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Conceptual Models in Learning Theory

Motor Function as a Conceptual Framework for Interpreting Fundamental Movement Skills

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Abstract

Purpose. To substantiate motor function as a functional system underlying the development of human motor activity, to determine the place of fundamental movement skills within its structure, and to develop a conceptual model of motor function development.

Material and Methods. The study was theoretical and methodological in nature and was conducted as a conceptual narrative review. The methodological foundation was based on conceptual analysis and knowledge synthesis. The materials included classical and contemporary scholarly works addressing motor function, motor control, motor development, motor learning, and fundamental movement skills. Historical-logical analysis, content analysis of scientific sources, comparative analysis, systems analysis, and conceptual modeling were employed.

Results. Motor function was conceptualized as an integrative functional system formed through the interaction of motor abilities, motor control mechanisms, sensory support systems, and motor experience. Motor control was identified as the central component of motor function, with its development progressing from the accurate reproduction of movement parameters to the differentiation of spatial, temporal, and force characteristics of movement actions. Fundamental movement skills were interpreted not as the foundation of motor development but as a form of motor function development and a mechanism for the accumulation of motor experience. A conceptual model of motor function development and a functional classification of fundamental movement skills were proposed, comprising stabilization, spatial orientation, temporal organization of movement, motor control, and adaptation. Programming was substantiated as the mechanism for the purposeful development of motor function.

Conclusions. Motor function represents the system-forming construct of motor development, integrating motor abilities, motor control mechanisms, sensory support systems, and motor experience in the process of solving motor tasks. Fundamental movement skills should be interpreted as a form of motor function development, whereas programming serves as the mechanism for its purposeful formation. The proposed framework expands the explanatory potential of contemporary Fundamental Movement Skills, Motor Competence, and Physical Literacy approaches.

Keywords: motor function, fundamental movement skills, motor development, motor control, motor experience, programming, motor learning.

Introduction

Research on human motor development constitutes one of the fundamental domains of motor learning theory, physical education, and sports training. A prominent position in contemporary research is occupied by the concept of Fundamental Movement Skills (FMS), according to which basic movement actions are considered the foundation for subsequent motor development, the formation of motor competence, and lifelong engagement in physical activity (Gallahue et al., 2012; Stodden et al., 2008; Lubans et al., 2010; Hulteen et al., 2018).

Within the FMS framework, a substantial body of scientific evidence has accumulated regarding the structure of fundamental movement skills, the patterns of their development, assessment methods, and their relationships with physical fitness, physical activity, and health outcomes (Lubans et al., 2010; Logan et al., 2012; Barnett et al., 2016; Khudolii et al., 2025a). The most widely accepted classifications divide fundamental movement skills into locomotor, object-control (manipulative), and stability skills (Gallahue et al., 2012; Barnett et al., 2016; Khudolii et al., 2025b). This approach provides a framework for describing basic forms of motor activity and identifying their role within the process of motor development.

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However, contemporary classifications of fundamental movement skills primarily reflect the external structure of movement actions and their place within developmental progression (Gallahue et al., 2012; Barnett et al., 2016; Hulteen et al., 2018). Considerably less attention has been devoted to the mechanisms underlying skill acquisition, variability, and effective application under changing environmental conditions. Consequently, there is a need for a theoretical framework that would allow motor development to be examined as an integrated process and fundamental movement skills to be interpreted as outcomes of a complex functional system.

The theoretical foundations for such an approach can be found in the works of Bernstein devoted to the problems of motor control and movement construction (Bernstein, 1967; Bernshtein, 1966). Further development of the concept of motor function is associated with the studies of Farfel (1975), Shlemin (1973), Liubomirskii (1974), Vilchkovskii (1983, 1993), and other scholars who considered motor function as a complex integrative formation that ensures movement acquisition, motor control, and adaptation to the conditions of activity. At the same time, research on fundamental movement skills and research on motor function have evolved largely independently, limiting the possibilities for a comprehensive explanation of the motor development process (Stodden et al., 2008; Barnett et al., 2016; Hulteen et al., 2018).

An analysis of the scientific literature reveals a contradiction between the high level of development of fundamental movement skill classifications and the insufficient understanding of the mechanisms underlying their formation. Contemporary concepts provide convincing explanations regarding which movement skills emerge through development and learning (Gallahue et al., 2012; Stodden et al., 2008; Barnett et al., 2016; Hulteen et al., 2018), yet they offer less insight into how motor abilities, sensory support systems, motor control mechanisms, and motor experience are integrated during skill formation.

Addressing this problem requires consideration of motor function as the system-forming construct of motor development. Within this framework, fundamental movement skills may be interpreted both as outcomes of motor function development and as mechanisms through which motor experience is accumulated. Such an approach makes it possible to move beyond the description of individual forms of motor activity toward the analysis of the principles governing the formation, development, and functioning of the human motor system.

The purpose of this study was to substantiate motor function as a functional system underlying the development of human motor activity, to determine the place of fundamental movement skills within its structure, and to develop a conceptual model of motor function development.

Materials and Methods

This study has a theoretical and methodological character and was conducted in the form of a conceptual narrative review aimed at examining the relationships among the concepts of motor function, motor abilities, motor experience, and fundamental movement skills within the context of contemporary theories of motor learning and motor development.

The methodological foundation of the study was based on the principles of conceptual analysis and knowledge synthesis proposed by Khudolii, Ivashchenko, and Khudolii (2026a, 2026b). According to this approach, the preparation of a scientific text is viewed as a sequential process of knowledge synthesis that includes orientation within the scientific field, problem conceptualization, evidence analysis, synthesis, and interpretation. Within the framework of the present study, the central meta-problem was to determine the place of fundamental movement skills within the structure of human motor development and to substantiate motor function as the system-forming concept for their interpretation.

The materials for the study consisted of classical and contemporary scholarly works addressing motor function, motor control, motor development, motor learning, and fundamental movement skills. The analysis incorporated the works of M.O. Bernshtein, V.S. Farfel, A.M. Shlemin, L.Ye. Lyubomirskiy, E.S. Vilchkovskyi, and Yu.V. Verkhoshanskyi, as well as contemporary research in the fields of Fundamental Movement Skills (FMS), Motor Competence, Physical Literacy, and Motor Learning.

The following methods were employed:

- *Historical-logical analysis* to examine the evolution of scientific views on motor function and to determine its place within the system of human motor development;
- *Content analysis of scientific sources* to identify key concepts, categories, and theoretical approaches to the interpretation of motor function, motor abilities, and fundamental movement skills;
- *Comparative analysis* to compare contemporary Fundamental Movement Skills concepts with classical perspectives on motor function and motor development;
- *Systems analysis* to investigate the structure of motor function, identify relationships among its components, and substantiate their role in skill formation;
- *Conceptual modeling* to develop a theoretical model of motor function and determine the place of fundamental movement skills within its developmental process.

The study was conducted in four stages.

During the first stage, the evolution of scientific views on motor function and fundamental movement skills was analyzed, and the principal directions in the development of theoretical approaches to their interpretation were identified.

During the second stage, the problem was conceptualized through the examination of motor abilities, motor control, motor experience, and fundamental movement skills, and their place within the system of human motor development was determined.

During the third stage, the relationships among motor abilities, motor control mechanisms, sensory support systems, vestibular stability and sensitivity, motor experience, and fundamental movement skills were examined.

During the fourth stage, the obtained findings were synthesized and interpreted, a conceptual model of motor function was developed, and an approach to interpreting

fundamental movement skills as a form of motor function development was substantiated.

The methodological basis for conceptual modeling was the proposition that motor function represents an integrative functional system formed through the solution of motor tasks as a result of the interaction among motor abilities, motor control mechanisms, sensory support systems, and motor experience. Within this framework, fundamental movement skills are considered both an outcome of motor function development and a mechanism for the accumulation of motor experience that supports the further refinement of the human motor system.

Results

Evolution of the Concept of Motor Function

An analysis of the scientific literature indicates that the concept of motor function emerged at the intersection of physiology, psychology, pedagogy, and motor learning theory (Bernshtein, 1966; Farfel, 1975; Shlemin, 1973).

In physiological research, motor function was primarily viewed as the result of the activity of bodily systems responsible for movement execution. V.S. Farfel argued that human motor abilities are supported by several physiological systems, including the motor system itself, the motor control system operating in conjunction with systems for information perception and processing, the energy supply system for muscular activity, the system of functional regulation and integration, and the system of higher mental functions. According to Farfel, each of these systems is morphologically and functionally embedded within the human genetic apparatus and contributes to the characteristics of human motor abilities (Farfel, 1975).

A further development of the concept of motor function is associated with the work of M.O. Bernshtein, who viewed movement as a process of constructing and reconstructing motor actions based on mechanisms of motor control, sensory corrections, and accumulated motor experience. Within this framework, the central object of analysis is not an isolated movement but rather the process of solving a motor task, which requires continuous interaction between motor control mechanisms and sensory regulation of movement activity (Bernshtein, 1966; Bernstein, 1967).

In pedagogical research, motor function gradually came to be understood as a complex integrative construct whose development depends not only on morphofunctional prerequisites but also on learning conditions. Particular importance should be attributed to the works of A.M. Shlemin, L.Ye. Lyubomirskiy, and E.S. Vilchkovskyi, in which the development of motor function is associated with the formation of movement control capabilities, the improvement of coordination mechanisms, and the accumulation of motor experience (Shlemin, 1973; Lyubomirskiy, 1974; Vilchkovskyi, 1983, 1993).

Our own investigations of the structure of motor function in preschool children demonstrated that its state is characterized by indicators of motor control, movement coordination, vestibular stability, flexibility, speed, strength and speed-strength fitness, as well as performance in tasks requiring movement speed and accuracy (Khudolii & Kasian, 2011). At the same time, the pivotal component of the motor function structure was found to be represented by motor control characteristics, particularly the accuracy and speed of movement execution. These characteristics integrate the manifestations of individual motor abilities during the process of solving motor tasks and determine the effectiveness of motor skill acquisition.

Taken together, these findings suggest a gradual evolution in the understanding of motor function—from a physiological characteristic of movement performance to an integrative functional system that combines motor abilities, motor control mechanisms, sensory support, and motor experience in the process of solving motor tasks.

Motor Function as a Functional System

Contemporary research on human motor development predominantly examines individual components of motor activity, including motor abilities, coordination abilities, motor skills, fundamental movement skills, and motor competence (Gallahue et al., 2012; Stodden et al., 2008; Robinson et al., 2015; Barnett et al., 2016; Hulteen et al., 2018). Although this approach is appropriate for analyzing specific aspects of motor activity, it does not fully explain the mechanisms underlying the formation of integrated motor behavior.

V.S. Farfel argued that human motor abilities are supported by several physiological systems, including the motor system itself, the motor control system operating in conjunction with systems responsible for information perception and processing, the energy supply system for muscular work, the system of regulation and integration of functional processes, and the system of higher mental functions. Each of these systems is morphologically and functionally embedded within the human genetic apparatus and determines the characteristics of motor abilities (Farfel, 1975). However, motor abilities cannot be regarded as isolated entities because their practical significance becomes evident only in the process of solving a specific motor task (Farfel, 1975; Bernshtein, 1966).

From the perspective of functional systems theory, the development of the human motor domain should be viewed not as the parallel development of separate abilities or skills but as the formation of an integrated functional system directed toward achieving a useful result (Anokhin, 1975). Within this framework, the development of motor abilities, the refinement of sensory support systems, vestibular stability and sensitivity, and the accumulation of motor experience are not independent goals but components of motor function development (Anokhin, 1975; Bernshtein, 1966).

The interpretation of motor function as an integrative construct is consistent with the fundamental principles of P.K. Anokhin's functional systems theory, according to which every functional system is organized around the achievement of a useful result. Within such a framework, individual morphological and functional components of the organism are not considered in isolation but are integrated into a system whose activity is directed toward producing a specific adaptive effect (Anokhin, 1975).

From this perspective, motor function cannot be reduced either to a set of motor abilities or to a collection

of motor skills. Motor abilities, sensory support systems, motor control mechanisms, and motor experience represent components of a functional system that become integrated during the process of solving a motor task (Anokhin, 1975; Bernshtein, 1966; Farfel, 1975). The system-forming factor is not any individual component but the useful result of motor activity itself.

In the context of motor development, this result is expressed as an individual's ability to solve motor tasks effectively under changing conditions of activity. The requirement to achieve this result determines the nature of the interaction among motor abilities, motor control mechanisms, sensory support systems, and accumulated motor experience.

Experimental studies of motor function development have demonstrated that improvements in individual motor abilities do not automatically lead to improvements in motor skill quality (Khudolii & Kasian, 2011). In particular, the maximal development of strength abilities is not necessarily accompanied by improvements in motor control (Khudolii, 2011). Rather, an optimal level of motor ability development creates the prerequisites for the refinement of motor control mechanisms, which in turn support the development of the capacity to differentiate the spatial, temporal, and force characteristics of movement actions. Such differentiation creates the conditions necessary for the formation of variable motor skills adapted to changing activity conditions (Khudolii & Kasian, 2011; Khudolii, 2011).

These findings make it possible to interpret motor function development as a process of progressive integration of its components. At the initial stages, functional prerequisites are established through a certain level of motor ability development, sensory support, and vestibular stability. Subsequently, motor control mechanisms emerge and develop, enabling the accurate reproduction and differentiation of spatial, temporal, and force characteristics of movement actions. The integration of these components ultimately results in the formation of variable motor skills that can be effectively applied under changing activity conditions (Khudolii & Kasian, 2011).

Motor experience occupies a particularly important place within the structure of motor function. Unlike traditional approaches, in which motor experience is viewed as a collection of acquired skills, the functional-systems perspective considers it a mechanism for accumulating and integrating the outcomes of motor activity (Bernshtein, 1966; Bernstein, 1967). Motor experience preserves and refines successful ways of solving motor tasks, thereby providing a foundation for the further development of motor function.

Of particular importance is the principle of feedback, which occupies a central place in functional systems theory. The results of movement execution are accumulated in the form of motor experience and subsequently used to improve motor control mechanisms. Consequently, motor experience functions not only as an outcome of motor function but also as a factor driving its further development (Anokhin, 1975; Bernshtein, 1966; Bernstein, 1967).

Thus, motor function development may be viewed as a continuous process of integration and reorganization of a functional system in response to new activity demands. Within this process, motor abilities create the functional prerequisites for development, motor control mechanisms regulate movement activity, sensory support systems provide the informational basis for movement control, and motor experience serves as a mechanism of feedback and accumulation of activity outcomes.

The result of motor function is not merely the acquisition of individual motor skills but, more importantly, the ability to use them effectively for solving motor tasks under changing conditions of activity. This ability represents the primary criterion of motor function development and reflects the degree of integration of its components into a coherent functional system.

Within the proposed framework, motor function can be operationalized through a system of indicators characterizing motor control and its sensory support. These indicators include the accuracy of reproducing spatial, temporal, and force characteristics of movements, the ability to differentiate these characteristics, measures of vestibular stability and sensitivity, and performance indicators in motor tasks that reflect the level of accumulated motor experience.

Therefore, motor function is a functional system that develops through learning and development as a result of the integration of motor abilities, motor control mechanisms, sensory support systems, and motor experience. The outcome of this system is the effective solution of motor tasks and the formation of variable motor skills adapted to changing activity conditions. Such an understanding of motor function provides the theoretical foundation for interpreting fundamental movement skills as a form of motor function development.

Fundamental Movement Skills: Contemporary Approaches to Classification

The concept of Fundamental Movement Skills (FMS) has emerged as one of the leading frameworks for studying children's motor development. It is based on the assumption that a set of basic movement actions serves as the foundation for the subsequent acquisition of more complex forms of motor activity, physical exercises, and sport-specific skills (Gallahue et al., 2012; Stodden et al., 2008; Hulteen et al., 2018).

In contemporary scientific literature, fundamental movement skills are generally defined as basic movement patterns acquired through learning and development that enable the effective performance of a wide range of motor tasks. Unlike reflexive or naturally occurring forms of movement behavior, fundamental movement skills are acquired in nature and develop under the influence of pedagogical and environmental factors (Gallahue et al., 2012; Logan et al., 2012; Barnett et al., 2016).

The most widely accepted classification divides fundamental movement skills into three major categories (Gallahue et al., 2012; Barnett et al., 2016):

- Locomotor skills;
- Object-control skills;
- Stability skills.

Locomotor skills include walking, running, jumping, hopping, galloping, and other forms of body displacement through space. Object-control skills encompass various forms of interaction with external objects, including throwing,

catching, striking, and dribbling. Stability skills involve maintaining balance, body control, turning movements, and other actions associated with controlling body position and posture (Gallahue et al., 2012).

The further development of the FMS concept has expanded understanding of their role in the formation of physical literacy, motor competence, and lifelong engagement in physical activity. Within this perspective, fundamental movement skills are viewed not only as individual movement actions but also as a foundation for subsequent motor development (Stodden et al., 2008; Lubans et al., 2010; Robinson et al., 2015; Barnett et al., 2016; Hulteen et al., 2018).

At the same time, most contemporary classifications of FMS are based primarily on the observable manifestations of motor activity and the manner in which movement actions are performed. While this approach provides an effective framework for organizing and describing diverse forms of movement, it offers a more limited understanding of the mechanisms underlying their formation and their place within the broader structure of motor development.

Consequently, the contemporary concept of fundamental movement skills provides a robust framework for describing and classifying basic forms of motor activity. However, it leaves unresolved the question of how fundamental movement skills are related to the structure of motor function and through which mechanisms they emerge during the processes of development and learning.

Fundamental Movement Skills as a Form of Motor Function Development

Traditional approaches to the interpretation of Fundamental Movement Skills (FMS) are based on the assumption that they constitute the foundation of subsequent motor development. Within this framework, locomotor, object-control, and stability skills are viewed as the basis for the acquisition of more complex movement actions, sport-specific skills, and motor competence (Gallahue et al., 2012; Stodden et al., 2008; Barnett et al., 2016; Robinson et al., 2015).

However, an analysis of motor function theory allows this issue to be considered from a different perspective. If motor function is understood as a functional system formed through the integration of motor abilities, motor control mechanisms, sensory support systems, and motor experience (Anokhin, 1975; Bernshtein, 1966; Farfel, 1975), then fundamental movement skills cannot be regarded as its primary element. Rather, they represent both an outcome of motor function development and a means for its further refinement.

The development of motor function involves the progressive formation of motor control mechanisms. Motor abilities create the functional prerequisites for this process but do not, by themselves, determine the quality of motor performance (Farfel, 1975). Of decisive importance is the capacity for motor control, which is expressed through the differentiation of the spatial, temporal, and force characteristics of movement actions (Bernshtein, 1966; Khudolii & Kasian, 2011).

The formation of fundamental movement skills results from the integration of these mechanisms during the process of solving motor tasks. Within this perspective, a skill is not merely an isolated movement action but a specific mode of realizing motor function under particular activity conditions (Bernshtein, 1966; Bernstein, 1967).

Of particular importance is the fact that an acquired motor skill becomes incorporated into motor experience and subsequently serves as a basis for solving new motor tasks. Consequently, fundamental movement skills are simultaneously outcomes of motor function development and elements of motor experience that support its further refinement (Bernshtein, 1966; Bernstein, 1967).

From the perspective of the functional-systems approach, motor function development represents the formation of a functional system integrating motor abilities, motor control mechanisms, sensory support systems, and motor experience (Anokhin, 1975). Motor abilities create the functional prerequisites for motor function development but do not directly determine the quality of motor skills. What is critical is the integration of motor abilities into the motor control system, enabling the differentiation of spatial, temporal, and force characteristics of movement actions. Such differentiation constitutes the mechanism through which the organism's functional capacities are transformed into acquired motor skills (Khudolii & Kasian, 2011; Khudolii, 2011). The outcome of motor function development is the formation of variable motor skills that are adapted to changing activity conditions and capable of ensuring the efficient solution of motor tasks.

Accordingly, fundamental movement skills should be interpreted not as the initial foundation of motor development but as a form of motor function development. From this perspective, FMS reflect the level of development of motor control mechanisms, the degree of integration of motor abilities into motor activity, and the volume of accumulated motor experience.

Classification of Fundamental Movement Skills as Elements of Motor Function Development

Traditional classifications of fundamental movement skills are based primarily on the observable characteristics of motor activity and the manner in which movement actions are performed. The most widely adopted approach categorizes fundamental movement skills into locomotor skills, object-control skills, and stability skills (Gallahue et al., 2012; Barnett et al., 2016). While this classification provides an effective framework for describing diverse forms of motor activity, it does not explain their place within the process of motor function development.

From the perspective of the functional-systems approach, fundamental movement skills should be considered forms of manifestation and development of motor function. Within this framework, the classification of skills should reflect not only the external structure of movement actions but also the functional mechanisms that underlie their formation and application (Anokhin, 1975; Bernshtein, 1966).

Motor function development is accompanied by the integration of motor abilities, sensory support systems, motor control mechanisms, and motor experience into a unified functional system (Farfel, 1975; Anokhin, 1975). Throughout this developmental process, fundamental movement skills

represent specific forms through which motor function is expressed at different levels of organization.

A functional analysis makes it possible to identify five principal directions of motor function development that simultaneously define the functional structure of fundamental movement skills: stabilization, spatial orientation, temporal organization of movement, motor control, and adaptation.

Stabilization

Stabilization ensures the maintenance of body position and balance under both static and dynamic conditions of activity. Fundamental movement skills associated with this direction involve the development of vestibular stability, postural control, and the maintenance of equilibrium during movement execution (Vilchkovskyi, 1983; Khudolii & Kasian, 2011).

Spatial Orientation

Spatial orientation enables the determination of body position and the position of body segments in space, the control of movement direction and trajectory, and orientation relative to surrounding objects. Within motor function development, this direction is expressed through skills related to locomotion, changes in movement direction, and spatial control of movement actions (Bernshtein, 1966).

Temporal Organization of Movement

Temporal organization refers to the ability to coordinate movements in time and includes the regulation of movement tempo, rhythm, and sequence. It creates the prerequisites for the development of more advanced forms of motor control (Bernshtein, 1966; Liubomirskii, 1974).

Motor Control

Motor control occupies a central position within the structure of motor function. At the first level of its development, individuals acquire the ability to accurately reproduce the spatial, temporal, and force parameters of movement actions. At the second level, motor control is manifested in the ability to differentiate these spatial, temporal, and force characteristics according to the requirements of a specific motor task. Such differentiation enables the transition from the reproduction of predefined parameters to their purposeful modification and regulation (Bernshtein, 1966; Khudolii & Kasian, 2011; Khudolii, 2011).

Adaptation

Adaptation represents the highest level of motor function expression and characterizes the ability to apply acquired motor skills under changing activity conditions. At this level, movement parameters are reorganized in accordance with environmental demands, enabling the effective solution of novel motor tasks (Bernstein, 1967; Hulteen et al., 2018).

Thus, fundamental movement skills may be interpreted as forms of motor function development reflecting the progressive complexity of mechanisms related to stabilization, spatial orientation, temporal organization, motor control, and adaptation. Within this framework, fundamental movement skills are viewed not as the initial foundation of motor development but as outcomes of the integration of motor function components and, simultaneously, as mechanisms for its further refinement.

The proposed classification is based not on the observable characteristics of movement actions but on the functional mechanisms that support their execution. The identified

Table 1. Levels of Motor Function Development and Forms of Fundamental Movement Skills Expression

Level of Motor Function Development	Stabilization	Spatial Orientation	Temporal Organization	Motor Control	Adaptation
Sensory Foundation	Maintenance of balance	Body orientation in space	Response to temporal cues	Basic movement control	Orientation to environmental changes
Parametric Control	Stability during movement	Control of movement direction and trajectory	Regulation of tempo and rhythm	Spatial, temporal, and force accuracy of movements	Anticipation of changing task conditions
Fundamental Movement Skills	Stable execution of movement actions	Controlled movement through space	Temporal coordination of movements	Differentiation of spatial, temporal, and force characteristics of movement	Variable execution of movement actions
Combined Motor Programs	Maintenance of stability during complex movement actions	Spatial integration of multiple movement actions	Temporal coordination of movement sequences	Control of complex movement actions	Modification of movement actions according to task conditions
Adaptive Motor Programs	Stability under uncertain conditions	Orientation within dynamic environments	Variable temporal organization of movements	Flexible regulation of movement parameters	Solving novel motor tasks under changing environmental conditions

Note. The rows represent successive levels of motor function development, whereas the columns represent functional directions of development. Progression across levels reflects increasing integration of motor abilities, sensory support systems, motor control mechanisms, and motor experience within a functional system.

directions reflect the progressive development of the motor system—from maintaining stability and orientation in space to the regulation of movement and adaptation to changing activity conditions. Each subsequent direction builds upon and incorporates the preceding one as part of a more complex level of functional organization. Consequently, stabilization, spatial orientation, temporal organization of movement, motor control, and adaptation should be understood not as separate groups of movement actions but as functional levels in the development of motor function (Table 1).

The proposed model reflects the hierarchical nature of motor function development. Each successive level does not replace the preceding one but incorporates it into a more complex functional system. Progression from the sensory foundation to adaptive motor programs is accompanied by increasing complexity of motor control mechanisms and the continuous expansion of motor experience (Anokhin, 1975; Bernshtein, 1966).

Motor control occupies a central position within the structure of motor function. At the level of parametric control, it is manifested in the ability to accurately reproduce the spatial, temporal, and force parameters of movement. At the level of fundamental movement skills, motor control is characterized by the ability to differentiate these characteristics according to the requirements of a specific motor task. Such differentiation of spatial, temporal, and force characteristics of movement provides the foundation for the development of variable motor skills capable of effective application under diverse activity conditions (Bernshtein, 1966; Khudolii & Kasian, 2011; Khudolii, 2011).

Within the proposed model, fundamental movement skills occupy an intermediate position between parametric movement control and combined motor programs. This position allows them to be interpreted not as the initial foundation of motor development but as an outcome of the integration of motor function components and, simultaneously, as a mechanism for accumulating motor experience necessary for the further development of motor function.

Consequently, fundamental movement skills represent a transitional level at which the functional capacities of the motor system are transformed into organized, variable, and task-oriented forms of movement behavior.

Programming as a Mechanism for Motor Function Development

Contemporary research on Fundamental Movement Skills (FMS) has focused primarily on the description of movement structures, age-related characteristics of development, and the assessment of skill proficiency (Gallahue et al., 2012; Barnett et al., 2016; Hulteen et al., 2018). In contrast, the mechanisms underlying the purposeful development of motor function remain insufficiently explored.

From the perspective of the functional-systems approach, motor function development is not a spontaneous process of accumulating motor experience. Rather, motor function develops under the influence of systematically organized pedagogical interventions that facilitate the integration of motor abilities, motor control mechanisms, sensory support systems, and motor experience into a unified functional system (Anokhin, 1975).

Within the processes of learning and development, pedagogical influences should be directed not toward the isolated development of individual motor abilities or the acquisition of separate motor skills but toward creating conditions for their integration within the structure of motor function. Consequently, the effectiveness of motor function development is determined not by the magnitude of individual indicators of strength, speed, or endurance but by the degree to which these capacities are incorporated into motor control mechanisms (Bernshtein, 1966; Farfel, 1975).

Experimental evidence indicates that improvements in individual motor abilities alone do not ensure the development of motor function and do not automatically lead to improvements in motor skill quality. Motor abilities create only the functional prerequisites for motor function development. Their integration into the motor control system is the decisive factor. In particular, research has demonstrated that an optimal level of motor ability development creates more favorable conditions for the refinement of motor control mechanisms than an exclusive orientation toward maximizing individual physical qualities. The development of motor control, in turn, enables the transition from the accurate reproduction of spatial, temporal, and force parameters of movement to their differentiation according to the requirements of a specific motor task. Such differentiation constitutes a necessary condition for the formation of variable motor skills adapted to changing activity conditions. These findings support the view that effective skill formation depends not on the isolated development of motor abilities but on their integration into the motor control system and on the structure of learning tasks employed during instruction (Khudolii & Kasian, 2011; Khudolii, 2011; Khudolii, Iermakov, & Bartik, 2020).

Thus, motor function development is a regulated process governed by the interactions among motor abilities, motor control, and motor experience. Within this framework, programming serves as the mechanism through which motor function can be purposefully developed.

Programming is understood as the scientifically grounded determination of the content, volume, intensity, and sequence of pedagogical interventions aimed at producing anticipated changes in the structure of motor function (Verkhoshanskii, 1988; Ivashchenko, 2020). Its primary purpose is not merely to develop individual components of motor activity but, above all, to create conditions for their integration into a coherent functional system.

This understanding of programming is consistent with contemporary pedagogical concepts of motor learning organization. Within the Spectrum of Teaching Styles framework, the learning process is viewed as a system of pedagogical decisions that determine the nature of teacher–learner interaction and facilitate the achievement of intended learning outcomes (Mosston & Ashworth, 2008). In the context of motor function development, this implies that the selection of movement organization strategies, feedback procedures, levels of learner autonomy, repetition schedules, and sequences of learning tasks becomes an instrument for the purposeful development of motor control mechanisms, the accumulation of motor experience, and the advancement of motor function as a whole.

The outcome of programming is the formation of variable motor skills that are adapted to activity conditions

and capable of ensuring the effective solution of motor tasks in changing environments. In this sense, programming functions both as a mechanism for directing motor function development and as a mechanism for the accumulation of motor experience.

Conceptual Model of Motor Function Development

The results of the present analysis support the interpretation of motor function development as a process of forming a functional system directed toward solving motor tasks under changing activity conditions (Anokhin, 1975; Bernshtein, 1966). Within the proposed framework, the central object of development is neither an individual motor ability nor an individual motor skill, but motor function itself as an integrative outcome of the interaction among motor abilities, motor control mechanisms, sensory support systems, and motor experience.

Motor abilities create the functional prerequisites for motor function development (Farfel, 1975). Through the processes of learning and development, these abilities become integrated into the motor control system, thereby supporting the formation of mechanisms responsible for the regulation of motor activity. A central role is played by motor control, which ensures the coordination of the spatial, temporal, and force characteristics of movement actions in accordance with the requirements of a specific motor task (Bernshtein, 1966; Bernstein, 1967).

Two interrelated levels may be distinguished in the development of motor control. The first level is characterized by the ability to accurately reproduce the spatial, temporal, and force parameters of movement actions. The second level is associated with the development of the ability to differentiate these spatial, temporal, and force characteristics according to activity conditions and task requirements. It is this process of differentiation that enables the transition from simple movement reproduction to purposeful movement regulation (Bernshtein, 1966; Khudolii & Kasian, 2011; Khudolii, 2011).

As motor function develops, fundamental movement skills emerge as forms through which motor function is expressed and further developed. The accumulation and refinement of fundamental movement skills contribute to the development of motor experience, which subsequently becomes an important factor in the continued advancement of motor function (Bernstein, 1967).

The ultimate outcome of motor function development is the formation of variable motor skills that are adapted to changing activity conditions and capable of ensuring the efficient solution of motor tasks. Accordingly, the ability to effectively apply acquired motor skills in variable environments represents the primary criterion of motor function development.

Based on the proposed framework, the process of motor function development may be represented as the following sequence:

Motor abilities → integration into the motor control system → movement accuracy → differentiation of spatial, temporal, and force characteristics of movement → fundamental movement skills → motor experience → variable motor skills adapted to activity conditions.

Programming functions as the mechanism through which this developmental process is regulated and directed, ensuring the purposeful formation of motor function at all stages of its development (Shlemin, 1973; Verkhoshanskii, 1988; Khudolii, 2011; Ivashchenko, 2020).

Consequently, motor function development can be understood as a process of integrating motor abilities, sensory support systems, motor control mechanisms, and motor experience into a functional system whose outcome is the formation of both fundamental and variable motor skills adapted to changing activity conditions. Within the proposed conceptual framework, fundamental movement skills should be interpreted not as the initial foundation of motor development but as a form of motor function development and a mechanism for the accumulation of motor experience.

Discussion

The scientific novelty of the proposed approach lies in interpreting fundamental movement skills not as the initial foundation of motor development but as a form of motor function development. Unlike FMS-based frameworks, which focus primarily on the classification and assessment of basic movement skills, Motor Competence approaches, which emphasize the level of motor proficiency, and Physical Literacy frameworks, which focus on lifelong engagement in physical activity, the present approach positions motor function as the system-forming construct that integrates motor abilities, motor control mechanisms, sensory support systems, and motor experience in the process of solving motor tasks.

The proposed concept of motor function does not contradict contemporary approaches to the study of motor development; rather, it extends their explanatory potential. Within the Fundamental Movement Skills framework, the primary object of analysis is the development and assessment of basic movement skills. The concept of Motor Competence focuses on the degree of proficiency in performing motor tasks. Physical Literacy emphasizes readiness for lifelong physical activity, encompassing not only motor competence but also motivational, cognitive, and behavioral dimensions. In contrast, the present framework identifies motor function as the central object of investigation and conceptualizes it as an integrative functional system responsible for the formation and application of motor skills during motor task performance.

The results of the present analysis confirm that the concept of Fundamental Movement Skills represents one of the most influential approaches to understanding children's motor development. Its contribution lies in identifying basic movement actions that support the acquisition of more complex forms of motor activity, physical exercises, and sport-specific skills. Consequently, FMS have been widely regarded as the foundation of motor competence, physical literacy, and lifelong participation in physical activity (Stodden et al., 2008; Lubans et al., 2010; Robinson et al., 2015; Barnett et al., 2016; Hulteen et al., 2018).

At the same time, most contemporary FMS models describe the forms of motor activity rather than the mechanisms through which they emerge. Traditional approaches primarily focus on movement classification, age-related developmental characteristics, and skill assessment (Gallahue et al., 2012; Barnett et al., 2016). In contrast, the

question of how motor abilities, motor control mechanisms, sensory support systems, and motor experience are integrated during skill formation remains insufficiently addressed.

The proposed framework interprets fundamental movement skills not as the starting point of motor development but as a form of motor function development. This perspective shifts attention from the description of observable movement patterns to the analysis of the mechanisms underlying their formation. Within this framework, motor function is conceptualized as a functional system (Anokhin, 1975), whereas fundamental movement skills are viewed simultaneously as outcomes of the integration of its components and as mechanisms for accumulating motor experience.

The relationship among motor function, fundamental movement skills, and motor experience is therefore cyclical in nature. Motor function enables the formation of fundamental movement skills; acquired skills are accumulated within the structure of motor experience; and motor experience subsequently becomes a factor contributing to the further development of motor function and the emergence of more complex forms of motor activity.

Particular importance within the proposed framework is assigned to motor control as the central mechanism responsible for integrating the components of motor function. The present findings are consistent with theoretical and experimental evidence indicating that improvements in individual motor abilities do not automatically result in improved motor performance or higher-quality motor skills (Farfel, 1975; Khudolii & Kasian, 2011; Khudolii, Iermakov, & Bartik, 2020). Experimental studies have shown that the effectiveness of motor learning depends not only on functional preparedness but also on the organization of the learning process and its capacity to facilitate the development of motor control mechanisms (Khudolii, Iermakov, & Bartik, 2020). Within the proposed model, motor control is regarded as the system-forming component of motor function that integrates motor abilities, sensory support systems, and motor experience during motor task performance. In this context, the ability to differentiate the spatial, temporal, and force characteristics of movement serves both as an indicator of motor control development and as a prerequisite for the formation of variable motor skills adapted to changing activity conditions (Bernshtein, 1966; Khudolii, 2011).

An important feature of the proposed framework is the possibility of operationalizing motor function as an object of empirical investigation. Within this conceptualization, the state of motor function may be assessed through indicators reflecting motor control and its sensory support. Such indicators include the accuracy of reproducing spatial, temporal, and force characteristics of movement, the ability to differentiate these characteristics, measures of vestibular stability and sensitivity, and performance indicators that reflect the level of accumulated motor experience.

Additional support for the proposed framework is provided by studies examining the influence of theoretical learning models on the effectiveness of skill acquisition. These studies indicate that the theory of functional systems and the theory of movement construction make substantial contributions to the organization of effective learning processes. The effectiveness of learning depends not only on the content of motor tasks but also on the theoretical framework guiding the organization of instruction. Such findings suggest that motor skill acquisition is not simply the result of accumulating motor experience or developing individual motor abilities. Rather, it depends on the purposeful management of the integration of motor abilities, motor control mechanisms, sensory support systems, and motor experience. This interpretation is consistent with the present framework, according to which motor function development is a regulated process achieved through the programming of pedagogical interventions aimed at forming an integrated functional system whose outcome is the development of variable motor skills adapted to changing activity conditions (Khudolii, Iermakov, & Bartik, 2020).

The proposed framework also offers a new interpretation of the role of motor abilities in motor development. Traditional models frequently regard motor abilities as the direct basis for motor skill acquisition. The present findings suggest that motor abilities create the functional prerequisites for motor function development but acquire practical significance only through their integration into motor control systems and motor activity itself (Farfel, 1975; Bernshtein, 1966).

Another important implication concerns the role of programming in the learning process. If fundamental movement skills are interpreted as a form of motor function development, programming should be directed not toward the isolated development of individual abilities or skills but toward creating conditions for the integration of motor function components and the formation of variable motor skills adapted to activity conditions (Shlemin, 1973; Verkhoshanskii, 1988; Khudolii, 2011; Ivashchenko, 2020).

In summary, the concept of motor function expands the possibilities for interpreting fundamental movement skills by placing them within the broader context of motor development as an integrated functional process. Future research should focus on the empirical validation of the proposed model, the refinement of the structure of motor function, and the development of evidence-based technologies for its purposeful formation across different stages of ontogenesis.

Conclusions

The analysis of the evolution of scientific views on motor function demonstrated a transition from understanding motor function as a set of physiological mechanisms supporting movement to interpreting it as an integrative functional system responsible for the effective solution of motor tasks throughout learning and development.

Motor function is formed through the integration of motor abilities, motor control mechanisms, sensory support systems, and motor experience. Motor abilities create the functional prerequisites for motor function development but acquire practical significance only through their integration into motor activity.

Motor control occupies a central position within the structure of motor function. Its development proceeds from the accurate reproduction of spatial, temporal, and force parameters of movement to the differentiation of these characteristics according to task requirements and activity conditions.

Fundamental movement skills should be interpreted as a form of motor function development rather than as the initial foundation of motor development. Within the proposed framework, fundamental movement skills are both outcomes of the integration of motor function components and mechanisms for the accumulation of motor experience.

A conceptual model of motor function development was developed in which motor abilities create the prerequisites for the formation of motor control mechanisms, motor control enables the differentiation of movement characteristics, and this process ultimately leads to the formation of variable motor skills adapted to changing activity conditions.

Programming functions as the mechanism through which motor function is purposefully developed. By ensuring the integration of motor abilities, motor control mechanisms, sensory support systems, and motor experience, programming facilitates the formation of variable motor skills capable of supporting the effective solution of motor tasks in changing environments.

Ethics Approval

Ethical approval was not required for this study because it is a theoretical and conceptual analysis based on published scientific literature and does not involve human participants, animals, or the collection of personal data.

Informed Consent

Not applicable. This study did not involve human participants or the collection of personal data.

Data Availability Statement

No new data were created or analyzed in this study. Data sharing is not applicable to this article.

AI Transparency Statement

The authors used AI-assisted tools to support language editing, conceptual organization, and manuscript preparation. All intellectual content, theoretical interpretations, conclusions, and final manuscript revisions were developed and approved by the authors, who take full responsibility for the content of this publication.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Рухова функція як концептуальна основа інтерпретації фундаментальних рухових навичок

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 11 с., 1 табл., 24 джерел.

Мета. Обґрунтувати рухову функцію як функціональну систему розвитку рухової діяльності людини, визначити місце фундаментальних рухових навичок у її структурі та розробити концептуальну модель розвитку рухової функції.

Матеріал і методи. Дослідження має теоретико-методологічний характер і виконане у форматі концептуального наративного огляду. Методологічною основою стали положення концептуального аналізу та синтезу знань. Матеріалами дослідження були класичні та сучасні наукові праці, присвячені руховій функції, управлінню рухами, руховому розвитку, руховому навчанню та фундаментальним руховим навичкам. Використано методи історико-логічного аналізу, контент-аналізу наукових джерел, порівняльного аналізу, системного аналізу та концептуального моделювання.

Результати. Показано, що рухова функція є інтегративною функціональною системою, яка формується в процесі взаємодії рухових здібностей, механізмів управління рухами, сенсорного забезпечення та рухового досвіду. Обґрунтовано, що центральне місце в структурі рухової функції займає управління рухами, розвиток якого пов'язаний із переходом від точного відтворення до диференціювання просторових, часових і силових характеристик рухових дій. Запропоновано розглядати фундаментальні рухові навички не як вихідну основу рухового розвитку, а як форму розвитку рухової функції та механізм накопичення рухового досвіду. Розроблено концептуальну модель розвитку рухової функції та функціональну класифікацію фундаментальних рухових навичок, що включає стабілізацію, просторову орієнтацію, часову організацію рухів, управління рухами та адаптацію. Обґрунтовано програмування як механізм цілеспрямованого формування рухової функції.

Висновки. Рухова функція є системоутворюючим концептом рухового розвитку, який інтегрує рухові здібності, механізми управління рухами, сенсорне забезпечення та руховий досвід у процесі розв'язання рухових завдань. Фундаментальні рухові навички доцільно розглядати як форму розвитку рухової функції, а програмування — як механізм її цілеспрямованого формування. Запропонований підхід розширює пояснювальні можливості сучасних концепцій Fundamental Movement Skills, Motor Competence та Physical Literacy.

Ключові слова: рухова функція, фундаментальні рухові навички, руховий розвиток, управління рухами, руховий досвід, програмування, моторне навчання.

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