Effect of lateral dominance on manual dexterity in people with Down syndrome

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ORIGINAL ARTICLE

ABSTRACT

Objective: To evaluate the effect of lateral dominance on manual dexterity in a group of children and adolescents with Down syndrome (DS) and to compare the results from participants with DS with people without the syndrome. **Method:** The study included 100 children and adolescents of both sexes with ages ranging from 7 to 9 years and 14 to 15 years. 50 people were diagnosed with DS (GDS) and 50 without the syndrome (GC). The Box and Blocks Test (BBT) was used because it allows assessment of motor activity by counting the number of blocks transferred between two divisions of a standard box. The BBT implementation is simple and does not require complex cognitive skills. **Results:** The number of blocks transferred per minute was lower in participants of GDS than the GC, with a clear disadvantage for manual dexterity in both hands. There was no effect of dominance in the GDS, but the GC showed better performance on the dominant side. **Conclusion:** The BBT was useful for the quantification of manual dexterity in people with DS as it is easy to apply and understand by people with cognitive impairment.

Keywords: child, down syndrome, hand, motor skills

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INTRODUCTION

The Down Syndrome (DS), also known as chromosome trisomy 21, is a genetic syndrome most frequently associated with mental retardation.[1] The development of motor skills reveals evidence that children with DS are slow in the acquisitions of the basic motor skills, in relation to children with normal development.[2-4] In terms of childhood development, we see a delay in the development of motor skills, indicating that these stages emerge at a different time from those children with typical development. Aspects such as muscle weakness, human cerebellar hypoplasia, and hypotonia have been suggested as the cause for these children's delay in acquiring motor skills.[5-10]

In children with DS, the ability to hold objects comes later than it does in normal children. Garcias et al.[11] observed that the function of holding objects for normal children occurs when they are four months old on average, while for approximately 40% of DS children it occurs only after seven months of age.

Considering the increase in life span for people with DS and the need for studies with this population, Godoy & Barros[12] sought a strength scale for adults with DS while evaluating and comparing grip strength between individuals with DS and a control group. They found that the grip strength in the group with DS was significantly lower than the other group without the syndrome.

In a brief history of evaluations that involve hand functions, we can point out that in 1956 the Crawford small parts test was the first to be publicized; in 1958, the Moberg sensitivity test appeared; in 1969, came the manipulation tests from Minnesota, and the seven-part Jebsen Taylor hand function test; in 1970, the O'Connor finger dexterity test appeared; in 1980, the Sollerman functional grip test was presented.[13]

In 1985, the Box and Blocks test and the Nine Holes test were validated and standardized by Mathiowetz. These tests were previously used indiscriminately, with data associated with the normalcy of the participants.[14]

After the validation by Mathiowetz,[14] the BBT was used by Goodkin et al.[15] in the evaluation of patients with multiple sclerosis, showing more sensitivity in the detection of changes in the functionality of upper limbs and useful to therapeutic monitoring.

Araújo[16] divides the hand evaluation into four parts: evaluation of motor, sensory, functional, and esthetic functions. In the motor function evaluation it is necessary to verify: measures of articular mobility (through goniometry), muscle strength, and pinch and grip strength. In the sensory evaluation the alterations of the various types of hand sensitivity are detected and measured: sensitivity to touch, thermal pain, proprioceptive, static and mobile two-point discrimination, vibration sensitivity,stereognosis, and evaluation of the sympathetic function. The functional evaluation identifies the hand's functional capacity, including gross and fine motor skills, manual dexterity, and performance of daily life activities (practical and work-related) in one and two-handed activities.

There are few instruments to evaluate the functions of the hand that consider the domestic socio-cultural reality. Some researchers linked to universities in Brazil have been willing to invest in the translation, transcultural adaptation, and validation of evaluation instruments to the Portuguese language, and also in the creation of typically domestic evaluations.

OBJECTIVE

Considering the need to better know the manual capacities of persons with DS, this study aimed to evaluate the influence of lateral dominance in the manual dexterity of a group of children and adolescents with this syndrome and compare it to a control group.

METHOD

In this study, 100 children and adolescents participated, fifty of whom with Down syndrome (DSG) and fifty as a control group (CG). Both groups were paired by gender and age, with each group made up of 10 children with 7, 8, and 9 years old, and 10 adolescents aged from 14 to 15 years old. From both groups participants were excluded: if they were diagnosed with a disease, disability, or limiting disorder on the upper limbs; if they regularly used medication that could interfere with their motor functions; and if they showed any difficulty in understanding the test instructions.

The Box and Blocks Test (BBT) was validated and standardized by Mathiowetz et al.[14] and seeks to quantify the manual dexterity of the subject. The subject is instructed to transfer the most wooden blocks possible from one side to the other of a wooden box with a central division, during one minute. In this study a small modification was made to the box by sealing the two central openings. This adaptation was necessary so that the subjects would not try to pass the blocks through the openings (Figure 1).

The result of the test is given by the number of blocks that the subject managed to transfer from one side of the box to the other in one minute. Such a procedure was validated in Brazil by Mendes et al.[17] In the present study, the evaluator counted out loud, one by one, the number of blocks transferred from one compartment to the other. This was done to help maintain attention and continuity to the task, making it possible to better control it.

The BBT is considered the simplest and most popular test for manual function. Used to measure the gross manual dexterity and applied individually, it allows the observation and measurement of time and resistance while performing the task of transferring the blocks, but does not evaluate the capacity to manipulate. In the evaluation of hand and fingers dexterity, the BBT makes it possible to measure the velocity of manipulation of objects and the quality of manual function. Despite being a test that does not allow one to classify the type of grip, it allows the perception of any irregularity in the form of handling the object.

The evaluations were made following the recommendations on the environment of application, according to the studies of Mendes et al.[17] a quiet well lit place, the subject seated comfortably in a chair appropriate to his/her size, the box placed horizontally in front of the subject, with the division aligned to the sagittal plane of the subject's head, allowing total aerial view of the apparatus used for his/her manual dexterity evaluation.

All the subjects trained for 15 seconds before the test was applied. After the training, the blocks were placed in their initial position. Two sequential evaluations for the dominant hand were made, and two for the non-dominant hand.

RESULTS

To better understand the motor performance of the subjects, the results are described as a function of the characteristics of the groups studied: presence of the syndrome, age of subjects, and manual dominance.

The final composition of the groups studied was as follows: of the 50 subjects in the DSG, 27 were boys and 23 were girls; in the CG there were 20 boys and 30 girls. To verify how identical the groups were in relation to

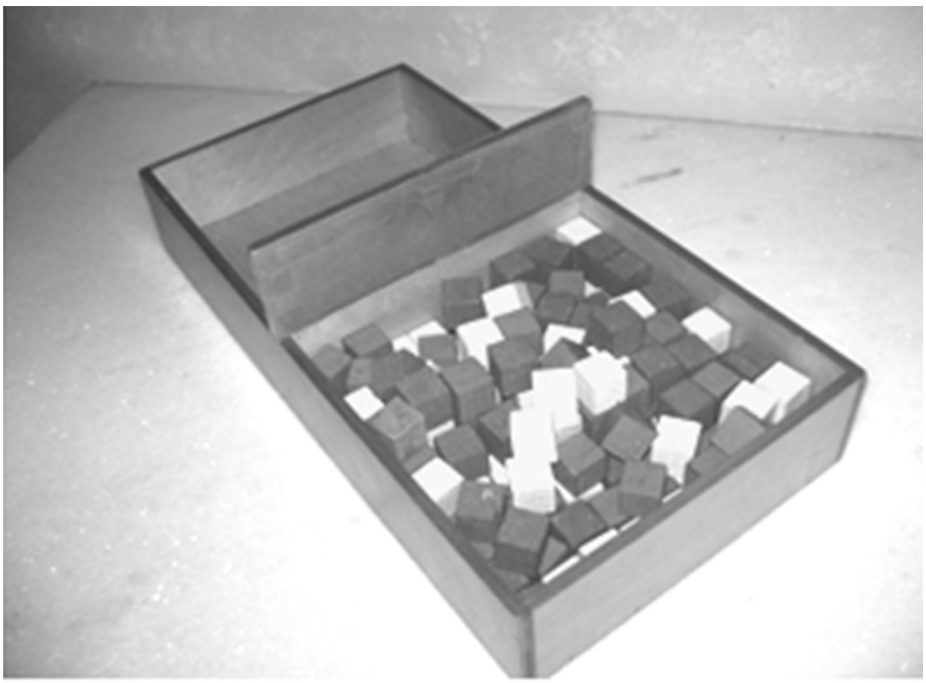

Figure 1. Box and Blocks Test with sealed openings

the subjects' gender, the chi-square test (χ^2) was applied and it revealed no significant difference between the groups (p = 0.161). To confirm whether the distribution was maintained in the two age intervals studied (7 to 9 and 14 to 15 years old), a new chi-square test was applied and a similar pattern was observed in the analysis of the groups concerning age. Table 1 shows the frequency of occurrences of gender in the two groups.

The chi-square test was applied again to verify whether the two groups differed in lateral dominance. Although 7 (14%) DSG subjects showed dominance to the left side and only 1 (2%) CG subject showed the same, this difference was not significant.

In the comparison between the dominant and non-dominant hand performances, the BBT showed a different pattern between the DSG and CG subjects. Thus, the *t* test for independent readings revealed, as expected, a significant difference between the dominant hand and the non-dominant for the CG, in the first evaluation ($t_{[49]}$ = 4.838; $p \leq 0.001$), as much as in the second ($t_{[49]}$ = 5.711; $p \leq 0.001$), with the dominant hand transferring an average of 3 more blocks in both trials. However, for the DSG, a difference between the dominant and non-dominant was found only in the second evaluation ($t_{[49]}$ = 3.628; $p \leq 0.002$). Table 2 shows the numbers of blocks transferred by the two groups in the first and in the second evaluations.

An ANOVA analysis of repeated readings revealed that the DSG performance was significantly lower than the CG in all the conditions. On the first evaluation, the number of blocks transferred by the DSG (m = 27.54; SD = 8.157) with the dominant hand was significantly less ($F_{[1.99]}$ = 466.635; $p \leq 0.001$) than the CG (m = 67.62; SD = 10.276). A similar pattern was also found for the non-dominant hand ($F_{[1,99]}$ = 415.611; $p \leq 0.001$). On the second evaluation, the same pattern was maintained, with the CG transferring more than twice as many blocks as the DSG subjects, for the dominant hand ($F_{[1,99]}$ = 430.571; $p \leq 0.001$) as well as for the non-dominant ($F_{[1,99]}$ = 400.778; $p \leq 0.001$).

The analysis of the relation between age and the BBT performance was made through the ANOVA for repeated readings for each hand in both evaluations. The results indicate the effect of age for the DSG subjects only on the first evaluation with the dominant hand ($F_{[4,49]}$ = 3.473; $p \leq 0.015$). According to *post hoc* analyses, 15 year-old subjects were able to transfer more blocks than all the other subjects. No differences were observed in the first evaluation for the non-dominant hand, as well as for either hand in the second evaluation. Figure 2 shows the average readings of the first and second evaluations for each of the hands of the DSG and CG.

DISCUSSION

Behaviors such as hyperactivity and inactivity were described by Pueschel,[18] referring to possible mood swings observed in children with DS. However, they can perform simple frequent repetition tasks that demand little eye-hand coordination, as long as they are appropriately stimulated.[19] The BBT is a perfect example of this type of task.

The performance of both groups was better in the second evaluation than in the first, especially for the dominant side. This data concurs with the results referred to by Mathiowetz et al.[14] that indicate better test performance for the dominant side. A better performance on the second evaluation can be linked to the familiarization of the subjects evaluated with the material presented, as well as a better understanding of the task to be fulfilled.

The evaluations proceeded as shown in the method, and although the colors of the blocks seemed not to have any influence in the original application of the BBT, some children with DS showed preference for certain colors in the present study. This happened especially during the initial 15 second training, but the color of the blocks can be a variable that interfered with the performance of DSG children. Although the use of standardized instruments demands following instructions correctly, studies that manipulate the color of the blocks may clarify the effect of this variable in the motor performance, even if the validity and reliability of the test are connected directly to its correct use.[13] Mathiowetz et al.[14] recommend the use of colorful blocks, but in the DSG case this characteristic seemed questionable and, maybe blocks of the same color or material could avoid some perceived distraction in this group. Such changes could be important, since color is not presented as an essential item for the application of the test and can interfere with the final conclusion by creating confusion between the attention and visual components of motor skill. Garros et al.[20] used the BBT to evaluate motor skill in patients with neurological sequelae, of the hemiplegic type; they suppressed the use of color and adapted the shape using cylinders instead of cubes.

The BBT was applied initially on the DSG and later on the CG, continuing to count out loud in the evaluation of subjects of this last group. This procedure allowed better control in the recording of the number of blocks transferred.

The search for an appropriate test and the consequent option for the Box and Blocks

Table 1. Frequency of occurrence of subjects from the Down syndrome group (DSG) and from the control group (CG) concerning gender and age

Characteristics		Groups		χ^2 (bicaudal)
Age (years)	Gender	DSG (n = 50)	CG (n = 50)	
Totals	Female	23 (46%)	30 (60%)	$p = 0.161$
	Male	27 (54%)	20 (40%)	
7 to 9	Female	14 (47%)	21 (70%)	$p = 0.070$
	Male	16 (53%)	09 (30%)	
14 to 15	Female	09 (45%)	09 (45%)	$p = 1.00$
	Male	11 (55%)	11 (55%)	

Table 2. Average number of blocks transferred by the Down syndrome group (DSG) and control group (CG) on the first and second evaluations of each of the hands

			Evaluation 1				Evaluation 2			
			Dominant		Non-Dominant		Dominant		Non-Dominant	
DSG	N	Age	Average	SD	Average	SD	Average	SD	Average	SD
	10	7	24.40	6.204	26.20	4.894	26.90	6.332	26.40	3.950
	10	8	26.00	6.566	25.30	5.813	30.20	5.287	26.60	6.736
	10	9	23.90	4.818	25.90	5.840	29.30	7.761	27.60	5.797
	10	14	28.80	8.203	30.90	10.279	32.40	9.812	31.20	10.612
	10	15	34.60	10.233	33.30	11.634	36.50	10.288	34.80	11.400
	50		27.54	8.157	28.32	8.457	31.06	8.450	29.32	8.522
CG	10	7	57.50	4.972	57.10	4.841	62.30	6.343	59.50	4.696
	10	8	63.20	5.846	58.80	4.940	64.10	6.154	60.60	5.147
	10	9	63.10	6.100	59.30	5.498	67.30	4.244	61.10	3.784
	10	14	77.00	7.832	72.10	5.877	79.70	10.361	75.50	6.258
	10	15	77.30	7.573	73.80	7.436	81.50	7.517	77.60	10.394
	50		67.62	10.276	64.22	9.139	70.98	10.661	66.86	10.158

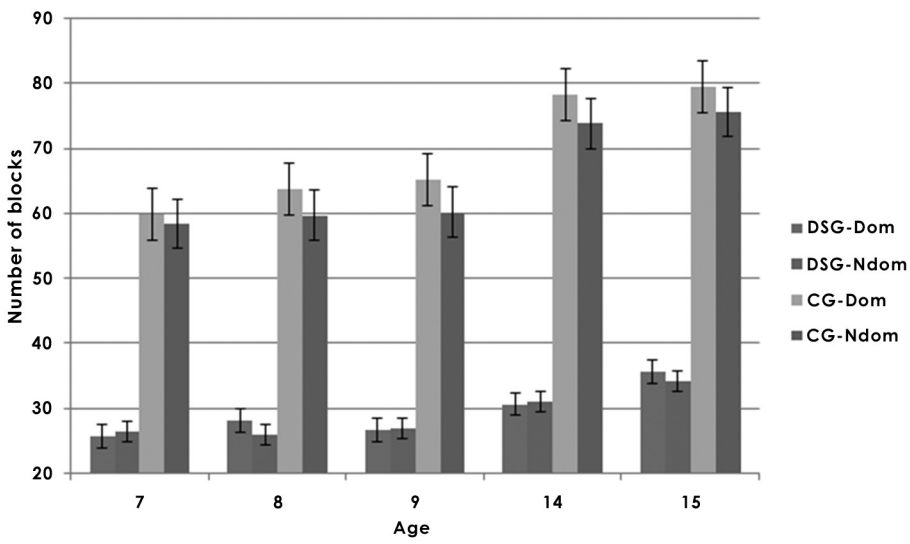

Figure 2. Average number of blocks transferred on two evaluations for Down syndrome subjects (DSG) and controls (CG) for the dominant hand (Dom) and non-dominant (Ndom)

test to evaluate the manual dexterity of individuals with DS is a first step in showing the need to emphasize the evaluation of the upper limbs motor function and coordination in this group of people.

CONCLUSIONS

The objectives of this study were reached, for it is possible to evaluate children and adolescents with DS through the Box and Blocks Test. The test seems to have been effective, due to its easy understanding of the order and simplicity of execution; therefore, being appropriate for using in intellectually deficient populations.

It was possible to use the BBT in the normal population and in the DS population in different age brackets, especially between 7 and 9, and 14 and 15 years of age, periods corresponding to entering elementary school and high school in Brazil, respectively. The BBT evaluation allowed the confirmation of important differences in the performance of children and adolescents with DS when compared to the control group, observing lower performance with the dominant and non-dominant hands for the Down Syndrome Group.

This study revealed improvement in the performance due to age for the CG and stabilization of results on both age brackets studied for the DSG. These results show a slight evolution in manual dexterity with increasing age for children with DS. In addition, the BBT proved to be a sensitive test for detecting and quantifying manual dexterity.

It is important to point out that no lateral dominance effect was observed in the DSG, for the number of blocks removed was similar for both hands. Moreover, the predominance of right-handed subjects in both groups was observed, suggesting that the dominance does not explain the absence of effect. However, new studies may shed some light on the lack of any lateralization effect in Down Syndrome.

The readings presented in this study by the BBT manual dexterity test made it possible to quantitatively compare the difference between a group of children and adolescents with Down syndrome and a normal group.

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