Manual dexterity performance by box and blocks test in brazilian children and adolescents

Caracterização do desempenho de destreza manual pelo teste caixa e blocos em crianças e adolescentes brasileiros

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ABSTRACT: The Box and Blocks Test (BBT) has been shown to be effective in evaluating manual dexterity, which is characterized by the ability of the hands and fingers to perform a task requiring coordinated movements, such as manipulating objects undergoing actions involving speed and force. The aim of this study was to characterize the performance of manual dexterity by BBT for the age group between 7 and 14 years. The study consisted of 105 participants, both sexes, divided into two groups: (7-10 years) and (11-14) without presenting upper limb abnormalities. The results showed better performance for the preferred side (right) in the BBT. Regarding the comparison of groups by age, the group of 11-14 year old children performed better, proving that the higher the age, the test performance for both hands is better (p=0,000 for preferred hand and not preferred hand for girls and p=0.000 and p=0.001 for preferred hand and non-preferred hand for boys). It can be concluded that, for the study population with typical development, the performance in the box and blocks test was better for the oldest age group for both hands and that, based on the data collected, it was possible to present performance parameters for this test in the age group between 07 and 14 years old, age which had not been contemplated in the original study proposal by Mathiowetz in 1985.

Keywords: Motor skills; Hand; Evaluation studies as topic; Child; Adolescent; Brazil.

RESUMO: O teste Caixa e Blocos (TCB) tem se mostrado eficaz para avaliar a destreza manual, que se caracteriza pela capacidade das mãos e dos dedos para desempenhar uma tarefa que requer movimentos coordenados, como a manipulação de objetos sob os aspectos de velocidade, resistência e força. O objetivo desse estudo foi caracterizar o desempenho de destreza manual pelo TCB para a faixa etária de 7 a 14 anos. O estudo contou com 105 participantes, de ambos os sexos, sem apresentação de anormalidades de membro superior, divididos em dois grupos: (7-10 anos) e (11 a 14). Os resultados mostraram melhor desempenho para o lado dominante (direita) no TCB. Em relação à comparação de grupos por idade o grupo de 11-14 anos obteve melhor desempenho, demonstrando que quando maior a idade, melhor o desempenho no teste para ambas as mãos (p=0,000 para mão dominante e mão não dominante para o sexo feminino e p=0,000 e p=0,001 para mão dominante e mão não dominante no sexo masculino). Pode-se concluir que, para a população estudada com desenvolvimento típico, quanto maior a idade, melhor o desempenho no teste caixa e blocos para ambas as mãos e que, a partir dos dados coletados, foi possível apresentar parâmetros de desempenho para esse teste na faixa etária entre 07 a 14 anos, faixa etária não contemplada na proposta do estudo original de Mathiowetz em 1985.

Descritores: Destreza motora; Mãos; Estudos de avaliação como assunto; Crianças; Adolescentes; Brasil.

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INTRODUCTION

The hand is the most important tactile sensory organ, and is able to perform fine movements, controlling strength and precision. It is also used for manipulating and grasping objects, being an important tool for the satisfactory execution of daily life activities due to its ability to perform dexterity skills and various other functions[1].

Manual dexterity is defined as the ability of the hands and fingers to perform a task that requires coordinated movements, like the manipulation of objects undergoing actions involving speed, stamina and strength. Finger dexterity, on the other hand, requires the handling of small objects and the ability to perform certain manipulations[2].

Some assessment tools can be used to quantify the performance of the manual ability of an individual, like the test box and blocks (BBT), validated and standardized by Mathiowetz et al.[3] and validated in Brazil for the general population, with 446 participants and 117 patients with multiple sclerosis, where both groups had participants between 15 and 86 years[4], the test being precise in detecting functionality changes in upper limb movements, including people with other diagnoses[5].

Considered a simple test of easy application for assessing manual functions, the BBT aims to assess and quantify the gross manual dexterity and skills of the participant. It also allows to observe the measurement of time and resistance in the test[5].

The BBT consists of a wooden, 53.7 cm long box, with a partition in the middle taller than the edges, the partition consisting of two holes in the middle that only assist in transporting the box, 150 wooden blocks 2.5 cm in size, these blocks evenly divided and painted in primary colors[3,4].

In order to administer the test, a quiet environment is required in which the examinee is oriented to sit in a chair that must be adequate to their height, with the box positioned in front of them horizontally on a table, allowing for complete vision of the box[4].

The examiner must guide the participant on how to proceed with the test. The test is simple and consists in transporting small wooden cubes from one side to the other for a minute. These blocks should be taken from one extremity to the other. At the end, the number of blocks must be registered both for the dominant and the non-dominant upper limbs, in two attempts. The examiner must always take into account verbal commands for better administering the test, stimulating the participant to achieve the highest number of block transfers within the estimated time[4,6].

When starting the test, the participant should be instructed to start with their dominant hand and, in order to do this, a laterality test can be applied, defining whether the subject is right-handed or left-handed[4,7].

This test has been used in the country in several studies, mostly targeted at populations with changes in development and neurological or orthopedic clinical diagnoses. A study Down Syndrome patients between 7 and 15 years shows there is no significant difference in manual dexterity of children between 7-9 years and between 14-15 years, indicating that these skills do not seem to evolve with age, unlike the population with typical development[5]. Fine motor performance was already evaluated in Brazil in groups with Down Syndrome through other golden standard instruments, such as the Bayley Scales of Infant and Toddler Development-BSITD-III, with lower performance being observed in the typical group, confirming the data found via BBT[8].

Some studies have demonstrated that manual dexterity may be related to better performance in some tasks, such as writing. In order for an individual to acquire this ability, it is necessary that there be coordination of fine and precise movements, with specialized use of the intrinsic hand muscles[9]. The literature also states that people with learning difficulties tend to have delays in coordination, manual dexterity, and fine motor skills[10].

In order for the dexterity assessment to be accurate, the use of instruments able to quantify the performance on motor tasks for all ages is required. Mathiowetz et al.[3] proposed BBT with parameters for ages between 20 and 94 years. In Brazil, BBT was used for the age group between 15 and 86 years, with typical groups and groups with multiple sclerosis[4]. Guimarães et al.[5] used the test for typical groups and groups with Down Syndrome in Brazil, including ages between 7 to 9 and 14 to 15 years. However, no studies using BBT were found that standardize the performance score for children and adolescents under the age of 15 years and without upper limb disorders, i.e. without the presence of conditions that compromise their manual functions.

Hence, it is relevant to investigate the distribution of scores for the test in the Brazilian population of this age group in studies involving large numbers of people for establishing parameters and performance estimates for different ages and potential changes in performance according to age.

OBJECTIVE

This study aimed to characterize the performance of manual dexterity through the test box and blocks (BBT) in children and adolescents between 07 and 14 years.

METHODOLOGICAL PROCEDURES

A total of 120 people participated, of both sexes, between 07 and 14 years, divided into two groups: Group 1 (7-10 years) and Group 2 (11-14 years), with typical development. The exclusion criteria were: having any orthopedic, rheumatism or neurological diagnosis that could compromise the performance of the upper limbs in the tasks proposed, and presenting ambidexterity for the test of manual preference.

The data were collected by means of a cross-sectional evaluation inside private schools, in cities of the metropolitan region of São Paulo, in physical spaces defined by the one responsible for the site, where participants could feel comfortable when executing the test. All patients that passed in the inclusion criteria and agreed to participate voluntarily in this study were included.

The sampling was of type convenience and the invitation for participation occurred through presentation of the project to schools and the consent of those responsible. The participants were presented the test, being free to proceed or not with the assessments, which took place during the period of two months, all those who have expressed interest in participating being evaluated, until the amount of participants necessary was complete.

Data collection was performed at a period scheduled with the participants who agreed to be part of the project, after approval of the study by the Ethics Committee of the university. The approval was registered under CAAE 45606715.4.0000.0084 and Opinion No. 1.131.752. The assessments were conducted individually, in peaceful surroundings, at which were present the examiner, an assistant, and the participant.

The Van Strien manual preference questionnaire[11], which requires the participant to indicate the preferred hand for conducting 11 tasks: get the pencil while drawing (1); hold the toothbrush (2); brush their teeth (3); unscrew the cap of a bottle (4); throw a ball (5); deal cards from a deck (6); grip a paddle (7); open the lid of a box (8); hold a spoon when eating soup (9); erase with an eraser (10); open a door with a key (11). For the option of the right hand will be assigned the value +1, and for the option of the left hand the value of −1, and for the option for "any of them" the value 0. Participants were classified as heavily right-handed (with values between 8 and 10) and heavily left-handed (with values between −10 and −8).

Afterwards, the participants were asked to execute BBT individually. For the test administration, the recommendations described by Mathiowetz et al.[3] and Mendes et al.[4] were followed.

The administration environment was in a place without noise and well lit, with participants sitting comfortably in a chair appropriate for their sizes. The box with the blocks was placed in front of the student, in horizontal position, with the partition aligned to the sagittal plane of the head, thus enabling total vision of the equipment used for the assessment of manual dexterity.

All participants were able to train for about 15 seconds before the test. After training, the blocks were placed in the starting position. Two sequential assessments were made for the dominant hand, and two for the non-dominant hand, taking the average of blocks transferred per minute for the calculation of scores.

The time recorded was one minute, and the number of blocks transferred were computed, this being the test score (blocks/minute).

RESULTS AND DISCUSSION

All participants assessed in the test showed interest and everyone was given a performance feedback, not existing any refusal nor mentioning difficulty in understanding the task, which was executed by all participants. Among the 120 participants, 15 were classified as ambidextrous through Van Strien manual preference test[11], being excluded according to the criteria proposed in the method. From the remaining participants, 99 students were right-handed (94.28%) and 6 were left-handed (5.72%). The final sample of the study consisted of 105 children and adolescents, divided in two groups, with Group 1: 7-10 years, with 29 girls and 26 boys; and Group 2: 11-14 years, with 27 girls and 23 boys.

The data were recorded on individual sheets with the scores of the two tests, Van Strien and BBT. After the collection, the data were tabulated in Excel spreadsheets and separated by sex and age group for statistical treatment.

The results of BBT performance were organized in tables considering sex, age range of the group, dominant hand (DH) and non-dominant hand (NDH), with an average of two tries for the subjects, standard deviation, and number of evaluated.

Normality tests (Anderson-Darling) of the sample were performed and there was normality for both groups. Fisher tests were performed for variances, and t-student for the averages.

In the sample analyzed, there was no performance difference between girls and boys in the age group 7-10 years between DH and NDH. In the case of the group with 11-14 years, results showed equal variances, and averages differ for DH and NDH, the best performance being shown for the girls (P=0.000 and P=0.005, respectively).

In the comparison of groups by age, it was observed that, for girls and boys, of both age groups and for DH and NDH there was equality of variances. However, there was difference in averages between age groups for the groups

of boys and girls, with a better performance for the group from 11 to 14 years, demonstrating that the higher the age, the better the performance on the test for both hands with p=0.000 for DH and NDH for girls and p=0.000 and p=0.001 for DH and NDH in boys.

Normative data of the sample compared to the BBT are detailed in Tables 1 and 2, for girls and boys, arranged according to the presentation of data provided by Mathiowetz et al.[3] and Mendes et al.[4], including age, number of participants (n), dominant and non-dominant hand (DH and NDH), average of cubes transported per minute and standard deviation, minimum and maximum number of cubes transported.

Table 1: Normative data for girls

Age (years)	N	Hand	Mean	SD	Minimum	Maximum
7-10	29	DH	62.03	5.816	46	91
		NDH	60.07	7.987	40	91
11-14	27	DH	77.87	7.060	64	95
		NDH	73.32	8.552	56	90

Table 2: Normative data for boys

Age (years)	N	Hand	Mean	SD	Minimum	Maximum
7-10	26	DH	61.79	7.454	45	78
		NDH	60.04	7.618	43	75
11-14	23	DH	70.63	6.298	58	89
		NDH	66.78	6.770	55	88

In this study it was opted to assess and analyze the results considering the manual preference identified by the Van Strien test[11], which determined the percentage of left- and right-handed participants. The studies by Mathiowetz et al.[3] and Mendes et al.[4] made the performance analysis considering right and left hand, regardless of manual preference. However, according to most recent studies[12], the analysis of manual asymmetry or preference must be analyzed according to the dominant and non-dominant hand, hence discarding any error in the interpretation of the data.

Mathiowetz et al.[3] did not consider the ambidextrous people in their manual preference assessment, distributing the 628 participants into left- and right-handed. The definition of laterality was made from a question to the

participants: are you right-handed or left-handed? The researchers recruited the subjects in shopping centers, fairs, senior centers, rehabilitation centers and the university. The audience of Americans participating in the study was distributed in age groups of 5 years starting from 20 years, until 74, plus another group that encompassed all participants with more than 75 years. Each group had at least 21 and not more than 29 members of each sex. In this study, the sample was composed of 105 participants between 7 and 14 years, divided into two groups (7-10 and 11-14), varying between 23 and 29 participants by sex in each of the two age groups, following a similar distribution to the original study by Mathiowetz.

Validation of the BBT in Brazil was performed with

a group composed of 446 individuals without orthopedic or neurological dysfunctions, with an age group between 15 and 86 years. The authors found 418 right-handed, 17 left-handed and 11 ambidextrous. The percentage of left-handed and ambidextrous individuals was of approximately 6%, while in this study it was of 17.5%, considering both left-handed and ambidextrous[4]. This difference may be related to the age investigated, since there is a high percentage of crossed laterality occurrence in school students in the early years of elementary school[13].

The study by Mendes et al.[4] grouped ages in blocks of ten years (15-24; 25-34; 35-44; and 45-54 years, with the last group being composed of subjects above 55 years). The number of members per group, also separated into men and women, ranged from 38 to 65. It is worth considering that this study assessed age groups with less than 5 years (7-10 and 11-14), complementing the groups not covered by the BBT parameters of Mathiowetz et al.[3] and Mendes et al.[4].

In Brazil, one study applying BBT with children and adolescents with Down Syndrome (DS) found that, for comparative purposes, performed the test in a control group (CG) on age groups between 7 and 9 years and between 14 and 15 years with the purpose of comparing the evolution of manual dexterity according to age. This hypothesis was confirmed for the CG, but not for the group with DS, for which there were no performance changes over time[5]. The average of blocks transported for the CG, which was composed of children and adolescents of 7, 8, 9, 14 and 15 years was between 60 and 79 for DH and 58 and 75 for NDH, with no differentiation between the sexes. However, data were not collected from ages between 10 and 13 years. It can be observed that the average number of blocks per minute transferred by the dominant and non-dominant hands does not differ much from the results obtained in this study, and in both groups there were improvements in manual performance according to age.

The data discussed here demonstrate the ease of administration of the test, with good understanding among participants and good performance, making it an effective instrument for the assessment of manual performance due to its practice preparation and low cost. The measures and instructions for obtaining the material are available in the original article[3], as well as all the instructions for administration, which were also published by Mendes et al.[4] in order to validate the test for the Brazilian population and additionally use it with patients with multiple sclerosis.

A total of 12 works in Brazil that made use of the BBT until April 2018 were found in the databases Lilacs, Medline, Pubmed, Web of Science and SciELO, all of them after the publication of Mendes et al.[4] in 2001. The studies are concentrated between 2009 and 2016, with populations with cerebrovascular accident (6); multiple sclerosis (2) and Down Syndrome (4). There is a predominance of adult audience in the literature, mostly aimed towards patients with cerebrovascular accident, focusing on spastic hand[14-19] and multiple sclerosis[20,21]. Studies with children or adolescents occurred only with Down Syndrome, and are available in smaller number in the databases consulted[1,6,22,23]. The establishment of parameters for younger age groups paves the way for assessing dexterity for this audience, whose focus on manual activity can benefit school activities and daily life.

With the use of objective assessments, it is possible for diagnostic and intervention actions that support evidence-based practice in the field of rehabilitation to be conducted.

FINAL CONSIDERATIONS

The data presented here allowed for the establishment of parameters for the age group between 7 and 14 years, complementing the scores already found in the literature, which were concentrated in ages starting from 15 years. Use of BBT is simple and suitable for ages younger than the ones hitherto described, opening possibilities for greater accuracy in assessing manual function, and enabling better therapeutic planning for different age groups and different clinical scenarios.

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