Evaluation of fine motor skills of children with Down syndrome in the handling of the material LEGO® education

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Abstract

Introduction: Down syndrome (DS), first described in 1866 by John Langdon Down, also known as trisomy 21, has specific features, such as delays in motor development and decreased muscle tone. Among the characteristics of DS, the present study highlights the manual function and the skills for handling LEGO® blocks, which involve fine motor coordination, grip strength, and precision for fitting them together. **Objective:** To investigate and describe the characteristics of fine motor skills and grip strength of children with DS for handling LEGO® material and the participants' interest in performing the proposed tasks. **Method:** The study was cross-sectional, exploratory, and descriptive research. Nineteen children aged between 6 and 12 participated, 9 with DS and 10 without the syndrome. The evaluation of manual pinches (tripod pinch, digital pinch, pluri-digital pinch, handgrip pinch, or strength) occurred in person, with the realization of filming authorized by those guardians. Aspects of interest and attention during the activities were also analyzed. The pinches models used by the groups were the same. Some difficulties of the DSG in the fittings were

Recebido em: 12/04/2023 | Aprovado em: 17/04/2023

observed, involving grip strength, visuomotor coordination, and attention. **Conclusion:** The data reinforce the presence of specific challenges for DS children and the need for studies that identify variables that can be configured as facilitators for the handling of the material, such as color identification, visuomotor coordination, attention, communication and the construction of a repertoire on the possible assemblies with LEGO®, to support the therapeutic planning with the use of this material and promote fine motor development, communication, and social interactions, as recommended in the literature.

Keywords

Down syndrome. Motor skills. Child development. Interdisciplinary practices. Play and playthings.

Avaliação da motricidade fina de crianças com síndrome de Down no manuseio do material LEGO® education

Resumo

Introdução: A síndrome de Down (SD), descrita pela primeira vez em 1866 por John Langdon Down, conhecida também como trissomia do cromossomo 21, possui algumas particularidades específicas, como atrasos no desenvolvimento motor e diminuição do tônus muscular. Entre as características da SD, destacam-se no presente estudo a função manual e as habilidades para manuseio dos blocos do LEGO®, que envolvem a coordenação motora fina, a força de preensão e a precisão para os encaixes. **Objetivo:** Investigar e descrever as características da motricidade fina e força de preensão de crianças com SD para o manuseio do material LEGO® e o interesse dos participantes para execução das tarefas propostas. **Método:** O estudo foi de caráter descritivo, comparativo e transversal. Participaram 19 crianças, entre 6 e 12 anos, nove com SD e dez sem. A avaliação das pinças manuais (pinça trípode, pinça digital, pinça pluridigital, pinça de preensão palmar ou força) ocorreu de maneira presencial, com a realização de filmagens autorizadas pelos responsáveis. Aspectos de interesse e atenção durante as atividades foram analisados também. **Resultados:** Os modelos de pinças utilizadas pelos grupos foram os mesmos. Foram observadas algumas dificuldades do GSD nos encaixes, envolvendo a força de preensão, a coordenação visomotora e a atenção. **Conclusão:** Os dados reforçam a presença de dificuldades específicas para a criança com SD e a necessidade de fundamentar o planejamento terapêutico com o uso desse material e promover o desenvolvimento motor fino, a comunicação e as interações sociais, como recomenda a literatura.

Palavras-chave

Síndrome de Down. Destreza motora. Desenvolvimento infantil. Práticas interdisciplinares. Jogos e brinquedos.

Evaluación de la motriz fina de niños con síndrome de Down em el manejo del materiales LEGO® educación

Resumen

Introducción: El síndrome de Down (SD), descrito por primera vez en 1866 por John Langdon Down, también conocido como trisomía 21, tiene características específicas, como retrasos en el desarrollo motor y disminución del tono muscular. Entre las características del SD, el presente estudio destaca la función manual y las habilidades para el manejo de bloques LEGO®, que involucran coordinación motora fina, fuerza de agarre y precisión para encajarlos. **Objetivo:** Investigar y describir las características de la motricidad fina y fuerza de prensión de niños con SD para el manejo de material LEGO® y el interés de los participantes en realizar las tareas propuestas. **Método:** El estudio fue de tipo transversal, exploratorio y descriptivo. Participaron 19 niños de entre 6 y 12 años, 9 con SD y 10 sin síndrome. La evaluación de los pellizcos manuales (pellizco de trípode, pellizco digital, pellizco pluridigital, pellizco de agarre o fuerza) se produjo de manera presencial, con la realización de la filmación autorizada por dichos tutores. También se analizaron aspectos de interés y atención durante las actividades. **Resultados:** Los modelos de pinchazos utilizados por los grupos fueron los mismos. Se observaron algunas dificultades del DSG en las adaptaciones, involucrando fuerza de prensión, coordinación visomotora y atención. **Conclusión:** Los datos refuerzan la presencia de desafíos específicos para los niños con SD y la necesidad de estudios que identifiquen variables que puedan configurarse como facilitadoras para el manejo del material, como la identificación de colores, la coordinación visomotora, la atención, la comunicación y la construcción de un repertorio sobre los posibles montajes con LEGO®, para apoyar la planificación terapéutica con el uso de este material y promover el desarrollo motor fino, la comunicación y las interacciones sociales, como se recomienda en la literatura.

Palabras clave

Síndrome de Down. Habilidades motoras. Desarrollo infantil. Prácticas interdisciplinarias. Juegos y juguetes.

INTRODUCTION

Down syndrome (DS) was described for the first time by an English pediatrician – John Langdon Down, in 1866 (Moreira, El-Hani; Gusmão, 2000). Decades later, in 1959, the French physician Jérome Lejeune identified the genetic cause of the syndrome. In the mid-1960s, the World Health Organization officialized the genetic picture as DS (Silva; Dessen, 2002).

DS is a condition generated due to an error in chromosomal distribution. It usually changes the copy quantity of chromosome 21, where three copies are found instead of two. It is an alteration of genetic origin found in different forms – simple trisomy 21, chromosomal translocation, or mosaicism (Memišević; Mačak, 2014).

Among the main developmental characteristics of DS, delay in the acquisition of motor skills, including gross and fine movements, stands out. Fine motor skills are movements that require greater precision and control and are fundamental for the child's physical, social, and psychological development. Therefore, the child must have manual dexterity during day-to-day activities (Coppede *et al*., 2012).

LEGO® therapy was created by the neuropsychologist Daniel Legoff in the United States of America and began to spread to other countries such as Canada, China, Australia, and others. This therapy can be applied individually or in a group. During application, rules must be followed to achieve the objective of the dynamics. Each participant will be responsible for an action, a crucial agenda for the interaction between participants (Legoff, 2004).

The LEGO® method has been explored for children with Autism Spectrum Disorder (ASD), as it prioritizes stimulating neurocognitive aspects, positively impacting the development of social interaction and verbal and non-verbal communication. However, this therapy model is believed to also benefit children with DS, with an additional focus on potential handling during requested tasks.

Several researchers have studied fine motricity skills in people with DS. They include peculiarities justified by the global delay in development and some oddities, such as the anatomy of the hands. These are reduced in size and with short fingers, which interferes with manipulative functions and may, together with muscular ligament hypotonia, affect grip strength and selective movements (Souza *et al*., 2013; Rezende *et al*., 2016).

As a result of their characteristics, children with DS have impaired manual function performance compared to groups of typical children. Studies that

evaluated this functionality using instruments such as the box and block test and hand dynamometer found reduced scores and measures for manual skills and grip strength, justifying the need to increase knowledge about manipulating objects and for the development of intervention programs for children and young people (Priosti *et al*., 2013).

In DS, fine manual skills, which require greater movement precision, do not seem to differ in performance from one hand to another (Guimarães, Blascovi-Assis; Macedo, 2012). However, this finding needs to be better explored since the reasons for this result are unknown in the literature. What has been observed in some studies is that laterality seems not to be defined. Studies report a higher percentage of left-handers in the population with DS than in typical individuals and a more significant number of ambidextrous people (Rezende *et al*., 2016).

Hand movement has two primary functions: pinching and gripping, with precision pinching being the hand's most essential and specialized function. The integrity of these movements is vital for carrying out activities of daily living (Freitas, 2006).

The Handgrip involves all the fingers of the hands. The integrity of the fingers' superficial and deep flexor muscles is fundamental for performing the flexion of the phalanges from the 2nd to 5th finger. The muscles of the thenar region and the long flexor of the thumb are responsible for flexing the 1st finger. The pulp-to-pulp pinch (thumb and index fingers digitals) is responsible for picking up small objects, being the most delicate and precise of the digital pinches. Others, such as the tripod, the lateral or the multidigital pinches, are responsible for movements such as holding a pen, a key, or a larger object, essential for maintaining dexterity and manual function (Ferreira *et al*., 2011).

Children with DS have joint laxity, hypotonia, and shortening of the hands, resulting in reduced grip strength and pinching. Few studies characterize how pinches occur in this group of children. However, though scarce, the literature demonstrates that significantly lower values are found in handgrip strength and hand and critical pinch strength in comparison to typical children (John; Dhanve; Mullerpatan, 2016). In this way, the present study investigates and describes the characteristics of fine motor skills and grip strength of children with DS for handling LEGO® material and participants' interest in performing the proposed tasks.

METHODOLOGY

This study is characterized as cross-sectional, exploratory, and descriptive research. Data collection occurred in a single meeting between the assessed child and the researcher to evaluate the proposed skills. The project was approved by the Ethics Committee of the Jô Clemente Institute under CAAE 2 9419120.2.3001.8647 and number 4.220.388. The Term of Free and Informed Assent (TFIA) collected the signatures or initials of the participants of both groups, the Down syndrome group (DSG) and the control group (CG), after the due explanations about the research. The legal guardians signed the Free Informed Term of Consent (FITC), authorizing the participation of the child or young person in the study and the person responsible for the Jô Clemente Institute, where we collected the data.

The DSG participants were invited to the study by the researcher through their guardians, whom the institution's representative introduced. Those who were willingly interested accompanied the children to the assessment room individually. Children were asked if they would like to participate in the evaluation session and play with LEGO®. There was no refusing. For the CG, the researcher gave the invitation, and the evaluations were scheduled at a convenient location for the collaborator.

Nineteen children were evaluated, nine with DS (DSG) and 10 without the syndrome, who made up the CG of both sexes. The inclusion criteria for DSG were being between six and 12, having the diagnosis of DS confirmed by the collaborating institution, and having a minimal understanding of the tasks and handling of LEGO® assembly. For the CG, the criterion was to be in the age group determined by the study. As an exclusion criterion for both groups, we considered the presentation of neurological or orthopedic diagnoses that could compromise the motor skills of the upper limbs, making it challenging to handle the LEGO® material.

For the DSG, data were collected at the Jô Clemente Institute, a reference institution in the city of São Paulo, which encourages research and is already a partner in the development of projects at Mackenzie Presbyterian University (Universidade Presbiteriana Mackenzie) linked to the line of research on Policies and forms of care for people with disabilities, supporting researchers in the production of scientific material. CG data were collected from the researcher's network of contacts.

After explaining the motivations and objectives of the research by presenting the LEGO® material to the users in agreement with the FITC and the TFIA, the proposed activities with the LEGO® education material were requested to the child, in the presence of a family guardian, always in a playful way, in a session that lasted between 30 and 40 minutes on average. Simple information was collected to identify the participants, with questions such as name, age, sex, diagnosis confirmation, lateral preference (right-handed or left-handed), and whether they have any LEGO® kits at home.

MackPesquisa, a financing agency at Mackenzie Presbyterian University, funded the materials used in the evaluations. LEGO® Education Creative kits were purchased, as described in detail in the Let's Build Social Skills Together manual (LEGO Education, 2024). The kit includes Animal Bingo, Community People Set, Build Me "Emotions", and Creative LEGO® DUPLO® Brick Set.

In all evaluations, at least two researchers were present. One researcher had, throughout the collection, his/her attention focused on the child. The research assistant assisted the accompanying family member and filmed the tasks, focusing on the child's hands without identifying her. The images were recorded on video to identify the type of clamp the participating children used to wrap the blocks (Boschi; Frère, 2013). For each child, after their consent, a sequence of tasks was requested, namely:

1) Let's play LEGO.
2) Let's arrange the blocks by separating them by color. The researcher encouraged the identification of the colors red, yellow, blue, and green.
3) Shall we build a tower with five blocks? The simple fitting of the pieces was observed to identify the pinches used, and the execution time was recorded.
4) Next, some doll faces with happy and sad expressions were presented to the child, asking for recognition of the emotion and requesting her to assemble with the doll, giving it a body.
5) Some articulated dolls were presented and requested to be placed in different positions, such as sitting, standing, or lying down, fitting them into the blocks.
6) Finally, a free moment was given for the child to perform his/her assembly with the material, and the child was asked to name it.
7) For all the actions, the child was observed picking up the LEGO® blocks, whether using both hands or transferring the object from one hand to the other.

8) It was also observed how the child interacted with the researcher, paid attention to the instruction, asked for help when necessary, and demonstrated shared attention.
9) At the end, the researcher gave feedback to the guardian, encouraging the use of toys that favor fitting in and fine motor skills and guiding the caregiver to interact with the child during the play.

RESULTS

The age range for both groups was between 6 and 12 (9.2 ± 2.0) for DSG, four boys, and five girls, and (8.7 ± 2.1) for GC, five boys, and five girls. The assessments took place individually, with the child seated at a table so that the material could be offered, and the tasks could be requested individually.

The DSG's guardian (father, mother, or grandmother) was asked about the child's hand preference (right or left), which was later checked while handling the blocks. For the CG, the question about lateral dominance was asked directly to the child.

The results showed that in the GC, all ten members were right-handed (100%). In the DSG, five children were right-handed (55.6%), three were left-handed (33.3%), and one was ambidextrous (11.1%).

LEGO® handling

The manipulation of the LEGO® blocks was analyzed through filming made by the cell phone by an assistant during the entire collection period. The videos' analysis aimed to identify the pinches models used: digitals, pluri-digitals, tripods, hand grip, or force. As a result, we used the same pinches to handle the blocks for both groups.

No difference was observed during the analysis of the used pinches. However, one can consider the homogeneity between the two groups in this regard. Still, differences were observed when handling the LEGO® in the requested activities, which will be described forward.

Despite the homogeneity between the pinches used in executing the requested tasks between both groups, observing some characteristics relevant to the study was possible. Children with DS showed little attention and eye-hand coordination, which made it difficult to fit the pieces together. Thus, the time to perform the tasks was longer in this group.

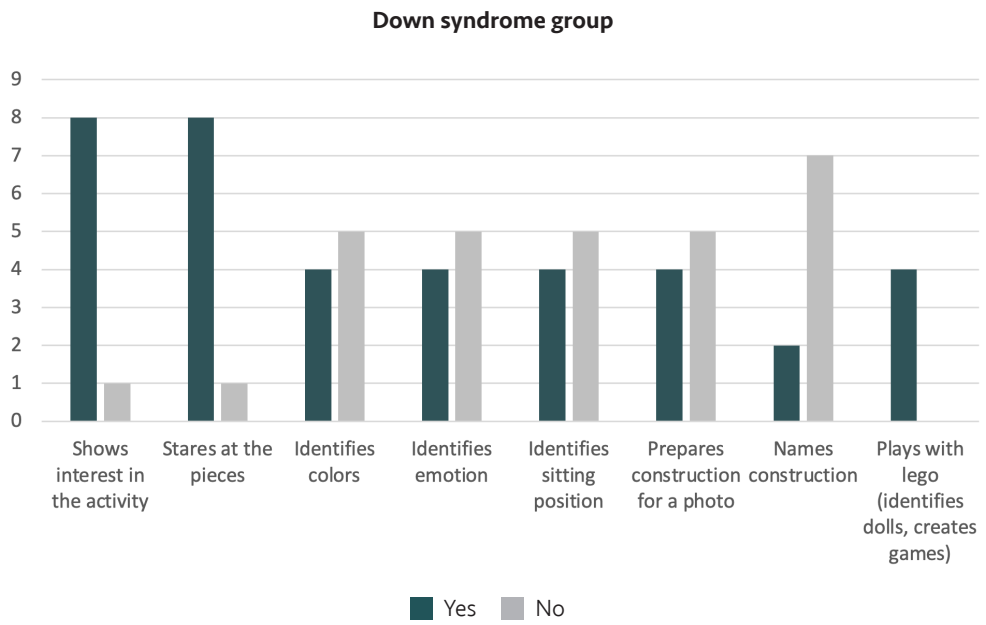
During the evaluation, the time to assemble a tower with five blocks, they differed among the participants, with an average time for DSG of 39.6 seconds and 9.1 seconds for GC.

In addition, the strength and precision applied to the fittings were relatively uneven between the SD and CG groups, with difficulties in fitting and several attempts by some children to perform the tasks being observed.

Attention during handling

Another attribute analyzed was adherence to activities during assemblies and tasks with LEGO® kits. The following aspects were observed: 1. shows interest in the activity; 2. stares at the piece; 3. identifies colors; 4. prepares a construction/assembly for a photo; 5. names the construction; and 6. plays with LEGO® (identifies dolls, creates games). In the DSG, eight of nine showed interest during the tasks and fixed their gaze on the piece. Among the nine, only four identified colors, emotions, and positions for the doll (sitting, lying down, standing), preparing construction for a photo, and playing with LEGO®. Finally, only two children named their assemblies, as shown in Graph 1.

Graph 1 Observations when handling the LEGO®

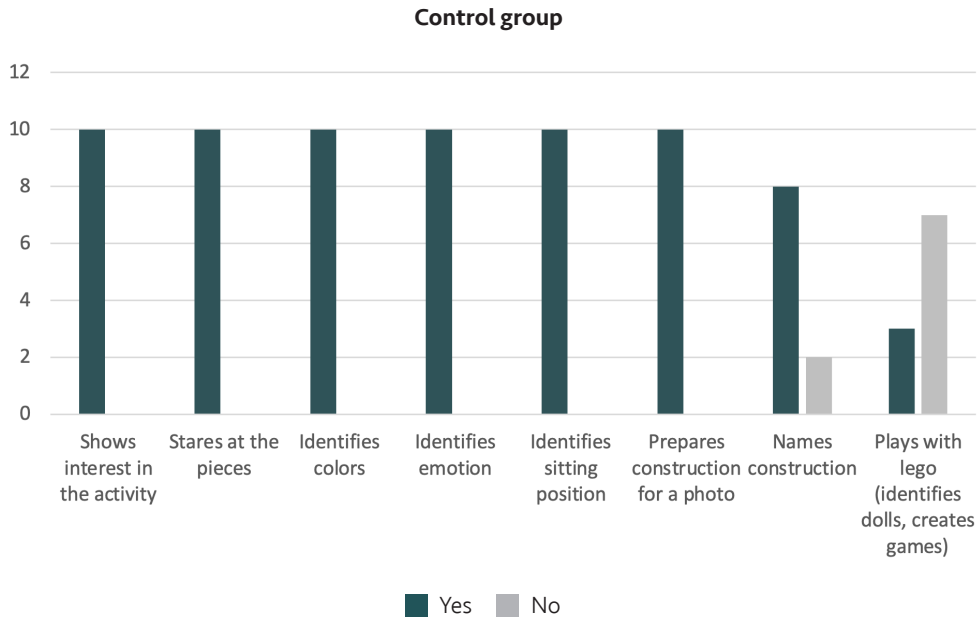


Source: Elaborated by the authors.

Cadernos de Pós-Graduação em Distúrbios do Desenvolvimento
São Paulo, v. 24, n. 1, p. 120-133, jan./jun. 2024
http://dx.doi.org/10.5935/cadernosdisturbios.v24n1p120-133

The CG demonstrated some uniformity in the results verified during the tasks. Of the eight observations, six (showing interest during tasks, staring at the piece, identifying colors, emotion, sitting position, preparing construction for a photo) were the same among the ten children without DS. The children's adherence to the other two activities was less. Only three played with LEGO®, and two named the construction as shown in Graph 2.

Graph 2 Observations when handling the LEGO®



Source: Elaborated by the authors.

DISCUSSION

The results obtained confirm that the delay in motor and cognitive acquisition correlated to the particularities of children with DS. The literature highlights challenges in the transmission process of some neural circuits (Silva; Kleinhans, 2006), causing, from a cognitive point of view, attention problems, higher reaction time, problems in auditory processing, and short and medium-term memory, difficulties in the processes of correlation, analysis, calculation, abstract thinking, limitations in perceptive discrimination, generalization capacity, and symbolization (Martinho, 2011; Barata; Branco, 2010).

Additionally, it is relevant to point out the morphological aspects, such as joint laxity, hypotonia, and shortening of the hands, highlighting the reduction of grip and pinch strength. Few studies characterize how pinches occur in this group of children, although the literature, even scarce, demonstrates that significantly lower values are found in handgrip strength (John; Dhanve; Mullerpatan, 2016).

Concerning lateral dominance, the findings of the present study corroborate indices found in the literature, indicating that compared to the typical population, there is a higher percentage of left-handers among the public with DS, equivalent to 33% of the sample, while for children without the syndrome, this index may be lower (Souza *et al*., 2021).

Besides this data, we could observe that the DSG performed differently from the CG due to the syndrome characteristics in all the requested tasks. It is possible to relate the differences found to morphological particularities, related to aspects such as hand anatomy (short fingers, thumb implantation, and absence of the last phalanx of the little finger), muscular ligament hypotonia, and ligament laxity that affect the strength to handle the instruments (Martinho, 2011).

The present study enabled the discussion of some aspects relevant to characterizing how this group behaved when assembling blocks with LEGO®, serving as a basis for future studies. It is known that there is wide diversity in the performance of children with DS and that there is a consensus in the scientific community that, although there are no degrees of DS, development differences arise from individual characteristics that are the result of genetic inheritance, stimulation, education, environment, clinical problems, among others (Silva; Kleinhans, 2006).

Identifying the need for specific interventions about fine and global motor skills as possible, correlating attention and interest. Basic hand movements such as pinching and gripping are essential for daily living (Freitas, 2006).

The force pinch predominantly used during the fitting maneuvers reinforces the difficulties in general coordination and fine motor skills, which are also problems children with DS face (Ornelas; Souza, 2001).

Based on the observations, some suggestions can be outlined to guide therapies with the use of LEGO® material, focusing on attention work. We propose to stimulate the recognition and naming of colors; the identification of the positions such as lying down, sitting down, and standing up regarding the LEGO® dolls; the recognition of emotions through figures of happy

(laughing) and sad faces; the characterization of the child's functional laterality and the expansion of a repertoire of constructions, besides the towers, with their respective names.

Works based on LEGO®, as a form of therapy proposed by Legoff (2004) and Legoff and Sherman (2006), deserve greater interest from researchers so that the benefits for communication, social interaction, and fine motor skills can be applied to children and young people with DS.

However, like all research, some limitations can be pointed out in this study, such as the reduced number of participants, as well as image analysis carried out by the researcher and assistant, and the absence of an individual assessment of the child in aspects such as language and behavior since these variables can influence performance in creativity and montages with the blocks. Thus, caution should be exercised when interpreting and generalizing the results.

CONCLUSIONS

This study aimed to investigate and describe the characteristics of fine motor skills and grip strength of children with DS for handling LEGO® material and participants' interest in performing the proposed tasks.

The research results allowed us to identify that the models of pinches used by the DS group in pairing with the control group were the same. However, physical characteristics related to the size of the hands and cognitive aspects peculiar to DS may have been decisive in differentiating the performance between the two groups, resulting in more significant challenges in fine motor coordination for performing the tasks with LEGO®.

Although the participating children showed interest in joining the activities with the material, cognitive difficulties such as color recognition, recognition of emotions, and focus of attention were registered, and a restricted repertoire for constructions and playful use of LEGO®.

Considering the exploratory, cross-sectional, and descriptive nature of the present study, it is suggested, based on the analysis carried out for this sample of children with DS, that the cognitive, social, and motor development of a child with DS can be improved and stimulated using LEGO®. Thus, it is pertinent that other investigations be conducted considering Legoff's proposals for promoting the development of the DS child.

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