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Effect of Training on manual reaching behavior in infants - Integrative Review of Clinical Trials

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ABSTRACT
This review was designed to seek evidence for clinical practice on training infants to manual reaching. For its execution, six stages were covered: 1) identification of the theme and elaboration of the research question; 2) establishment of inclusion criteria; 3) definition of the information to be extracted; 4) evaluation of studies; 5) interpretation of results; 6) synthesis of knowledge. The databases used were: National Library of Medicine, Literatura Latino-Americana e do Caribe em Ciências da Saúde, Medical Literature Analysis, Biblioteca Virtual em Saúde, Scientific Electronic Library Online, Science Direct, Pan American Health Organization, COCHRANE Library. Evidences indicate that the training provides fundamental experiences for the improvement of motor behavior, and should be used in clinical practice by parents and/or caregivers.

Keywords: Practice, Training, Manual reaching, Infant.

1 INTRODUCTION

Manual reaching marks the beginning of an important new skill in infant development, acquired between three and five months of age (Thelen et al 1993; Thelen, Corbetta, & Spencer, 1996; Clearfield, Feng, & Thelen, 2007; Soares, Kamp, Savelsbergh, & Tudella, 2013). It is defined as the ability to locate and touch an object in space, with one or both upper limbs (Guimarães, Cunha, Almeida, & Tudella, 2013), with or without prehension (Toledo, Soares, & Tudella, 2011). The range is imprecise at first, demonstrating poor control over the hand trajectory. As infants get older, reaching becomes more direct and with fewer units of movement (Thelen, Corbetta, & Spencer, 1996; Guimarães, Cunha, Almeida, & Tudella, 2013; Soares, Cunha, & Tudella, 2014).

Motor skills such as manual reaching are fundamental to human daily activities. For this, it is necessary to practice the task to learn and perform it better. This learning can be defined as a change in the ability to perform a skill, featuring a significant and permanent improvement in performance, due to practice or experience (Braganholo, 2013).

There are some ways to organize the practice, which can be constant or varied. Constant practice is characterized by the execution of a single task, and is related to the specificity of the practice, its only possibility of variation is in the determination of the total number of attempts. Varied practice, on the other hand, can be conceptualized as the execution of several tasks simultaneously. In studies on contextual interference, which address learning acquisition and retention, block practice, random varied practice and serial varied practice are observed (Lage, Fialho, Albuquerque, & Benda, 2011).

Block practice consists of skill learning trials where all trials are practiced before starting the practice of another activity. On the other hand, the varied random practice, referred to as being of high contextual interference, consists of the practice of activities in no particular order, causing changes about which activity is practiced in sequence (Lage, Fialho, Albuquerque, & Benda, 2011). And the serial varied practice, which presents different tasks organized in a defined series (Schmidt & Lee, 2016; Lage, Fialho, Albuquerque, & Benda, 2011).

A high level of contextual interference has been observed in studies with children and adults, in the change of activities, generated with varied random practice, and also with serial practice (Lage, Fialho, Albuquerque, & Benda, 2011). With random or serial practice, the skills to be learned remain active in the memory during practice, enabling more effective learning. The interference of one activity on the other forces the learner to reconstruct their action plan to perform such activity (Lage, Fialho, Albuquerque, & Benda, 2011).

Studies on the effect of practice or training on manual reaching behavior in infants show that infants need ten to 18 weeks of practice to achieve adequate reaching (Thelen, Corbetta, & Spencer, 1996; Cunha, Soares, Ferro, & Tudella, 2013). Furthermore, the reaching pattern, that is, the performance of proximal and distal adjustments, may be different, according to motor development, and considering the infant's condition (Toledo, Soares, & Tudella, 2011; Martin, Engber, & Meng, 2005).

Soares, Cunha, & Tudella (2014) observed the effect of a short-duration serial varied practice session on reaching emergence in late preterm (34 to 36 weeks) and full-term (greater than 37 weeks) newborns and confirmed the hypothesis that preterm infants have a lower ability to reach, but that serial practice is effective in increasing the motor variability of proximal and distal adjustments.

A single session of short-term varied practice in the emergence of reaching in preterm infants born between 29 and 33 weeks of gestational age had a positive effect of the practice, as the infants presented a higher frequency of reaching, compatible with the mature reaching, being slower and with fewer movement units. (Guimarães, Cunha, Mira, & Tudella, 2015).

However, there is still little evidence on the effects of specific practices on the performance of manual reaching in infants (Lobo, Galloway, & Savelsbergh, 2004; Heathcock, Lobo, & Galloway,

2008; Lobo, & Galloway, 2008). The studies involving preterm infants (Guimarães, Cunha, Almeida, & Tudella, 2013) are even scarcer.

Given this, and considering the results of pioneering studies on learning retention in late preterm infants (Soares, Kamp, Savelsbergh & Tudella, 2013), and the effect of short-term specific practice in preterm and low birth weight infants (Guimarães & Tudella, 2015; Guimarãoes, Cunha, Mira & Tudella 2015, the present study aims to analyze studies on the effect of practices on the acquisition and learning of manual reaching in infants, through the elaboration of an integrative review of clinical trials.

It is also intended to provide, with its results, subsidies to professionals involved in the area, on how the sensorimotor system adjusts itself in response to the influence of extrinsic restrictions (type of practices). And, still, to favor a better understanding of the process of development of reaching, making it possible to base preventive measures and strategies of early intervention in the dysfunctions of sensorimotor development.

2 METHODOLOGY

This article is an integrative review of clinical trials. The integrative literature review aims to identify, analyze and synthesize current research, including experimental, quasi-experimental and non-experimental studies, to better understand the effects of a given theme and its contributions to clinical practice (Sousa et al, 2018; Botelho, Cunha, & Macedo, 2011).

For the construction of the integrative review, six steps were taken, namely: 1) identification of the theme and selection of the hypothesis or research question for the elaboration of the integrative review; 2) establishment of eligibility criteria; 3) definition of the information to be extracted from the selected studies/categorization of the studies; 4) evaluation of included studies; 5) interpretation of results; 6) presentation of the review/synthesis of knowledge (Mendes, Silveira, & Galvão, 2008).

Initially, the research question "Does practice and its respective types have an evident effect on the acquisition of the skill and improvement of the manual reaching behavior of infants?" was elaborated, which guided the choice of theme.

The eligibility criteria defined were: articles on practice or training in the manual reaching of infants up to two years old, with the design of randomized clinical trials or not, controlled or not, published between the years of 2008 and 2021, in indexed journals with an impact factor of 1.0 or higher, in English and Portuguese.

Articles on practice or training performed in children over two years of age were not included in the review. Articles on practice or training performed in infants who presented duplicity in different databases, and those who did not meet the eligibility criteria, were excluded.

The survey was carried out in the following electronic databases: National Library of Medicine (PubMed), Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), Medical Literature Analysis (MEDLINE), Biblioteca Virtual em Saúde (BVS), Scientific Electronic Library Online (SciELO), Science Direct, Pan American Health Organization (PAHO), COCHRANE Library, using the descriptors: “practice or training”, “reaching”, “infant”, in addition to the specific terms from Medical Subject Headings (MeSH): "reaching training”, “manual reaching”.

During the initial search, articles were selected based on titles and abstracts, excluding those that did not meet the eligibility criteria. When the title and abstract were not clear, the reviewer searched for the article in its entirety, to verify if it met the eligibility criteria.

After the initial search in the databases, a detailed analysis of the selected studies was carried out and the information was organized and summarized, creating a database composed of: the author, year of publication, impact factor of the journal, objectives, studied population, methodology and outcomes.

Then, a methodological evaluation of the selected studies was carried out through the Critical Review Form - Quantitative Studies (Law et al, 1998), using the criteria: study objective, literature review, methodology adequacy, intervention, results, conclusions and clinical implications, totaling 16 items. A score of one was assigned when the article met the criteria for each item evaluated; zero, when the criterion was not met; NA, if the criterion did not apply to the research; a question mark symbol (?), when the item was not clearly described. A score greater than or equal to 12 was considered low risk for bias; and less than or equal to 7 was considered high risk for bias.

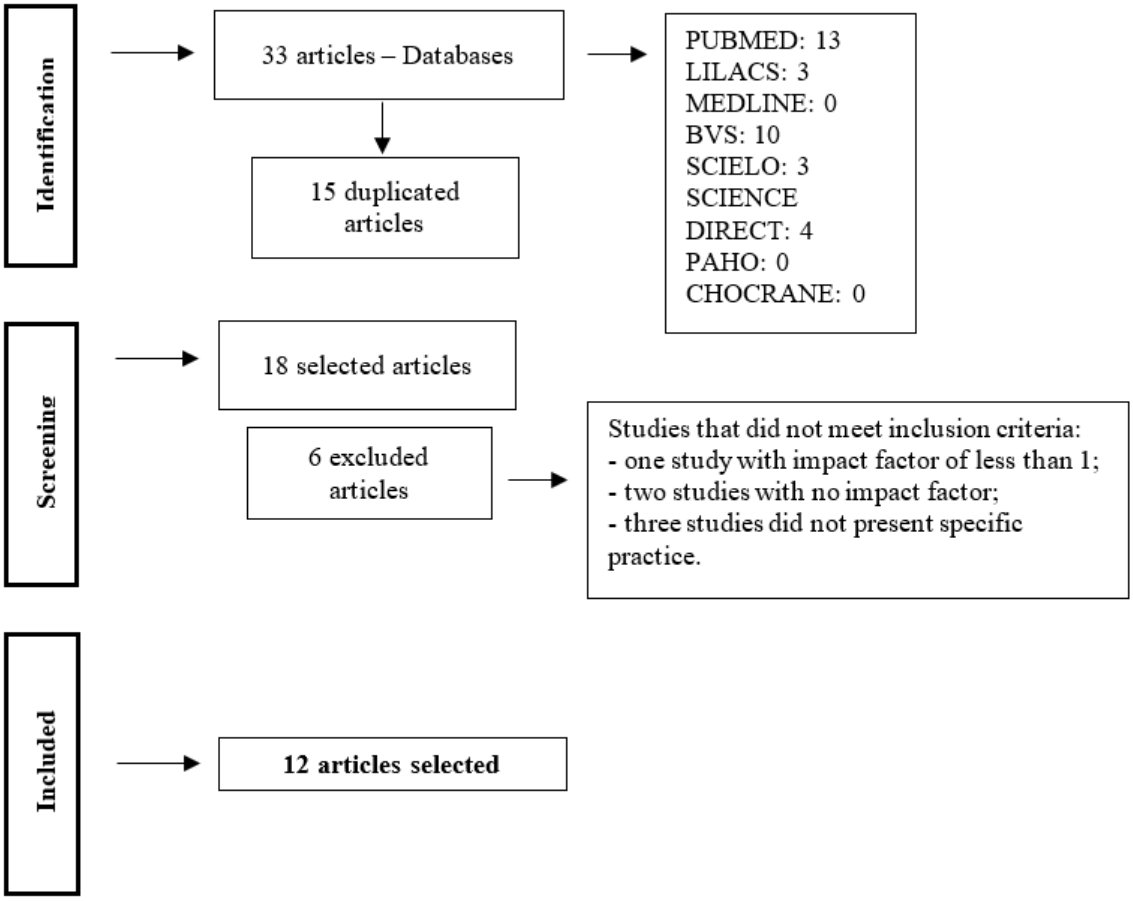
Subsequently, the interpretation of the results was made, where the main findings were discussed, comparing with the theoretical knowledge.

Finally, the synthesis of knowledge was carried out, with a clear explanation of the procedures used in the previous stages, evidencing the analysis of the articles included.

3 RESULTS

The review comprised articles published between January 2008 and December 2021, with 33 articles found. Of the 33 articles, 15 were excluded, as they were available in more than one search base, three were published in a journal with impact factor lower than one or with no impact factor, and three did not address specific reaching practice, only spontaneous reaching. The final selection was defined by a consensus among three researchers and resulted in twelve articles, six developed in Brazil and six developed in the United States. The article selection process is shown in figure 1.

Figure 1. Flowchart of search and selection of articles for review



Source: The authors, 2023.

The description of the twelve articles selected in terms of objectives, methodology and outcomes, as well as the evaluation of the journal's impact factor can be found in Chart 1. In the qualitative evaluation of the articles included, it was observed that all of them obtained a score greater than 12, indicating low risk of bias (Table 1).

Chart 1. Characteristics of the studies included in the review, according to the defined eligibility criteria.

Author	Year	Impact Factor	Objective	Study Design	Population/ Training Method	Outcomes
Heathcock, Lobo, & Galloway.	2008	2.587	To compare the range between full-term and preterm infants born at less than 33 weeks of gestational age, and to verify the effect of training in preterm	Randomized controlled clinical trial. Longitudinal.	Thirty-nine infants, 13 full-term infants and 26 preterm infants participated in the study, divided into a full-term control group (13 infants), a preterm control group (13 infants)	The full-term control and trained preterm groups reached earlier, with more stable reaching, in addition to contacting the toy more often with an open hand and ventral surface

			infants on skill emergence.		and a preterm experimental group (13 infants). Daily training performed by parents, 20 minutes a day, for eight weeks. Three types of activities were performed: general movements, midline movements and specific movements.	than the preterm control group. The trained preterm group demonstrated an increase in the number of hand-object contacts, in the number of consistent reaches and in the percentage of time interacting with the toy. Initially, preterm infants showed differences in the quantity and quality of teaching concerning full-term infants. The training was effective in reducing some of these short-term differences.
Libertus & Needham.	2010	2.069	Investigate the influence of active and passive training using Velcro® gloves on the manual and visual exploration of objects.	Controlled clinical trial Longitudinal.	Participants were 58 full-term infants, divided into an active training group (18 infants; 2 to 3 months of age), a passive training group (18 infants; 2 to 3 months of age), a control group (9 infants; 3 months of age) and control group (23 infants; 5 months). The training took place daily for two weeks. Gloves with Velcro® were used for reaching training. In the	Infants in the active training group decreased attention to the evaluator. There was an increase in reaching and prehension, in addition to an increase in the number of searching episodes after training. Passive training was not enough to change reaching and observation behavior of infants. Training can stimulate infants' reaching

					active training group, the objects contained Velcro®, making them stick to the gloves. In the passive training group, objects did not stick to the gloves.	learning and inform their perception of observed actions.
Cunha, Woollacott,& Tudella.	2013	1.699	To investigate the effect of short-term training on spatiotemporal parameters of reaching in the infant, in different positions, supine or reclined, in the period of the emergence of reaching.	Randomized controlled clinical trial.	Thirty-three full-term infants aged between 3 and 4 months participated, divided into a control group (11 infants), a group trained in the reclining position (11 infants), and a group trained in the supine position (11 infants); The single training session, composed of three activities, is in block practice condition.	The training was effective in favoring ranges with shorter duration of movement in the specific position in which the infant was trained. Training in the recumbent position was effective in promoting shorter and faster reaches, indicating a possible lower muscle torque at the beginning of the movement and lower postural requirements. A short training session was effective in improving the infants' spatiotemporal parameters.
Soares, Kamp, Savelsbergh, & Tudella	2013	2.750	To assess the immediate and late effect of a short period of practice on reaching frequency and behavior on skill emergence in late preterm infants.	Randomized controlled clinical trial.	Thirty-six late preterm infants participated, divided into Block Practice Group (12 infants), Serial Practice Group (12), and Control Group (12 infants).	There was an increase in the number of reaches from pre to post-training in the serial practice group, which did not occur in the block practice. In retention, there was a

					The training was performed in just one session, consisting of three activities performed in blocks or series.	decrease in the number of reaches in the post-test of the serial practice group, and there was no difference between the post-test and retention in the block practice or control group. Kinematic parameters were not affected by the practice. Short-term training was effective and improved reaching behavior after serial practice, however, the changes were not consolidated after one day, indicating the need for more training time.
Soares, Cunha, & Tudella.	2014	2.750	To compare the effect of a short period of serial practice on reaching behavior in late preterm and full-term infants on skill emergence.	Randomized clinical trial.	Twenty-four infants participated, divided into a group of late preterm infants (12) and a group of full-term infants (12). Both groups received a single training session consisting of three activities in a series.	There was no difference between groups in the total number of pre and post-training reaches. Late preterm infants had less reach, with a half-open hand and no prehension on pre-training than full-term infants. Post-training, these preterm infants had greater motor variability in proximal adjustments, with a greater proportion of bimanual reaches,

						however, they explored and selected more distal control and grip compared to the full-term group. Differences in the range between late preterm and full-term can be found in skill emergence. The practice provides new opportunities for preterm infants to explore reach, however, relative to full-term infants, they are still less developed to benefit from the experience.
Guimarães & Tudella.	2015	1.513	Assess the immediate effect of a single, short-term, specific training session on parameters range kinematics, in the period of skill emergence in preterm and low birth weight infants.	Randomized controlled clinical trial.	Sixteen preterm infants participated, divided into an experimental group (8 infants) and a control group (8 infants). The training was carried out in the condition of serial practice, composed of three activities, in a single session.	The experimental group showed a significant increase in the frequency of reaching post-training, while the control group showed no significant difference between pre and post-training. The peak speed decreased significantly in the experimental group between pre and post-training, the other variables did not show a significant difference. The training effect magnitude test indicated that

						training was effective in performing slower movements, with greater adjustment and fewer movement units. The results showed that after specific training, the infants presented a mature reach similar to the reach of full-term infants.
Williams, Corbetta, & Guan.	2015	1.669	Investigate the effect of reaching experience using “sticky” and “non-sticky” gloves.	Controlled clinical trial. Longitudinal.	Thirty-seven full-term infants, aged two months, participated in the study, divided into the Sticky Gloves Group (13 infants), Non-sticky Gloves Group (11 infants), and Control Group (13 infants). Practice performed with gloves with Velcro® and gloves without Velcro®. Infants were encouraged to make ten reach attempts per day for 14 days.	Both groups that received training progressed over time, however, neither performed significantly better than the control group. At the end of the last day of training, only the “non-sticky” group made significantly more contact with the object than the control group. Infants in the “non-sticky” group focused their eyes on the object more often than the “sticky” glove group. All infants in the experimental group had an increase in the number of intentional contacts. At the end of the study, there was a decrease in the positive

						correlation between looking and reaching intention, suggesting that infants no longer needed to look for the object. These results suggest that, by providing simple repeated exposure to the task, infants discovered and selected their reaching movement patterns better.
Cunha, Lobo, Kokkoni, Galloway, & Tudella.	2016	1.513	To verify if three short-duration training sessions change the spatio-temporal parameters of reach and prehension, in the emergence of the skill.	Randomized controlled clinical trial.	Thirty infants participated, divided into a control group (15 infants) and an experimental group (15 infants). Three short-term training sessions were carried out, consisting of three activities in the condition of serial practice.	There was a higher frequency of reaching in the trained group than in the control group, after training. There was a significant difference in the vertical position of the hand, for the experimental group with the control. The trained group had less closed-manual reaching in the post-training assessment and more ventral hand contact. The trained group had a shorter duration of movement compared to the post-training control. Few short training sessions were effective in promoting shorter,

						smoother reaches, with better hand positioning.
Wiesen, Watkins, & Needham.	2016	2.089	To verify long-term changes in the reaching behavior of infants after active training with Velcro® gloves.	Clinical trial. Longitudinal.	Thirty-two full-term infants participated, divided into a group with active training (16 infants) and a group with passive training (16 infants). The training was performed by the parents, in ten sessions lasting 10 to 12 minutes each, using gloves with (active) or without (passive) Velcro®.	Two months after training, infants who participated in active training showed an increase in object exploration skills, involving complex patterns of hand engagement with the object, such as bimanual exploration, compared to their peers who participated in passive training with Velcro®-free gloves. Training with Velcro® gloves provided an opportunity for infants to actively engage with objects through reaching and grasping.
Needham, Wiesen, Hejazi, Libertus, & Christopher	2017	2.424	To evaluate the effects of active and passive training experiences on the reach of infants and to verify if the auditory feedback produced during specific training affects the subsequent exploration of the object.	Clinical trial Transversal.	Study 1: 38 full-term infants participated, divided into an active training group (19 infants) and a passive training group (19 infants). Training performed using gloves with or without Velcro®, in a single session.	Study 1: In the group with active training, there was an increase in the post-training gaze toward the object. Study 2: Infants in the higher auditory feedback group significantly increased their vision concerning the

					Study 2: Thirty-six full-term infants who did not participate in Study 1 participated, divided into a group with greater auditory feedback (18 infants) and a group with less auditory feedback (18 infants). Training performed on a table covered or not with foam, using gloves with Velcro®, in a single session.	object, in addition to touching the object significantly more post-training. In the condition of less auditory feedback, there were no changes. Active object control, including sensory feedback, promotes the development of object exploration in infants.
Nascimento, Toledo, Merey, Tudella & Soares-Marangoni.	2019	2.161	Examine whether brief reach training with sticky gloves was effective for improving reaching behavior in preterm infants.	A randomized clinical trial with a balanced parallel-group design.	Twenty-four late preterm infants participated, divided into a control group (12 infants) and an experimental group (12 infants). Practice three reaching activities with Velcro® gloves and gloves without Velcro®, with 6 repetitions being performed in 4 minutes or in at least 87% of this time in the experimental group, while the control group was encouraged to perform the reach spontaneously.	In the post-training evaluation, the experimental group had a greater number of reaches than the control group, but this difference was not maintained in the retention test 4 minutes after the end of training. The experimental group showed an increase in the number of reaches from pre to post-training but decreased in the retention test. The control group also showed a lower number of reaches in the retention test about the post-training. Although training had a

						positive influence on reaching in late preterm infants, it was not enough to increase open-hand behavior and gripping outcomes.
Maitre, Jeanvoine, Yoder, Key, Slaughter, Carey, Needham, Murray & Heathcock.	2020	3.020	To evaluate the effectiveness of an intervention in increasing the smoothness and ability of unimanual reaching of the affected upper limb in infants aged 2 years and younger with a diagnosis of cerebral palsy.	Randomized clinical trial. Longitudinal.	Seventy-three babies with cerebral palsy participated, being divided into an intervention group (37 infants) and a waiting list group (36 infants). A four-week intervention directed by the therapist and administered by the parents was carried out, including daily bimanual game activities; less affected upper limb using soft-constraint (six hours a day, electronically monitored); reach training in the most affected upper limb; graded sensorimotor training; parent education. Babies on the waiting list received only bimanual play activities.	The evaluation after the intervention period showed a significant increase in the smoothness of reaching and in the unimanual motor skill in the most affected upper limb. The intervention improved somatosensory processing, in addition, it demonstrated an unexpected treatment effect on the smoothness of reaching the least affected upper limb. There was a significant difference between the groups, with the intervention group showing better results at the end of the study period. Thus, the intervention performed demonstrated efficacy and safety to develop sensory and motor systems, with improvement in the smoothness of

						reach and development skills.

Source: The authors, 2023.

Table 1. Qualitative evaluation using the Critical Review Form – Quantitative Studies of the articles included in the review.

Authors	Questions																Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Heathcock, Lobo & Galloway, 2008.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	14
Libertus & Needham, 2010.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Cunha, Woollacott & Tudella, 2013.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Soares, Kamp, Savelsbergh & Tudella, 2013.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Soares, Cunha & Tudella, 2014.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Guimarães & Tudella, 2015.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Williams, Corbetta & Guan, 2015.	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	13
Cunha, Lobo, Kokkoni, Galloway & Tudella, 2016.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Wiesen, Watkins & Needham, 2016.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Needham, Wiesen, Hejazi, Libertus & Christopher, 2017.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Nascimento, Toledo, Merey, Tudella & Soares-Marangoni, 2019.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Maitre, Jeanvoine, Yoder, Key, Slaughter, Carey, Needham, Murray & Heathcock, 2020.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	15

1 = was the objective clear?; 2 = was a review of the relevant literature on this topic carried out?; 3 = was the design adequate for the study question?; 4 = was there any errors that may have influenced the results of the study?; 5 = was the sample described in detail?; 6 = was there a justification for the sample size?; 7 = did the subjects sign the consent form? (if not described, assume not); 8 = were the outcome measures reliable? (if not described, assume not); 9 = were the outcome measures valid? (if not described, assume not); 10 = was the intervention described in detail?; 11 = were the results reported in terms of statistical significance?; 12 = were the analysis methods adequate?; 13 = was clinical importance reported?; 14

= were the conclusions consistent with the study methods and results?; 15 = are there implications for clinical practice given the research results?; 16 = were the study limitations recognized and described by the authors?
Item scores: 0 = does not meet the criterion; 1 = meets the criterion; ? = not clearly described; NA = not applicable.
Source: The authors, 2023.

The twelve articles found were published in English, and, in the quality analysis following the Critical Review Form – Quantitative Study, they were considered to have a low risk of bias.

Two types of practice under different conditions appeared in the studies: random practice performed using Velcro® gloves for active and passive experiences, the other with predetermined activities, where activities were repeated in the block condition, and the serial condition. Studies with block practice and serial practice were also analyzed considering the supine and reclined position of the infant. The effect of practice on manual reaching was also analyzed considering full-term and preterm condition of the infants.

The effect of practice on manual reaching was evaluated according to the frequency of reaching, reaching behavior (distal and proximal adjustments), changes in kinematic variables, and skill retention.

Regarding the type of practice/training, four studies used the practice with serial condition, two with a longitudinal design and two with a transversal design. Two studies used the practice with block condition, one longitudinal and one transversal. One study compared practices/trainings with serial and block conditions, with a cross-sectional design. In all of them, the frequency, the reaching behavior and the kinematics of the reaching movement were analyzed. The other four studies used practice/training with Velcro® gloves, three with a longitudinal design, which evaluated the infant's visual behavior in addition to manual behavior, and two with a cross-sectional design, one of which also evaluated the role of auditory feedback. in range training.

The twelve studies demonstrated positive effects of practice/training on the frequency and/or behavior and kinematics of the hand-reaching movement. However, studies comparing the types of practice/training showed that the practice with serial condition presented better results than the practice with block condition, both in frequency and in reaching behavior, demonstrating the importance of indicating the type of practice for the skill development and enhancement.

4 DISCUSSION

The present study aimed to examine studies that investigated the effect of practice on the process of acquiring and refining motor skills such as manual reaching, acquired from repetitions of the task about the objective to be achieved. In the studies found, it was observed that the practice of manual reaching provides the necessary experiences for the refinement of this skill.

In the twelve articles analyzed, it was possible to verify two main types of practice/training: the training protocol based on studies by Lobo, Galloway, and Savelsbergh (2004), Heathcock, Lobo, and Galloway (2008) and Cunha, Soares, and Tudella (2013), which consists of performing three activities: activity 1 - the researcher holds the object in the midline of the infant and, with the other hand, leads the child's hand to the object; activity 2 - the researcher holds the object in the midline and positions the infant's forearm within his/her visual field; and activity 3 – the researcher performs tactile stimulation on the infant's arm and forearm and takes the object to the midline, waiting to be reached; and, the training based on the studies of Needham, Barrett, and Peterman (2002) and Libertus, and Needham (2010) where reaching experiences were simulated through the use of Velcro® gloves. In active practice with the gloves, the objects stuck to the "sticky" gloves, simulating successful reach, and in passive practice, the gloves did not stick to the objects. Thus, it is observed that the practice can be through various activities and strategies to acquire learning and have better performance (Braganholo, 2013)

According to Lage, Fialho, Albuquerque, and Benda (2011), the practice can develop in a constant or varied way, the latter being able to be in block, serial or random. When comparing types of practice and learning retention after 24 hours of training, as in the study by Soares, Kamp, Savelsbergh, and Tudella (2013) who used block and serial practice in reaching training in late preterm infants, an immediate increase in reaching frequency was observed after serial practice. However, the increase was not retained after 24 hours, indicating that more intensive practices are needed in the long term. Similar results were also observed in the study by Guimarães and Tudella (2015), where the immediate effects of a single short-term specific training session were evaluated in preterm and low birth weight infants, through kinematic variables of the range movement. In this study, the experimental group received a single training session with serial condition, and showed a significant increase in the frequency of post-training reaching, while the control group received only a verbal interaction during the same time (approximately 5 minutes), without tactile stimuli, there was no statistically significant difference. As for the kinematic variables of the reach, through the effect magnitude test, clinical relevance of the training (Cohen's d) was observed, with a decrease in peak velocity, average velocity and number of movement units for the post-training experimental group, suggesting that something was learned immediately after training, thus justifying the indication of serial practice for skill learning, as described by Lage, Fialho, Albuquerque, and Benda (2011).

In the longitudinal study by Cunha, Lobo, Kokkoni, Galloway, and Tudella (2016), the effect of three short training sessions on reaching on two consecutive days was investigated. On the first day, there was a pre-training assessment, a training session with serial condition, and a post-training assessment. On the second day, two training sessions and immediate post-training evaluation were

performed. The control group received no specific training, only verbal interaction during the same time as the experimental group, approximately 6 minutes. The results showed an increase in the frequency of reaching, with the hand in the vertical position and ventral surface in the experimental group in the post-training evaluation 1 and 2. The experimental group also presented a shorter duration of movement compared to the control group, indicating that three short-term training sessions with serial condition are effective in improving reaching behavior.

Maitre et al (2020) evaluated the effect of a four-week intervention on the kinematics of unimanual reach of the most affected upper limb in children aged 0 to 2 years. diagnosed with cerebral palsy. The intervention consisted of activities with bimanual games, restriction of the least affected upper limb for 6 hours a day, reaching training in the most affected upper limb, graded sensorimotor training and guidance to parents. The results showed improvement in the smoothness of the reach, the frequency of manual reach, and the somatosensory processing in the most affected upper limb.

The results observed in the aforementioned studies regarding the conditions of serial and block practice demonstrate that motor learning occurs through the practice of a skill, according to the effective organization of practice, the amount of training time, and also the practice schedule (Schmidt, & Lee, 2016). Associated with this, adjustments in movement are necessary to improve motor performance, promoting the acquisition and maintenance of motor skills (Benda, 2006).

In the studies that used Velcro® gloves, Libertus and Needham (2010) investigated the influence of active and passive training on the manual and visual exploration of objects, as well as attention to objects. Williams, Corbetta, and Guan (2015) verified the effect of reaching experience with sticky and non-sticky gloves and observed that all infants, regardless of glove type, increased the frequency of intentional hand-to-object contact. The study by Nascimento, Toledo, Merey, Tudella, and Soares-Marangoni (2019), verified the effectiveness of a 4-minute training session with the use of sticky gloves in late preterm infants and observed that the trained group performed a greater number of reaches in post-training, however, this result was not maintained for a prolonged period. The results of the study by Libertus and Needham (2010) showed that training with Velcro® gloves encouraged infants' reaching and grasping behavior, as well as visual attention toward the examiner and objects. These results corroborate those observed in the study by Williams, Corbetta, and Guan (2015), who used a methodological adaptation of the previous study, where the intervention groups were followed longitudinally for 16 consecutive days and the control group was seen only twice (evaluation start and end). Reach training was performed at home by the researchers, where they stimulated ten reaching attempts per day, with a single different object each time, and changed every day, thus avoiding habituation. In this study, it was observed that infants began to look more at the object, then at the researcher-examiner, and finally at the hands.

In the study by Wiesen, Watkins, and Needham (2016), also with practice using active and passive gloves, the effect was analyzed after two months of practice, however, parents were instructed to perform the practice and each session lasted between 10 and 12 minutes. Practice with active gloves provided an opportunity for infants to actively engage with objects through reaching and grasping. After two months, infants who participated in active practice showed an increase in object exploration skills, compared to their peers who participated in practice with passive gloves, such results also corroborate Lage, Fialho, Albuquerque, and Benda (2011), who considers long-term and random training (with several trials in no particular order) with high contextual interference in the acquisition and retention of learning.

Still considering the practice with gloves and Velcro®, Needham, Wiesen, Hejazi, Libertus, and Christopher (2017), carried out two studies to observe the manual exploration of objects and verify the role of auditory feedback during practice. In the first study, infants were divided into an active training group and a passive training group. In the active group, the examiner demonstrated for the first time up to three times that toys could adhere to gloves; in the passive condition, the examiner also touched each toy on the infant's palms to provide a tactile experience. The study showed that infants' learning during a ten-minute training period is unlikely to be the same as during daily ten-minute sessions over two weeks. However, it is believed that the observed short-term effects may provide a basis for further learning, as described by Needham, Barrett, and Peterman (2002); Wolf, Galloway, and Savelsberg (2004); Corbetta and Snapp-Childs (2009); Guimarães and Tudella (2015); Nascimento, Toledo, Merey, Tudella, and Soares-Marangoni (2019). In the second study, assessing auditory feedback during practice, full-term infants who did not participate in the first study were divided into a group with greater auditory feedback and a group with less auditory feedback. In the lowest feedback condition, the table was covered with foam to reduce sounds, and in the highest feedback condition, the toys made high-impact noises when hitting the table, as well as bells were sewn into the sticky gloves, and also placed inside the objects. The results showed that infants in the group with greater auditory feedback significantly increased their vision about the object in the post-training period, which did not occur in the condition of less auditory feedback. Infants in the higher auditory feedback group touched the object significantly more post-training, and although infants in the lower auditory feedback group also touched the object more, this increase was not significant. Such results indicate the positive effect of practice when associated with auditory feedback.

Thus, among the selected studies, it was observed that six explained the type of practice with block condition and/or serial condition (Heathcock, Lobo, & Galloway, 2008; Cunha, Woollacott, & Tudella, 2010; Soares, Kamp, Savelsbergh, & Tudella, 2013; Soares, Cunha, & Tudella, 2014; Guimarães & Tudella, 2015; Cunha, Lobo, Kokkoni, Galloway, & Tudella 2016). All had good results,

however, when comparing the effect of the two types of practices for manual reaching in infants, it was found that both were positive, but the serial practice suggested better results, especially for learning retention.

Preterm and low birth weight infants may have a delay in the acquisition of motor skills, such as reaching, which was evident in the study by Heathcock, Lobo, and Galloway (2008), who compared the emergence of reaching among preterm infants. with less than 33 weeks of gestational age and full-term infants with typical development, and evaluated the effectiveness of the practice of reaching the emergence of the skill in preterm infants. The results showed differences in the amount and quality of reaching in preterm infants in the emergence of reaching, presenting an initial disadvantage among full-term infants, however, daily practice improved the quality of reaching in this group. These results corroborate the results of Soares, Cunha, and Tudella (2014), who also compared the effect of a short-term serial practice, with only one session, on the reaching behavior of late preterm and full-term infants, in the reach emergency. The results showed differences in reaching and gross motor behavior between late preterm and full-term infants in reaching emergence, and indicated that a short period of guided practice can minimize these differences, offering new opportunities to explore reaching. Considering the effect of practice on preterm infants, the study by Guimarães and Tudella (2015), with infants born with a gestational age under 33 weeks and with low weight, showed that a single training session with serial condition promoted an increase of reaching frequency in trained infants, reaching with slower movements, with greater adjustment and fewer movement units, similar to the mature reaching of the full-term infant.

The study by Cunha, Woollacott, and Tudella (2013), verified the effect of a short-term training on the kinematic parameters of reach, in the period of the emergence of the skill, performed in the recumbent position and the supine position. The training was structured with a block condition and the results showed that the training was effective in favoring ranges with shorter duration of movement in the specific position in which the infant was trained. However, in the recumbent position, the average velocity of the trained group was higher than in the other groups, indicating that training in this position is associated with lower muscle torque when initiating the movement and lower postural demand, allowing shorter and faster reaches. These results were also observed in the study by Carvalho, Gonçalves, and Tudella (2008), where body positions interfered with reaching behavior after a period of spontaneous practice of the movement, indicating that the seated positioning favors unimanual reaching, which also stimulates postural control, as it promotes weight bearing on the contralateral upper limb.

Because of the results observed and discussed in the selected studies, it is possible to infer the positive effect of the various types of practices, with the practice with the serial condition being more

effective for infants in the periods of emergence and development of reach. In addition, visual and auditory information during active exploration of objects allows the infant to better adjust its reach.

5 CONCLUSION

The studies found indicate a positive effect of the practice of manual reaching in infants. The repetition of movements favors the refinement of the skill. The type of activity or condition of practice is important for skill acquisition and refinement, as well as for learning behavior. Reach is critical for lifelong activities, and the development of this skill can be improved by practice, thus interfering with the infant's overall development.

Thus, the studies presented in the review indicate intervention strategies for the acquisition, as well as for the improvement, of the ability to reach, which can be used in professional clinical practice, by parents and/or caregivers at home, using games with objects, promoting greater interaction of the infant's hands with the object, and the advancement in the acquisition and improvement of reach.

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