CIENTÍFICO

THE ASSESSMENT OF MOTOR COORDINATION IN CHILDREN WITH DOWN'S SYNDROME WITH THE MOVEMENT ASSESSMENT BATTERY FOR CHILDREN (MOVEMENT ABC)

María Luisa Rodríguez Hernández
Unidad Docente de Educación Física y Deportiva. Universidad de Alcalá de Henares (UAH)

Fecha de recepción: 16 de julio de 2015 / Fecha de aceptación: 4 de octubre de 2015

Abstract

Motor alterations are common in children with Down´ s syndrome (DS). These motor coordination deficits usually affect different skills including visual-hand coordination, laterality control, time of reaction and equilibrium. In the present study the applicability of different tasks has been analyzed, included in the motor test -*Movement Assessment Battery for Children* (MABC), which measures motor competence in children without disabilities, to 125 children with Down´s syndrome nine to fourteen years old. The aims of the study were to ascertain the applicability of this motor test in children with Down syndrome and evaluate the motor skills of these children with the above-mentioned test in a large population of both girls and boys. The results were that the MABC, with minor adaptations is useful to evaluate motor skills in children with Down syndrome and the degree of motor development in nine to fourteen years old children with Down syndrome is lower than that of the four to six years old non-disabled children as measured with the MABC test.

Key words: special physical education, MABC, motor competence, Down´s syndrome, motor coordination.

Título: Evaluación de la coordinación motora en escolares con síndrome de Down utilizando el Test MABC.

Resumen

Las alteraciones de la motricidad son comunes en personas con síndrome de Down. Estos déficits en la coordinación motora normalmente afectan a diferentes habilidades incluyendo la coordinación óculo-manual, la lateralidad, el tiempo de reacción y el equilibrio. En el presente estudio se ha analizado la aplicabilidad de algunas tareas incluidas en el test motor -*Movement Assessment Battery for Children* (MABC)- que mide la competencia motriz infantil en escolares sin discapacidades, en 125 niños y niñas de nueve a catorce años con este síndrome. Los principales objetivos fueron estudiar la aplicabilidad de este test motor en niños y niñas con síndrome de Down y evaluar la coordinación motora de estos niños y niñas, mediante la aplicación del test motor mencionado. Los resultados obtenidos fueron que el test motor MABC, con algunas adaptaciones, es aplicable para evaluar la competencia motriz de escolares con síndrome de Down y que el grado de desarrollo motor de los escolares con síndrome de Down de nueve a catorce años, medido por el test MABC, es inferior al promedio de la población de escolares de cuatro a seis años sin syndrome de Down.

Palabras clave: Educación Física Especial, MABC, competencia motora, síndrome de Down.

* Correo electrónico: mluisa.rodriguez@uah.es

INTRODUCTION

Motor alteration is a constant disorder in patients affected of Down´s syndrome (DS). Langdon Down in the early description of the syndrome in 1866 stated that "The coordinating faculty is abnormal, but not so defective that it cannot be greatly strengthened. By systematic training, considerable manipulative power may be obtained" (Down, 1866).These motor coordination deficits usually affect to different skills including visual-hand coordination, laterality control, time of reaction and equilibrium.

Most of the efforts towards the education and rehabilitation of children with DS in developed countries are directed to the early stimulation. This kind of actuation has permitted to integrate in the society a high percentage of children with DS. Sport also plays an important role as a socialization measure in adolescents with DS, and increasing their self-esteem (Perán, Gil, Ruiz y Fernández-Pastor, 1997). Although there is a considerable repertoire of test and batteries to evaluate motor skills in children there is still a lack of specific instruments for the evaluations of basic abilities and motor coordination in intellectually disabled coordination. Based in this, the study tried to adapt and compare this motor test to a large number of children in scholar ages of both genders. The final aim of this study was to obtain a test that can be easily performed by the teachers of Special Physical Education that could help them to specifically reinforce the motor skills of the scholars affected of DS

MATERIALS AND METHODS

Sample

All the subjects in this study were scholars of the "Centro de Educación Especial María Corredentora", a private Roman Catholic institution devoid exclusively to the education of intellectually disabled children of both genders aged 5 to 20. A total of 125 children with DS participated in this study. Written consent was obtained from their parents. They were distributed according to their gender, age, intellectual level and physical activity ("poor" when limited to school activity and "sufficient" when they did any extra physical activity).

Table 1: **Sample description**

SAMPLE	DESCRIPTION
125	- GENDER (46 boys, 79 girls) - AGE (<11 years 98, >11 years 27) - INTELECTUAL LEVEL (50 level 2, 75 level 3) - PHYSICAL ACTIVITY (53 sufficient,72 poor)

Test

In the study is applied the Movement Assessment Battery for Children (MABC) (Henderson and Sudgen, 1992) designed for the evaluation of motor skills of 4 to 12 year old children with a total of 32 items divided in four sets of eight.

Each range is intended for the use with children of specific ages (Spanó, Mercuri, Rando, Pantó, Gagliano, Henderson y Guzzeta, 1999). A selection of the different tasks of this battery in the range designed for use with 4 to 6 year old kids was made according to the opinion of the teachers directly involved in the educations of these children. One task (see below) was modified to get it more understandable and more easily feasible.

Table 2: **List of tasks MABC (adapted from Burton and Miller, 1998)**

AGE BAND	TASKS
4-6 years	- Posting coins (seconds) - Threading beads(seconds) - Bicycle trail (fail number) - Catching beanbag (pass number) - Rolling ball into goal (pass number) - One-leg balance-R(seconds) - One-leg balance-L(seconds) - Jumping over cord (cm) - Walking heels raised (step)

Although MABC was designed for different ranges of age, as stated above in our study we only used one of the ranges (4 to 6 year old kids). The components of the battery were always run in the same order: manual dexterity, visual motor coordination (ball skills) and static and dynamic balance. Test was always performed from 10 a.m. to 1p.m. The Physical Education teacher was present as well as two other evaluators, one keeping track of time and the other of the performance. After informing them individually about the test, the children were invited to perform an attempt to ascertain their degree of comprehension.

Due to its complexity the task of MABC "two feet jumping over cord" was substituted for a horizontal displacement of two feet jumping.

Results

The Statistical Package for Social Sciences (SPSS) 17.0 was used to analyze the data.

We used standard descriptive techniques, minimum, maximum punctuation, means and standard deviations to present the basics characteristics of the variables. The comparison of means was analyzed using the *Student-T* test for independent samples with a 95% of confidence interval and the reliability of the test motor adapted to children with DS by calculating with the *Cronbach Alpha* coefficient.

It was considered a bilateral significance level of $p<0.05$, $p<0.01$ y $p<0.001$.

The applicability of the battery was assessed by the fact that all the children were able to perform all the tasks (**Table 3)**. Although as stated above the task "jump with feet together" was modified.

Table 3: **Descriptive data MABC tasks (4-6 year old kids)**

TASKS	Sample	Minimum	Máximum	Means	Standard Deviation
Posting coins.	125	0,00	70,00	33,07	10,87
Threading beads	125	0,00	150,00	57,78	25,85
Bicycle trail	118	0,00	14,00	3,55	2,99
Catching beanbag	125	0,00	10,00	6,57	2,70
Rolling ball into goal.	125	0,00	10,00	5,72	2,36
One-leg balance (Right)	125	0,00	106,00	6,72	10,90
One-leg balance (Left)	125	0,00	120,00	7,21	14,14
Jump with feet together	125	0,00	150,00	72,48	28,15
Walking heels raised	125	0,00	21,00	11,39	2,84

Boys got better scores than girls in the tasks "catching beanbag" (p<0.01), "rolling ball into goal" (p<0.01)," right static balance" (p<0.05), "left static balance" (p<0.05) and "jump with feet together" (p<0.001). In the other tasks there were not statistical significant differences between genders. **(Table 4 and Figure 1)**

Table 4: **Gender differences in the MABC tasks.**

TASKS	Boys			Girls			P >
	Means	Sample	Standard Deviation	Means	Sample	Standard Deviation	
Posting coins.	31,24	46	9,58	34,14	79	11,48	0.1330
Threading beads	60,13	46	31,22	56,42	79	22,26	0.4810
Bicycle trail	2,98	45	2,65	3,92	73	3,15	0.0850
Catching beanbag	7,37	46	2,19	6,11	79	2,86	**0.0070**
Rolling ball into goal.	6,50	46	2,33	5,27	79	2,27	**0.0050**
One-leg balance (Right)	10,33	46	17,07	4,63	79	2,94	**0.0300**
One-leg balance (Left)	11,78	46	22,2	4,56	79	3,76	**0.0340**
Jump with feet together	85,98	46	27,02	64,63	79	25,87	**0.0000**
Walking heels raised	11,13	46	2,72	11,54	79	2,91	0.4260
***(p < 0.05)**		**** (p<0.01)**		*****(p<0.001)**			

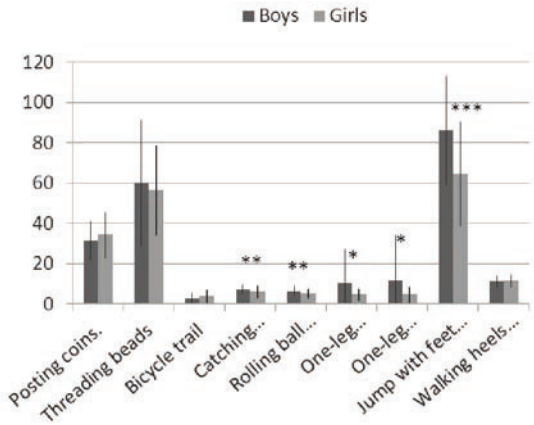

Figure 1: **Gender differences in the MABC tasks.**

The comparison of the performance according to the intellectual level 2 or 3 **(Table 5 and Figure 2),** shows statistically significant in three of the eight tasks, "posting coins" (p< 0.05), "bicycle trail" (p< 0.05) and "jump with feet together" (p< 0.01)

Table 5: **Intellectual level differences in the MABC tasks.**

TASKS	Intellectual Level 2			Intellectual Level 3			P <
	Means	Sample	Standard Deviation	Means	Sample	Standard Deviation	
Posting coins.	35,52	50	10,2	31,44	75	11,1	**0.036**
Threading beads	57,92	50	22,6	57,69	75	27,99	0.96
Bicycle trail	4,46	46	3,15	2,99	72	2,765	**0.011**
Catching beanbag	6,14	50	3	6,87	75	2,457	0.158
Rolling ball into goal.	5,32	50	2,22	5,99	75	2,436	0.116
One-leg balance (Right)	6,58	50	14,6	6,83	75	7,599	0.913
One-leg balance (Left)	7,24	50	16,8	7,2	75	12,16	0.988
Jump with feet together	63,34	50	24,3	78,59	75	29,03	**0.002**
Walking heels raised	11,9	50	3,04	11,05	75	2,671	0.113
***(p < 0.05)**			**** (p<0.01)**			*****(p<0.001)**	

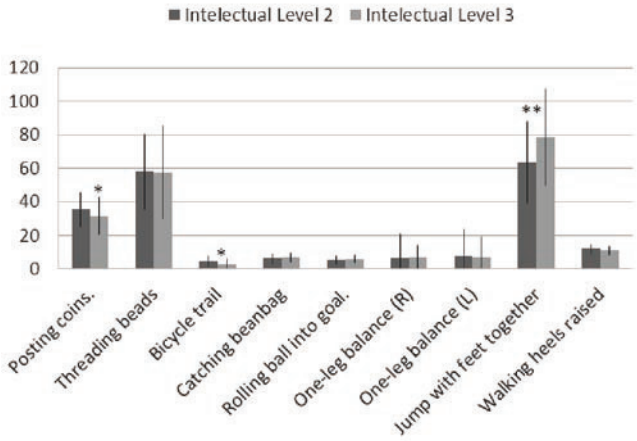

Figure 2: **Intellectual level differences in the MABC tasks.**

As expected older children performed better than younger (**Table 6 and Figure 3),** The most significant differences for children of 11 or above, were observed in the tasks "posting coins" (p< 0.05), "threading beads" (p< 0.01),), "bicycle trail" (p< 0.001), "catching beanbag" (p<0.01), "rolling ball into goal" (p<0.01), "jump with feet together" (p< 0.001) and "walking heels raised" (p< 0.05).

Table 6: **Differences between age groups in the MABC tasks.**

TASKS	< 11 years			≥ 11 years			P<
	Means	Sample	Standard Deviation	Means	Sample	Standard Deviation	
Posting coins.	35,69	55	11,782	31,01	70	9,701	**0.019**
Threading beads	65,87	55	28,935	51,43	70≤	21,291	**0.003**
Bicycle trail	4,92	51	2,862	2,52	67	2,682	**0.000**
Catching beanbag	5,85	55	2,947	7,14	70	2,361	**0.009**
Rolling ball into goal.	5,05	55	1,84	6,24	70	2,601	**0.003**
One-leg balance (Right)	6,89	55	14,224	6,6	70	7,428	0.891
One-leg balance (Left)	6,58	55	16,061	7,71	70	12,539	0.668
Jump with feet together	62,16	55	26,254	80,6	70	27,088	**0.000**
Walking heels raised	12,07	55	3,474	10,86	70	2,101	**0.025**
***(p < 0.05)**			**** (p<0.01)**			*****(p<0.001)**	

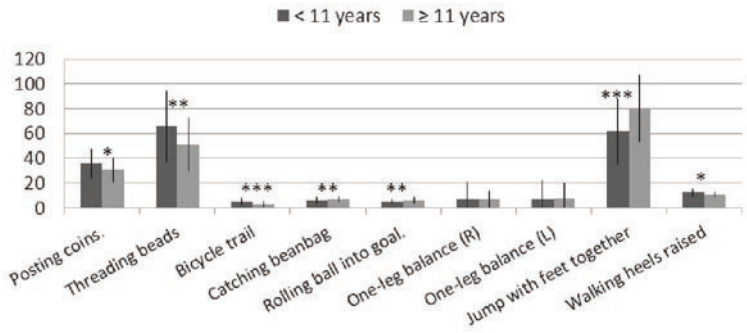

Figure 3: **Differences between age groups in the MABC tasks.**

The level of physical activity had little influence (**Table 7 and Figure 4)** in the performance, showing only statistical significant differences the task "rolling ball into goal" (p<0, 05), better in the group with higher physical activity

Table 7: **Differences between physical activity groups in the MABC tasks.**

TASKS	Sufficient			Poor			P<
	Means	Sample	Standard Deviation	Means	Sample	Standard Deviation	
Posting coins.	31,60	53	9,189	34,15	72	11,911	0.179
Threading beads	55,58	53	30,212	59,40	72	22,206	0.438
Bicycle trail	3,76	51	3,320	3,40	67	2,742	0.529
Catching beanbag	6,92	53	2,533	6,32	72	2,808	0.210
Rolling ball into goal.	6,32	53	2,319	5,28	72	2,315	**0.014**
One-leg balance (Right)	8,21	53	15,752	5,64	72	4,792	0.255
One-leg balance (Left)	8,77	53	18,383	6,07	72	9,944	0.335
Jump with feet together	74,43	53	25,683	71,06	72	29,946	0.500
Walking heels raised	11,81	53	2,354	11,08	72	3,134	0.141
***(p < 0.05)**			**** (p<0.01)**			*****(p<0.001)**	

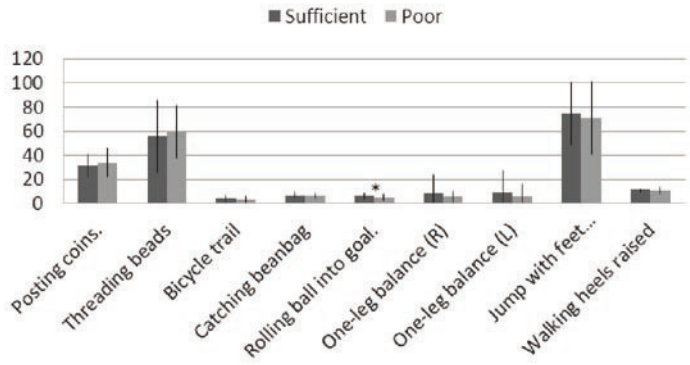

Figure 4: **Differences between physical activity groups in the MABC tasks.**

To check the internal consistence of the MABC test (calculated with the standardized scores for each task) the method of Cronbach Alpha was employed. MABC test achieved an *Alpha Coefficient* =0,812. The reliability obtained can be considered in the DS population for future research (Nunnally y Bernstein, 1994)

DISCUSSION

Research over the last decade has indicated quite clearly that Down syndrome children are a distinct, the delays being a result of both physical and cognitive problems (Hartley, 1986)

Considerable variability exists among infants and children with DS with regard to the degree of disability and the features affected (Ulrich, Lloyd, Tiernan, Looper y Angulo, 2008). Greater joint range of motion, presumably attributable to ligamentous laxity (Livingstone y Hirst, 1986), delayed development of postural reactions and myelination (Haley, 1986), low muscle tone (Sacks y Buckley, 2003), and congenital heart defects (Spicer, 1984) all contribute to delayed motor skills.

Individuals with this syndrome exhibit a peculiar motor development and neuropsychological profile with some abilities more preserved and others more impaired. This finding may have theoretical and practical implications. In fact, a better definition of the cognitive pattern in DS may contribute to understand the nature of mental retardation in general and, also, it may suggest individualized rehabilitation treatment protocols (Vicari, 2006).

The most serious DS disabilities in this study are related to the balance and postural control by cerebellum abnormalities (Pueschel, Gallagher, Zartler y Pezzullo, 1987). These neuronal alterations explain the difficulties of DS brains to develop the somatosensory information produced by the cortex (Chiarenza, 1993) because the cerebellum seems most crucial for adapting the movements to novel situations through trial-by-trial learning mechanisms (Bastian, 2006)

If we compare the results of the present study with those published by other authors, Ruiz, Graupera, Gutierrez y Miyahara, 2003, who studied a sample of children aged 4-6 year, we must conclude that the performance of the tasks in children 9-14 year old affected with SD is worse (lower) than that of non-afected 4-6 year old. These authors also found better scores in

boys than in girls y the tasks of static and dynamic balance and in visual-motor coordination. By contrast previous result did not show differences in the motor competence in children with DS of both genders at ages of 9-11, starting these differences in children aged 11 and above (Ulrich, Lloyd, Tiernan, Looper y Angulo, 2008)

The fundamental motor skills are consolidated between 2 and 7-8 years of age (Ruiz, Graupera, Gutierrez y Mayoral, 1997). This pattern is clearly delayed in DS, and despite being 9-14 year old, children with DS show more motor difficulties than 5 year old children non-affected with DS. These difficulties are more relevant in maintaining the body balance and in moving according to different patterns of movement.

The child with mental retardation may have motor development that progresses at a slower rate than what is expected for a child with average intelligence. A study about the gross motor and fine motor skills of a group of children with DS, who were evaluated using the Bruininks Oseretsky Test of Motor Proficiency, showed results indicating a poor performance in overall gross motor and fine motor skills in comparison with mentally retarded children without DS but of comparable chronological and mental ages (Conolly y Michael, 1986)

In another study with twenty one children with DS and aged between 4,5 and 14 years old who were assessed with the motor test MABC, the results indicated a poor performance in most areas of motor functioning (Spanó et al, 1999)

As a corollary, the test motor used has shown a level of difficulty and appropriate applications, and allows comparison with the normal population. This will help the assessment of motor development in mental disabilities and more specifically in children with DS and the early detection of motor difficulties to improve their quality of life and the planning of programs and physical activities and sports for the optimal development of all daily abilities life of these people.

CONCLUSIONS

The adapted MABC - range 4 to 6 years- is applicable to assess motor coordination in children with DS from 9 to 14 years. The segmental motor skills of this motor test show that there is an improvement when increasing children cognitive level and the amount of physical activity without statistics differences. Depending on gender, boys show significant differences on static and dynamic balance tests and in the visual motor coordination of the MABC and manifest a clear positive trend after 11 years old, it could be due to the early stimulation they receive in the college. Finally, the reliability obtained by the test –MABC, *ALPHA*=0,812-, is acceptable for use in children with DS for research and discrimination of groups.

REFERENCES

Bastian, A. J. (2006). Learning to predict the future: the cerebellum adapts feedforward movement control. *Current Opinion Neurobiol*. 16, pp.645-648.

Burton, A. W. & Miller, D. E. (1998). *Movement skill assessment*. Champaign, IL: Human Kinetics.

Chiarenza, G. A. (1993). Movement-related brain macropotentials of persons with Down syndrome during skilled performance. *Am J Ment Retard*. 97, pp.449-467.

Connolly, B.H. & Michael, B.T. (1986). Performance of retarded children, with and whithout Down syndrome, on Bruininks Oteretsky Test of Motor Proficiency. *Physical Therapy*. 6, pp.344-348

Down, J. H. (1866). Observations on an Ethnic Classification of Idiots by J. Langdon H. Down, M. D., London. *London Hospital Reports*. 3, pp.259-262.

Haley, S. M. (1987). Squence of development of postural reactions in infants with Down syndrome. *Developmental Medicine and Child Neurology,* 29, pp. 674-679.

Hartley, X. Y. (1986). A summary of recent research into the development of children with Down's syndrome. *F. ment. Defic*. 30, pp.1-14.

Henderson, S. E. & Sugden, D. A. (1992). *The Movement Assessment Battery for Children*. Londres: Psychological Corporation, Ltd.

Livingstone, B. & Hirst, P. (1986) Orthopedic disorders in school children with Down's symdrome with special reference to the incidence of joint laxity. *Clin Orthop Relat Res,* 207, pp.74-76.

Nunnally, J. C. y Bernstein, I. (1995). *Teoría psicométrica*. México: McGraw-Hill.

Perán, S., Gil, J. L.; Ruiz, F. & Fernández- Pastor, V. (1997). Development of physical response after athletics training in adolescents with Down's syndrome. *Scandinavian Journal of Medicine & Science in Sports,* 7, pp.283-288.

Pueschel, S. M., Gallager, P. L., Zartler, A. S. & Pezzullo, J. C. (1987). Cognitive and learning processes in children with Down syndrome. *Res Dev Disabil*, 8 (1), pp.21-37.

Ruiz, L. M., Graupera, J. L., Gutiérrez, M. & Miyahara, M. (2003). The assessment of motor coordination in children with the Movement ABC test: A comparative study among Japan, USA and Spain. *International Journal of Applied Sport Sciences*, 15(1), pp. 22-35

Ruiz, L. M., Graupera, J. L., Gutiérrez, M. & Mayoral, A. (1995). *Manual básico del Test motor ABC de Henderson y Sugden (1992)*. Proyecto de investigación, CIDE-95.

Sacks, B. & Buckley, S. (2003). *Motor Development for Individuals with Down Syndrome: An Overview.* United Kingdom: The Down Syndrome Educational Trust.

Spicer, R. L. (1984). Cardiovascular disease in Down syndrome. *Pediatr Clin North Am*, 31(6), pp.1331- 43.

Spanó, M., Mercuri, E., Rando, T., Pantó, T., Gagliano. A., Henderson, S. & Guzzetta. F. (1999) Motor and perceptual-motor competence in children with Down syndrome: variation in performance with age. *European Journal of Paediatric Neurology,* 3 (1), pp.7-13.

Ulrich, D. A., Lloyd, M. C., Tiernan, C. W., Looper, J. E. & Angulo- Barroso, R. (2008). Effects of Intensity of Treadmill Training on Developmental Outcomes and Stepping in Infants With Down Syndrome: A Randomized Trial. *Physical Therapy*, 88, pp.114-122

Vicari, S. (2006). Motor development and neuropsicological patterns in persons with Down syndrome. *Behaviour Genetic,* 36 (3), pp. 355-364.