tester 5m from the target line.	The tester's eyes are blindfolded, and they roll a ball to stop on the target line.		The tester is given 5 attempts, and the distance between the ball and the line is recorded.
13	Dropped Ball and Blindfold	Centimeters	Motor Perception	- White tape. - Plastic ball. - Blindfold.	A line for the tester 5m from the target line.	The tester's eyes are blindfolded, and they drop the ball from above to land on the target line.		The tester is given 5 attempts, and the distance between the ball and the line is recorded.
14	Ball Drop	Centimeters	Motor Perception	- White tape. - Plastic ball.	A line for the tester 5m from the target line.	The tester drops the ball from above to land on the target line.		The tester is given 5 attempts, and the distance between the ball and the line is recorded.
15	Balloon and Rope	Number	Vision	- 2 cloth bags. - Ropes. - 2 balloons.	A 1m rope.	Two assistants hold balloons in cloth bags attached to elastic ropes, spaced 4m apart. The tester stands 2m away and tries to catch the balloon when released.		The tester is given 5 attempts, and the number of successful catches is recorded.
16	Ball Catch	Number	Vision	- 2 plastic balls.	Two assistants hold balls, spaced 4m apart. The tester stands 2m away and tries to catch the ball when released.			The tester is given 5 attempts, and the number of successful catches is recorded.
17	Color and Motion	Seconds	Vision	- Light bulbs. - Wooden board. - White tape.	Three light bulbs (blue, red, white) on a 50cm x 30cm wooden board. The board is 5m from the starting line. Three geometric shapes (triangle, rectangle, square) with 2m sides are placed 3m from the starting line.	The tester runs to the corresponding shape when a light is turned on.		The average time of three attempts is recorded to the nearest decimal.

18	Geometric Shapes	Number	Vision	- Light bulbs. - Wooden board.	Three light bulbs (blue, red, white) on a 50cm x 30cm wooden board. The board is 5m from the starting line. Three geometric shapes (triangle, rectangle, square) with 2m sides are placed 3m from the starting line.	The tester runs to the shapes in a specified order based on the light color.		The number of correct attempts is recorded.
19	Ball and Line	Number	Motor Perception	- White tape. - 4 plastic balls.	Four lines, each 2m long and 1m wide, spaced 2m apart. A rolling line is 4m from the nearest line.	The tester rolls each ball to a different line.		The number of successful rolls is recorded.
20	Rolling and Blindfold	Number	Motor Perception	- White tape. - 4 plastic balls. - Blindfold.	Four lines, each 2m long and 1m wide, spaced 2m apart. A rolling line is 4m from the nearest line.	The tester's eyes are blindfolded, and they roll each ball to a different line.		The number of successful rolls is recorded.
21	Walking to the Circle	Number	Motor Perception	- White tape. - Blindfold.	A circle with a diameter of 2m, 4m from the starting line.	The tester walks to the circle and stands inside it.		The tester is given 5 attempts, and the number of successful attempts is recorded.
22	Walking to the Circle with Blindfold	Centimeters	Motor Perception	- White tape. - Blindfold.	A circle with a diameter of 2m, 4m from the starting line.	The tester's eyes are blindfolded, and they walk to the circle and stand inside it.		The tester is given 5 attempts, and the distance between the tester and the center of the circle is recorded.
23	Running to the Circle	Number	Motor Perception	- White tape.	A circle with a diameter of 2m, 4m from the starting line.	The tester runs to the circle and stands inside it.		The tester is given 5 attempts, and the number of successful attempts is recorded.
24	Running to the Circle with Blindfold	Number	Motor Perception	- White tape. - Blindfold.	A circle with a diameter of 2m, 4m from the starting line.	The tester's eyes are blindfolded, and they run to the circle and stand inside it.		The tester is given 5 attempts, and the distance between the tester and the center of the circle is recorded.
25	Throwing to the Circle	Number	Motor Perception	- White tape. - Blindfold. - 5 balls.	A circle with a diameter of 2m, 5m from the starting line.	The tester's eyes are blindfolded, and they throw 5 balls into the circle.		The tester is given 5 attempts, and the number of successful throws is recorded.
26	Colors and Running	Seconds	Vision	- Light bulbs. - Wooden board. - White tape.	Three light bulbs (blue, red, white) on a 50cm x 30cm wooden board. The board is 5m from the starting line. A triangle with 1m sides is placed 1m from the starting line.	The tester runs to the triangle based on the light color and follows a specified path.		The average time of three attempts is recorded to the nearest decimal.

27	Colored Ruler	Number	Vision	- Ruler. - Chair.	A 1m ruler with four colors (red, blue, white, black), each 25cm long.	The tester sits on a chair with arms extended. The examiner drops the ruler, and the tester catches it at the specified color.		The tester is given 5 attempts, and the number of successful catches is recorded.
28	Ruler and Feet	Number	Vision	- Ruler. - Chair.	A 1m ruler with four colors (red, blue, white, black), each 25cm long.	The tester sits on a chair with knees raised. The examiner drops the ruler, and the tester catches it at the specified color.		The tester is given 5 attempts, and the number of successful catches is recorded.
29	Descendin g Order of Balls	Seconds	Touch	- 5 balls of different weights. - Blindfold.	Five balls weighing 100g, 300g, 500g, 700g, and 1000g.	The tester's eyes are blindfolded, and they arrange the balls from heaviest to lightest.		The time is recorded to the nearest decimal.
30	Ascending Order of Balls	Seconds	Touch	- 5 balls of different weights. - Blindfold.	Five balls weighing 100g, 300g, 500g, 700g, and 1000g.	The tester's eyes are blindfolded, and they arrange the balls from lightest to heaviest.		The time is recorded to the nearest decimal.
31	Jumps	Number	Inner Ear	- Stopwatch. - Blindfold.		The tester's eyes are blindfolded, The tester jumps and turns 90 degrees to the left, then 90 degrees to the right, for 30 seconds.		The number of turns is recorded.
32	Jump and Clap	Number	Inner Ear	- Stopwatch. - Blindfold.		The tester jumps, turns 180 degrees, and claps, alternating directions for 30 seconds.		The number of turns is recorded.
33	Consecutiv e Turns	Number	Inner Ear	- Stopwatch. - Blindfold.	The tester jumps, turns 360 degrees to the right, then 90 degrees to the left, for 30 seconds.			The number of turns is recorded.
34	Running Around the Circle	Seconds	Inner Ear	- Stopwatch. - White tape.	A circle with a radius of 5m.	The tester runs around the circle, alternating directions.		The time is recorded to the nearest decimal.
35	Running Around the Circle	Seconds	Inner Ear	- Stopwatch. - White tape.	A circle with a radius of 3m.	The tester runs around the circle, alternating directions.		The time is recorded to the nearest decimal.

36	Running Around the Circle	Seconds	Inner Ear	- Stopwatch. - White tape.	A circle with a radius of 2m.	The tester runs around the circle, alternating directions.		The time is recorded to the nearest decimal.
37	Triangular Circle	Seconds	Inner Ear	- Stopwatch. - White tape.	Three circles (1, 2, 3) arranged in a triangle, each with a diameter of 2m, spaced 3m apart. The starting line is 3m from the nearest circle.	The tester runs around the circles in a specified pattern.		The time is recorded to the nearest decimal.
38	Running and Jumping	Seconds	Inner Ear	- Stopwatch. - White tape.	A circle with a diameter of 2m.	The tester runs around the circle and jumps, alternating directions.		The time is recorded to the nearest decimal.
39	Circle and Triple	Seconds	Inner Ear	- Stopwatch. - White tape.	A circle with a diameter of 2m.	The tester runs around the circle, jumps, and rolls.		The time is recorded to the nearest decimal.
40	Varied Jumps	Seconds	Inner Ear	- Blindfold. - Stopwatch.	The tester jumps, turns, and rolls in a specified pattern.			The time is recorded to the nearest decimal.
41	Consecutiv e Weights	Number	Motor Perception	- 5 balls of different weights. - Blindfold.	Five balls weighing 100g, 300g, 500g, 700g, and 1000g.	The tester's eyes are blindfolded, and they arrange the balls from heaviest to lightest.		The time is recorded to the nearest decimal.

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