RUSSIAN JOURNAL OF
SPORTS SCIENCE
2023, Vol. 2 (4)

Publication date: 01.12.2023
DOI: 10.24412/2782-6570-2023_02_04_2
UDC 612

# MOTOR DEVELOPMENT OF THE CHILD – THEORY, INHERITANCE, INCENTIVES

**J. Subotić-Krivokapić, L. Milenović, Š. Sinanović, S. Potić**
High Medical College of Professional Studies "Milutin Milankovic", Belgrade, Serbia

**Annotation.** A child's motor development is one of the first areas of development that we observe in children. Due to the increasingly rapid scientific advances, modern diagnostic tests that allow assessment and prediction of further motor development are non-invasive and are based on the observation of the quality of spontaneous motility. This review article aims to present the theoretical foundations of motor development, but also theories that deal with the influence of inheritance and the importance of stimulation for the motor development of a child.
**Keywords:** motor development, inheritance, stimulation, encouragement.

**Introduction.** A child's motor development is one of the first areas of development that we observe in children. Due to the increasingly rapid scientific advances, modern diagnostic tests that allow assessment and prediction of further motor development are non-invasive and are based on the observation of the quality of spontaneous motility.

The basic instrument for assessment is Gestalt perception. It involves observing the child as a whole and its patterns of spontaneous, self-induced motility (without sensory stimulus) from the child's birth to the 3rd month (Qualitative assessment of spontaneous motility according to Prechtl) [1].

This means that from the birth of the child, which is especially important for premature children, we can monitor the change in spontaneous motor patterns at shorter intervals of a few weeks (after training for the application of this technique) and already around the third month (corrected age applies to premature children predict in which direction the child's development will take place (normal or with neurological deviations). This is especially important due to the early inclusion of children in stimulating treatment in order to develop their potential.

**Methods and organization.** We conducted an analysis of scientific literature in the PubMed and Google Scholar databases on the topic of child motor development. A total of 20 references were selected.

**Results and discussion.** *Motor development.* The development of movement, since the fetal period, is complex and takes place very dynamically, all with the aim of preparing the fetus for the postnatal period. As far back as 1885, the British physiologist William T. Prayer showed that in chicken embryos, the first movements appear 7 days before a reflex response to a sensory stimulus appears [2]. His observations were confirmed by Victor Hamburger and his colleagues that the motor response really occurs in the absence of sensory receptors, or that motor functions appear before sensory ones [3].

Now we know that only a few neurons are enough to generate the first movements and are important in initiating the further development of neural structures. During pregnancy, a woman feels the first movements of the fetus between the 16th and 22nd gestational week (GW), when the fetus resists strongly enough against the walls of the uterus [4].

The introduction of ultrasound diagnostics for pregnancy monitoring has given insight into when certain fetal movements appear and how their complexity increases with each week of gestation:

- the heart action of the fetus is registered between the $5^{th}$ and $6^{th}$ GW;

- the first movements of the fetus are seen around the $7^{th}$ GW: tilting the head left and right, a few days later – fine, small movements of the limbs [4-5];

-in the 9.5 GW fetal movements involving all body segments and showing variations in speed, amplitude, direction and sequence of movements and hiccups are seen;

- in the 10th GW, isolated movements of the extremities are seen;

-in the 11th GW, you can see the opening of the lower jaw, hand-to-face contact, breathing movements;

- in the 12th GW opening and closing fingers, stretching and yawning can be seen;

- in the 13th GW, isolated movements of the fingers are registered, as well as separation of the index finger and protrusion of the tongue;

- in the 14th GW, sucking and swallowing are seen.

Hiccups, movements of the diaphragm, swallowing of amniotic fluid prepare the fetus for the postnatal functions of breathing, sucking and swallowing [6]. The importance of early fetal movements according to Provin can have several possible functions:

- survival of the fetus inside the uterus by preventing the formation of adhesions and local stasis in the fetal skin's circulation;

-shaping of the skeletal system in such a way as to allow mechanical influence on the bones and joints [7-8].

Observing the development of fetal movements has encouraged many scientists to think about the possibility of assessing and predicting the postnatal development of the child.

From the beginning of the 20th century, a great number of theories of motor development viewed the motor behavior of the child as a reflex activity that is gradually replaced by voluntary targeted movements with the maturation of the central nervous system (CNS) [9]. In the last twenty years of the last century, two theoretical principles dominate, which share the opinion that motor development is not a linear process, but is dependent on many factors and has transition phases. These are the theory of dynamic systems by Ester Thelen and the theory of neuronal group selection by Edelman [10-11].

The theory of neuronal group selection provides a basis for observing the quality of spontaneous motility and evaluating the motor profile of a child, which has variability in neural behavior as a starting point. According to this theory, motor behavior is characterized by two phases of variability: primary and secondary [12].

Development begins with the phase of primary variability, where during spontaneous activity, the nervous system explores all motor possibilities from its repertoire. In this phase, there is no targeted, directed activity, but motor skills are characterized by phases of rest that alternate with phases of movement in different patterns: stretching, trunk twisting, different amplitudes in arm and leg movements, flexion-extension movements of limbs. Afferent information that the CNS receives during movement affects directly or indirectly gene expression and further shapes the nervous system (development based on experience) [13].

Such spontaneous motor activity prepares the nervous system for adequate use of afferent information in order to adapt motor behavior depending on the task in the next phase of secondary variability that occurs around the third month. From this age, the nervous system clearly processes afferent information from a wide repertoire of possibilities (which it developed during the phase of primary variability), selects the movement patterns that best fit the task (targeted reaching with the hand for a toy, grasping, manipulation of objects, postural control, turning, sitting, crawling, walking...) [14].

In other words, the child learns to adapt motor behavior according to experience and task, mastering the landmarks of motor development that are characterized by large individual differences. To master a certain motor skill there is a period of time when we expect it to appear [15-16]. Thus, the largest number of children are expected to independently move to a sitting position and crawl between the ages of 7 and 13 months, stand up independently between 8 and 18 months, and walk independently between 10 and 20 months [17].

At the stage of secondary variability, the child learns from their own experience according to the principle of trial and error (development based on experience). In this

phase, proprioceptive, visual, auditory, tactile information influences the acquisition of experience and encourages cognitive, linguistic abilities, socio-emotional development. Therefore, it is very important to keep in mind that motor development is not an isolated phenomenon. The ability to crawl will allow him to explore the space: while the parent reads him a book, he turns the pages, points, feels, listens to speech [18].

*Heredity and stimulation.* The development of motor skills is influenced by body mass and length, environment, possibility to explore, manipulation of objects and cultural differences. Individual differences in the mastery of motor patterns are great if we take into account all the factors that influence development. The achievement of motor patterns depends on living conditions, availability of a place suitable for movements and games, comfortable clothes, diapers as factors that influence motor development [19].

A solid flat surface, comfortable clothes, diapers that do not restrict movement, enable the child to develop more easily and quickly. Learning according to the trial-error model, the possibility of free exploration, using the best motor strategy that corresponds to the task, creates a good base for further learning. Moreover, a level of motivation of a child for movement and verticalization significantly increases.

According to some studies, children who learned to stand up fell 69 times in one hour. The children, who learned to walk, initially took 2368 steps in one hour, covered about 701 m, which is the length of 7.7 football fields, and fell 17 times [20]. In the course of one day, in 6 hours of movement (the usual active waking time of a child under the age of 18 months), they take 14,000 steps, which is the length of 46 fields, and fall about 100 times.

When they walk independently, we see variable sequences in children's movement; short periods of movement alternate with longer periods when they are not moving. Most often, they take 1-3 steps, move and stop according whenever they want, move to different surfaces, overcome obstacles, perform walking sideways, walking backwards, change speed of movement, from a standing position to other forms of movement. They explore multiple locations in the space and engage in different activities [20].

**Conclusion.** Forming a great number of motor skills open up an ever-increasing space for exploration and learning. In its turn, it affects the better development of perception, planning, problem solving, and memory. Presence of certain factors (richer environment, the availability of more information, clothes, shoes, diapers, made so as not to restrain the child) on the scales for evaluating all domains of development contribute to better test results. Taking into account cultural differences, inherited attitudes about child development, environmental conditions, greater involvement of parents and an understanding of the importance of stimulation, provide a completely new perspective that should expand possibilities of children in accordance with the times we live in and the tasks that children will face.

**Conflict of interest.** The authors declare no conflict of interest.

**REFERENCES**

1. Prechtl H.F.R. General movement assessment as a method of developmental neurology: new paradigms and their consequences. The 1999 Ronnie MacKeith Lecture. *Dev Med Child Neurol*, 2001, no. 43, pp. 836-842.

2. Preyer W.T. Special Physiology of the Embryo. Leipzig: Grieben, 1885. 644 p. [In German].

3. Hamburger V. Wenger E., Oppenheim R. Motility in the absence of sensory input. *J Exp Zool*, 1966, no. 162, pp. 133-160.

4. Einspieler C., Prayer D., Prechtl H.F.R. Fetal behaviour: A Neurodevelopmental approach. *Clinics in developmental medicine,* London: Mac Keith Press, 2012, no. 189, 212 p.

5. Felt R.H.M., Mulder E.J.H., Lechinger A.B., van Kan C.M., Taverne M.A.M., de Vries J.I.P. Spontaneous cyclic embryonic movements in humans and guinea pigs. *Dev Neurobiol*, 2012, no. 72, pp. 1133-1139.

6. Einspieler C., Prayer D., Marschik P.B. Fetal movements: the origin of human behavior.

*Dev Med Child Neurol*, 2021, no. 63(10), pp. 1142-1148.
7. Provine R.R. Prenatal behavior development: Ontogenic adaptations and non-linear processes. *dvances in Psychology*, 1993, vol. 97, pp. 203-236.
8. Prechtl H.F.R. Continuity of neural functions from prenatal to postnatal life. Oxford: Blackwell, 1984. 225 p.
9. Sherrington C.S. The integrative action of the nervous system. Yale University Press, 1906. 433 p.
10. Thelen E. Motor development. A new synthesis. *American Psychologist*, 1995, no. 50, pp. 79-95.
11. Edelman G.M. Neural Darwinism: selection and reentrant signalling in higher brain function. *Neuron*, 1993, no. 10, pp. 115-125.
12. Hadders-Algra M. Variation and variability: key words in human motor development. *Physical Therapy*, 2010, no. 90, pp. 1823-1837.
13. Hadders-Algra M. The Neuronal Group Selection Theory: a framework to explain variation in normal motor development. *Developmental Medicine & Child Neurology*, 2007, vol. 42, issue 8, p. 566.
14. Heineman K.R., Bos A.F., Hadders-Algra M. The Infant Motor Profile: a standardized and qualitative method to assess motor behaviour in infancy. *Developmental Medicine & Child Neurology*, 2008, vol. 50, issue 4, p. 275.
15. Heineman K.R., Middelburg K.J., Hadders-Algra M. Development of adaptive motor behaviour in typically developing infants. *Acta Paediatrica*, 2018, no. 99, pp. 618-624.
16. Adolph K.E., Franchak J.M. The development of motor behavior. Wiley Interdisciplinary Reviews: Cognitive Science, 2017, no. 8(1-2), p. e1430.
17. Hadders-Algra M. Early human motor development: from variation to the ability to vary and adapt. *Neurosci Biobehav Rev*, 2018, no. 90, pp. 411-427.
18. Bornstein M.H., Hahn C.S., Suwalsky J.T. Physically developed and exploratory young infants contribute to their long-term academic achievement. *Psychological Science*, 2013, no. 24, pp. 1906-1917.
19. Gentile A.M. Skill acquisition: Action, movement, and neuromotor processes. In Movement science: Foundations for physical therapy in rehabilitation 2nd ed. J. Carr & R. Shepard (Eds.). New York: Aspen Press, 2000. pp. 111-187.
20. Adolph K.E., Cole W.G., Komati M. Garciaguirre J.S., Badaly D., Lingeman J.M., Chan G.L., Sotsky R.B. How do you learn to walk? Thousands of steps and dozens of falls per day. *Psychol Sci*, 2012, no. 23(11), pp. 1387-1394.

**INFORMATION ABOUT THE AUTHORS:**

**Jelena Subotić-Krivokapić –** PhD, Lecturer, High Medical College of Professional Studies "Milutin Milankovic", Belgrade, Serbia**,** e-mail: jelena.s.krivokapic@gmail.com.
**Lidija Milenović –** Master of Science, Lecturer, High Medical College of Professional Studies "Milutin Milankovic", Belgrade, Serbia.
**Šćepan Sinanović –** Master of Science, Lecturer, High Medical College of Professional Studies "Milutin Milankovic", Belgrade, Serbia.
**Srećko Potić –** PhD, Professor, High Medical College of Professional Studies "Milutin Milankovic", Belgrade, Serbia.

**For citation**: Subotić-Krivokapić J., Milenović L., Sinanović Š., Potić S. Motor development of the child – theory, inheritance, incentives. *Russian Journal of Sports Science: Medicine, Physiology, Training*, 2023, vol. 2, no. 4. DOI: 10.24412/2782-6570-2023_02_04_2