Pediatrics

Manipulative skills and games performed by children ranging from 4 to 6 years of age while exploring sensorial cubes

Karina Pereira[1], Yngrid Silveira Souza[2], Raquel de Paiva Palhares[2], Paula Berteli Pelizaro[1]

[1]*Universidade Federal do Triângulo Mineiro, Departamento de Fisioterapia Aplicada, Programa de Pós-Graduação em Fisioterapia, Laboratório de Fisioterapia Pediátrica, Uberaba, MG, Brazil* [2]*Universidade Federal do Triângulo Mineiro, Departamento de Fisioterapia aplicada, Laboratório de Fisioterapia Pediátrica, Uberaba, MG, Brazil*

Associate Editor: Giordano Marcio Gatinho Bonuzzi, [1]Universidade Estadual do Piaui, Picos, PI, Brazil. [2]Graduate Program in Kinesiology, Universidade Federal do Vale do São Francisco, Petrolina, PE. Brazil. E-mail: giordanomgb@gmail.com.

Abstract - Aim: To identify and describe the manipulative actions of typical children ages between 4 and 6 years, and the games performed while exploring cubes with different sensorial stimuli. **Methods:** Cross-sectional, descriptive, and exploratory study. Sixteen typical children aged 4 to 6 years (mean age: 5.78 ± 1.04 years) were filmed, from different angles, during the exploration of six cubes with different sensorial stimuli (transparent, black, tactile, auditory, luminous, and high-contrast). The cubes were delivered in random order and the children explored the cubes for 40 s each. At the end of the explorations, they were asked about what kind of game they could play with that object. The images were observed by the BS Player Profile. **Results:** Seventeen different types of interactions with the cubes were registered, such as: pushing, shaking, reaching for (bimanual and unimanual), bringing closer to the eyes, knocking, touching with the fingers/hand, throwing upwards, and others. The tactile cube was the favorite among the children (9 children), followed by the luminous cube (6 children). They proposed games with all of the cubes, standing out playing dice (all cubes), building towers, and castles. **Conclusion:** In the observed group of children, 17 manipulative skills were identified. The games performed during the exploration of the cubes were based on association with other similar objects previously known, related to the visual stimuli provided by the cubes, verbal description of actions that could be performed with that cube, imagination related games using figurative images, and sports-related activities/games.

Keywords: motor skill, childish behaviour, creativity and children.

Introduction

Motor actions are refined in restricted contexts related to the environment, the task, and the organism at a given time, and might change accordingly to the context in which it was acquired and refined. Therefore, motor acquisitions are individual for each being, and depend on the organism's attraction to stimuli, to perceive and perform certain actions[1].

Childhood is considered a fundamental phase in the process of acquisition of motor skills, which are determined by the interaction between biological and environmental factors[2]. Play develops physical and sensorial aspects, so playing is an expected activity in the daily life of any child, as it is essential and necessary for child development[3].

Playing brings a cultural history of customs, values, and precepts[4]. Certain games can be understood as cultural learning, as attention and cognition are needed to understand the rules of games taught by more experienced children[5].

Sensorial stimuli are essential to arouse the child's curiosity, encourage manipulating objects, and create games. Oliveira et al.[6] study has shown that, while manipulating sensorial cubes, children can imagine games, for instance, the luminous cube was compared to a lampshade in a playhouse, and the cube with auditory stimulation could be used to make music and play basketball. It is noticeable that the imagination allows the child to create different meanings for the same object, whether to interact with a friend or to play by themselves[7], being an important mediator for child development and perception of the self as a whole[8].

Thus, mental activity as to creativity is related to the particularities of each child, and their actions change according to the abilities and stimuli provided to them[9]. During a professional assessment or intervention with children, playing is a motivational resource, making the

activities enjoyable, benefiting both child and professional, and being an attractive and effective approach to observing their performance[10].

The first six years is extremely important period in the child's cognitive development and playing comes as a supportive resource for the enhancement of broad and fine skills[11]. The child is constantly developing and the games evolve accordingly to their age[12].

Exploring objects serves a central role in the early development of perception, action, and memory. While touching and looking at an object, bringing it to their mouths, and manipulating it, babies learn about its physical properties, memorizing its specific characteristics so they can use this newly acquired knowledge to plan future actions[13].

The play takes place at preschool age due to the child's need to act in the world of adults' objects and take ownership of the actions performed with them in the social learning process[14].

Little is known about the motor abilities of children between 4 and 6 years old and it is extremely important to describe them and provide data to the scientific literature, as it is the developmental phase in which the child acquires various motor skills and matures them. Throughout the act of playing it is possible to observe the way children manipulate objects and gather parameters to know the repertoire of actions within typical children.

The following study's goal was to identify and describe the manipulative skills and games performed by typical children while playing with cubes of different sensorial stimuli.

Methods

Study description

The study was cross-sectional, descriptive, and exploratory and was approved by the Committee of Ethics and Research with Human Beings (resolution 466/12) of the University, under deliverance no. 3.607743/2019.

Participants

Sixteen typical children were invited to participate in the study. They were selected by expediency and the recruitment took place in a municipal school in Cristais Paulista/SP - Brazil. The mean age of the children was 5.78 years (± 1.04 years), and of both sexes.

None of the children presented visual, orthopedic, neurological, sensorial, or cognitive alteration. The "Consent form" (under 18 years old) and image usage authorization were signed by the legal guardians. The children/guardians were free to withdraw from the study at any given time.

Materials

This research adopted the same methodology used in the study by Oliveira et al.[6] During the evaluation, cubes with the following specifications were used: six cubes 15 cm, 410 g (Figure 1): (A) transparent cube (plain acrylic); (B) black cube (non-contrast); (C) high-contrast cube (with different shaped stimuli in black and white); (D) light stimulus cube (two transparent sides, with a light source inside the cube = the other sides were colored in yellow, blue, green and red); (E) auditory stimulus cube (with a rattle inside and covered with light gray paper) and (F) tactile stimulus cube (each side have a texture of different materials, including soft, wavy (narrow and broad), rough and wrinkly).

Two digital cameras were used to record the children's manipulative actions while playing with the cubes. A Samsung® (DVD SC-DX 103) camera was placed on a tripod (Power Pack= trip 21) and a Sony Handycam® (DCR-SX21) camera was placed sideways, allowing full viewing angle of the activities. Additionally, two square rubber mats 1 m, 3 cm and a digital stopwatch were used (Figure 2).

Height, distance, and angulations standards were set by a pilot study, allowing adjusting the measurements according to the anthropometric profile of the children.

Data survey

The assessments were carried out in a room provided by the school, with favorable conditions, such as lighting, temperature, and controlled noise. Each child received the cubes in a random order (the showing facet was also delivered at random). To make the child comfortable and to promote an enjoyable activity, the appraiser made sure to interact with the child from the early moments of the evaluation.

During the test, the child was seated legs bent on the mat and the appraiser positioned one cube at a time in

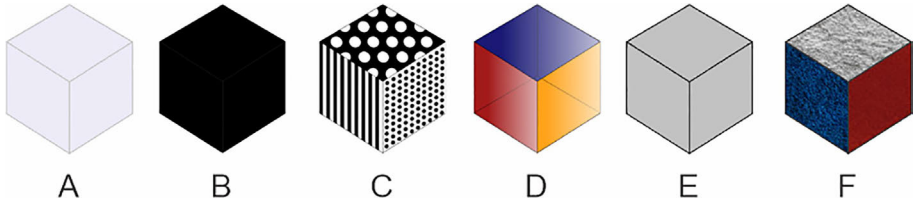

Figure 1 - Cubes representation. Source: Oliveira, Silva, Pelizaro and Pereira, 2020.

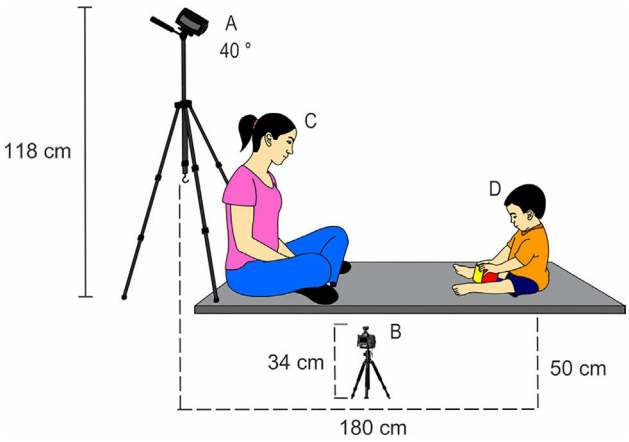

Figure 2 - Representation of the environment. Source: Oliveira, Silva, Pelizaro and Pereira, 2020. Caption: A = Camera 1 (Samsung®); B-Camera 2 (Sony Handycam ®); C = Appraiser; D = Child.

front of the child, for 40 s each, with a delivery interval between cubes of 10 s. Some pre-settled verbal commands were used to encourage the child to explore the cubes, as follows:

1. Let's see the toy? (at receiving the cube);
2. Tell me about it (at 10 s);
3. Can you tell me a game you could play with this cube? (at 20 s);
4. Are we going to meet another cube? (at 40 s). After the individual presentation of each cube, all the six cubes were put as a set, followed by the questions:
5. Which cube did you like best?
6. Can you think of a game you could play with all cubes?

Statistical analysis

The footage was analyzed using the software "BSPlayer Profile". To better identify and define the manipulative actions performed by the children during the exploration of the cubes, the video speed was reduced. To identify the games and the favorite cube, the normal speed of reproduction was used. Descriptive data analysis was performed, considering absolute frequency, average, and standard deviation.

Results

By observing the children's manipulative actions performed on the cubes, it was possible to identify a total of 17 variations, such as: moving it away, shaking, bimanual reaching, unimanual reaching, bringing the cube closer to the eyes, hitting the cube, sliding hands and/or fingers, rotating the cube, throwing the cube upwards, balancing it on one edge, moving towards the cube to look closer, holding the cube with one hand, balancing the cube on the corner, throwing the cube down, throwing horizontally and rolling the cube in the ground.

The tactile cube (14 actions) and the high-contrast cube (12 actions) presented a greater variety of manipulative actions, as seen in Figure 3.

A single child acted as moving the cube away and throwing the cube upwards, these actions being performed in high contrast and tactile cubes respectively. The number of children who performed the actions per cube is described in Table 1.

Table 2 presents the games performed by the children while manipulating the cubes. Playing "dice" was proposed with all cubes, followed by throwing and color matching. When all the cubes were presented as a set, most of the proposed games were related to stacking the cubes as a tower or castle. Regarding the interest in creating games, the luminous and tactile cubes stood out among children. In addition, it was observed that when asked to develop a game with all cubes, only one child did not express interest (Figure 4). The cube reported as preferred by most children was the tactile one.

During the assessment, all children performed at least one game. However, they did not manage to propose a game in 29 situations. The high-contrast cube had a total of 14 children developing games. On the other hand, 7 children did not create games with the transparent cube. When all cubes were delivered as a set, only one child did not develop games.

Discussion

During this study, 17 manipulative actions were identified and described among children from 4 to 6 years old. The period between 2 and 6 years of age is when a child obtains most of the fundamental motor skills development[11], and that is why it is possible to observe such a large variety of manipulative actions performed during this study.

The tactile cube (14 actions) and the high-contrast cube (12 actions) presented a larger variety of manipulative actions when explored. The total of manipulative actions performed by the children when considering the

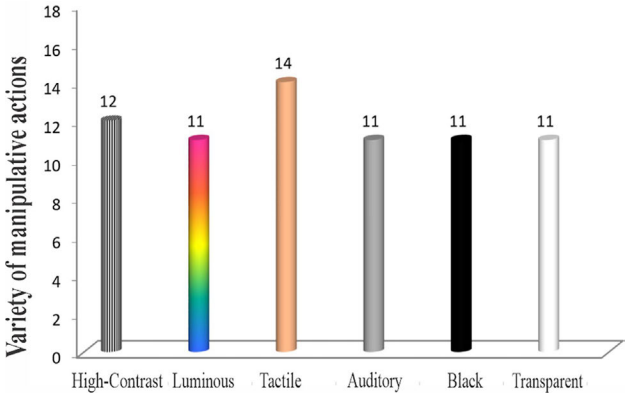

Figure 3 - Variety of manipulative actions performed per cube.

Table 1 - Number of children who performed each action per cube.

Manipulative actions	Cubes					
	High-contrast	Luminous	Tactile	Auditory	Black	Transparent
Ove the cube away	1	0	0	0	0	0
Shake the cube	4	8	7	9	3	1
Bimanual reach	9	10	8	8	10	9
Unimanual reach	6	5	7	7	5	6
Bring the cube closer to the eyes	1	3	0	2	2	1
Knock on the cube	5	7	3	5	5	5
Hit the cube on the floor	0	2	1	0	0	0
Slide hands/fingers	13	13	14	12	12	12
Spin the cube	13	12	12	11	14	14
Throw the cube upwards	0	0	1	0	0	0
Balance the cube the edge	11	11	9	8	10	11
Move closer to look at the cube	3	8	0	1	3	4
Hold the cube with one hand	1	0	4	1	1	1
Balance the cube on the corners	5	5	3	4	15	4
Throwthe cube down	0	0	1	0	0	0
Throw horizontally	1	1	1	1	0	0
Roll the cube	5	2	2	2	4	4

Table 2 - Games performed by children.

Cubes	Games
High-contrast	Dice; color; spinning; guess the color; knocking; piano; chair; “when you touch it, it turns blue”
Luminous	Dice; drums; blinker; ball; volleyball; build a castle; knocking; colors; “throw and see which color faces upwards”; color cube
Tactile	Throw to the sister; hot potato; dice; slide the hand and shake it; “Hulk”; throw to another child; swing; tree with some animals; throw; wave’ sounds
Auditory	Throw to the sister; shaking; pieces; turn around; fliping; dice; play dice; finding colors; turn the dice and knock; music; sit down; “If it touches something, it will turn blue”
Black	Play tag; spinning; “Spider-Man”; dice; put one inside the other; knock; creativity; throw to another child; “If the cube touches the ground, some object will turn black”
Transparent	Throw to a friend; “escravos de Jó” (traditional group game); spinning; “glass dice”; castle; knock; dice; shape; catch the cube
All the cubes as a set	Tower; drum. “Fofão” (popular Brazilian character); play whatever fancies the friends; “Spider-Man”; dice; playing dice; knock; playhouse; build a castle; throw; stack one on the top of the other; castle

sum of the six cubes equals 70. In the study by Oliveira et al.[6] (children with low vision and typical children and ages ranging from 7 to 10 years old), 61 manipulative actions were observed among the typical children group.

Considering all of the manipulative skills detected, the action of sliding hands and/or fingers and turning the cube were the most common actions among children, with 14 of them sliding their hand and/or fingers on the tactile cube, which correspond to the act of exploring the various stimuli provided by the object. The action of turning the black and transparent cubes was also performed by 14 children. The action of balancing the cube on the edges was performed by 11 children and the bimanual reach was performed by 10 children.

The actions performed by children are a set of manipulative skills; these skills involve the manipulation or control of objects[11]. Therefore, manipulative action involves the process of perceiving and acting: the child feels the object (perceives him, through exploration), and based on that perception they act accordingly (performs some action). When exploring, the child uses the information available in the environment (sensorial stimuli offered by each cube) according to their needs[15].

Throwing the cube upwards was performed only with the tactile cube, supporting a study by Schmitt and Pereira[9] with typical children. In the study by Oliveira et al.[6], this action was observed both in the tactile and in the transparent cube among the typical children group[6]. The action of knocking the cube on the floor was observed

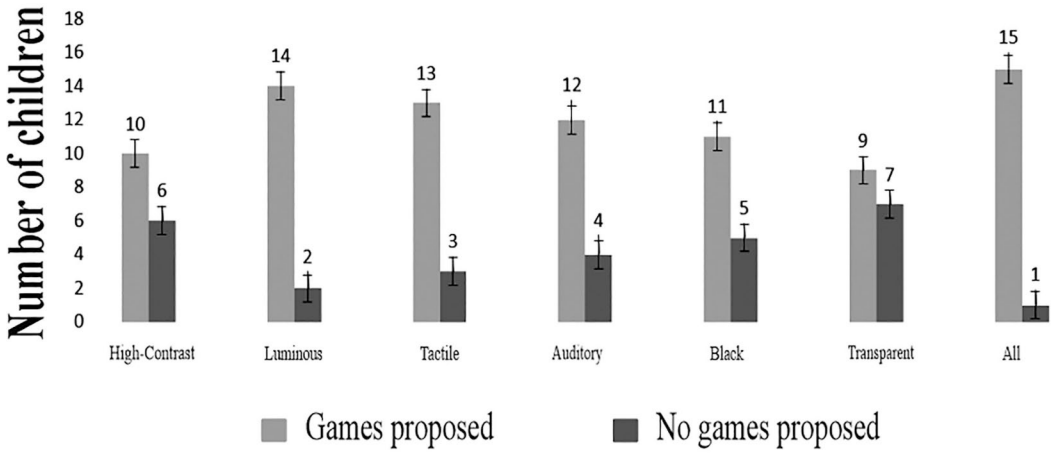

Figure 4 - Number of children who created games x number of children who did not create games.

in both the luminous and tactile cubes, while in Schmitt e Pereira[9] it was only performed in the black cube among the group of typical children.

It is also possible to observe that the tactile cube aroused greater interest, as it was chosen by 9 children when asked to pick a favorite one and it was also the most manipulated cube. This is, in fact, the most diverse cube in the stimuli level, resulting in a greater interest by the children.

If we take as an example the auditory cube, it always provides the same kind of stimulus, but it generates different responses among the children leading to different games, such as throwing the cube to the sister, music, and turning the "dice" and knocking. This comes from each child's different experiences. Thus, as observed in the study by Schmitt and Pereira[9], playing is a particular activity for each child, and children's motor actions depend on their organic possibilities as well as on task and environment stimuli (experiences)[15]. However, within all of the performed games, there is at least one proposed activity in common with the study by Oliveira et al.[6] for each of the cubes, such as playing music with the auditory cube and when the cubes were presented as a set, building castles and towers, as in piling up the cubes, was a broad favorite.

Affordance is directly linked to the possibilities of action offered to the agent by the environment, enabling the development of children's actions based on acquired experiences. Gibson highlights the importance of the environment for the individual's perception[16].Thus, offering stimuli that favor manipulation will grant more interaction with the given object. It is worth mentioning that is not qualities or properties of the environment that are captured in the perceptive act, but the possibilities of action[16]. We can see the differences between the perception of one child and another when one shook the auditory cube to hear the sound and the other felt like playing drums.

Around this age children masters fundamental movement skills, which influence the child's success in cultural games. Allied with the improvement in language usage, they expand the fields of activity and imagination. By playing, children learn about their body and movement potential, it also makes it easier for the child to grow both cognitive and effectively, and is an important tool for the development of broad and fine skills[11].

The high-contrast and luminous cubes provoked a higher number of games referring to the colors of the object, for instance, playing with colors, finding the color, and "touching it turns blue". The tactile and auditory cubes, on the other hand, originated games related to acting, notably throwing the cube. When they put the six cubes together, stacking play stood out.

During the study, several games were proposed. They can be categorized and described as: associative games, associating to a similar object; games related directly to the visual stimulus provided; verbal descriptions of possible actions to be taken; imagination-related games, assigning them figurative roles, and sports-related activities/games. These categories can help educators during children's learning by associating the objects used with the children's interactions and responses.

Playing "dice" was recurrent within all six cubes individually and together, possibly due to the similar shape. The transparent cube was referred "glass dice" by some children, describing the similarity of the material to the object. With the auditory cube the actions of throwing dice, turning the dice, and knocking it, all involved making the object move and producing more auditory stimulus, placing the object within reality.

The designing of games changes according to the diversity of each person, with characteristics that comprise several factors like culture, family, ethnicity, gender, and religion, among others, and incorporates acquired skills and expressing previous experiences within a given context[17].

Many of the games were related to the visual stimuli presented, such as playing with colors, describing the color visualized in the cube or one of the facets, or "throw and see which color faces upwards", which is also a game to describe the colors, but intending to guess the color that will be drawn when throwing the cube.

Some children, using some imagination, performed and described games such as "if you touch it, it turns blue". Powered by the make-believe, touching an object can change its color so it matches the cube. Another similar idea was when exploring the black cube, the child imagined that "if it touches the ground, it will turn dark". Many other games were also related to the colors, especially in the High-Contrast and Luminous cubes. When playing with imagination, the child uses concepts and generalizations that are beyond the possibilities of reality but can be articulated in their actions in fantasy[8].

Another form of playing consisted of a verbal description of an action, which was more commonly performed with the tactile and auditory cubes. To better acknowledge the auditory cube, it was necessary to explore the sensorial through hearing, by shaking and rattling it to hear the sound coming from the object or even "playing music" was named by one of the children. The tactile cube encouraged touching actions and games such as sliding the hand and shaking, swinging, turning, spinning, and knocking were mentioned. Sampaio et al.[8] demonstrated that children between the ages of 4 and 5 years use speech as an intermediate assistant while planning their actions[8]. The child uses speech to assist in processing their thoughts while solving a task and, at the same time, interposes in the process of developing their thinking. Vygotsky realized that speech and movement intertwine[11,19].

Still about describing an action that could be performed with that object, playing with someone else was recurrent in nearly all cubes and was brought as "throw it to my sister", "throw it to my friend" or "throw it to the other", reinforcing the socialization / social interaction in this age group. Piaget says that ages 2 to 7 comprehend the pre-operational stage when the child's social interest in their world expands. This is the phase where the acquisition of cognitive processes of thought takes place[11,18,19].

The fourth category of games encompasses those that explore the imagination, by creating a figurative object. The children gave a new meaning to that object, by when pretending that the cube was a tower, a ball, a tree, and others. Until reaching the age of 3, the child has a concrete relationship with objects in the real world, by the preschool age they can, through their imagination, represent objects mentally, giving new meaning and verbalizing[8].

Some children mentioned games involving popular characters, like "Hulk" and "Spider-Man", which is typical of the pre-operational thinking stage proposed by Piaget when children develop cognitive functions that result in logical thinking and concept formulation, and the use of symbols and language becomes broader. Preschoolers' fantastical imagination makes it possible to imitate both actions and symbols, with little concern for the accuracy or proper sequencing of events[11,18].

Lastly, some of the children proposed games related to activities such as sports (volleyball) or group games ("hot potato", "tag" or "slaves of Job"). In this age group, recreational activities are used as physical exercises. It must include popular games, make-believe games, sports practiced in a relaxed way, and a multitude of bodily practices so that the child experiences direct contact with other children and adults, which allows exploring the socio-cultural context[8].

If we observe the creation of games in general, the luminous cube stood out, being the one with the largest number of children proposing games. The transparent cube was the cube with fewer games performed because the luminous cube provides great possibilities for extrinsic stimuli than the transparent acrylic cube. Finally, when all the cubes were presented as a set, only one child did not propose a game.

According to Winnicott, children play because they like it and they acquire experience while playing, so it is an important part of their life as they find richness mainly in fantasy. Playing is equivalent to a child's job and is the prime way they learn about their bodies and movement potential[11,18,19].

Winnicott implies that when you overlap the child's play with someone else's experience, you create an opportunity to produce enrichment. He states that adults contribute when they recognize the importancerole-playing can take for the child and by teaching traditional games without obstructing the child's initiative[18,19]. By knowing their preferred stimuli and allowing their independence, it is possible to guide the development of children using more attractive activities and objects, which favor manipulation and, consequently, their development[18,19].

Conclusion

The typical children aged 4 to 6 years performed 17 manipulative actions; the tactile cube showed the highest number of manipulative actions and stood out as the favorite, showing the importance of the presence of tactile stimuli in toys. The games created during the exploration of the cubes allowed the subdivision into five categories: associations with similar objects previously known, related to the visual stimuli provided by the cubes, verbal description of actions performed with the cubes, imaginary games using figurative means, and sports activities/ games.

Acknowledgments

We would like to thank the families who allowed their children to participate in the research and the school coordinators for allowing the evaluations to be carried out in the institutions.

References

1. Barela JA. Aquisição de habilidades motoras: do inexperiente ao habilidoso. Motriz: J Phys Ed. 1999;1(5):53-7. doi
2. Ré AHN. Crescimento, maturação e desenvolvimento na infância e adolescência: implicações para o esporte. Motricidade. 2011;7(3):55-67.
3. Takatori M, Bomtempo E, Benetton MJ. O brincar e a criança com deficiência física: a construção inicial de uma história em terapia ocupacional. Cad Bras Ter Ocup. 2001;9(2):91-105.
4. Jurdi APS, Silva CCB, Liberman F. Inventários das brincadeiras e do brincar: ativando uma memória dos afetos. Interface.2018;22(65):603-08. doi
5. Santos SLE, Marin EC, Normando GSP. O brincar na rua e a transmissão cultural da brincadeira de pipa. Licere Ed Mar. 2019;22(1):148-66.
6. Oliveira C, Silva NQP, Pelizaro PB, Pereira K. Ações manipulativas e o ato de criar brincadeiras com cubos em crianças com e sem baixa visão. Ver Saúde e Desenvolv Hum. 2020;8(1):49-58. doi
7. Silva EARD, Pereira MC. O papel ativo da criança em situações lúdicas na educação infantil. Est e Pesq em Psic. 2018;18(2):532-49.
8. Sampaio JO, David AC, Castellani Filho L, Húngaro EM. A prática corporal como expressão da imaginação da criança na brincadeira: uma perspectiva da psicologia histórico-cultural. Movimento. 2017;23(4):1447-58.
9. Schmitt BD, Pereira K. Caracterização das ações motoras de crianças com baixa visão e visão normal durante o brincar: cubos com e sem estímulo luminoso ou alto contraste. Bras Educ Espec. 2014;20(3):435-48. doi
10. Cordazzo STD, Vieira ML. A brincadeira e suas implicações nos processos de aprendizagem e de desenvolvimento. Est Pesq em Psicol. 2007;7(1):92-104.
11. Gallahue DL, Ozmun JC, Goodway JD. Compreendendo o desenvolvimento motor: bebês, crianças, adolescentes e adultos. 7 ed. Porto Alegre, AMGH; 2013. 481 p.
12. Queiroz NLN, Maciel DA, Branco AU. Brincadeira e desenvolvimento infantil: um olhar sociocultural construtivista. Paidéia. 2006;16(34):169-79.
13. Corbetta D, Snapp-Childs W. Seeing and touching: the role of sensory-motor experience on the development of infant reaching. Infant Behav Dev. 2009;32(1):44-58. doi
14. Biscoli IA. Atividade lúdica uma análise da produção acadêmica brasileira no período de 1995 a 2001. Dissertação [Mestrado em Educação], Universidade Federal de Santa Catarina, Florianópolis; 2005.
15. Morais, SR. A percepção visual e suas regras de processamento segundo os representacionistas. Avesso. 2000; (1):52-63.
16. Oliveira FIS; Rodrigues ST. Affordances: a relação entre agente e ambiente. Ciênc. Cogn. 2006;(9):120-30.
17. Kishimoto TM. Jogos, brinquedos e brincadeiras do Brasil. Espacio sem blanco. Rev Educ. 2014;(24):81-105.
18. Winnicott DW. A criança e seu mundo. 6. ed. Rio de Janeiro, LTC; 2020. 272 p.
19. Winnicott DW. O Brincar e a realidade. São Paulo, Ubu; 2019. 256 p.

Corresponding author

Karina Pereira. Universidade Federal do Triângulo Mineiro, Departamento de Fisioterapia Aplicada. Centro de Pesquisa Professor Aluízio Rosa Prata. Rua Vigário Carlos 100 4° andar, Sala 408, 38025350, Uberaba, MG, Brazil.
E-mail: karina.pereira@uftm.edu.br.

Manuscript received on December 18, 2021
Manuscript accepted on April 18, 2022