2 ASSESSMENT OF COORDINATION SKILLS IN CHILDREN WITH ANXIETY AND DISTRUST

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2.1 Components of movement

Several essential components of normal human movement can be identified. The 4-element model describes all the primary elements essential for movement: motion, force, motor control and energy. Motion refers to the ability of a tissue or joint to be passively moved. Force refers to the ability of contractile (muscles) and non-contractile structures (tendons) to generate movement and provide dynamic stability around joints during static and dynamic tasks. Motor control refers to the ability to plan, execute and adapt targeted movements so that they are precise, coordinated and efficient. Motor control refers to smoothness, coordination and timing of movement. Energy refers to the ability to perform sustained or repeated movements. It depends on the integrated functioning of the cardiovascular, pulmonary and neuromuscular systems. All movement is influenced by the environmental context (e.g. terrain, supporting surface and external distractions) and personal factors (e.g. age, gender, co-morbidities, self-efficacy, self-confidence, fear of movement and motivation) specific to the individual (Zarzycki et al., 2022).

2.1.1 Motor control – main components of control

The ability to finely control the movement of our bodies is important for both motor and cognitive development and to achieve skills that we use and develop throughout our lives.

Motor control depends on the reception and processing of task-relevant sensory inputs from visual, vestibular and somatosensory systems, and then the selection, planning and execution of actions to achieve task goals. Transition from perception to action relies on the integrity of sensory-motor pathways and intact perceptual and cognitive networks in the brain, including the cerebellum and basal ganglia. In general, motor control involves feedforward mechanisms essential for planning and execution, as well as feedback mechanisms necessary for adapting goal-directed actions (McClure et al., 2021; Sibley et al., 2015).

2.1.2 Sensory systems

Normal visual development starts at birth and continues throughout childhood. It involves changes in visual acuity, convergence and accommodation until adequate binocular vision (the ability to coordinate the eyes in a motor sense and integrate images to perceive and interact with the dynamic three-dimensional world) and stereopsis (depth perception) are achieved. Binocular vision and the accurate perception of depth enables the child to perform upper and lower limb movements correctly. Visual impairment usually cause a change in motor development. Authors have reported that surgical correction of strabismus led to partial restoration of binocular vision and improved eye-hand coordination skills. Others mentioned that proper development of the visual system is highly important for the development of correct balance, with research showing that a group of children with visual impairment had greater postural instability than children with normal vision (Sánchez-González et al., 2022; Candy&Cormack, 2022).

The vestibular apparatus is a complex group of structures and neural pathways that perform a variety of functions (Casale, 2023). It is responsible for sensing the spatial position of the body, maintaining normal posture and balance (Gerebenné Várbíró, 2021). Functions include the perception of orientation and acceleration of the head in any direction, which involves compensation for eye movement and posture. These reflexes are called vestibulo-ocular and vestibulospinal reflexes (Casale, 2023). The centre of the balance system is located in the inner ear. This organ interacts with a variety of multisensory information, with a good number of interconnected central processing programs, as well as with the descending locomotor pathway systems. In response to movement, nerve impulses are activated here and, after evaluation in the central nervous system, travel to different parts of the body and to the spinal cord (Gerebenné Várbíró, 2021). The vestibular system consists of two main parts. The first, three semicircular canals filled with fluid and arranged at right angles to each other and the second, utricle and saccule, also filled with fluid. Special hair cells are located in these organs and are stimulated by the fluid set in motion by the movement of the body. The angular acceleration and rotation of the head in different planes is detected by the semicircular canals (Casale, 2023; Bielefeldt, 2020). The central extensions of the sensory cells located in the vestibular ganglia form the vestibular nerve, through which information is transmitted to the cerebellum. Displacement of the hair cells activates nerve impulses that provide the brain with information about the direction, angle and extent of movement. This allows corrective muscle movements to be made (Blythe, 2006). The vestibulo-ocular reflex allows the eyes to remain fixed on an object while the head is moving. The vestibulo-ocular reflex maintains balance and posture by coordinating the muscles of the spine with the movement of the head. The known central vestibular connections include the vestibulo-thalamo-cortical tract, the tract between the dorsal tegmental nucleus and the entorhinal cortex, and the tract between the nucleus reticularis pontis oralis and the hippocampus. These play a functional role in self-motion perception, spatial navigation, spatial memory and object recognition memory. Dysfunction of the vestibular system can cause cognitive deficits related to spatial memory, learning and navigation (Casale, 2023).

Somatosensory system includes the receptors in our skin, muscles, tendons and joints provide information about the spatial position of our body, the location of our body parts, their interconnection and their interaction. The basic somatosensory modalities are pain, heat, tactile sensation and proprioception. There are many interactions between them and the speed of their transmission varies, depending on the myelination of the nerve fibre (Gerebenné Várbíró, 2021).

Proprioception is the conscious and involuntary perception of the position of the joints (Blythe, 2006). Proprioception, or the sense of movement, provides us with awareness of the spatial positioning of our body parts - at rest and during movement - maintain proper posture, and is involved in motor control, learning new movements, and has a protective function. Proprioceptors are found throughout the body, these are mainly located in joints, ligaments, and between the connections of muscles and tendons (Tóth, 2017). Information from them is processed primarily by the balance system, but they also influence body movements, and the adjustments needed to perform fine movements and are involved in joint protection (Sziliné Hangay & Gerencsér, 2005). Signs of proprioceptive weakness include poor posture, constant restless movements, strong urges to lean, clumsiness, and little concept about the spatial location of body parts (Blythe, 2006).

2.1.3 Action systems

Next to the sensory systems action systems play a crucial part in motor control. This system includes basal ganglia, cerebellum, central pattern generators and motor cortex. The choice of action and decision making represents a highly complex level. The basal ganglia play a main role and depend on input coming from the cortex, thalamus and dopamine system. The basal ganglia control command centres in the brainstem. These activate different command pathways to specific central pattern generator networks in the spinal cord or brainstem responsible for executing a particular motor program. The cerebellum plays a central role in motor learning and fine-tuning of different movements (Grillner&El Manira, 2020). The cerebellum is fundamentally involved in motor functions, but evidence is accumulating that it also contributes to non-motor, cognitive functions. It is now widely recognized that the cerebellum contributes to both motor behaviour and cognition. Anatomically and functionally, the cerebellum has extensive connections with brain areas that play key roles in non-motor functions, and these connections form consistent, closed loops. It has been suggested that these loops may form the basis for unified processing patterns across different functional domains. In other words, since the cerebellum is critically important for coordination and timing in the motor domain, it may fulfil similar functions in the cognitive domain as well (Peterburs&Desmond, 2016).

All in all, the cerebellum is a vital component of the human brain. It plays a role in regulating motor movements and balance, coordinating walking, maintaining posture, regulating muscle tone and voluntary muscle activity, but it cannot initiate muscle contraction. The cerebellum receives afferent information about voluntary muscle movements from the cerebral cortex, muscles, tendons and joints, and about balance from the vestibular nuclei. The cerebellar hemispheres control the same side of the body, and in case of damage, the symptoms appear ipsilaterally. Its damage results in the loss of the ability to control fine movements, maintain posture, and learn motor skills (Jimsheleishvili&Dididze, 2023).

2.1.4 Laterality

Lateral dominance, including hand dominance means that the child uses one hand more often (e.g. a ball is always thrown with the same hand or pencil must be held in the dominant hand while writing). The dominant hand is slightly more skilled than the other one (Tóth, 2017).

Some research suggests that older adults show a stronger lateral preference than young adults. This supports the theory that handedness develops or becomes more stable with age (Marcori et al., 2019). If someone is dominantly right lateralized, then the left hemisphere of the brain is more competent than the right hemisphere in terms of fine motor skills and/or strength (Bondi et al., 2020). It has been shown that a less lateralised brain, which corresponds to a less lateralised behavioural preference, is associated with certain deficits in cognitive development (Crow, 1998). A higher prevalence of left-handedness or mixed handedness has been reported in a number of developmental disorders in the motor domain (e.g. developmental coordination disorder) compared to the general population (Darvik et al., 2018). Nevertheless, it cannot be clearly stated that these forms of handedness are risk factors for developmental disorders. The term "crossed laterality" is used to describe people whose hand, eye, foot or ear dominance is not equally right- or left-sided. It encourages the creation of a range of interventions to restore or consolidate lateral dominance (Ferrero et al., 2017).

2.1.5 Limb coordination

One of the key components of motor control is inter-limb coordination. It is achieved by synchronizing the spatial and temporal aspects of limb movements. It refers to movements that require synchronised and rhythmic use of both sides of the body (sequential, simultaneous or rhythmic). We can distinguish two categories: bimanual coordination (e.g. throwing a big ball with two hands, finger tapping with index fingers of both hands, finger tapping with one hand and tracing a circle with the other hand) or hand-foot coordination (e.g. tapping with hands and feet, clapping while walking) (Rose &Winstein, 2013; Arya&Pandian, 2014; Bobbio et al., 2009).

This movement involves the dexterous coordination of the two arms in a two-handed operation – the so-called bimanual action. Bimanual movements require coordination within the limbs (intra-limb coordination), as well as integration and sequencing of actions between limbs (i.e., inter-limb coordination). Bimanual control begins around age 4 and significant changes occur between the ages of 4 and 10 years (Bobbio et al., 2009). Many activities of daily life depend on successful bimanual coordination. The complexity of bimanual coordination tasks ranges from those as simple as clapping, which an infant performs almost reflexively, to those that require a lifetime of practice, such as playing a piano. However, the direction of movement is not an insignificant consideration. When the left and right hands move in a symmetrical or mirror-like pattern along the midline, they are easier to perform than when they have to move in the same direction, i.e. parallel, in an asymmetrical pattern (Bobbio et al., 2009; Sisti et al., 2022).

Inter-limb coordination involves the simultaneous coordination of the upper and lower extremities. Actions can be performed with the upper and lower limbs on the same side of the body (ipsilateral movements), or with the limbs on both sides (contralateral movements). The rhythmic coordination of non-homologous limbs like hands and feet is more difficult to implement than movements using two hands due to mechanical differences between the limbs Improvements can be detected between the age of 4 to 10 years (Bobbio et al., 2009).

2.2 Motor development

2.2.1 Developmental milestones

Motor development is the step-by-step process of modifying movement patterns, based on an individual's genetic potential and previous and new movement experiences, occurring through the interaction between the organism and the environment. Motor development encompasses the individual development of complex movement forms and motor skills (such as crawling, climbing, walking, running, jumping, throwing, catching, hitting, and kicking), as well as the development of conditional abilities (strength, speed, endurance, joint flexibility), and coordination and balance skills. Different perspectives can be encountered regarding the stages of motor development (Farmosi, 2011).

The stage of reflex-like movements encompasses the period from birth to the end of the first year of life. The newborn is born with so-called primitive reflexes and elementary movement patterns. The primary function of these is to aid in feeding and defense, supporting the survival of the newborn. The secondary function of some of them is to serve as the basis for later voluntary movements. In the initial stages of motor development, only the lower-level, so-called subcortical centers are responsible for regulating movements, which are increasingly inhibited as the cortical nervous system centers mature (Vass, 2020).

The next stage - stage of elementary voluntary movements - is between 1 to 24 months. Elementary voluntary movements are considered the foundation of human locomotion, posture changes, and manipulative motor skills. There are movements related to stability (posture changes), manipulation, and locomotion. During this developmental period, the first voluntarily coordinated movements occur. Goal-directed grasping, upright posture, and independent locomotion develop. The characteristic developmental direction of this period is cephalocaudal, meaning that coordinated movement starts from the head and progresses toward the feet. So, coordinated elementary voluntary movements appear first in relation to the mouth, eyes, and head, followed by the development of coordinated movements of the arms, trunk, and legs (Vass, 2020; Rachwani, 2015). Contralateral symmetrical movements are characteristic (e.g. if an infant moves the left arm, the right arm will move simultaneously). Increased muscle tone also persists, which is most noticeable in the inefficient execution of movements. This primarily indicates the predominance of excitatory processes in the nervous system, which gradually balance out with the engagement of inhibitory mechanisms in the nervous system. This stage is characterized by the gradual development of manipulative movements and the coordination of fine motor skills. Successful manipulation of objects fundamentally consists of three phases: reaching, grasping, and releasing (Farmosi, 2011). The development of the characteristic human posture and walking is the greatest achievement of this period (Farmosi&Gaál Sándorné, 2007).

In the stage called „Basic forms of movement stage (2–7 years of age)", motor development is characterized by the perfection of already acquired elementary voluntary movement patterns, the expansion of basic motor skills, and the emergence of the first movement combinations. Basic movement patterns can be grouped into postural (position-changing), locomotor (location-changing), and manipulative movement forms. Development follows three main directions, which are manifested in performance improvement, execution quality, and the combination of known movements (Porkolábné Balogh, 1995).

In the „Initial stage (between 2–3 years)" the child begins to consciously and purposefully apply basic movement patterns to explore and discover their environment. The involvement of individual body parts in a given motion or sequence of movements is often inadequate, or in some cases, certain body parts do not participate in the movement at all. More muscle groups are involved simultaneously during movements than necessary for the successful execution of the movement, and the already acquired movement patterns can only be applied under limited environmental conditions. If the execution of a particular movement pattern becomes uncertain, the child will choose another movement pattern in which they feel more confident (e.g. instead of walking unsteady on an unstable surface they switch to crawling). A low level of awareness regarding their own body, spatial orientation, and energy expenditure can be observed in their movements.

During „Elementary stage (3–5 years old)", due to the constant practice, there is a significant improvement in the sequencing of the limbs involved in the movements, the applicability of the movement patterns, and the coordination of movements. The limbs involved in the execution of a given movement are used in the correct order, the involvement of muscle groups that are not necessary for the execution of the movement decreases, and the range of environmental applicability expands. In terms of movement coordination, there is a significant improvement in the spatial and temporal synchronization of the limbs. Overall, there is an elevated level of awareness regarding their own body, spatial orientation, and energy expenditure during movements.

At „Proficient stage (5–7 years of age)", the implementation of basic forms of movement reaches the highest level. This means that during the execution of movements, the engaging and disengaging of each limb in a given movement, and ultimately the sequencing, is largely observed. Also, the economy of movement, that is, movement in terms of turning off the functioning of unnecessary muscle groups, the highest degree is reached. In case of movements there is a high level of awareness of one's own body, spatial orientation and energy investment.

The stage of specific movements (over 7 years of age) can be divided into three substages. Approximately between the seventh and tenth years of life - the transitional; between the age of eleven and thirteen - the application; from the age of thirteen - the life long utilization period.

The individual stages differ from each other both qualitatively and quantitatively. The characteristic and importance of the transition period lies in the continuous and smooth transition from basic to sport-specific movements. The application phase includes movements that are already specific to sports, which continue in the stage of movements that can be used later in life (Vass, 2020).

According to a different categorization the stages of motor development from preschool to early school age are the following.

- From 3.5 years to 7-7.5 years: This period is characterized by the rapid perfection of fundamental movement forms, the emergence of the first movement combinations, and the development of the ability structure. The increasing precision of movements enables their integration.
- From 7-7.5 years to 9-10 years: This stage is marked by the rapid development of the ability to learn movements. During this period, numerous new movements are acquired.
- Girls: from 9-10 years to 11-12 years, Boys: from 9-10 years to 12.5-13.5 years: In childhood, this stage is the most intense phase of movement learning, with gender-specific differences and individual movement characteristics becoming more pronounced (Farmosi, 2021).

(Summary Table 1 for ages 4-7 – Appendix 1)

2.2.2 Motor learning

During motor learning, by mastering the actions, we gain new movement skills, and we raise our previously acquired skills to a higher level. The process is created through practice based on individual experience. Part of it is the development, refinement, consolidation, application and retention of movement skills. The key elements are the feedback and correction instructions obtained by repeating the given movement skill.

Motor learning is therefore a process during which a change occurs in the motor performance of the given person. Many models have already been developed in relation to motor learning. Most theories are based on four different ideas about learning:

- a dynamic process that leads to the acquisition of the ability to perform specific actions;

- for its realization, the opportunity to practice and gather experience must be provided, making mistakes is a necessary part of the learning process;

- motor learning itself cannot be directly observed, it can be inferred by observing changes in motor behaviour;

- through motor memory, what has been learned can be applied or adapted in a changed task situation or within environmental constraints.

There are some important factors which affect motor learning process: verbal instructions (maintaining capacity for attention); characteristics and variability of practice, training (distributed practice, with prolonged rest periods rather than continuous repetition of tasks without rest periods); the individual's active participation and motivation (progress depends on these); the option of making mistakes; postural control (control over the body's position in space); memory (key component in learning process); and feedback (provide information about how the action is being carried out) (Cano-de-la-Cuerda et al., 2015).

According to one theory motor learning includes the following stages.

- *The development of rough coordination of movement:* first the task is understood, this is based on cognitive abilities, but the acceptance of the task and the development of interest also mobilize the emotions. After understanding, a relatively accurate picture of the movement is formed, which is mainly based on visual information. After the understanding and the idea, the first attempt to execute the movement takes place, which is then typically "jerky", sometimes unsuccessful. Apart from vision, the other senses are only moderately involved in the regulation process. Although information is received from the proprioceptors, it is not yet perceived by the nervous system. Previous movement experiences can help in the efficient processing of sensory information. On the other hand, movement elements stored in movement memory similar to the movement to be learned can hinder the improvement of coordination.

- *The stage of fine coordination of movement:* the coordination of movements improves along with continuous practice and correction of mistakes. Using kinesthetics information improves coordination. Movements are characterized by continuity, economy and rhythm.

- *Consolidation of the fine coordination of movement:* means application in changing conditions. The individual takes in the information necessary for successful execution, processes it and adapts the movement performance to the external circumstances (Polgár&Szatmári, 2011; Király&Szakály, 2011).

According to Fitts and Posner, there are three stages in motor learning.

- *Cognitive stage:* Learning a new skill or relearning an existing one. Frequent practice is required with supervision. Mistakes are neccessary and it is important to know how to correct them in this process. Movements are inefficient and slow, there is a need for cognitive activity.

- *Associative stage:* Being able to perform the task in a specific environment. Errors occur during the activity and correction is easier. Individual will begin to understand how the components of a skill are interrelated. Movements are smoother and more efficient, less cognitive activity is enough.

- *Autonomous stage:* Being able to move in different settings and maintain control during the task. The movements are precise and efficient, with little or no cognitive activity required. Learning is completed when there is the ability to retain a skill and apply it in various settings via automatisation. It is crucial, due to practical situations in real life are mostly random (Magill& Anderson, 2010; Fitts&Posner, 1967).

Gentile's two-stage model commences with comprehending the task's objective, formulating the requisite movement strategies for its execution, and discerning the environmental cues pertinent to the organization of movement. In the second stage, known as fixation or diversification, the individual seeks to refine their movement patterns. This involves enhancing the ability to adapt movements to varying tasks and environments, as well as achieving consistent and efficient task performance (Cano-de-la-Cuerda et al., 2015; Gentile, 1972).

2.3 Motor skills

The term "motor" is derived from Latin, meaning a device that generates kinetic energy or initiates movement. Motor skills are combinations of physical or bodily attributes that are prerequisites for performing a movement-oriented action aimed at a specific goal (Meszler&Tékus, 2015). Motor skills are essential for moving the body and body parts based on the activity of skeletal muscles as effectors (Tóth, 2017). Skills are determined by factors such as body structure, the functioning of organs and organ systems, and functional changes resulting from various influences. Adaptation is achieved through the unified functioning of structure and function.

Motor skills can be divided into fine and gross motor skills. Certain resources also mention hand-eye skills as a third type in addition to the previous ones, as part of coordination (detailed below). Gross motor skills are vital for human beings, these help individuals move, and this involves using the large muscles of the body. These motor skills require proper functioning of muscles, bones, nervous system and motor coordination. Fine motor skills include the use of smaller muscles, mostly of the hands. By these skills we perform various tasks or manipulate objects that we need in everyday situations. The precise movement of the hand required, for example, to write with a pen or to play a musical instrument (Tóth, 2017). Fine motor skill is often interpreted as the skill to perform small manual operations which require hand-eye coordination as well (Luo et al., 2007). Two main aspects of this skill are manual dexterity and finger dexterity. Dexterity is often equated with object manipulation skills, that is why it is often measured with object manipulation tasks (e.g. coin tossing, beading, etc.) (Fischer et al., 2020; Petermann, 2015). Therefore, performance is often scored by the speed of completing a given task. Finger agility is described as the ability to move the fingers intentionally and individually. It is considered an essential skill measured, for example, in a tapping task (Roesch et al., 2021; Fischer et al., 2022). These skills strongly predict school achievement, the acquisition of fine motor skills is essential for children to learn handwriting (Grissmer et al., 2010; Seo, 2018). In addition, children with fine motor developmental problems have difficulty learning fine motor skills, they probably experience problems in school with writing or cutting tasks, or in everyday situations like tying shoelaces or zipping (Blank et al., 2019).

According to another classification of motor skills, there are three main groups: conditional abilities, coordination abilities, and joint mobility. Conditional abilities represent the energetic prerequisites for executing movements and can be characterized by physical measures. To successfully perform a movement, the ideal strength, speed, and endurance must be established. Conditional abilities the current performance capacity of the body and the ongoing adaptive phenomena within it. Influencing factors include the capacity of the nervous system, muscle tissue, cardiovascular system, respiratory system, and metabolic systems. Joint mobility is the condition of movements that reflects the freedom and limitations of the range of motion derived from the anatomical structures of the human motor system and regulated by various nervous system mechanisms. Coordination refers to the precision, effectiveness, and efficiency of movements. This motor skill is primarily depending on the functioning level of the nervous system. Movement coordination is a complex sensorimotor phenomenon that demonstrates the regulatory background of actions (Meszler & Tékus, 2015). The effectiveness of motor activity is determined by appropriate spatial and temporal orientation, the ability to connect component elements, differentiated movement perception, proper balance, complex reaction capability, adaptability, and rhythm sense (Polgár&Szatmári, 2011).

The acquisition of motor skills is not only essential for the functioning of everyday life, but also affects the cognitive and social development of children (Cools et al., 2009).

2.3.1 Conditional abilities

The three fundamental elements of conditional abilities are strength, speed, and endurance. Due to the interactions and relationships among these abilities, we can refer to abilities such as speed-strength, speed-endurance, and endurance-strength. Certain literature also classifies joint mobility in this group (Farmosi, 2011).

Conditional abilities provide the energetic conditions for executing movements, which can be characterized by physical measures. These parameters define the speed, duration, and the extent of exertion during movement. They are easy to measure and are the most accurately measurable abilities. They ideally characterize an individual's current performance capacity and the adaptive phenomena within the body (Meszler et al., 2015).

Strength*:* A conditional ability that is created by muscle tension, shortening, or lengthening, enabling us to overcome various levels of resistance (Király & Szakály, 2011).

Speed*:* A conditional ability that allows high-speed execution of movements under given conditions. Speed is largely inherited, so its trainability is limited (Dorka et al., 2013). Literature divides speed into four elements: reaction speed, movement speed, frequency speed, and speed-strength required for acceleration.

Endurance: According to Nádory (1991), endurance is the body's resistance to fatigue during prolonged exertion. More broadly, endurance encompasses the physiological processes that enable the body to maintain biological balance over a long period under significant physical stress. Its most intense development phase occurs between 7-10 years of age, for both boys and girls. There are three types of endurance: long-term, medium-term, and short-term endurance. Additionally, due to the interactions with other conditional abilities, we can also talk about endurance-strength and speed-endurance.

Long-term Endurance: Characterized by exertion lasting over 15-30 minutes, where the intensity and pace do not significantly decrease, and the work is mainly aerobic.

Medium-term Endurance: Characterized by exertion lasting 2-9 minutes, where the intensity does not significantly change, and energy is supplied aerobically after 2 minutes.

Short-term Endurance: Characterized by exertion lasting 45 seconds to 2 minutes (Dorka et al., 2013).

2.3.2 Coordination abilities

Coordination abilities allow us to mobilise our conditional skills in a given task situation in a way that is appropriate to the task. Motor coordination enables a given movement to be executed accurately, smoothly, rhythmically, harmoniously, and aesthetically and enables us to adapt to an ever-changing environment, to adapt our behaviour and to perform our actions as a whole. Based on the analyses carried out so far, coordination abilities presuppose constant nervous regulation and control. Early childhood coordination refers to a child's motor skills, including walking, running, and jumping, and their smooth execution with harmonious movement. The characteristics of coordinated movement are appropriate speed, distance, direction, timing and muscle tension. Age-appropriate balance and coordination allows the child to experience success in sport by helping the body move to perform physical skills (e.g. ball games).

The classification of coordination abilities is diverse. In the early stages of motor development research, coordination abilities were referred to as a single ability - dexterity. With the expansion of research and literature, there was a need for more precise definitions, leading researchers to break down dexterity into distinct abilities (Farmosi, 2011). The main subabilities include balancing ability, spatial orientation ability, rhythm ability, and speed coordination ability.

Balance skills

The balance system develops by the 16th week of intrauterine life, allowing the fetus to sense directions and orient itself within the mother's womb (Blythe, 2014). Balance is based on the cooperation of the cerebellum, antigravity muscles, and the eyes (Blythe, 2006). There are three types of balance perception that can be distinguished.

<u>Static Balance:</u> This type is responsible for sensing the position and acceleration of the head in space. To maintain this and perform daily activities, it primarily relies on information from the proprioceptive system and the skin. Static balance involves the stable fixation or maintenance of a body part or posture despite the potential for continuous loss of balance (Dubecz, 2009).

<u>Dynamic Balance:</u> This type senses angular velocity and changes in speed, requiring more complex sensory information for its execution (Shaffer & Harrison, 2007). Dynamic balance involves establishing and maintaining a balanced position during movements of various directions and speeds that would otherwise disrupt balance (Dubecz, 2009).

<u>Object Balance:</u> This type involves balancing while carrying objects (Pappné Gelencsér, 2023).

Balancing is an extremely complex process realized through the vestibular, somatosensory, and visual systems (Dulházi, 2018).

Additional coordination abilities

<u>Spatial Orientation Ability:</u> It involves coordinating the movement of one's own body, body parts, others, or foreign objects in space, particularly evident in play with others or complex spatial movements (Meszler et al., 2015). It is the perception of our position, the perception of the distance, speed, and direction of movement of various stationary and moving objects (persons, objects) relative to each other and to us, and the determination of expected changes (Polgár&Szatmári, 2011). As spatial orientation relies on perception, integration and interpretation of visual, vestibular and proprioceptive sensory information, vision, hearing, tactile and kinesthetics analysers are involved in it, their complex appearance creates this ability (Hamar, 2008).

<u>Speed Coordination:</u> Essentially the regulated, precise execution of movement and action programs under time constraints. This ability has a strong genetic component, making its sensitive period, which occurs during early school years (grades 1-3), critical for development (Dorka et al., 2013).

<u>Rhythm ability:</u> The understanding of the temporal and dynamic order of movement processes, the perception of the inherent or predetermined rhythm in the movements, and its display in

the execution of the movement. It can be found in the performance of all physical exercises and in the movement material of sports (Polgár&Szatmári, 2011; Hamar, 2008).

Reaction ability: A specific ability, with the help of which the individual can respond to stimuli and information from the environment with appropriate speed and appropriate actions. Its simpler and more complicated forms are also present in the field of life and sports activities, from stimuli that trigger an immediate response to a reaction that requires a decision and requires perception.

Movement perception (kinaesthesia): The type of coordination skills that manifests itself in kinesthetics differentiation through the perception of information indicating the degree of muscle tension and relaxation. This ability helps the individual to carry out the movements accurately and economically, as well as the pleasant feeling of the movement experience created during the lightness by eliminating unnecessary efforts (Hamar, 2008).

Eye-hand coordination

Eye-hand coordination depends on the integrated control of ocular and sensorimotor systems to achieve a single goal, such as touching a visual target. It is a complex process that requires precise activation of the eye and hand motor systems. Optimal function relies on complex feedforward and feedback-mediated connections between the visual-perceptual, ocular, and appendicular motor systems, and exploits finely tuned synergies between these systems in both the temporal and spatial domains. Timed and dexterous movements, such as reaching and grasping small objects, depend on the acquisition of high-quality visual information about the environment and the simultaneous control of the eyes and hands (Rizzo et al., 2019; Rizzo et al. 2020). Eye-hand or sometimes referred as hand-eye coordination or hand-eye skills include the control of the hands in a task such as catching or throwing a ball.

2.3.3 Consequences of poor skills

Children with low motor skills are less likely to take part in physical activities at home, school or in the community, and are often excluded from activities by their peers. They tend to show lower fitness levels than typically developing children. Research has reported reduced health-related fitness (explosive strength, power and endurance) and cardiorespiratory fitness in connection with lower motor skills. This suggests that low motor skills negatively affect health-related fitness components. Denysschen et al. (2021) found that children with low motor skills showed poorer outcomes in aerobic capacity, muscle strength and endurance compared to children with typical developmental milestones.

Gross motor skills (GMS) are the basis for many sports and physical activities. Moreover, higher levels of these motor skills are associated with lower body mass index, better cardiorespiratory fitness, increased cognitive development, social development and language skills. Lower self-esteem and higher anxiety are more common in children with poor gross motor skills (Veldman et al., 2016). The proper development of gross movements is a prerequisite for the development of fine motor patterns, the basis for the development of fine movements (Farmosi, 1999).

Engaging in physical activity enhances the structural plasticity of both grey and white matter in children and adolescents. It facilitates the modulation of brain activation patterns in response to specific tasks, improves the structure of the brain and functional networks. Consequently, physical activity fosters positive changes in cognitive abilities, including attention, memory and thinking, as well as executive functions (Shi&Feng, 2022).

It is important to ensure the development of movement up to the age of 5 years, when the necessary organ functions (nervous system, muscular system, heart, lungs, blood circulation) are further developed, enabling children to acquire the important basic human skills (walking, running, jumping, throwing, crawling, climbing, etc.). Depending on the external influences, the control functions that are important in the organization of movement execution also develop, thus enabling the acquisition of more and more complex movements. The sense of balance, hand-eye coordination, spatial perception, sense of direction and rhythm, sense of pace, etc., are developed, which are also related to the development of thinking.

The consequences of developmental delay: learning problems (dyslexia, dysgraphia, dyscalculia, hypermotility); hyperactivity; disorders of cognitive functions (perception, attention disorders, memory and thinking); muscle tone, gross and fine motor disorders; behavioural disorders (aggressiveness, anxiety, integration disorders) (Király&Szakály, 2011).

2.4 Examination of motor skills

Since the development of motor skills is not a fixed linear process, it is recommended to monitor children's motor development from time to time, rather than assessing them once. Every child has their own individual learning pace and motor skills develop by leaps and bounds. By monitoring from time to time, the progress of their development can be detected. Motor development problems can be recognized at an early stage. By starting targeted diagnostic methods and therapy in time, the effects of their motor development problems can be reduced (Gerber&Erdie-Lalena, 2010; Brons et al., 2021).

2.4.1 Tests presented in the course

The tests used can be adapted to younger and older children based on the skills and developmental milestones expected at a given age, and, where appropriate, allow for retesting after a developmental program. These are easy-to-use tests with minimal equipment that allow the examiner to map child's motor skills and compare them with age-appropriate levels. The recordings show tests to assess fine and gross motor skills. However, it is important to mention that the following data should be recorded before the tests are carried out (Dannemiller et al., 2020).

History of the child:

- General intake data: date of birth, date of examination, gender, reason for referral, parent/caregiver concerns, general health, list of other service providers.
- Medical history: birth history (prematurity, birth weight), onset of symptoms that relate to motor concerns, medications, other medical conditions including vision or hearing concerns, coexisting conditions such as attention deficit hyperactivity disorder (ADHD), etc., events such as accidents or surgical procedures, medical interventions.
- Developmental history: developmental milestones in gross/fine motor, language, and social/adaptive skills, other areas of intellectual or developmental concern, behavioral or emotional differences.
- Family history: medical or developmental conditions that exist in the family, such as clumsiness, developmental coordination disorder (DCD), attention deficit disorder (ADD) or ADHD, specific learning disabilities, and intellectual disability (ID).
- Educational history: interventions received in early intervention or developmental preschool program, reports of difficulties with physical activities or academics, special education services in school, intellectual testing and determinations.
- Participation history: home activities of daily living (ADL) and chores, activities with family and friends, physical activity preferences that are motivating at home, school, and community, fitness level.
- Additional history may include, with parent/caregiver consent: reports secured from other professionals such as occupational therapists, speech therapists, psychologists, physicians, teachers, or other significant adults.
- Musculoskeletal screen: height and weight.
- Neuromuscular screen: fall history, toe walking.
- Cognitive/behavioural screen: ability to follow instructions and communicate needs, behavioural regulation and attention, ability to interact with adults and peers.
- Vision screen: history of acute changes in visual function, history of treated or untreated visual impairments or diagnoses.

Before completing the tests, the examiner needs to make sure that the examined child understands the tasks and has had chance to try them.

Assessment of fine motor skills

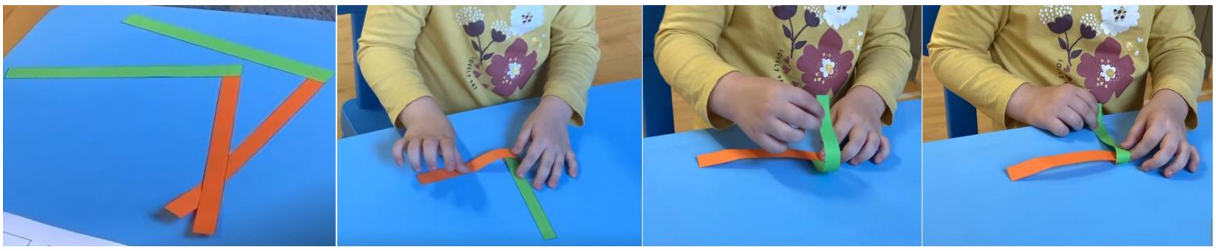
1. **Copying a square, a triangle and a diamond**

Equipment required: paper with geometric shapes, pencil. The child should copy three shapes using a pencil on a paper. Precision, quality of task implementation and pencil grasping is observed. The result can be compared to what is expected at a given age (Picture 1) (Radanović et al., 2021).

Picture 1 Copy test and observation of pencil grip

2. **Folding paper strips**

Equipment required: 2 paper strips (width 1.5 cm, length 20 cm) glued together at the end at right angles to each other, stopwatch. The child sits at the table, the glued strips of paper are in front of the child on the table. The examiner demonstrates the task by folding the paper strips over each other again and again as tight as possible, and verbally explains what he/she is doing. Then the child should fold the strips of paper over each other again and again until he/she reaches the end of the strips (Picture 2). Maximum time: 3 min – age 5; 2 min – age 6-8. Time is measured. Quality of performance is assessed. Possible scoring: the score is the number of correctly completed folds (i.e. the folded part covers the underlying part). The folds of both paper strips are counted, incomplete folds are not counted (URL 1).



Picture 2 Folding paper strips test

3. **Cutting paper with scissors**

Equipment required: colouring picture, scissors, stopwatch. The child sits at the paper with the colouring picture and the scissors in front of him/her. In this picture, a string is attached to the balloon. The child should start cutting at the end of the string and cut the string until he/her reaches the balloon. Not allowed to cut outside the black area of the string (Picture 3). Maximum time: 3,5 min – age 5; 3 min – age 6-7; 2 min – age 8. Time is measured. Quality of performance is assessed. Possible scoring: the score is the number of times the child crossed the lines (irrespective of the size of the error; also, a dot outside the lines is considered an error) (URL 1).

Picture 3 Cutting paper with scissor test – cutting inside the line not touching the balloon

Assessment of hand-eye skills and bilateral motor coordination

1. **Catching ball with two hands - Throwing the ball at a target**

Catching ball with two hands from 2 meters distance in 5 trials. Throwing the ball in a bin 2 meters distance in 5 trials. Quality of performance is assessed – whether the child can catch the ball in a smooth manner by timing the catch with two hands and throw it at a target successfully. The result can be compared to what is expected at a given age.

2. **Finger-foot same side synchronized**

Tapping finger/hand and foot on same side synchronized manner for 30 seconds (Picture 4). Best of 3 trials. Quality of performance is assessed – whether the child can synchronize the movements.

Picture 4 Tapping same side synchronized

3. **Finger-foot opposite side synchronized**

Tapping alternately finger/hand and foot of one side with the other side for 30 seconds. Best of 3 trials. Quality of performance is assessed – whether the child can maintain the rhythm of alternate limbs (Bobbio et al., 2009).

Assessment of gross motor skills

Pediatric Balance Scale: Pediatric Balance Scale is a version of the Berg Balance Scale adapted for children, designed to assess, and measure balance and stability in school age children - school age children (5-15) for children with mild to moderate motor impairments; typically developing children plateau around age 7-8. Administration and scoring take less than 15 minutes. Verbal instructions for each item are given. The child may receive one practice trial per item. If the child is unable to understand the directions, a second trial may be given. Verbal and visual instructions are given to clarify (Franjoine et al., 2010; Vekerdy-Nagy, 2019).

Equipment required: adjustable height bench, chair with back support and arm rest, stopwatch or watch with a second hand, masking tape, – 1 inch wide (1 inch = 2,54 centimetres), a step stool 6 inches (15,24 cm) in height, chalkboard eraser, ruler or yardstick, a small level. Optional equipment that may be helpful includes: 2 child size footprints, blindfold, brightly coloured object at least 2 inches (5,08 cm) in size, flash cards, 2 inches (5,08 cm) of adhesive-backed hook, two 1-foot (30,48 cm) strips of loop.

14 item test - each item is scored 0 – 4 (max. 56 points)

Test 1 – Sitting to standing

Equipment: a bench of appropriate height to allow the child's feet to rest supported on the floor with the hips and knees maintained in 90 degrees of flexion. Instructions: child is asked to "Hold arms up and stand up." The child is allowed to select the position of his/her arms. Best of three trials.

4 points -able to stand without using hands and stabilize independently

3 points - able to stand independently using hands

2 points - able to stand using hands after several tries

1 point - needs minimal assist to stand or to stabilize

0 point - needs moderate or maxima assist to stand

(Test 1 and 2 may be tested simultaneously if, in the determination of the examiner, it will facilitate the best performance of the child.)

Test 2 – Standing to sitting

Equipment: a bench of appropriate height to allow the child's feet to rest supported on the floor with the hips and knees maintained in 90 degrees of flexion. Instructions: child is asked to sit down slowly, without use of hands. The child is allowed to select the position of his/her arms. Best of three trials.

4 points - sits safely with minimal use of hands

3 points - controls descent by using hands

2 points - uses back of legs against chair to control descent

1 point - sits independently, but has uncontrolled descent

0 point - needs assistance to sit

Test 3 – Transfers

Equipment: two chairs, or one chair and one bench. One seating surface must have armrest. One chair/bench should be of standard adult size and the other should be of an appropriate height to allow the child to conformably sit with feet supported on the floor and ninety degrees of hip and knee flexion. Instructions: arrange chair(s) for a stand pivot transfer, touching at a forty-five-degree angle. Ask the child to transfer one way toward a seat with armrests and one way toward a seat without armrests.

4 points - able to transfer safely with minor use of hands

3 points - able to transfer safely; definite need of hands

2 points - able to transfer with verbal cueing and/or supervision (spotting)

1 point - needs one person to assist

0 point - needs two people to assist or supervise (close guard) to be safe

Test 4 – Standing unsupported

Equipment: a stopwatch or watch with a second hand, a twelve-inch-long masking tape line or two footprints placed shoulder width apart. Instructions: the child is asked to stand for 30 seconds without holding on or moving his/her feet. A taped line or footprints may be placed on the floor to help the child maintain a stationary foot position. The child may be engaged in non-stressful conversation to maintain attention span for thirty seconds. Weight shifting and equilibrium responses in feet are acceptable; movement of the foot in space (off the support surface) indicates end of the timed trial.

4 points - able to stand safely for 30 seconds

3 points - able to stand 30 seconds with supervision (spotting)

2 points - able to stand 15 seconds unsupported

1 point - needs several tries to stand 10 seconds unsupported

0 point - unable to stand 10 seconds unassisted

____ Time in seconds

Special instructions: if a subject is able to stand 30 seconds unsupported, score full points for sitting unsupported. Proceed to item #6

Test 5 – Sitting with back unsupported and feet supported on the floor

Equipment: a stopwatch or watch with a second hand, a bench of appropriate height to allow the feet to rest supported on the floor with the hips and knees maintained in ninety degrees of flexion. Instructions: please sit with arms folded on your chest for 30 seconds. Child may be engaged in non-stressful conversation to maintain attention span for thirty seconds. Time should be stopped if protective reactions are observed in trunk or upper extremities.

4 points - able to sit safely and securely 30 seconds

3 points - able to sit 30 seconds under supervision (spotting) or may require definite use of upper extremities to maintain sitting position

2 points - able to sit 15 seconds

1 point - able to sit 10 seconds

0 point -unable to sit 10 seconds without support

____ Time in seconds

Test 6 – Standing unsupported with eyes closed

Equipment: a stopwatch or watch with a second hand, a twelve-inch-long masking tape line or two footprints placed shoulder width apart, blindfold. Instructions: the child is asked to stand still with feet shoulder width apart and close his/her eyes for ten seconds. Direction: „When I say close your eyes, I want you to stand still, close your eyes, and keep them closed until I say open." If necessary, a blindfold may be used. Weight shifting and equilibrium responses in the feet are acceptable; movement of the foot in space (off the support surface) indicates end of timed trial. A taped line or footprints may be placed on the floor to help the child maintain a stationary foot position. Best of 3 trials.

4 points - able to stand 10 seconds safely

3 points - able to stand 10 seconds with supervision (spotting)

2 points -able to stand 3 seconds

1 point - unable to keep eyes closed 3 seconds but stays steady

0 point-needs help to keep from falling

____ Time in seconds

Test 7 – Standing unsupported with feet together

Equipment: a stopwatch or watch with a second hand, a twelve-inch-long masking tape line or two footprints placed together. Instructions: the child is asked to place his/her feet together and stand still without holding on. The child may be engaged in non-stressful conversation to maintain attention span for thirty seconds. Weight shifting and equilibrium responses in the feet are acceptable; movement of the foot in space (off the support surface) indicates end of timed trial. A taped line or footprints may be placed on the floor to help the child maintain a stationary foot position. Best of 3 trials.

4 points - able to place feet together independently and stand 30 seconds safely

3 points - able to place feet together independently and stand 30 seconds with supervision (spotting)

2 points - able to place feet together independently but unable to hold for 30 seconds

1 point - needs help to attain position but able to stand 30 seconds with feet together

0 point - needs help to attain position and/or unable to hold for 30 seconds

____ Time in seconds

Test 8 – Standing unsupported one foot in front

Equipment: a stopwatch or watch with a second hand, a twelve-inch-long masking tape line or two footprints placed heel to toe. Instructions: the child is asked to stand with one foot in front of the other, heel to toe. If the child cannot place feet in a tandem position (directly in front), they should be asked to step forward far enough to allow the heel of one foot to be placed ahead of the toes of the stationary foot. A taped line and/or footprints may be placed on the floor to help the child maintain a stationary foot position. In addition to a visual demonstration, a single physical prompt (assistance with placement) may be given. The child may be engaged in non-stressful conversation to maintain his/her attention span for 30 seconds. Weight shifting and/or equilibrium reactions in the feet are acceptable. Timed trials should be stopped if either foot moves in space (leaves the support surface) and/or upper extremities support is utilized. Best of 3 trials. (Picture 5)

4 points - able to place feet tandem independently and hold 30 seconds

3 points - able to place foot ahead of other independently and hold 30 seconds

Note: The length of the step must exceed the length of the stationary foot and the width of the stance should approximate the subject's normal stride width.

2 points - able to take small step independently and hold 30 seconds, or required assistance to place foot in front, but can stand for 30 seconds

1 point - needs help to step, but can hold 15 seconds

0 point - loses balance while stepping or standing

____ Time in seconds

Test 9 – Standing on one leg

Equipment: a stopwatch or watch with a second hand, a twelve-inch-long masking tape line or two footprints placed heel to toe. Instructions: the child is asked to stand on one leg for as long as he/she is able to without holding on. If necessary, the child can be instructed to maintain his/her arms (hands) on his/her hips (waist). A taped line or footprints may be placed on the floor to help the child maintain a stationary foot position. Weight shifting and/or equilibrium reactions in the feet are acceptable. Timed trials should be stopped if the weight-bearing foot moves in space (leaves the support surface), the up limb touches the opposite leg or the support surface and/or upper extremities are utilized for support. 3 trials average score. (Picture 6)

4 points - able to lift leg independently and hold 10 seconds

3 points - able to lift leg independently and hold 5 to 9 seconds

2 points - able to lift leg independently and hold 3 to 4 seconds

1 point - tries to lift leg; unable to hold 3 seconds but remains standing

0 point - unable to try or needs assist to prevent fall

Picture 5-6 Standing unsupported one foot in front and standing on one leg – static balance tests

Test 10 – Turn 360 degrees

Equipment: a stopwatch or watch with a second hand. Instructions: the child is asked to turn completely around in a full circle, STOP, and then turn a full circle in the other direction.

4 points - able to turn 360 degrees safely in 4 seconds or less each way (total of less than eight seconds)

3 points - able to turn 360 degrees safely in one direction only in 4 seconds or less completes turn in other direction requires more than four seconds

2 points - able to turn 360 degrees safely but slowly

1 point - needs close supervision (spotting) or constant verbal cueing

0 point - needs assistance while turning

____ Time in seconds

Test 11 – Turning to look behind left and right shoulders while standing still

Equipment: a brightly coloured object of at least two inches in size, or flash cards, a twelve-inch-long masking tape line or two footprints placed shoulder width apart. Instructions: the child is asked to stand with his/her feet still, fixed in one place. „Follow this object as I move it. Keep watching it as I move it, but don't move your feet." (Picture 7)

4 points - looks behind/over each shoulder; weight shifts include trunk rotation

3 points - looks behind/over one shoulder with trunk rotation; weight shift in the opposite direction is to the level of the shoulder; no trunk rotation

2 points - turns head to look to level of shoulder; no trunk rotation

1 point - needs supervision (spotting) when turning; the chin moves greater than half the distance to the shoulder

0 point - needs assist to keep from losing balance or falling; movement of the chin is less than half the distance to the shoulder

Picture 7 Turning to look behind left and right shoulders while standing still – static balance test

Test 12 – Pick up object from the floor from a standing position

Equipment: a chalkboard eraser, a taped line or footprints. Instructions: the child is asked to pick up a chalkboard eraser placed approximately the length of his/her foot in front of his/her dominant foot. In children, where dominance is not clear, ask the child which hand they want to use and place the object in front of that foot.

4 points - able to pick up an eraser safely and easily

3 points - able to pick up eraser but needs supervision (spotting)

2 points - unable to pick up eraser but reaches 1 to 2 inches from eraser and keeps balance independently

1 point - unable to pick up eraser; needs supervision (spotting) while attempting

0 point - unable to try, needs assist to keep from losing balance or falling

Test 13 – Placing alternate foot on step stool while standing unsupported

Equipment: a stopwatch or watch with a second hand, a step/stool of four inches in height

Instructions: the child is asked to place each foot alternately on the step stool and to continue until each foot has touched the step/stool four times. (Picture 8)

4 points - stands independently and safely and completes 8 steps in 20 seconds

3 points - able to stand independently and complete 8 steps >20 seconds

2 points - able to complete 4 steps without assistance, but requires close supervision (spotting)

1 point - able to complete 2 steps; needs minimal assistance

0 point - needs assistance to maintain balance or keep from falling, unable to try

____ Time in seconds

Picture 8 Placing alternate foot on step stool while standing unsupported

Test 14 – Reaching forward with outstretched arm while standing

General instruction and set up: a yardstick affixed to a wall via Velcro strips will be used as the measuring tool. A taped line and/or footprints are used to maintain a stationary foot position. The child will be asked to reach as far forward without falling, and without stepping over the line. The MCP joint of the child's fisted hand will be used as the anatomical reference point for measurement. Assistance may be given to initially position the child's arm at 90 degrees. Support may not be provided during the reaching process. If 90 degrees of shoulder flexion cannot be obtained, then this item should be omitted. Equipment: a yardstick or ruler, a taped line or footprints, a level. Instructions: The child is asked to lift his/her arm up like this. „Stretch out your fingers, make a fist, and reach forward as far as you can without moving your feet." 3 trials average results. (Picture 9)

4 points - can reach forward confidently >10 inches (25,4 cm)

3 points - can reach forward >5 inches, safely (12,7 cm)

2 points - can reach forward >2 inches, safely (5,08 cm)

1 point - reaches forward but needs supervision (spotting)

0 point - loses balance while trying, requires external support

_____ total test score

Picture 9 Reaching forward with outstretched arm while standing

Dynamic balance tests

1. **One-leg hop test**

Hopping on one leg as many times as the child could without stopping between hops and then to repeat the exercise on the other leg. The best measurement out of three is documented for each leg. The result can be compared to what is expected at a given age (Yanovich&Bar-Shalom, 2022).

2. **Tandem Gait (Heel-to-Toe)**

Walking in a straight line with the front foot placed such that its heel touches the toe of the standing foot (without shoes). 3 meters of tape is used for the line. Counted as mistake: stepping off the line, losing balance, not stepping close to the toes with the heel. Best of 3 trials. Quality of performance is assessed. The result can be compared to what is expected at a given age (Howell et al., 2019). (Picture 10)

Picture 10 Tandem Gait (Heel-to-Toe) - heel touches the toe of the standing foot

3. **Tandem Walk**

Walking along a 2-m length balance beam (8 cm width), starting with the dominant foot. Participant can wear comfortable shoes. Walking speed is self-selected, but time is measured. 1. Step on to the balance beam; 2. walk along the balance beam; 3. step off, turn around, step back onto the balance beam; 4. return back to the original position - recorded in seconds. Task failure: stepping off the beam during the trial. Best of 3 trials. Quality of performance is assessed (Hill et al., 2019).

There are many ways of approaching the assessment of the skills under investigation. It is important that the tests are preceded by a detailed interview with the parent/caregiver about the child's history in order to assess the current situation. Asking parents/caregivers or using a questionnaire about the child's daily activities is an important additional piece of information for planning therapy. The tests are short and can be administered quickly but, as mentioned before, there should be an opportunity to try out the test situations beforehand. It is worth allowing a break/free play time between test groups, or even between two sessions, to ensure relevant results. In the tests presented, the quality of the implementation was the main focus.

Developmental Coordination Disorder Questionnaire 2007 (DCDQ’07) can be used as a parental questionnaire. The DCDQ ‘07 measures three distinct factors: (1) ‘Control during movement’, which includes items related to the motor control of the child while performing a motor task (e.g., ‘Your child hits an approaching ball or birdie with a bat or racquet accurately’); (2) items concerning ‘fine motor and writing’ (e.g., ‘Your child’s printing or writing or drawing in class is fast enough to keep up with the rest of the children in the class’s); and (3) ‘general coordination’, which includes items about sports, clumsiness, fatigue and learning new motor tasks (e.g., ‘Your child is quick and competent in tidying up, putting on shoes, tying shoes, dressing, etc.’). The three-factor scores alone do not provide any indication of the presence or absence of DCD, but the questionnaire provides support for the identification of difficulties in motor skills exhibited by the child (Rivard et al., 2014).

When completing the DCDQ’07 coordination questionnaire, after recording the general data, the parent/guardian's task is to compare their child's coordination with the abilities of other children of the same age. For the 15 statements, they are asked to circle the number that best describes their child. The 5 choices are: (1) „Not at all like your child”, (2) „A bit like your child”, (3) „Moderately like your child”, (4) Quite a bit like your child, (5) „Extremely like your child”.

After the assessment of the statements is completed, the score sheet follows, on which the total score can be calculated based on the points assigned to the categories of „Control during movement", „Fine motor/handwriting" and „General coordination". This can then be evaluated by the examiner according to age bands (5 years - 7 years 11 months; 8 years - 9 years 11 months; 10 years - 15 years). In the age range between 5 years and 7 years 11 months, between 15-46 points, DCD exists or is suspected, and between 47-75 points, DCD probably does not exist. (All other information can be found at the link: https://www.dcdq.ca/uploads/pdf/DCDQAdmin-Scoring-02-20-2012.pdf (URL 2))

2.4.2 Other test options and assessment tools

Many tests and test packages (assessment tools) are available for testing and evaluating children's motor skills. In the following, options will be presented, most of which are not available for free, but may be suitable for multi-aspect evaluation of abilities. In addition, questionnaires are available that approach the child's everyday functional activity and movement performance from the perspective of parents, teachers and/or therapists, thus collecting information on factors that limit activity (Dannemiller et al., 2020).

The *Original Movement Assessment Battery for Children (MABC)* was developed for children aged 4–12 years. The new and validated version has been standardized to identify impairments in motor performance of children and adolescents aged 3–16 years. The tasks and the normative samples are also designed for three age groups (3–6, 7–10, and 11–16 years). The tasks are about manual dexterity, ball skills, and balance. The assessment tool includes a 60-question checklist as well. It requires a parent or teacher to judge qualitatively how movement skills are performed by the child in natural contexts. According to the results, the professional decides whether the child should be assessed using the complete MABC-2 or not. The checklist also has a version where the items are reduced to 30 (Staples et al., 2012; Brown&Lalor, 2009).

The *Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)* is a test using goal-directed activities to measure motor skills, fine and gross motor skills (motor skill efficiency) in individuals ages from 4 to 21 years. The BOT-2 highlights motor performance in the functional areas of stability, mobility, strength, coordination, and object manipulation. This test has a broad application in physical therapy. It can be used to monitor motor efficiency and can help in decision-making in order to adapt different programs for children. The short form of the test includes fourteen subtests for the assessment of fine motor precision and integration, bilateral coordination, balance, running speed, agility, upper body coordination, and strength (Deitz et al., 2007; URL 3).

The *Peabody Developmental Motor Scales, Third Edition (PDMS-3)* is an early childhood motor assessment and development program focusing on gross and fine motor skills. This tool measures interrelated motor abilities that develop early in life. It was designed to assess skills in children from birth to 5 years of age. Tests include the assessment of body control, body transport, object control, hand manipulation, eye-hand coordination, and physical fitness as a supplemental subtest (URL 4).

The *Test of Gross Motor Development (TGMD)* is a developmental framework for the examination of the performance of twelve fundamental movement skills which are necessary for successful presence in physical education and play in playgrounds. These include locomotor skills such as running, galloping, hopping, sliding, leaping, jumping and object control skills like striking and kicking a stationary ball, dribbling, catching, throwing and rolling. Therefore coordinated movements and the ability to play with and/or manipulate balls is assessed. This measuring system is created for children aged 3 to 10 years 11 months (Staples et al., 2012).

The *Körperkoordinations Test für Kinder (KTK test; Coordination Test for Children)* measures the dynamic coordination and motor control of the body. It can be used for normal developing children as well as for children with brain damage, behavioural issues and learning difficulties. The test focuses on the presence of motor deficits, and includes the analysis of balance, laterality, rhythm, speed, and agility. Four tasks are assessed: balance (in forward and backward paths); coordination of the lower limbs and their dynamic power (hopping on one leg over an obstacle); speed of execution with alternating jumps (jumping laterally); laterality and space–time structure (shifting platforms). The test is designed for analysis of motor coordination of children between ages of 5 to 14 years (Scordella et al., 2015; Biino et al., 2022).

Ages & Stages Questionnaires®, Third Edition (ASQ®-3) is a screening tool created for use by early educators and health care professionals. It assesses fine and gross motor skills, communication, problem solving, and personal-social aspects of development. It is designed to follow up the developmental progress in children between the ages of one month to 5 ½ years. This tool relies on parents as experts, as it is based on the parents' own observations of their child (Kendall et al., 2019; URL 5).

The *DCDDaily-Q* is a parental questionnaire, created for the investigation of specific Activities of Daily Living (ADL) difficulties in children with Developmental Coordination Disorder (DCD). The questionnaire assesses “self-care and self-maintenance,” “productivity and school” and “leisure and play”. The DCDDaily-Q is an addition to the DCDDaily which is a measuring tool with which professionals are enabled to assess children’s capacity in ADL in an objective way. The DCDDaily-Q has been designed for children age 5 to 8 years at risk for DCD (URL 6).

The use of *sensor-enhanced toys* has many advantages in the signal of children's fine motor development problems. A sensor-augmented toy can measure the smoothness of movements made with the toy or the accuracy how the game was played therefore these toys are suitable for indicating fine motor development problems in children (Brons et al., 2021).

2.4.3 Additional tests to assess muscle strength and endurance

In order to fully rule out the possibility of the developmental coordination disorder (DCD), it is also necessary to perform muscle strength and endurance tests in children.

Developmental coordination disorder (DCD) is a common neurodevelopmental disorder associated with difficulty learning gross or fine motor skills. As a result, academic results or functional impairment of everyday activities may be seen. The diagnosis is made only if the motor difficulties cannot be linked to a medical condition or disease, such as cerebral palsy (CP) or visual impairment, but the individual has low scores on standardized motor tests and motor problems for early development are in your medical history (Blank et al., 2019). Some test options related to measuring endurance and muscle strength can be found below.

The *six-minute walk test (6MWT)* is a simple assessment tool to quantify functional exercise capacity. The technical requirements of the test are low. Children and adolescents from 3 to 18 years can also be tested by this self-paced assessment tool. The task is to walk as fast as possible without running on a flat surface in 6 minutes. The distance walked is measured and recorded (ATS, 2002; Dannemiller et al., 2020).

During *Reduced Cooper test*, the child runs or walks around a measured, marked rectangle for 6 minutes. The distance covered in meters during the given time is recorded (Fjørtoft et al., 2011).

The *Muscle Power Sprint Test (MPST)* is a field test for evaluating anaerobic performance in children and adolescents (6-12 years) capable of walking, running, or self-propelling a wheelchair. It is commonly used with typically developing children and adolescents, as well as children with Developmental Coordination Disorder (DCD). The test involves an anaerobic field test consisting of six timed 15-meter sprints, with 10 seconds of recovery between each sprint (Verschuren et al., 2007; Dannemiller et al., 2020).

Standing broad jump (SBJ) is a valid field-based test used to evaluate the explosive strength of the lower limbs and physical fitness. Participants perform the test on a hard surface, jumping as far as possible from a standing position with feet parallel, using a free-arm swing, and must land with both feet together. The test is conducted three times with five-minute rest intervals, and the best score, measured in centimetres from the starting line to the nearest heel, is recorded (Thomas et al., 2020).

The *Functional Strength Measurement (FSM)* can be used for ages 4-10. This is a test for functional strength which includes eight items including muscle power (overarm and underarm throwing, standing long jump, chest pass) and muscle endurance (lateral step-up, sit to stand, lifting a box and stair climbing). It is not only a reliable assessment tool for typically developing children but can also be used for children with mild motor problems (Aertssen et al., 2016; Dannemiller et al., 2020).

Hand-held dynamometry (HHD) is frequently used for muscle strength testing, offering a reliable and objective method that is not gravity-dependent in its interpretation. The device can be used by children and adolescents aged 4-17 years (van den Beld et al., 2006; Dannemiller et al., 2020).

The *Sensory Organization Test (SOT)* is an objective test to identify dysfunctions in the visual, vestibular, and somatosensory systems by requiring reliance on one sensory input, such as the vestibular system, to maintain postural control. During testing other inputs like vision and somatosensation are isolated. This test measures overall balance and the use of specific sensory inputs through posturography (Sinno et al., 2022; Dannemiller et al., 2020).

2.4.4 Other aspects to consider – Persistence of primitive reflexes

In order to get a full picture of the child's condition, it is necessary to carry out other tests or analyse the results of these tests. Primitive reflexes play a developmental role preparing the newborn for movement against gravity and leading to voluntary movement in the first months of life.

Primitive reflexes are involuntary motor responses originating in the brainstem. These are present for relatively short period of time after birth, but facilitate survival. These reflexes - which are actually central nervous system motor responses - are inhibited by 4 to 6 months of age as the brain matures. These mass movements are replaced by voluntary motor activities but may return in case of neurological disease. The Asymmetrical Tonic Neck Reflex (ATNR), Symmetrical Tonic Neck Reflex (STNR) and Tonic Labyrinthine Reflex (TLR) influence the functioning of the vestibular system, moreover these affect its interaction with other position and motion sensors (Modrell & Tadi, 2023; Sohn et al., 2011; Mestre & Lang, 2010; Blythe, 2014; Berg, 2014).

Children and also adults who have residual primitive reflexes (not inhibited in the right time) and/or under-developed postural reactions can have symptoms such as behavioural disorders, specific learning difficulties, under-achievement and anxiety states. These can also appear within the family and at school, in higher education. Balance - as mentioned before - requires the cooperation between proprioception, vestibular functioning, mechanoreceptors and vision, and a function of cerebellum. The vestibular system informs the brain where the head (the point of reference) is in the context of the external environment. The proprioceptive system informs the brain where the head is in relation to the rest of the body and to its supporting base. The brain understands where the body is in relation to its structural support. With this information the brain can place of the head and body in relationship to itself and the external environment. Abnormal primitive reflexes can show the lack of integration in the functioning of these systems, which are crucial in the sensation of position and stability in space. Problems can occur in control of balance in the field of postural control, coordination, control of eye movements (problems in visual perception); perception issues (in the sensation of direction and disorientation), vegetative symptoms (e.g. dizziness) and psychological signs such as anxiety and fear may be present (Blythe, 2014). Table 2 shows the most important primitive reflexes which can affect balance and coordination skills.

Table 5: Description of the effects of the primitive reflexes that most affect balance and coordination (self-edited based on Blythe, 2014; Blythe, 2015)

Reflex	Role after birth	Consequences of residual reflexes
Asymmetrical Tonic Neck Reflex (ATNR) • **inhibited between four and six months (postnatal)**	• part in spontaneous movements • developing ipsilateral movements • pre-conscious factor in training hand–eye coordination	Can interfere with the development of motor abilities: • rolling over, commando-style crawling, control of upright balance when the head is turned to one side, the ability to cross the midline of the body when the head is turned to the affected side, lateral eye movements and hand–eye coordination • activities which involve crossing the midline - writing position • mixed laterality
Symmetrical Tonic Neck Reflex (STNR) • **present for a few days at birth, re-emerges between five and eight months (for a few weeks)**	• helping to defy gravity • learning to push up on to hands and knees in preparation for crawling • pulling to standing at the side of an item of furniture	Can interfere: • with the next developmental stages of crawling, sitting and standing posture • hand–eye coordination In school: • problems in sitting posture when writing
Tonic Labyrinthine Reflex (TLR) • **forward: inhibited circa at four months of age (postnatal)** • **backward: inhibited between six weeks and three years**	• reaction to gravity - recedes as head control, muscle tone and postural control develop • affects muscle tone in the whole body	• problems with posture, muscle tone, balance, coordination and control of the eye movements needed for reading, writing, copying and mathematics, can affect spatial skills
Moro reflex • **inhibited between two and four months (postnatal)**	• sympathetic nervous system activation	• over-react and hyper-sensitive to specific stimuli • over-reactive startle response and increased propensity to anxiety

	• poor balance and coordination • problems with visual perception

Properly tested primitive reflexes can contribute to improved early psychomotor development in children in need, thus preventing many of the difficulties that children may encounter in their social and school lives.

More information about primitive reflexes, their examination and integration program are available in the literature of The Institute for Neuro-physiological Psychology (INPP) (Blythe, 2014; Blythe, 2015).

2.4.5 Red flags – warning signs of developmental delays

In the following, symptoms and signs of suspicion are mentioned that are cause for concern and may attract the attention of parents or professionals regarding the development of preschool children. These signs may predict delays in motor development and may indicate the performance of specific tests, further monitoring or the involvement of several specialists.

At age 4, warning signs include delays in gross motor skills such as being unable to balance on one foot even for a short time, inability to jump in place even with both feet, inability to run, pedal a tricycle, catch, throw, or kick a ball. The child may only descend stairs by crawling or with assistance. In terms of fine motor skills, the child cannot draw lines, circles, or people, does not like to draw, holds a pencil with a fist grip instead of between fingers. The child has difficulty turning pages and does not prefer playing with small objects.

At age 5, signs include poor balance, clumsiness in walking, running, climbing, and descending stairs, only able to descend with support or assistance, unable to stand on one foot even briefly or to jump repeatedly. The child does not jump or hop. He/she has significantly different ball skills compared to peers. The child is very clumsy, and is afraid of heights, unable to climb down from playground equipment. Fine motor skills are also delayed, with the child unable to draw simple Pictures like stick people, squares, or crosses, and generally dislikes drawing, still holding the pencil with a fist grip. The child does not eat or dress independently, does not play with small objects, and lacks dexterity.

At age 6, warning signs include the inability to stand on one foot even briefly with eyes open, unable to descend stairs or slopes without holding on or assistance, not jumping or hopping. The child is clumsy and does not enjoy sports or active games (e.g., hide and seek, dodgeball, tag). He/she has poor ball handling skills, cannot hit a target from 1 meter, cannot throw an object farther than 1 meter, and cannot catch a large ball. Fine motor skills are lacking, with difficulties in drawing, an inadequate pencil grip, and a continued lack of interest in small toys, with poor hand dexterity. The child has not developed lateralization.

At age 7, in addition to the previous factors, the child cannot climb anything, is overall clumsy with poor coordination and "jerky" movements, and is unable to learn dynamic activities like cycling. Fine motor skills are underdeveloped, with poor drawing abilities, disinterest in drawing, an immature pencil grip, and significantly déledé Picture drawing for their age. The child has not developed lateralization, and finger dexterity is poor, showing insufficient development.

At any stage: the child does not reach the indicated developmental milestones, loses skills significantly, response to sound or visual stimuli is incomplete or absent, there is a difference between the right and left sides of the body in muscle strength, movement or muscle tone (loose and floppy - low muscle tone; stiff and tense - high muscle tone) (Scharf et al., 2016; URL 7; URL 8).

2.5 Movement and skill development program

When motor development is delayed, therapy can be most effective if it is personalized, with sessions planned to the individual's pace of development, conducted daily, and continuously adjusted for proper execution of exercises.

Movement development exercises can be beneficial not only for children with varying abilities but also for typically developing children, promoting additional developmental progress. For children lagging behind, timely intervention can reduce or sometimes eliminate the severity of problems (Király&Szakály, 2011).

Movement development is the process of the formation and development of different forms of movement, movement skills, the conditional skills and coordination skills necessary for their execution. The purpose of the development program is to decrease difficulties arising from the immaturity of the nervous system, improve fine and gross motor skills, develop movement coordination and balance, strengthen basic skills, stimulate learning processes, promote emotional life and increase self-confidence. Therapy also plays a role in improving spatial orientation, cross-movements, body schema, and stabilizing lateral dominance. Ideally, these elements are included in preschool and school physical education (Király & Szakály, 2011).

The two pillars of movement development are the targeted compilation of movement tasks and their daily practice. The body takes in the information, as a result of which the different brain areas are activated and integrated, and we give an adaptive response to the environmental stimuli. Controlling the movement of body parts and staying in balance is a constantly developing skill for children. It is extremely important to develop proper movement coordination, movement safety and balance, as all later learning abilities are based on these skills (Gerebenné et al., 2021). Skill in movement – as mentioned before - means that you perform the given movement challenge or task expediently, efficiently, and smoothly. Dexterity can usually be interpreted in natural movements (Boronyai et al., 2015). Movement therapy often works with tools that help to strengthen the awareness of body parts, and the discrimination skill of the body surface can be developed by involving different materials and increasing sensory stimulation. Such supplies can be, for example, textiles, shawls, scarves, blankets, ropes, balls made of different materials and of different sizes, elastic bands, pillows, etc., which are used for various movement purposes (Papp, 2020). During proprioceptive training, the basic task is to develop static and dynamic balance, building up the therapy from simpler exercises to more complex tasks, increasing the complexity of the exercises by increasing the speed of execution of the tasks, and additionally increasing the complexity of the exercise sequence by removing visual control and increasing the frequency of dynamic tasks (Sziliné & Gerencsér, 2005). Among the very successful methods in the development of children are obstacle courses, since this procedure directly affects and improves perception. After the movement experiences, the child is able to gain experiences about both his own body and his environment. The obstacle course can take place indoors or outdoors, and it is possible to create courses with various layouts built from different gymnastic equipment. During the tasks, the children perform planned and organized movement exercises, and they can gain many tactile experiences of their body, which helps to recognize cause-and-effect relationships, the development of imagination and anticipation, and affects the development of thinking and speaking. The development of the body schema is essential in the movement development of preschool children. It means the adaptation of the movement of the muscles to gravity and the balance of the body. The development of the vestibular system determines the quality of movement learning (Gerebenné et al., 2021).

The kindergarten period is also a great challenge for children. During this time, they have to learn how to tie their shoelaces, how to put on and take off their clothes, how to use cutlery and eat independently. There are good games that can develop children's fine motor skills, such as building with blocks/cubes or playing with puzzles (Tóth, 2017).

The following methods, some of which are specific to Hungary, are aimed at supporting motor development and enhancing the nervous system through movement. Their goal is the complex development, the strengthening of neural pathways, and the support of the child's functional presence in everyday life.

1. *Vojta Method:* It is a diagnostic and therapeutic system based on the fact that movement patterns are genetically coded in the central nervous system. It is a therapeutic approach based on neurophysiological principles of motor and postural control. The therapy uses tactile and proprioceptive sensory stimulation to activate innate movement complexes in humans, called "innate patterns" (Reflex locomotion - reflex crawling and reflex rotation). It aims to develop strength, coordination, muscle tone and function (Sánchez-González et al., 2024; Király&Szakály, 2011; Blythe, 2014).

2. *Ayres Therapy - Ayres Sensory Integration (ASI):* Originally developed to address learning disabilities, this method is effective for various childhood developmental issues by providing varied sensory stimuli. Sensory integration theory emphasizes the active, dynamic sensorimotor processes that support movement and interaction in social and physical environments and act as catalysts for development. It involves activities that offer tactile, proprioceptive, and vestibular stimulation (Lane et al., 2019; Király&Szakály, 2011; Blythe, 2014).

3. *Institute for Neuro-Physiological Psychology - INPP Therapy (Goddard Method):* It provides a unique system for assessing and treating signs of neuromotor immaturity in both children and adults. The INPP program integrates the remaining reflexes in a number of different ways depending on the condition of the person being treated. The exercises are based on the movements performed by normally developing babies in their first year of life (Blythe, 2014).

4. *Neuromotor Task Training (NTT):* Neuromotor task training is an activity-oriented approach specifically developed for children with DCD to facilitate participation in everyday situations. NTT is based on the principles of motor control and motor learning, but also takes into account motor teaching and motivational principles. Each activity or task has a specific purpose that involves physical movement (e.g. skipping rope, throwing, tying shoelaces, writing, etc.) and can usually be learned and refined with practice. The ultimate goal of the treatment is not only to improve the performance of functional tasks during the treatment, but also to transfer the learned skills to everyday life performance (Schoemaker et al., 2003; Smits-Engelsman& Verbecque, 2022).

5. *A combination of virtual reality and physical activity - Action Video Game (AVG):* AVG can provide a rich practice environment, resulting in prolonged, intensive practice, which can help solve many motor control problems in a fun way. Tasks in virtual environments can enhance motor skill learning by integrating multiple sensory processes such as proprioceptive, visual, auditory, and vestibular information into cognitive processes. Visualizing the body's movements on a screen can aid performance in balance tasks. Children receive immediate, safe feedback through the screen (Smits-Engelsman& Verbecque, 2022).

6. *Dévény Method (Dévény Special Manual Technique, DSGM):* the essence of the manual technique is the treatment started at an early age, which restores normal movement and movement development. The principle of the method is to ensure a direct effect on the nervous system and to restore the pathological condition of muscles and tendons. The goal of the gymnastics method, which uses individual gymnastics and musical group sessions, is to develop conscious, precise, expedient and harmonious movement (URL 9; URL 10; Király&Szakály, 2011).

7. *Basic Therapy*: it is a complex therapy that develops the nervous system, which is based on the development of movement. Its goal is to "restart" the sequence of human developmental movements, thereby developing movement skills. The development can start at the age of 5 (from age 5 to 16 years), as this method requires a sense of responsibility and commitment. It was developed in Hungary based on the Delacato method (Marton Dévényi et al., 2002; URL 11).

8. *BHRG Model - Budapest Hydrotherapy Rehabilitation Gymnastics:* This model includes HRG (Hydrotherapy Rehabilitation Gymnastics) for water-based development and TSMT (Planned Sensorimotor Training) for land-based exercises. The first is a complex movement development program carried out in water, which has a beneficial effect on

physical and psychological functions. TSMT is a movement development procedure aimed at sensory integration, which is used in children aged 0.5-12 years who have delayed movement development, who are characterized by muscle tone problems, poor movement coordination, impaired speech skills, behavioral disorders, and poor fine motor skills. Its purpose is to improve the maturation processes of the nervous system, to achieve the motor, psychological, cognitive and social performance level expected at a given age. (URL 12; Király&Szakály, 2011).

2.6 Communication

In this part of the lesson, you will learn how to communicate with an anxious and distrustful 5-year-old child and his mother, and what cultural and communication rules should be applied in such a case.

Healthcare professionals face a variety of communication problems when communicating with patients of different ages. Communicating with an elderly person, a teenager or a young child, even an infant, has completely different characteristics and difficulties. The purpose of this lesson is to show what can make it difficult and what can help when communicating with children - especially an anxious and distrustful 5-year-old and his mother.

Communication between the physiotherapist and the patient is one of the most important elements of the healthcare process. *In addition to providing correct information, effective physiotherapist-patient communication means providing encouragement and support, thereby increasing the patient's confidence, motivation and self-efficacy* - whether the patient is an adult or a child. Patients' positive (self-)assessment of their health status can influence their future development.

When it comes to communicating with children, promoting appropriate communication is an essential element of creating a healthcare culture that cares for and focuses on patients and their needs. Information should be provided in a clear and age-appropriate manner, enabling children and their families to be competent partners in the consultation process.

Communication with the child should be

- **open and complete**, in accordance with the needs and developmental characteristics of children
- **based on dignity and respect** (the physiotherapist listens to the patient and takes into account his or her cultural background, beliefs and preferences when developing the health plan)
- **participatory** - both the child and parents/carers are encouraged to take part in the assessment and decision-making process

- **collaborative** - physiotherapists, patients and their families work together for high quality performance and efficiency

(Kolucki & Lemish, 2011)

The specific topics that we look at for communication development are:

- understanding the psychological and cognitive development of a child of a certain age
- what are the difficulties in communicating with children? (e.g. understanding emotions affecting the care of children, involving the child in treatment, etc.)
- child-parent-physiotherapist triad (video 4)
- what can help communication with the child? (e.g. preliminary preparation of the child, creation of a child-friendly environment, contact, method of taking anamnesis, use of age-appropriate communication techniques that can be used during the examination) (videos 1 and 2)
- specifics of informing the child, involving the child in his own treatment
- the importance and method of praise (video 3)

Characteristics of psychological and cognitive development in preschool children

Children have different characteristics depending on their age. There are many different approaches to describing these characteristics. In order to be able to communicate with a child of a certain age in the most appropriate way, we need to know what his average developmental characteristics are: how he thinks, what his cognitive functions are, how he relates to the social environment, what is important in terms of his personality development. In the following description, there are things that come to the fore in the characterisation of a pre-school child that are definitely worth remembering and keeping in mind as a physiotherapist during an examination or treatment. After the general description, we will look at the individual elements in detail:

During the pre-school years, the child continues to develop, becoming more independent and open to the world. Emotions play an important role in the life of a preschool child, influencing all his or her behaviour and actions. In everyday life, this process can be characterised as "choosing with the heart". Among the cognitive processes, imagination and fantasy play a prominent role, with the help of which he tries to explain things that are unknown to him. His strong love of fairy tales is also related to his emotions and imagination.

The preschooler is most likely to pay attention to and remember what is emotionally engaging and intriguing. He will mainly remember things with a very positive or very negative emotional charge. His characteristic is involuntary attention and memory. Motivation plays an important role in the activities of preschool children.

His main form of activity is play, in which he likes to imitate adults, in his play he tries to participate independently in their lives and activities, he tries to have the experiences that appeal to him in the behaviour of adults.

1. Development of the movement and the nervous system

The preschooler's need for movement and action is great, and the adult must satisfy this need by giving the child the opportunity to practise different forms of movement, according to his age and in the greatest possible safety. The child's movement is constantly enriched and becomes more and more varied thanks to the many activities and games.

As a result of **the intensive development of the pre-school child's nervous system**, he learns quickly, but in order to retain the knowledge, he needs a lot of repetition and practice. The plasticity of the nervous system (malleability, formability, flexibility) is great. The formation of conditional nerve connections is fast, short and effective. Among the processes of the nervous system, stimulation predominates over inhibition, which explains the high need for movement in children of this age. In the middle of the life stage, in parallel with the continuous maturation of the nervous system, stimulation and inhibition balance each other out and children become more and more calm and serene.

2. Perception and cognition

Among the perceptual processes of pre-school children, **visual perception** plays the most important role. At the beginning of the period, *emotional syncretism* (emphasis on an emotional basis) is characteristic of the perception of shape and form. At the end of the period, this changes into *intellectual syncretism*, i.e. while at the beginning he observes that detail, often an insignificant feature of the observed object, which for some reason has captured him emotionally, his later observation becomes more conscious, more purposeful, more planned, he no longer emphasises what is interesting to him, but what he considers logical and important.

The development of **spatial perception** depends on the development of the body schema. The body schema is the knowledge of the *spatial relations* between the organism and its environment, as well as between the organism and its parts, the information derived from these is called organization into perceptual schemes.

As a result of a long learning process, he becomes visually and kinaesthetically aware of how he fills the space with his own body and experiences its limits. The quality of reading and writing plays a decisive role in learning to read and write at school.

A preschool child's **sense of time** is initially underdeveloped. They are already aware of the concept of "now", but the expressions "yesterday", "tomorrow", "later", etc. are not yet clear to them. This begins to crystallise towards the end of the age group - around the age of 6.

3. Attention and memory

Preschool children – at about 3-4 years old - are characterised by involuntary attention in small groups. He/she is *able to pay attention to what has captured him emotionally*, what has aroused his interest sufficiently, so it is important for the adult to provide motivation and an emotional base. A preschooler's attention tends *to fluctuate* (wander) and be distracted. Therefore, it is not enough to motivate him once during an activity, but to keep his attention with more and more "favours". *By the end of this stage (5-6 years), his /her attention becomes more sustained.*

In preschool age, the child's attention often *wanders (gets stuck)* on one or another thing or event that has occupied him emotionally, so it is more difficult for him to switch to something else to observe, so his division of attention is weak at first. Outward signs of focused attention: dilated pupils, rigid posture, open lips. *Involuntary attention* turns into *conscious attention* when the child recognises the interest of the observed object and intellectualises it.

Similar to attention, memory is also characterised by spontaneity, involuntary, i.e. his memory images are recorded involuntarily, he mainly records things and stories that capture him emotionally. From the age of five, the involuntary memory is replaced by a **deliberate memory,** he concentrates consciously and deliberately and tries to remember things. The same qualitative change means that, in addition to his mechanical memory, his logical memory plays an increasingly important role, i.e. he interprets the things to be remembered, which makes his memory more efficient. The preschooler's memory is not reliable, its development is embedded in the process of learning active language. In preschool, memory can be much more effective if it is linked to action. If you can manipulate and play with an object, you can remember it better than if you just hear its name. Memory activity is more effective in a game situation than in a direct task situation.

4. Imagination

Imaginative activity is a unique way of processing reality. The brain rearranges the previously collected experiences stored in memory in a special way. Although a child's imagination is not more developed than an adult's - they have less experience, knowledge and memories, so they have fewer elements to build on - their imagination often seems richer because the child is able to make up for their incomplete knowledge, bring their unrealisable wishes to life and mobilise their imagination much more bravely and courageously than an adult. Although they have less experience and memory, they use their limited knowledge much more courageously than adults who cling to reality. The preschool years are characterised by **fantasy lies** used to satisfy desires or to make up for incomplete knowledge. This is not done deliberately or consciously, because the child believes the lie, which is divorced from reality.

5. Development of thinking

For preschoolers, the thinking process begins with the emergence of a need, aspiration and desire to solve a practical task or get out of a problem situation. A problem situation arises when the child wants to achieve a goal but does not know or only partially knows the way to the solution.

At this stage of life, thinking cannot be studied alone, but only through the complex system of all cognitive activity, because *thinking is not yet an independent mental activity*. As the years go by, a serious qualitative change can be observed in the thinking of 3-6 year olds. From **active-perspective thinking**, it gradually moves to the level of **visual-imaginative thinking** and finally to the level of abstract language. This means that a preschooler at the level of active-perspective thinking understands only the problem situation that is linked to action and perspective, i.e. he can act and observe the given problem situation himself. For example, does the larger red cube fit into the smaller green cube? This will only become clear to him if he can try it out, i.e. if he acts and listens and observes.

At the level of **visual-imaginative thinking**, there is no longer any need for specific manipulation, it is enough to see the problem situation and carry out the solution in your mind. In this case, even without a practical test, you can see which is the smaller cube and which fits into the other.

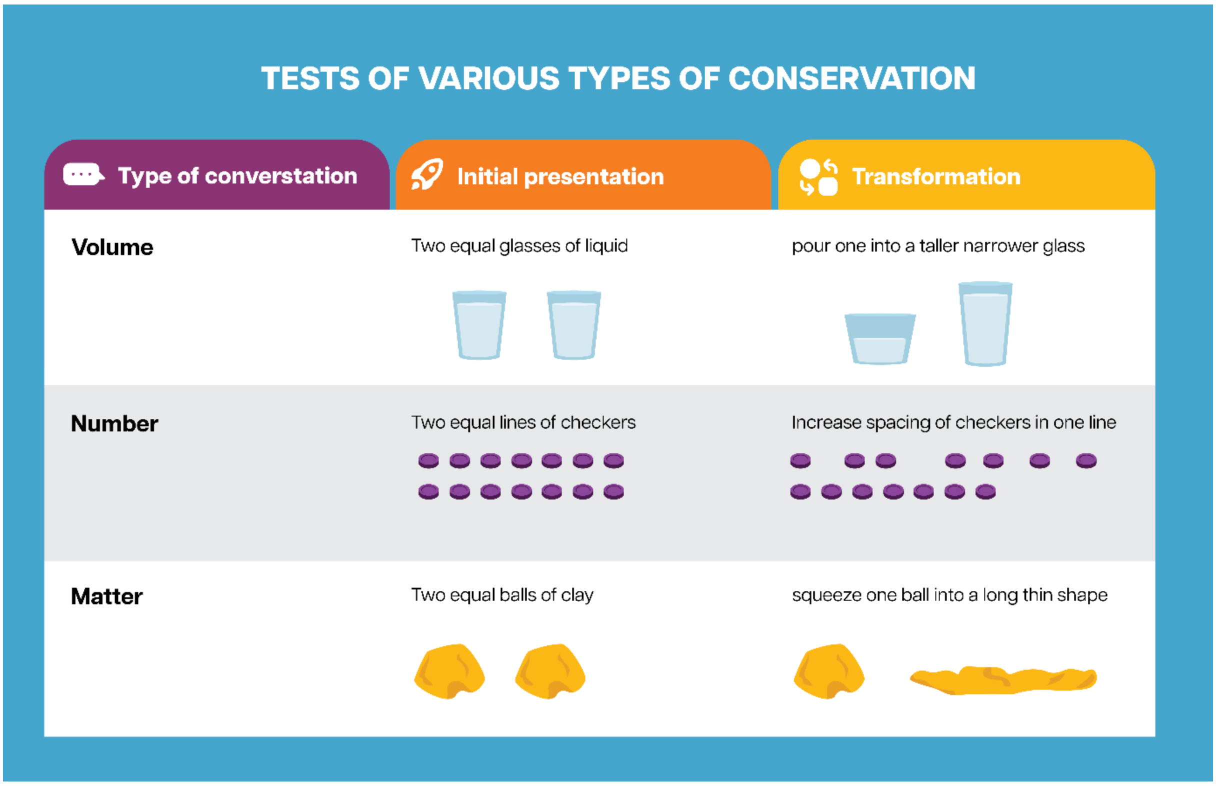
The child's thinking becomes more effective as his language develops. The more he can process everything verbally, the more he goes beyond the action-perspective and visual-imaginary levels of thinking. This is how you get to **abstract linguistic thinking**, where you don't even need visuals or illustrations to solve a problem. At this point he does everything in his head.

(Lightfoot, Cole & Cole, 2018; Leman, 2019; Keil, 2013; Thavakugathasalingam, 2022).

The Swiss psychologist Jean Piaget (1896-1980) has written the most comprehensive and influential description of children's intellectual development. The basic theme of his theory is development as a series of successive qualitative changes. In his view, intellectual development takes place in several successive stages, the beginning and end of which may change, but the sequence of which is constant. In Piaget's stages, cognitive abilities are formed relatively independently of the environment, as a result of internal maturation, and they reach the form characteristic of adults through active experience.

He divides intellectual development into four main stages and several sub-stages. The main stages are *the sensorimotor stage (0-2 years), the pre-operational stage (2-6 years), the concrete operations stage (6-12 years) and the formal operations stage (12-18 years).*

The typical pre-school stage is the **pre-operational stage**. Piaget says that the pre-school child's thinking is egocentric, he cannot take other people's points of view, he is not able to decentre, he is not able to change mental perspective, it is difficult for him to learn relationships, he does not yet have invariance. More specifically, all this means that symbolic operations develop in the second year of life. The child begins to speak, objects and words can symbolise another object. Internal images appear and postural intuitive thinking becomes characteristic. The child is mentally unable to separate itself from what is available to its senses, its available experiences divert its thinking. For example, if we pour water from a high, thin glass into a low, thick glass, an adult knows that the amount of water has not changed (*principle of conservation*) and that the same amount of water could be poured back, whereas the child believes that the amount of water has decreased. According to Piaget, in a **conservation process**, the child is unable to take into account more than one of the quantities characterising an object at the same time (*one-dimensional thinking*), i.e. he takes one or the other as a basis, because he does not yet recognise the reversibility of action and thought sequences, i.e. he is not yet able to use the logical operations essential to thinking. For example, if a pile of money is placed in a straight line, the child believes that there are more discs in it than in the pile, because he only takes into account the most characteristic size for him, the length. This is one of the basic features of the pre-operational phase. (Figure1)


TESTS OF VARIOUS TYPES OF CONSERVATION

Type of converstation	Initial presentation	Transformation
Volume	Two equal glasses of liquid	pour one into a taller narrower glass
Number	Two equal lines of checkers	Increase spacing of checkers in one line
Matter	Two equal balls of clay	squeeze one ball into a long thin shape

Figure 1 Conservation (source: Preoperational Stage: Definition & Examples (simplypsychology.org))

The other is **egocentrism**, that is, a kind of self-centeredness; the child is not able to imagine more than one point of view of a situation, and this only point of view is his own point of view (he thinks that everyone thinks the way he does; everyone sees and feels what he does). (Figure 2)

Figure 2 Egocentrism (source aka pastor guy Three Mountains and the Echo Chambers We Live In (jphdenis.com))

Difficulty distinguishing between **appearance and reality**: not knowing what objective reality is and what is 'as if'. **Precausal reasoning**: unable to see cause-and-effect relationships and use such reasoning. " We want to go sledding, that's why it's snowing".

At this stage, development affects not only the understanding of the physical world, but also the social world. At this stage, the child is characterised by **moral realism**, believing that morals and rules are constant, unchanging truths; for example, if he offends his parents, he will be punished immediately, even if his parents do not punish him. For the child, moral laws are just as much laws as physical laws.

(Piaget, 1966, Mooney, 2000, Parrat-Dayan, 2023)

6. Speech development

During the preschool years, the child's language activity increases by leaps and bounds. He comes into contact with countless new stimuli, activities, people, objects and knowledge that make him think and therefore speak. *Speech is the linguistic expression of thought*, so these two things develop together, in parallel, i.e. the more you speak and communicate, the more you mobilise and develop your thinking. At the age of small groups, situational speech is even more characteristic, and at the older preschool age, speech gradually changes into self-interpretable, connected, *so-called contextual speech*. Contextual speech develops only when the child's thinking has moved beyond the action-conceptual level, i.e. concrete action is not a prerequisite for his thinking.

Around the age of 3-4, the *"first why-era"* begins. It is characterised by an endless, uninterrupted series of questions in which one question follows another, but it happens that, for example, the fifth question has nothing to do with the first. The adult must recognise the motivation behind the questions, that the child does not want to be alone, and maintains the communication relationship with continuous questions so that the adult cannot ignore him. This is why the phenomenon is called social why. If the child experiences rejection and never or very rarely receives answers to his questions, on the one hand he will stop asking questions (this endangers the intimacy of the parent-child relationship), and on the other hand various psychological problems may arise due to the loss of his sense of security.

7. The child's emotional development

Emotions play an important role in the life of a pre-school child, all his actions and behaviour can be influenced or approached through his emotions. At this stage, their emotions are still labile (*they can be happy and well-balanced one moment and completely desperate the next*) or polarised (*they can go from one extreme to the other extremely quickly*), but this does not mean that the child is capricious or hysterical.

The development of the preschooler's emotions is reflected in the high degree of differentiation and gradual intellectualisation of emotions. At this age, the child is characterised by a high degree of emotional irritability and low emotional stability. In comparison with childhood, the child's emotions expand, including the so-called higher emotions: intellectual, moral-social and aesthetic emotions.

8. The child's volition life

The activities of the nursery school child are characterised by voluntariness, but there are also areas of his life where he has to adapt to certain rules. There is an increase in the expression of emotions in their behaviour, which is increasingly differentiated, sustained and rich in content. He is characterised by an **increased striving for independence** and, depending on his individual characteristics, he does not tolerate help from his environment. However, the development of his abilities is not always in proportion to his aspirations, desires and ideas, so he often suffers from failure, but he is not always able to deal adequately with frustration. Either he does nothing, becoming inactive, or a defiant reaction is triggered. **Self-control** increases significantly during the preschool years, by the end of which he is able to manage his will and emotions adequately, self-motives are replaced by social motives (while at the beginning of the preschool years emotions still dominate the will, by the end of the preschool years the exclusivity of emotions ceases to be active in motivating and controlling behaviour). It is important to develop a **sense of responsibility** that prepares the child for school life. The member of the small group does not knead, play and build for the pleasure of the function, the activity itself, not for the result, but the member of the large group already strives to finish his creation. In the course of his activities, he is able to overcome increasing difficulties for the joy of completing tasks. The achievement of the game and the work goal is satisfying even without praise or other rewards, and the completion of the task itself motivates him (in longer-term activities, however, he needs to be motivated several times). The work and the purpose of the work are the source of pleasure, so they experience it as a reward in itself. **Awareness of rules.** In preschool there are defined rules, and although these rules often do not correspond to the child's interests, they nevertheless become motives for his actions, because the child wants to secure the love, recognition and praise of the adult through obedience. By repeating these actions several times, the child becomes accustomed to them, not only automatically, but also by imagining what to do and what not to do. Later, consciousness joins the action, and the rule gradually becomes conscious. The ability to adapt to the rules becomes more and more characteristic at the age of 5-6, when he follows the rules even when they are not favourable to him.

(Lightfoot, Cole & Cole, 2018; Leman, 2019; Keil, 2013; Thavakugathasalingam, 2022).

Erikson's theory of psychosocial development

Erikson's eight-stage development model, which also includes adulthood, is called the **psychosocial development theory**, which is one of the least controversial and popular theories. Its popularity is due to the fact that it considers a person as a creative being who always develops new and new strengths during his life, who is capable of positive changes and active management of his life. At each stage of life, we experience psychosocial crises and conflicts, which need to be adequately resolved in order to enter the next stage of life. Erikson's division is based on the crises and attainable values typical of the given age. *The stage boundaries are approximate, it is not possible to tie them to the exact age, because each person progresses according to a different rhythm.* (Figure 3)

ERIKSON'S PSYCHOLOGICAL STAGES

Stages	Basic Conflict	Virtue	Description
Infancy 0-1 year	Trust vs. mistrust	Hope	Trust (or mistrust) that basic needs, such as nourishment and affection, will be met
Early childhood 1-3 years	Autonomy vs. shame/doubt	Will	Develop a sense of independence in many tasks
Play age 3-6 years	Initiative vs. guilt	Purpose	Take initiative on some activities - may develop guilt when unsuccessful or boundaries overstepped
School age 7-11 years	Industry vs. inferiority	Competence	Develop self-confidence in abilities when competent or sense of inferiority when not
Adolescence 12-18 years	Identity vs. confusion	Fidelity	Experiment with and develop identitiy and roles
Early adulthood 19-29 years	Intimicy vs. isolation	Love	Establish intimacy and relationships with others
Middle age 30-64 years	Generativity vs. stagnation	Care	Contribute to society and be part of a family
Old age 65 onward	Integrity vs. despair	Wisdom	Asses and make sense of life and meaning of contributions

Figure 3 Erikson's Stages of Development (source: Erikson's Stages of Development (simplypsychology.org))

The third stage can be assigned to the pre-school age (3-6 years) and can be interpreted in terms of the dimension of initiative or guilt. Initiative - based on autonomy - gives the child the knowledge of intention, striving, planning, where intention is built on play, fantasy, successful and less successful attempts. In this way he learns the purpose of things, learns to regulate his social relationships, in role-playing he can experience feelings that are not realistically available in the adult world, the continuity of past, present and future intentions. At this age, the child begins to separate from his environment, becomes independent and shows a great deal of initiative. They want to experience everything and initiate independent actions. If there are no obstacles and the child is given the opportunity to work independently, he or she will later become an initiator, be creative and enjoy his or her achievements. Otherwise, he will be accompanied by a constant sense of guilt, he will always be afraid that he is not doing something right, he will have doubts about his own resources.

(Erikson, 1950, Erikson, 1998, Lightfoot, Cole & Cole 2018, Mooney, 2000, Maree, 2021, Orenstein, 2022, Okunev, 2023).

What are the difficulties in communicating with children?

1. Emotions that affect caregiving

Children evoke strong emotions in most people. We usually think of them with love, we think of them as sweet, kind and happy. However, a sick child struggling with health problems evokes bad feelings: it can make adults feel sad, pitiful, frustrated or helpful. In addition, a child who is struggling with a problem and feeling bad or in pain is likely to be anxious, tense, nervous and even angry. Children may also be afraid of unfamiliar surroundings, they may be dismissive of people they do not know, and they may be particularly afraid of medical staff with whom they may have had many unpleasant experiences. For this reason, children may be dismissive and hostile towards physiotherapists.

Children can therefore generate many emotions which can affect the relationship with them, communication and even their care. Similarly, **the physiotherapist may be affected by the parents' strong concerns and expectations** about the treatment. Therefore, the physiotherapist needs to be constantly aware of his or her emotions and the impact of his or her emotions in order to avoid the possibility of making mistakes related to them, either by trivialising the problems of a child who is behaving unpleasantly, or by overtreating because of the child's anxiety or the parents' strong concern. (Pilling, 2020.)

2. Difficulties in adapting to different ages

Babies, toddlers, preschoolers and teenagers can and should be communicated to at different levels and in different ways. But this diversity is also a difficulty. According to research**, it is a common problem that medical staff/physiotherapists do not communicate with children according to their age, cognitive development and level of knowledge**. (Pilling, 2020.)

3. Using inappropriate communication methods

There are many communication methods that are sometimes used with children in the health sector, but their use is not recommended at all. Many people even **babble** to children of pre-school age, speaking to them in a voice much higher than their usual tone of voice. This patronising, contrived style of speaking is often confusing; **it would be sufficient to speak to the child in a warm tone instead.**

Other ways of communicating can be downright harmful. It is common, for example, to try to **deceive** a child before a painful examination by saying "don't be afraid, it won't hurt". **This lie fundamentally shakes the child's faith in health care workers and adults, undermines trust**, and in the future will also fear examinations that are not actually painful. **The child should never be falsely threatened with serious consequences**. If, for example, the health-care worker says, "If you don't stop crying, it will hurt more", in order to get the child's cooperation, he or she is at the same time **casting doubt on the legitimacy of the child's feelings** and causing further anxiety. Such sentences are particularly damaging. (Pilling, 2020.)

4. Lack of involvement of the child

Medical staff communicate mostly with parents, **the child is mostly excluded from communication.** An analysis was carried out in paediatric clinics to see what percentage of all verbal expressions in paediatric clinics were to/from the child. The child spoke in only 4 per cent of the time spent in verbal communication; in the research, almost two-thirds of the time the doctors dominated the conversations and almost one-third of the time the parents spoke. In thirty-six per cent of consultations, the children who could already speak did not speak at all. **Nowadays, it is more likely that the health professional will inform the child at an age-appropriate level and try to involve them in their own treatment**. (Pilling, 2020., Howells & Lopez, 2008. Pérez-Duarte Mendiola, 2024.)

5. Difficulties in the relationship with parents

The physiotherapist almost always comes into contact with the parents when examining or treating a child. Communicating with them is much more difficult for most physical therapists than communicating with the child. Parents are usually very concerned about their child, which is easy to understand, but at the same time, heightened emotions and excessive and often quite firm parental expectations can be the source of many communication difficulties. Another complicating factor is that the simultaneous presence of the child and the parents creates **a triadic relationship**, which can be the source of many communication problems (when and with whom should the specialist talk, who to ask, to whom and how to provide information)? If the physiotherapist is not able to handle these situations well, the parent will be less satisfied and will most likely not follow the therapy recommendations.

It can make communication with parents easier if we know **the types of parental behaviour** that occur when a child's health problems occur. We distinguish between the following four types of parental behaviour:

- The **supportive parent** is sympathetic and calm. He notices and acknowledges the child's experience of procedures and hospital conditions. With words they say: "I'm here with you, calm down" and with body language they say, "I know you are feeling bad or in pain right now, but I am here with you and together we will get through this".

- The **normalising parent** acts as if the hospital treatment is just a new, albeit previously unfamiliar, everyday task that can be dealt with routinely, e.g. I don't feel like brushing my teeth at home in the evening. It keeps the child busy with interesting activities, diverts his attention from procedures, pain and boredom, and at the same time greatly appreciates the child's achievements, e.g. in tolerating pain or complying with medical and nursing instructions.

- The **distant parent** (apparently) withdraws from uncomfortable situations both emotionally and physically, e.g. leaving the room when the infusion is started, or the feeding tube is inserted. In a hospital situation, he is not able to get close to his child in the usual way because he always focuses on (and suggests this pattern to his child) "what is expected, what we have to do". This is what the literature says: "passively cooperates": he is with his child but does not take the initiative. At the same time, he actively cooperates with the medical staff and other relatives, even encouraging them. This pattern is fed by the adult experience of having to deal with situations in life alone. As a result, the parent comes across as an "external relative" rather than a close relative, suggesting: "You're in this situation, it's your job and I won't be able to be there all the time".

- The **invalidating parent** doubts and "overwrites" the authenticity of his or her child's experiences, or even if he or she acknowledges them, sees them as an educational task. They are irritated by the child's anxiety, fear of intervention, or signs of pain, or they don't respond at all, or they mock or trivialise the child's reactions. The unconscious message is: "Life is hard, don't run away, don't pretend, bear what you have to bear, just like me". Obviously, the messages of this type of parent reflect their own childhood patterns.

The impact of communication patterns:

Based on the survey, the most commonly used parenting model was supportive, followed by normalising, distancing and invalidating. Individual communication patterns also changed according to treatment phase.

Children of 'supportive' parents reported less pain than those of 'invalidating' parents but did not differ in their outcomes from those whose parents were 'distant' or 'normalising'. The worst results were obtained by the "invalidating" group. *The role of the parents is therefore crucial in the triangle, and for this reason the paediatrician must observe the parents' behaviour and try to encourage "supportive" behaviour. If there are signs of "invalidating" behaviour, it is advisable to talk to the parent separately and try to persuade them to cooperate in order to achieve a successful therapy.* (Picture 11)

Picture 11 The supportive proximity of the parent

During a longer examination, the physiotherapist must also make sure that **the child can rest and satisfy his physiological needs** if he needs it (fatigue, hunger, etc. are factors that can affect the result of the examination)

(Pilling, 2020., Wassmer et al., 2004., Howells & Lopez, 2008., Kolucki & Lemish, 2011., Pérez-Duarte Mendiola, 2024.)

The general rules of the communication

In order to provide the most effective communication strategies, it is important to understand some details about the young child and the parent/carer. Here are some questions to consider:

- Communication techniques vary depending on the child's age, developmental stage, personality and emotional state.
- Understanding specific behavioural elements that the child is currently experiencing can help to tailor communication.
- Understanding the cultural background of the parents/caregivers will make it easier to understand their cultural norms and even the reason for the child's developmental differences.
- It is always worth highlighting positive changes in behaviour and acknowledging the efforts of parents/caregivers.
- Always be aware of cultural beliefs and practices regarding discipline. If necessary, offer more culturally appropriate alternatives.
- Avoid technical terms or jargon unfamiliar to the layperson. Use clear, concise language and provide information and resources tailored to their level of understanding. Avoid overloading them with complicated theories; let's talk slowly. Pictures and demonstration tools can be useful for children, but also for adults who absorb visual information more easily. So let's try to share the information in different ways and modalities.
- Always assess the parents' knowledge of the child's developmental progress and possible delays
- Be patient and use clarifying, open-ended questions. Listen to underlying concerns and use open-ended questions to encourage elaboration.
- Provide a safe space for questions and concerns. Validate their feelings and acknowledge their role in managing the behaviour.
- Remember that effective communication requires active listening, empathy and respect for the role and feelings of parents/caregivers. By adapting your approach to the situation, you can build trust and help create a collaborative environment for dealing with the child's behaviour that is complicating the evaluation/therapy.

(Pilling, 2020., Wassmer et al., 2004., Howells & Lopez, 2008., Kolucki & Lemish, 2011., Pérez-Duarte Mendiola, 2024.)

What can help you communicate with children?

1. Preparing the child for the examination

- If possible, we ask the parents to prepare the child for the visit to the physiotherapist and the examination during the preliminary consultation. It is good if the child knows where he or she is going, what the purpose is and, in general, what will happen. Picture books about the human body, the specific problem and its treatment can help to prepare. (Pilling, 2020.)

2. Create a child-friendly environment

- Walls decorated with colourful fairy tale characters and drawings make the healthcare facility and examination room more child friendly. The dominance of blue and green colours and the preference for natural materials have a calming effect.
- As the white coat causes anxiety in many children, it is helpful if, for example, the physiotherapist wears colourful clothes, perhaps decorated with cute Pictures.
- It is important to have toys, educational materials and books for children of different ages in the waiting room and examination room. It may be useful to place these at different heights, for example on shelves, so that each child can encounter toys and tools appropriate to their age. (Pilling, 2020.) (Picture 12)

Picture 12 Child-friendly environment (source: [Improve the Experience of Pediatric Therapy Patients | IDS Blog (idskids.com)](idskids.com))

3. Establishing a relationship

- **Introduction** - greet the child by calling them by their name, preferably the name they are used to being called (e.g. "Hi, Andris") and then introduce yourself. Already at this stage it is possible to assess how the child feels about the situation and about us. (Picture 13)

Picture 13 "...and how can I call you?"

- **Following and leading** - one of the best ways to connect. The point is to enter the child's world first. Let's talk to them about it, and only when the right rapport has been established can we begin to steer the conversation in the direction that is more important to us. For example, we might start by praising her clothes or asking about the toy she is holding, and then suggest that she do what we want, such as come into the examination room with us.

- **Yes-set** - When communicating with a child, suggestive methods of communication can be particularly effective, and an anxious child may be particularly receptive to what the physiotherapist is telling them due to their emotional state. The yes-set method can be used by asking questions that are likely to be answered with a yes. For example: "Hello, is my name Andris?" "Is this your mum?" "Do you go to kindergarten?" "Did you come by tram?" and then as questions 3, 4, 5 (when we feel that we have succeeded in getting the child to say yes) there is already a question that moves the work with the child forward: "Will you come to the gym with me?"

- **Introducing the environment** - it can be very helpful if the child is first introduced to the environment. This method works well with the follow-lead method.

(Pilling, 2020.)

4. Taking an anamnesis

- **Talk to the child at eye level**. Sit at the same height as the child or crouch next to him/her. Avoid bending down, and if possible, do not talk to the child from above. (Picture 14)

Picture 14 Always speak to the child at eye level.

- **Ask the child for personal information**. For children over the age of three, we also ask the child for personal information such as name, date of birth and address. This is important for building a relationship with the child and for the child's involvement, also because of the partnership.
- **Ask simple questions**. The first questions should be sufficiently open-ended, e.g. "Tell me what happened to you? "How did you hurt your leg?"
- Always ask one thing at a time.

(Pilling, 2020.)

5. Communication during examination or treatment

- **Parental presence provides reassurance.** Infants or toddlers should be examined on the lap of the parent, young children with the parent beside them.
- **Observe non-verbal communication**. In many cases, careful observation of a child's non-verbal communication can be of diagnostic value. The child will show how serious his or her condition is, how anxious he or she is about the examination or how worried he or she is about the situation, and an attentive physiotherapist may also notice signs that are the result of changes associated with the given condition.
- **Develop cooperation by asking the child for help**. During the examination or treatment, things should not be done against the child, but preferably with his or her active participation. We do this by asking for the child's help beforehand, for example: "I want to help you so

that your feet don't hurt. I want to examine you first. Will you help me?" (Do not ask young children if we can examine them, as they will probably say no).

- **Double-bind**. We give the child two alternatives, both of which are good, whichever one he chooses. However, once the child is allowed to choose, he or she is no longer a passive participant, but an active one. For example, "Which leg do you want to jump on first?"

- **Playfulness,** the children are much more willing to participate in the investigation if the form is playful, for example similes can be used, "Now stretch up high like a giant" or "Stand on one leg like a stork". We can also use playful equipment. (Picture 15)

Picture 15 "Our hands will become big, big spiders"

- **Use of analogies**. When the physiotherapist has to talk to the child about examinations that he or she may not be familiar with, we can use analogies that make the essence of the examination understandable to the child.

- **Say-show-do method**. Let's start by briefly explaining what will happen at a level appropriate to the child's age. For example, "Now I'm going to see why your leg hurts. The next step, if possible, is to show the tool we are going to use. The third step is the examination itself, which can be done with the child's knowledge, consent and co-operation. (Picture 16)

Picture 16 "We're playing Supermen... this is how you have to lean forward"

- **Distraction** is a method that can be used mainly for short examinations. Again, the child must first be told what we are going to do. Without this, the distraction method cannot be used because it would be deceiving the child, which leads to a loss of trust. We can then divert the child's attention from the examination itself. For example, we can give him a task that will temporarily occupy him, such as holding his left ear with his right hand and his right ear with his left hand, or starting a conversation with him about a topic he has already mentioned.

- **Give the child control**. In the case of a long, uncomfortable examination or procedure, it is important to give the child control over what is happening. Let's talk to him about a sign he can use to do this. For example, "I want to help you, so I am going to examine your leg. If you like, we can stop for a while. Just raise your hand. In most cases, the children will try to see if we are telling the truth and use the agreed sign. In such cases, of course, you really have to stop, praise the child, and then continue with the same rules.

(Pilling, 2020., Wassmer et al., 2004., Howells & Lopez, 2008., Kolucki & Lemish, 2011., Pérez-Duarte Mendiola, 2024.)

6. Informing the child

- **The child has a right to be informed.** Health professionals most often ask the child questions. It is much less common to inform the child about the results of the examination and the proposed treatment. This information is usually given only to the parents. There is no doubt that, in the case of a child, the parents must have the necessary information, but children also have a right to information. CLIV of 1997 on Health, paragraph 13, point (5) of the Act reads as follows: "Incapacitated minors, minors with limited legal capacity and patients with mental illness shall be informed." (According to Hungarian law, a child is considered to be incapacitated until the age of 14, and between the ages of 14 and 18). Of course, children should not be informed about the pathophysiological background of their illness; they are mostly interested in practical questions such as how often they have to go to the physiotherapist, how long they have to do the exercises at home, whether their problem will get better.

- **Provide age-appropriate information**. Of course, the child needs to be given information at a level appropriate to his or her age. In this case, we should use simple expressions and deliver information more slowly and in smaller chunks. Let's encourage children to ask questions!

- **Involve the child in his or her own treatment**. Treatment can be more effective if the child is also cooperative. Ask the child to help with the treatment. For example, say the following "To help your leg heal, you need to do some exercises every day. Please remind your parents that you will do exercises every afternoon.

- **Conclusion of contract.** We ask for the child's cooperation in exchange for a future reward. For example: "There are only two tasks left and then we will go on the trampoline". (Pilling, 2020.) (Picture 17)

Picture 17 We should always keep our promises to the child.

7. The importance of praise

Praise is important for all children, but especially for younger children. For longer tests, simple, **general, positive feedback** can be very important: "how clever you are", "that's it, you're doing very well" - we can keep them motivated with this, but it may not be enough on its own. At the same time, positive feedback is also very important from the point of view of the physiotherapist-child-patient relationship, so that the child feels safe in receiving feedback and therefore responds positively to the physiotherapist's comments.

Specific, positive feedback is what can clearly give the child something to hold on to in a task situation, as it tells and emphasises what the child has done well. For example, "You threw the ball with just the right amount of force so that it fell into the stool!" "It was great how you paid attention the whole time you were cutting with the scissors!"

Constructive, corrective feedback is not negative feedback, but a sentence like "You didn't swing your leg well!" instead of "Swing your legs higher, Hanna!", which includes the method of correction.

The so-called **"sandwich model"** can help you learn this. According to this, feedback consists of three steps in a specific order:

1. positive statement

2. developmental feedback

3. praise

"Hannah! The throw was good, but the arc of the throw was a little flat. Try harder to get the ball up in your next attempt. You are very good!"

(Arends, 1994, Tates & Meeuwesen, 2001) (Figure 4)

EFFECTIVE VS. INEFFECTIVE FEEDBACK

Effective

- Clear
- Relevant
- Timely
- Specific
- Honest
- Task-directed and impersonal
- Targeted at obervable and actionable behavior
- Explains reasons, impaczs and way forward
- Talored to the employee

Ineffective

- Unclear
- Trivial
- Generic
- Condescending
- Blaming
- Shaming
- Personality focused
- Manipulative
- Used for retribution

Figure 4 Effective vs ineffective feedback (sources: Effective vs ineffective feedback in the workplace between employees (symondsresearch.com))

REFERENCES:

Aertssen W. F. M., Ferguson G. D. & Smits-Engelsman B. C. M. (2016). Reliability, structural and construct validity of the Functional Strength Measurement (FSM) in children aged 4-10 years. Physical Therapy 96, 888–97.

Arénás, R. (1994). Learning to Teach. New York: McGraw-Hill Inc.

Arya, K. N., & Pandian, S. (2014). Interlimb neural coupling: implications for poststroke hemiparesis. Annals of physical and rehabilitation medicine, 57(9-10), 696–713. https://doi.org/10.1016/j.rehab.2014.06.003

ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories (2002). ATS statement: guidelines for the six-minute walk test. American journal of respiratory and critical care medicine, 166(1), 111–117. https://doi.org/10.1164/ajrccm.166.1.at1102

Berg, B. (2014). Brain Development, Normal Postnatal. In: Encyclopedia of the Neurological Sciences (Second Edition).

Bielefeldt, E. (2020). Tapintás és érzés. Budapest, Medicina Könyvkiadó Zrt.

Biino, V., Giustino, V., Guidetti, L., Lanza, M., Gallotta, M. C., Baldari, C., ... & Schena, F. (2022). Körperkoordinations test für Kinder: A short form is not fully satisfactory. In Frontiers in Education (Vol. 7). Frontiers Media SA.

Blank, R., Barnett, A. L., Cairney, J., Green, D., Kirby, A., Polatajko, H., Rosenblum, S., Smits-Engelsman, B., Sugden, D., Wilson, P., & Vinçon, S. (2019). International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. Developmental medicine and child neurology, 61(3), 242–285. https://doi.org/10.1111/dmcn.14132

Blythe, S.G. (2006, 2015). Reflexek, tanulás és viselkedés. Budapest, Medicina Könyvkiadó Zrt.

Blythe, S.G. (2014). Neuromotor Immaturity in Children and Adults: The INPP Screening Test for Clinicians and Health Practitioners. Neuromotor Immaturity in Children and Adults: The INPP Screening Test for Clinicians and Health Practitioners. 1-124. 10.1002/9781118736906.

Blythe, S.G. (2014). Akaratlagos figyelem, biztos egyensúly, csodálatos összhang. Budapest, Medicina Könyvkiadó Zrt.

Bobbio, T., Gabbard, C., Cacola, P. (2009). Interlimb Coordination: An Important Facet of Gross-Motor Ability. Early Childhood Research & Practice, 11(2)

Bondi, D., Prete, G., Malatesta, G., & Robazza, C. (2020). Laterality in Children: Evidence for Task-Dependent Lateralization of Motor Functions. International journal of environmental research and public health, 17(18), 6705. https://doi.org/10.3390/ijerph17186705

Boronyai Z., Király T., Pappné Gazdag ZS., Csányi T. (2015). A mozgásfejlődés és ügyességfejlesztés elméleti és gyakorlati háttere. In Csányi T. (szerk.), Mozgásfejlesztés, ügyességfejlesztés mozgáskoncepciós megközelítésben (pp.6-14). Budapest, Magyar Diáksport Szövetség.

Brons, A., de Schipper, A., Mironcika, S., Toussaint, H., Schouten, B., Bakkes, S., & Kröse, B. (2021). Assessing Children's Fine Motor Skills With Sensor-Augmented Toys: Machine Learning Approach. Journal of medical Internet research, 23(4), e24237. https://doi.org/10.2196/24237

Brown, T., & Lalor, A. (2009). The Movement Assessment Battery for Children--Second Edition (MABC-2): a review and critique. Physical & occupational therapy in pediatrics, 29(1), 86–103. https://doi.org/10.1080/01942630802574908

Candy, T. R., & Cormack, L. K. (2022). Recent understanding of binocular vision in the natural environment with clinical implications. Progress in retinal and eye research, 88, 101014. https://doi.org/10.1016/j.preteyeres.2021.101014

Cano-de-la-Cuerda, R., Molero-Sánchez, A., Carratalá-Tejada, M., Alguacil-Diego, I. M., Molina-Rueda, F., Miangolarra-Page, J. C., & Torricelli, D. (2015). Theories and control models and motor learning: clinical applications in neuro-rehabilitation. Neurologia (Barcelona, Spain), 30(1), 32–41. https://doi.org/10.1016/j.nrl.2011.12.010

Casale, J., Browne, T., Murray, I. V., & Gupta, G. (2023). Physiology, Vestibular System. In StatPearls. StatPearls Publishing.

Cools, W., Martelaer, K. D., Samaey, C., & Andries, C. (2009). Movement skill assessment of typically developing preschool children: a review of seven movement skill assessment tools. Journal of sports science & medicine, 8(2), 154–168.

Crow, T. J., Crow, L. R., Done, D. J., & Leask, S. (1998). Relative hand skill predicts academic ability: global deficits at the point of hemispheric indecision. Neuropsychologia, 36(12), 1275–1282. https://doi.org/10.1016/s0028-3932(98)00039-6

Dannemiller, L., Mueller, M., Leitner, A., Iverson, E., & Kaplan, S. L. (2020). Physical Therapy Management of Children With Developmental Coordination Disorder: An Evidence-Based Clinical Practice Guideline From the Academy of Pediatric Physical Therapy of the American Physical Therapy Association. Pediatric physical therapy : the official publication of the Section on Pediatrics of the American Physical Therapy Association, 32(4), 278–313. https://doi.org/10.1097/PEP.0000000000000753

Darvik, M., Lorås, H., & Pedersen, A. V. (2018). The Prevalence of Left-Handedness Is Higher Among Individuals With Developmental Coordination Disorder Than in the General Population. Frontiers in psychology, 9, 1948. https://doi.org/10.3389/fpsyg.2018.01948

Deitz, J. C., Kartin, D., Kopp, K. (2007). Review of the Bruininks-Oseretsky test of motor proficiency, (BOT-2). Physical & occupational therapy in pediatrics, 27(4), 87-102.

Denysschen, M., Coetzee, D., & Smits-Engelsman, B. C. M. (2021). Children with Poor Motor Skills Have Lower Health-Related Fitness Compared to Typically Developing Children. Children (Basel, Switzerland), 8(10), 867. https://doi.org/10.3390/children8100867

Dorka, P., Molnár, A., & Orbán, K. (2013). Motoros képességek és tesztek, edzéstani alapok. Szegedi Tudományegyetem.

Dubecz J. (2009). Általános edzéselmélet és módszertan. Budapest, Rectus Kft.

Dulházi F. (2018). A vizuális és vesztibuláris rendszerek egyensúlybeli szerepének vizsgálata táncosok és tánctapasztalattal nem rendelkező nők szempontjából. Biomechanica Hungarica, 9 (2), 85-92.

Erikson, E. H. (1950). Childhood and society. New York: W. W. Norton & Co.

Erikson, E.H. (1998). The Life Cycle Completed. New York: W.W. Norton & Co.

Farmosi I. (1999): Mozgásfejlődés. Budapest–Pécs, Dialóg Campus Kiadó. 47. p.

Farmosi I. (2011). Mozgásfejlődés. Budapest-Pécs, Dialóg Campus Kiadó.

Farmosi I. (2021). Mozgásfejlődés. Budapest, Flaccus Kiadó.

Farmosi I., Gaál Sándorné (2007). Óvodások és kisiskolások testi és mozgásfejlődése. Pécs, Dialóg Campus Kiadó.

Ferrero, M., West, G., & Vadillo, M. A. (2017). Is crossed laterality associated with academic achievement and intelligence? A systematic review and meta-analysis. PloS one, 12(8), e0183618. https://doi.org/10.1371/journal.pone.0183618

Fischer, U., Suggate, S. P., & Stoeger, H. (2020). The implicit contribution of fine motor skills to mathematical insight in early childhood. Frontiers in Psychology, 11, 508640.

Fischer, U., Suggate, S. P., & Stoeger, H. (2022). Fine motor skills and finger gnosia contribute to preschool children's numerical competencies. Acta psychologica, 226, 103576. https://doi.org/10.1016/j.actpsy.2022.103576

Fitts, PM., & Posner, MI. (1967). Human Performance. Brooks/Cole Pub. Co; Belmont, CA.

Fjørtoft, I., Pedersen, A. V., Sigmundsson, H., & Vereijken, B. (2011). Measuring physical fitness in children who are 5 to 12 years old with a test battery that is functional and easy to administer. Physical therapy, 91(7), 1087–1095. https://doi.org/10.2522/ptj.20090350

Franjoine, M. R., Darr, N., Held, S. L., Kott, K., & Young, B. L. (2010). The performance of children developing typically on the pediatric balance scale. Pediatric physical therapy: the official publication of the Section on Pediatrics of the American Physical Therapy Association, 22(4), 350–359. https://doi.org/10.1097/PEP.0b013e3181f9d5eb

Gentile, AM. (1972). A working model of skill acquisition with application to teaching. Quest. 17(1), 3-23.

Gerber, R. J., Wilks, T., & Erdie-Lalena, C. (2010). Developmental milestones: motor development. Pediatrics in review, 31(7), 267–277. https://doi.org/10.1542/pir.31-7-267

Gerebenné Várbíró K., Reményi, T., & Rosta, K. (2021). Szenzoros információfeldolgozás, mozgás, nyelvi képesség. Budapest, [Gondolat Kiadói Kör Kft.]()

Grillner, S., & El Manira, A. (2020). Current Principles of Motor Control, with Special Reference to Vertebrate Locomotion. Physiological reviews, 100(1), 271–320. https://doi.org/10.1152/physrev.00015.2019

Grissmer, D., Grimm, K. J., Aiyer, S. M., Murrah, W. M., & Steele, J. S. (2010). Fine motor skills and early comprehension of the world: two new school readiness indicators. Developmental psychology, 46(5), 1008–1017. https://doi.org/10.1037/a0020104

Hamar P. (2008). Testnevelés- elmélet Sportismeretek I. Csanádi Árpád Általános Iskola és Pedagógiai Intézet.

Hill, M. W., Wdowski, M. M., Pennell, A., Stodden, D. F., & Duncan, M. J. (2019). Dynamic Postural Control in Children: Do the Arms Lend the Legs a Helping Hand?. Frontiers in physiology, 9, 1932. https://doi.org/10.3389/fphys.2018.01932

Howell, D. R., Brilliant, A. N., & Meehan, W. P., 3rd (2019). Tandem Gait Test-Retest Reliability Among Healthy Child and Adolescent Athletes. Journal of athletic training, 54(12), 1254–1259. https://doi.org/10.4085/1062-6050-525-18

Howells, R., Lopez, T. (2008) Better communication with children and parents. Paediatrics and Child Health. 18(8):381-385 https://doi.org/10.1016/j.paed.2008.05.007

Jimsheleishvili, S., & Dididze, M. (2023). Neuroanatomy, Cerebellum. In StatPearls. StatPearls Publishing.

Keil, F. (2013) Developmental Psychology: The Growth of Mind and Behavior. New York: W.W. Norton & Co.

Kendall, S., Nash, A., Braun, A., Bastug, G., Rougeaux, E., & Bedford, H. (2019). Acceptability and understanding of the Ages & Stages Questionnaires®, Third Edition, as part of the Healthy Child Programme 2-year health and development review in England: Parent and professional perspectives. Child: care, health and development, 45(2), 251–256. https://doi.org/10.1111/cch.12639

Király T., Szakály Z. (2011). Mozgásfejlődés és a motorikus képességek fejlesztése gyermekkorban. Pécs, Dialóg Campus Kiadó.

Kolucki, B., [Lemish](), *D. (2011)* [Communicating with children: Principles and practices to nurture, inspire, excite, educate and heal](). *UNICEF*

Lane, S. J., Mailloux, Z., Schoen, S., Bundy, A., May-Benson, T. A., Parham, L. D., Smith Roley, S., & Schaaf, R. C. (2019). Neural Foundations of Ayres Sensory Integration®. Brain sciences, 9(7), 153. https://doi.org/10.3390/brainsci9070153

Leman, P. (2019) Developmental Psychology. London: McGraw-Hill Education

Lightfoot, C., Cole, M., Cole, S. (2018) The Development of Children. Macmillan Learning,

Luo, Z., Jose, P. E., Huntsinger, C. S., & Pigott, T. D. (2007). Fine motor skills and mathematics achievement in East Asian American and European American kindergartners and first graders. British Journal of Developmental Psychology, 25(4), 595-614.

Magill, R., & Anderson, D. I. (2010). Motor learning and control. New York: McGraw-Hill Publishing.

Marcori, A. J., Grosso, N. D. S., Porto, A. B., & Okazaki, V. H. A. (2019). Beyond handedness: assessing younger adults and older people lateral preference in six laterality dimensions. Laterality, 24(2), 163–175. https://doi.org/10.1080/1357650X.2018.1495725

Maree, J. G. (2021). The psychosocial development theory of Erik Erikson: critical overview. Early Child Development and Care, 191(7–8), 1107–1121. https://doi.org/10.1080/03004430.2020.1845163

Marton Dévényi É., Szerdahelyi M., Tóth G., Keresztes K. (2002): Alapozó Terápia tanulmány, Alapozó Terápiák Alapítvány, Budapest.

McClure, P., Tevald, M., Zarzycki, R., Kantak, S., Malloy, P., Day, K., Shah, K., Miller, A., & Mangione, K. (2021). The 4-Element Movement System Model to Guide Physical Therapist Education, Practice, and Movement-Related Research. Physical therapy, 101(3), pzab024. https://doi.org/10.1093/ptj/pzab024

Mestre, T., & Lang, A. E. (2010). The grasp reflex: a symptom in need of treatment. Movement disorders: official journal of the Movement Disorder Society, 25(15), 2479–2485. https://doi.org/10.1002/mds.23059

Meszler B., Tékus É. (2015). Pályatesztek a mozgáskoordináció mérésére. In: Dr. Váczi Márk (ed.) Motorikus képességek mérése (pp.3-97). Pécs.

Meszler, B., Tékus, É., & Váczi, M. (2015). A motorikus képességek mérése. Pécs: Pécsi Tudományegyetem Természettudományi Kar Sporttudományi és Testnevelési Intézet.

Modrell, A. K., & Tadi, P. (2023). Primitive Reflexes. In StatPearls. StatPearls Publishing.

Mooney, C. G. (2000) Theories of Childhood: An Introduction to Dewey, Montessori, Erickson, Piaget and Vygotsky. St. Paul, MN: Redleaf Press

Nádori L. (1991): Az edzés elmélete és módszertana. Magyar Testnevelési Egyetem, Budapest.

Okunev, R. (2023). Erikson's Life and Psychosocial Developmental Stages. In: The Psychology of Evolving Technology. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4842-8686-9_7

Orenstein, G. A., & Lewis, L. (2022). Eriksons Stages of Psychosocial Development. In StatPearls. StatPearls Publishing.

Papp Zs. (2020). Mozgásterápiák gyermekeknek. Budapest, Pactum Kiadó.

Pappné Gelencsér Zs. (2023). Egyensúlyozás, koordinációs kompetenciák fejlesztése. Budapest, Flaccus Kiadó.

Parrat-Dayan, S. (2023). Why Piaget Enchants Me? The Importance of Piaget's Theory. In: Campos, R.H.d.F., Lourenço, É., Ratcliff, M.J. (eds) The Transnational Legacy of Jean Piaget . Latin American Voices. Springer, Cham. https://doi.org/10.1007/978-3-031-38882-8_2

Pérez-Duarte Mendiola P. How to communicate with children, according to Health Play Specialists in the United Kingdom: A qualitative study. Journal of Child Health Care. 2024;28(1):166-180. doi:10.1177/13674935221109113

Peterburs, J., & Desmond, J. E. (2016). The role of the human cerebellum in performance monitoring. Current opinion in neurobiology, 40, 38–44. https://doi.org/10.1016/j.conb.2016.06.011

Petermann, F. (2011). M-ABC 2–Movement Assessment Battery for Children Second Edition. In:. Pearson Assessment.

Piaget, J. (1966). The Psychology of Intelligence and Education. Childhood Education, 42(9), 528. https://doi.org/10.1080/00094056.1966.10727991

Pilling, J. (2020.) Medical Communication in Practice. Budapest: Medicina Kiadó

Polgár T., Szatmári Z. (2011). Koordinációs képességek. In Polgár, T. (ed.), A motoros képességek. (pp. 9-50). Pécs, Dialóg Campus Kiadó.

Porkolábné Balogh K. (1995). Mozgás – Testkép – Énkép. Mozgásfejlesztés és értelmi fejlődés összefüggései. Fejlesztő Pedagógia, 6(2-3), 33-34.

Rachwani, J., Santamaria, V., Saavedra, S. L., & Woollacott, M. H. (2015). The development of trunk control and its relation to reaching in infancy: a longitudinal study. Frontiers in human neuroscience, 9, 94.

Radanović, D., Đorđević, D., Stanković, M., Pekas, D., Bogataj, Š., & Trajkovic, N. (2021). Test of Motor Proficiency Second Edition (BOT-2) Short Form: A Systematic Review of Studies Conducted in Healthy Children. Children (Basel, Switzerland), 8(9), 787. https://doi.org/10.3390/children8090787

Rivard, L., Missiuna, C., McCauley, D., & Cairney, J. (2014). Descriptive and factor analysis of the Developmental Coordination Disorder Questionnaire (DCDQ'07) in a population-based sample of children with and without Developmental Coordination Disorder. Child: care, health and development, 40(1), 42–49. https://doi.org/10.1111/j.1365-2214.2012.01425.x

Rizzo, J. R., Beheshti, M., Naeimi, T., Feiz, F., Fatterpekar, G., Balcer, L. J., Galetta, S. L., Shaikh, A. G., Rucker, J. C., & Hudson, T. E. (2020). The complexity of eye-hand coordination: a perspective on cortico-cerebellar cooperation. Cerebellum & ataxias, 7(1), 14. https://doi.org/10.1186/s40673-020-00123-z

Rizzo, J. R., Beheshti, M., Shafieesabet, A., Fung, J., Hosseini, M., Rucker, J. C., Snyder, L. H., & Hudson, T. E. (2019). Eye-hand re-coordination: A pilot investigation of gaze and reach biofeedback in chronic stroke. Progress in brain research, 249, 361–374. https://doi.org/10.1016/bs.pbr.2019.04.013

Rose, D. K., & Winstein, C. J. (2013). Temporal coupling is more robust than spatial coupling: an investigation of interlimb coordination after stroke. Journal of motor behavior, 45(4), 313–324. https://doi.org/10.1080/00222895.2013.798250

Rösch, S., Bahnmüller, J., Barrocas, R., Fischer, U., & Möller, K. (2021). Die Bedeutung von Fingergnosie und Fingerbeweglichkeit für die Rechenfähigkeit im Kindergartenalter: The relevance of finger gnosis and fine motor skills for basic arithmetic in kindergarten. Empirische Pädagogik-Landau: Empirische Pädagogik eV,, 35(3). pp. 5-23

Sánchez-González, J. L., Sanz-Esteban, I., Menéndez-Pardiñas, M., Navarro-López, V., & Sanz-Mengíbar, J. M. (2024). Critical review of the evidence for Vojta Therapy: a systematic review and meta-analysis. Frontiers in neurology, 15, 1391448. https://doi.org/10.3389/fneur.2024.1391448

Sánchez-González, M. C., Palomo-Carrión, R., De-Hita-Cantalejo, C., Romero-Galisteo, R. P., Gutiérrez-Sánchez, E., & Pinero-Pinto, E. (2022). Visual system and motor development in children: a systematic review. Acta ophthalmologica, 100(7), e1356–e1369. https://doi.org/10.1111/aos.15111

Scharf, R. J., Scharf, G. J., & Stroustrup, A. (2016). Developmental Milestones. Pediatrics in review, 37(1), 25–47. https://doi.org/10.1542/pir.2014-0103

Schoemaker, M. M., Niemeijer, A. S., Reynders, K., & Smits-Engelsman, B. C. (2003). Effectiveness of neuromotor task training for children with developmental coordination disorder: a pilot study. Neural plasticity, 10(1-2), 155–163. https://doi.org/10.1155/NP.2003.155

Scordella, A., Di Sano, S., Aureli, T., Cerratti, P., Verratti, V., Fanò-Illic, G., & Pietrangelo, T. (2015). The role of general dynamic coordination in the handwriting skills of children. Frontiers in psychology, 6, 580. https://doi.org/10.3389/fpsyg.2015.00580

Seo S. M. (2018). The effect of fine motor skills on handwriting legibility in preschool age children. Journal of physical therapy science, 30(2), 324–327. https://doi.org/10.1589/jpts.30.324

Shaffer, S.W., Harrison, A.L. (2007). Aging of the somatosensory system: A translational perspective. Physical Therapy & Rehabilitation Journal, 87 (2), 193-207.

Shi, P., & Feng, X. (2022). Motor skills and cognitive benefits in children and adolescents: Relationship, mechanism and perspectives. Frontiers in psychology, 13, 1017825. https://doi.org/10.3389/fpsyg.2022.1017825

Sibley, K. M., Beauchamp, M. K., Van Ooteghem, K., Straus, S. E., & Jaglal, S. B. (2015). Using the systems framework for postural control to analyze the components of balance evaluated in standardized balance measures: a scoping review. Archives of physical medicine and rehabilitation, 96(1), 122–132.e29. https://doi.org/10.1016/j.apmr.2014.06.021

Sinno, S., Najem, F., Dumas, G., Abouchacra, K. S., Mallinson, A., & Perrin, P. (2022). Correlation of SVINT and Sensory Organization Test in Children with Hearing Loss. Audiology research, 12(3), 316–326. https://doi.org/10.3390/audiolres12030033

Sisti, H. M., Beebe, A., Bishop, M., & Gabrielsson, E. (2022). A brief review of motor imagery and bimanual coordination. Frontiers in human neuroscience, 16, 1037410. https://doi.org/10.3389/fnhum.2022.1037410

Smits-Engelsman, B., & Verbecque, E. (2022). Pediatric care for children with developmental coordination disorder, can we do better?. Biomedical journal, 45(2), 250–264. https://doi.org/10.1016/j.bj.2021.08.008

Sohn, M., Ahn, Y., & Lee, S. (2011). Assessment of Primitive Reflexes in High-risk Newborns. Journal of clinical medicine research, 3(6), 285–290. https://doi.org/10.4021/jocmr706w

Staples, K. L., MacDonald, M., & Zimmer, C. (2012). Assessment of motor behavior among children and adolescents with autism spectrum disorder. In International review of research in developmental disabilities (Vol. 42, pp. 179-214). Academic Press.

Sziliné Hangay Á., Gerencsér Zs. (2005). Mit tudhatunk a proprioceptív tréningről. Mozgásterápia, 14(3), 3-9.

*Thavakugathasalingam, M., Schwind, J. K. (2022) Experience of childhood cancer: A narrative inquiry, Journal for Specialists in Pediatric Nursing, 10.1111/jspn.12367, **27**, 2,*

Thomas, E., Petrigna, L., Tabacchi, G., Teixeira, E., Pajaujiene, S., Sturm, D. J., Sahin, F. N., Gómez-López, M., Pausic, J., Paoli, A., Alesi, M., & Bianco, A. (2020). Percentile values of the standing broad jump in children and adolescents aged 6-18 years old. European journal of translational myology, 30(2), 9050. https://doi.org/10.4081/ejtm.2019.9050

Tóth, R. (2017): Improvement of fine motor skills in cerebral paretic patients. Különleges Bánásmód, III. évf. 2017/1. szám, 79-85. doi 10.18458/kb.2017.1.79

van den Beld, W. A., van der Sanden, G. A., Sengers, R. C., Verbeek, A. L., & Gabreëls, F. J. (2006). Validity and reproducibility of hand-held dynamometry in children aged 4-11 years. Journal of rehabilitation medicine, 38(1), 57–64. https://doi.org/10.1080/16501970510044043

Vass Z. (2020). Mozgásfejlődés, mozgástanulás, mozgástanítás – Elméleti alapok és módszertani megfontolások. Budapest, Magyar Diáksport Szövetség.

Vekerdy-Nagy, Z. (2019). A gyermekrehabilitáció sajátosságai. (Z. Vekerdy-Nagy, Ed.). Budapest, Medicina Könyvkiadó.

Veldman, S. L., Jones, R. A., & Okely, A. D. (2016). Efficacy of gross motor skill interventions in young children: an updated systematic review. BMJ open sport & exercise medicine, 2(1), e000067. https://doi.org/10.1136/bmjsem-2015-000067

Verschuren, O., Takken, T., Ketelaar, M., Gorter, J. W., & Helders, P. J. (2007). Reliability for running tests for measuring agility and anaerobic muscle power in children and adolescents with cerebral palsy. Pediatric physical therapy : the official publication of the Section on Pediatrics of the American Physical Therapy Association, 19(2), 108–115. https://doi.org/10.1097/pep.0b013e318036bfce

Yanovich, E., & Bar-Shalom, S. (2022). Static and Dynamic Balance Indices among Kindergarten Children: A Short-Term Intervention Program during COVID-19 Lockdowns. Children (Basel, Switzerland), 9(7), 939. https://doi.org/10.3390/children9070939

Zarzycki, R., Malloy, P., Eckenrode, B. J., Fagan, J., Malloy, M., & Mangione, K. K. (2022). Application of the 4-Element Movement System Model to Sports Physical Therapy Practice and Education. International journal of sports physical therapy, 17(1), 18–26. https://doi.org/10.26603/001c.30173

Moraal-van der Linde, B. W., van Netten, J., & Schoemaker, M. M. (2018). DCDDaily Manual. Groningen. Available at http://dcddaily.com/assets/manual_dcddaily_feb2018.pdf (accessed June 14, 2024).

The Developmental Coordination Disorder Questionnaire 2007©©© (DCDQ'07). (n.d.). Available at https://www.dcdq.ca/uploads/pdf/DCDQAdmin-Scoring-02-20-2012.pdf (accessed June 14, 2024).

Bruininks, R. H., & Bruininks, B. D. (n.d.). BOT-2™ Bruininks-Oseretsky Test of Motor Proficiency, Second Edition Complete Form Report. Available at https://www.pearsonassessments.com/content/dam/school/global/clinical/us/assets/bot-2/bot-2-complete-form-sample-report.pdf (accessed June 8, 2024).

Folio, M. R., & Fewell, R. (n.d.). PDMS-3 Online Scoring and Report System Detailed Narrative Report. Available at https://www.pearsonassessments.com/content/dam/school/global/clinical/us/assets/pdms/pdms-3-detailed-narrative-report.pdf (accessed June 8, 2024).

ASQ-3 - Ages and Stages. (n.d.). Available at https://agesandstages.com/products-pricing/asq3/ (accessed June 8, 2024).

Moraal-van der Linde, B. W., van Netten, J., & Schoemaker, M. M. (2018). DCDDaily Manual. Groningen. Available at http://dcddaily.com/assets/manual_dcddaily_feb2018.pdf (accessed June 8, 2024).

The Royal Australian College of General Practitioners. (2018). Guidelines for preventive activities in general practice (9th edn, updated). East Melbourne, Vic: The Royal Australian College of General Practitioners Ltd. Available at https://www.racgp.org.au/getattachment/21c724bc-9280-4262-814f-77366aa9e640/Appendix-3A.pdf.aspx (accessed June 12, 2024).

Gyermek-alapellátási útmutató a 0–7 éves korú gyermekek szűrési vizsgálatainak elvégzéséhez, 2., javított kiadás. (n.d.). Available at http://www.gyermekalapellatas.hu/ (accessed June 12, 2024).

Dévény módszer – DSGM. (n.d.). Available at https://dsgm.eu/deveny-modszer/ (accessed June 12, 2024).

A Dévény-módszer. (n.d.). Available at https://www.deveny.hu/a-deveny-modszer (accessed June 12, 2024).