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THE ONTOGENETIC DEVELOPMENT PREREQUISITES OF PHYSICAL ACTIVITIES IN THE AQUATIC ENVIRONMENT IN EARLY CHILDHOOD

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Summary: The text deals with neurophysiological and kinesiological developmental principles associated with the early development of young children as the fundamental prerequisites for physical education in the aquatic environment. Swimming in infancy and early childhood using the developmental principles and understanding of individual variability represent enormous potential to create a positive attitude of the child to exercise in aquatic environments. We believe that the experience with these basic tasks can play a key role in future exercise habits and swimming literacy of the individual. Parents attending infant swimming courses led by an instructor acquire practical skills and deeper insight into principles of their child's motor learning. All activities in the aquatic environment at an early age should allow transfer of child´s experiences to preswimming education and result in full swimming literacy.

Key Words: Swimming literacy, infant and toddler swimming, neurophysiological prerequisite

Introduction

Understanding the neurophysiological and kinesiological principles of motor development is essential for the evaluation of preparedness of young children to be introduced to targeted physical activities. Physical education leading to a satisfactory level of physical literacy can result in building a routine of adequate physical activity throughout life and can be started in the aquatic environment. Introduction to swimming literacy often occurs during early childhood, usually in the preschool period (Nováková et al. 2015). An adequate level of physical literacy is required for width and quality of sport training and specialized high-performance sports (Whitehead 2010; Bailey et al. 2010; Balyi et al. 2013; Giblin et al. 2014, Giblin, Collins & Button 2014; Kyselovičová et al. 2016).

Another health benefit of swimming (or another effective physical activity in the aquatic environment) performed throughout the entire life can be reduced risk or at least delay of the onset of the civilization diseases. Swimming can also full fill the role in prevention of childhood obesity. Additionally, exercise in the aquatic environment has a positive effect on delaying and possibly reducing the onset of dementia, ischemic heart disease, myocardial infarction and diabetes (Findholt 2007; Khan 2009; Rolland et al. 2008; Verghese et al. 2003).

Training of skills forming the primary swimming competency is offered as a service in the baby clubs for early childhood (infant, toddler). It is not possible to agree fully with it, although some elements of water competency a child can learn at this age. Follow-up swimming literacy is related with the quality of swimming locomotion. The availability of swimming movements is required for everyone on own his/her musculoskeletal system level. We focus on efficient swimming technique characterized by correctly mastered swimming position, swimming breathing and symmetry in model stroke movements (Nováková et al. 2015; Langendorfer & Bruya 1995).

The authors of this paper assume that the introduction to controlled movement experience in water normally begins after the first year of life. Further studies show a positive influence of repeated movement experience in the aquatic environment on the child during a period right after the disappearance of primitive reflexes. The positive effect is particularly noticeable on the rate of acquiring some of coordination skills in water at a later age (Zelazo & Weiss 2006). This early period ends when the fundamental pattern of coordination is combined and elaborated into context-specific movements (Clark 2005). The text deals with the period from new-born until four years of age also known as the “pre-beginner” period.

The analysis of published works shows a clear tendency to use the widest possible comprehensive concept of physical literacy. To achieve physical literacy, the focus should be on encouragement of acquisition of all partial and significant components in parallel rather than in a serial fashion as is done in many swimming education programs. An important prerequisite of these concepts is the establishment of the link between unique and individual aspects of motor ontogenesis and the common principles of motor development as both are embodied in movement education (Nováková et al. 2015; Langendorfer & Bruya 1995; Benčuriková & Putala 2017, Logan et al. 2015).

Neurophysiological and kinesiological prerequisite for the effective (reasonable) physical activities in the aquatic environment in early childhood

Humans are born physically (in terms of movement control) immature. Only the gradual development of the central nervous system (CNS) accompanied by purposefully experimenting with basic trial and error muscle functions and the postural development subsequently allow goal-oriented postural and locomotor movements to emerge in a young child's movement repertoire. Every movement is unique and is adapted to the particular situation. Postural control changes only gradually from the second month on. Postural strategies are one motor development example that illustrates how qualitative and quantitative changes depend on the character of the environmental context and on the complexity of the goal of the motor task (Faladová & Nováková 2009).

Early movement behaviour is accompanied by the child's mental activity of discovering. The sensory inputs are the most common basis for motivation to move. The evaluation of the importance of sensory perceptions for orienting responses in young children is basis for the early initiation of motion. The voluntary correction and anticipation mechanisms come forth with increasing experience and difficulty of the tasks. Cortical parts of CNS provide integration and memory functions that underlie movement patterns as a basis for voluntary physical activity. Some very basic reflexive, non-voluntary movements may be controlled by primitive subcortical structures in the brain and are associated with certain simple stimuli. Subcortical brain structures implement less differentiated functions which are already automatized, instinctive or reflexive (Véle 2006).

Until the beginning of the second year of age the child does not independently orientate in space and usually does not evaluate the speed of surrounding objects or people. Consequently, the small child doesn´t respond to these environmental and task constraints during movement and still usually fails to identify his/her own body or to react effectively to obstacles in the way.

Interestingly, the period between the first and third year of life is characterized by the fear of unknown or unfamiliar experiences. This fear may significantly affect the child's primary motivation for physical activity in the aquatic environment. During this same period, new motor skills emerge resulting the child freeing their hands from support and postural functions (e.g., crawling). At the same time improving vestibular function and oculomotor coordination enable more differentiated and advanced voluntary movements.

During the toddler period (i.e., years two and three) children begin to learn how to use movement purposefully and create relationships to movement (locomotion, sport) that extend to the remainder of their lives. Postural control (especially in the vertical position) and stability increase dramatically during this period. Children acquire the ability to predict dynamic changes in their surroundings and use them for their self-chosen and directed goals. Children can adjust their postures, which allow them to move with anticipated consequences. There is an enhancement in the coordination of individual components of movement that allows children to use movement patterns more effectively for chosen activities. Significant changes in the quality of coordination of motor skills occur from the second to sixth year of age (Kobesová & Kolář 2014).

Between the fourth and sixth year the myelination of pyramidal pathways occurs. More advanced cerebellar functioning manifest in development of equilibrium skills, fine motor skills, and speech, and higher-order cortical functions become more adult-like. Somatesthesia and kinesthesia are important for the perception of motion, error detection and possible corrections. The role of somatesthesia, vision and tactile input into the motor control greatly increases in this period. From the sixth year children can use kinesthesia to copy the movement of the arm and head in space without optical control (Kobesová & Kolář 2014; Kučera et al. 2011).

Rhythmic skills in movement develop from three years of age on and eventually are manifested by the ability to handle a sequence of jumps on one or both legs. During pre-school period the opportunity to improve the quality of complex movements with independent movements of limbs results in the body synkinesis. It improves the overall dynamic coordination of cyclic and acyclic movements (Kolář 2009).

The positioning in the aquatic environment requires coordination of a specific postural motor situation. The aquatic environment creates conditions that are different from the terrestrial environment, especially in the sense of equilibrium functions resulting from gravity. Thus, the aquatic environment brings other exteroceptive (temperature and water flow) and proprioceptive stimuli (the "relief" of the body by the overhanging, the reduction of the loading load of the joints, the water resistance against the body segments), which are processed in the CNS. Extension of the range of sensory exteroceptive, proprioceptive and vestibular system stimuli is appropriate for development or maintenance of motor control. Repeated experience can increase the quality of somatognosis, feedback or feedforward relationships that are indispensable in the process of posture acquisition and voluntary movement control (Nováková & Čechovská 2012).

The developmental examples of limitation in the preswimming skills

We present developmental parameters that influence the child's motor behavior in the aquatic environment under the assumption that all other conditions are optimal (the child motivation, no fear of water, adequate environment...).

Presence (emergence) of primitive reflexes (Piek 2006) causes reflex motor responses (reflex grip, lateroflexion of trunk in Galant reflex or startle response) in the case of manual contact at the trigger point of the reflex reaction or unstable body position in the water. It occurs from birth to about 3 months of age.

The "flexed" or "extended" developmental period (Kobesová & Kolář 2014) with change in the basic muscle tone is the prerequisite for child tendency to respond with primarily flexed or more straighten position of the trunk - two periods are described as flexion (0-1 month, 4 to 9 month) and two as extension (2 to 3 month, 10 to 12 month of age). Whether the infant tolerates individually positions in water, the range of motion in joints or level of general relaxation in floating are developmentally dependent on the flexed or extended period.

Level of the postural stabilization (Kobesová & Kolář 2014) improves from 3 months of age on with the progressing postural development. Increased ability to stabilize the trunk improves range of motion in proximal joints and allows more precise differentiation of the extremities muscle function. Prone position in case of not stabilised upright cervical spine is impossible to perform safely. Even the ability to grasp a toy or balance for assisted gliding skills will depend on a sufficient level of stabilization of axial system (head, spine, pelvis).

Orientation in water is dependent on **visuomotor coordination**, which develops significantly starting at 6 months of age (Shumway-Cook & Woollacott 2007). **Preferred position in the spontaneous motor behaviour** predetermines the child's reaction to different positions in the aquatic environment. A typical example is decreased level of relaxation in floating when they are offered the non preferred position: in the 3rd trimenon infant uses almost exclusively the prone position, which corresponds to his/her sensory needs. During this period most infants have the tendency to scroll to the prone position from a position on the back in the aquatic environment.

Low differentiation of limbs movement (Piek, 2006) before locomotion in the terrestrial environment (creeping or crawling) limits dissociation of arm/leg function before the half of the 3rd trimenon (limbs work reflectively without selective alternating movement). The level of verticalisation (the ability to hold the body against gravity) always determines a suitable position of the child in the aquatic environment, but also limits the practice of his/her entry or fall to the water.

Conclusions

Alarming rate of obesity and declining physical fitness in both paediatric and adult population raises concerns for all experts. The so called infant (baby) swimming in compliance with the principles of development and understanding of individual variability brings enormous potential to develop a positive lifelong relationship of the child to exercise in general. Exercise in a specific aquatic environment is a benefit for the child’s future physical literacy, in particular swimming. Another positive aspect is the participation of the child’s parents in the swimming courses. There is a prerequisite for a shared physical activity in the aquatic environment as the basis for influencing the exercise habits of children but also of the parents themselves as well. Parents attending infant swimming courses led by an instructor acquire practical skills and deeper insight into principles of their child's motor learning.

All activities in the aquatic environment at an early age should allow transfer of child´s experiences to pre swimming education and result in full swimming literacy. For this reason, it is important not to develop the pathological movement stereotypes (due to the high difficulty of rebuilding them) in the aquatic environment in infants and toddlers.

Conflicts of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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