

The influence of exercises with a temporal structure of movements on the development of coordination abilities in primary school children

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ABSTRACT

Background. During the period of primary school age, there is a peak in the development of coordination abilities. The development and implementation of new exercise programs, the use of specialized devices and innovative methods is an urgent task for further improvement of coordination.

Aim. The aim is to evaluate the impact of exercises with a temporal structure of movements on the components of coordination abilities in primary school children.

Materials and methods. The participants of the experiment were children of primary school age (8–9 years old). The experiment consisted of two stages: a four-week one (classes were conducted according to the standard curriculum) and a six-week one, where participants performed a developed program of exercises with a time-based structure of movements on a coordination ladder. The organization of the two stages of the study included classes lasting 30 minutes with a frequency of 3 times a week. Two-time testing (T) was performed at the beginning (T1) and the end (T2) of the second stage. The following tests were used: "Shuttle running: 3×10 m", "Tandem walking", "Walking backwards", "Sensitized Romberg test". To determine the statistical significance of the differences between the indicators, the Student's t-test was chosen. The results were considered statistically significant at $p < 0.01$.

Results. Positive dynamics was revealed in all tests. A general and differentiated assessment of the results was carried out. The difference between the averages was: The test "Shuttle running: 3×10 m, s", T1 — 11.8 ± 0.5 and T2 — 10.1 ± 0.1 amounted to 13.4%; "Tandem walking, cm/s", T1 — 27.2 ± 2.3 and T2 — 30.1 ± 2.8 amounted to 9.6%, "Walking backwards, cm/s" T1 — 56.0 ± 2.2 and T2 63.9 ± 4.9 was 12.3%, "Sensitized Romberg sample, s" T1 — 17.1 ± 0.7 and T2 — 18.1 ± 0.8 amounted to 5.5%.

Conclusions. The results of the study confirm that exercises with a temporal structure of movements have a positive effect on the components of coordination abilities in children of primary school age. The differentiated effect of these exercises on dynamic and static coordination parameters has been established.

Keywords: primary school age, coordination abilities, tempo-rhythmic structure of movements, agility ladder

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Влияние упражнений с темпоритмовой структурой движений на развитие координационных способностей у детей младшего школьного возраста

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РЕЗЮМЕ

Актуальность. В период младшего школьного возраста наблюдается пик развития координационных способностей. Разработка и внедрение новых программ упражнений, использование специализированных устройств и инновационных методов представляется актуальной задачей для дальнейшего совершенствования координации.

Цель — провести оценку воздействия упражнений с темпоритмовой структурой движений на компоненты координационных способностей у детей младшего школьного возраста.

Материалы и методы. Участники эксперимента — дети младшего школьного возраста (8–9 лет). Эксперимент состоял из двух этапов: контрольный (4 недели, сентябрь) — занятия по стандартной учебной программе; экспериментальный (8 недель, октябрь–ноябрь) — программа с использованием упражнений с темпоритмовой структурой движений на координационной лестнице. Продолжительность занятия составляла 30 минут, частота — 3 раза в неделю. Тестирование проводилось дважды: на старте (Т1) и по завершении (Т2) второго этапа. Использованы тесты «Челночный бег 3×10 м», «Тандемная ходьба», «Ходьба спиной вперед», «Модифицированная проба Ромберга». Статистическая значимость различий оценивалась с использованием t-критерия Стьюдента для парных выборок при уровне значимости $p < 0,01$.

Результаты. По всем тестам зафиксирована положительная динамика. Проведена общая и дифференцированная оценка результатов. Разница между средними значениями: тест «Челночный бег 3×10 м, с» Т1 — $11,8 \pm 0,5$ с и Т2 — $10,1 \pm 0,1$ с, улучшение на 13,4%; «Тандемная ходьба» Т1 — $27,2 \pm 2,3$ см/с и Т2 — $30,1 \pm 2,8$ см/с, прирост 9,6%; «Ходьба спиной вперед, см/с» Т1 — $56,0 \pm 2,2$ см/с и Т2 — $63,9 \pm 4,9$ см/с, увеличение на 12,3%; «Модифицированная проба Ромберга» Т1 — $17,1 \pm 0,7$ с и Т2 $18,1 \pm 0,8$ с составила рост на 5,5%.

Выводы. Результаты исследования подтверждают, что упражнения с темпоритмовой структурой движений оказывают положительное воздействие на компоненты координационных способностей у детей младшего школьного возраста. Установлено дифференцированное влияние данных упражнений на динамические и статические параметры координации.

Ключевые слова: дети младшего школьного возраста, координационные способности, темпоритмовая структура движений, координационная лестница

Как цитировать

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BACKGROUND

In the context of modern education, school physical education classes play a key role in the development of motor abilities in primary school children [11].

Motor skills are fundamental elements of a child’s physical development. They determine a child’s ability to actively participate in a variety of activities and adapt to changing environmental conditions [3, 14, 17, 23].

Insufficient development of fundamental motor skills during childhood can lead to musculoskeletal disorders. This is due to the immaturity of the central nervous system, which is responsible for coordinating muscle activity and movement patterns [1, 7, 10, 16].

Coordination is the process of achieving coordinated muscle activity required to perform new motor actions. It represents a complex of abilities comprising three key components: precise control of the temporal, spatial, and dynamic parameters of movements; maintenance of static and dynamic balance; and the execution of motor actions with optimal muscular tension [19]. The sensitive period for the development of coordination abilities is between the ages of 6 and 12 years [8, 18]. During this period, improvements in the precision and expressiveness of children’s movements are observed.

Research on the development of coordination in primary school children within educational settings shows that physical education teachers employ various methods for selecting exercise programmes and instructing their implementation [3, 9, 13]. The authors emphasize the need to revise and optimize approaches to coordination training, utilizing innovative methods [2, 6, 15, 22].

Nevertheless, the level of coordination abilities achieved through specialized methods has not been sufficiently studied. An analysis of the literature indicates that the use of agility ladder exercises and me-

thods incorporating musical accompaniment for movements is rare in practice [4, 5, 12, 20, 21].

Addressing this gap, an exercise programme with a tempo-rhythmic structure of movements was developed and tested within this study. A key element was the use of agility ladder exercises combined with rhythmic music, in which the beat tempo was progressively increased.

AIM

The aim of this study was to evaluate the effects of exercises with a tempo-rhythmic movement structure on the components of coordination abilities in primary school children.

MATERIALS AND METHODS

The study was conducted in a secondary school in St. Petersburg equipped with a sports hall. In accordance with the principles of confidentiality, the name of the school and participants’ data were not disclosed. During the preparatory phase, meetings were held with parents and teachers to explain the aims, objectives, and procedures of the study.

The effectiveness of the programme was evaluated between September and December. The study involved 20 primary school children aged 8–9 years, including 10 boys and 10 girls. Participants were selected based on anthropometric data (Table 1) and baseline physical fitness test results (Table 2). The tests included the following exercises: sit-ups (number of repetitions per minute) and squats (number of repetitions per minute).

Statistical analysis revealed no significant differences between boys and girls in age, anthropometric parameters (height, body weight, body mass index, and foot length), or physical fitness indicators (less than 1%). On this basis, a single sample was formed without stratification by sex.

Table 1. Anthropometric indicators of the study participants based on testing results, M±m

Таблица 1. Антропометрические показатели участников исследования по результатам тестирования, M±m

Группа / Group	Возраст, мес / Age, mon	Рост, см / Height, cm	Масса тела, кг / Weight, kg	Индекс массы тела, кг/м ² / Body mass index, kg/m ²	Длина стопы, см / Foot length, cm
Мальчики / Boys (n=10)	98,2±4,2	129,7±3,7	27,8±2,4	16,2±0,2	22,4±0,8
Девочки / Girls (n=10)	99,8±4,8	128,0±4,4	27,4±1,9	16,5±0,6	21,8±0,9

Table 2. Physical indicators of participants according to testing results, M±m

Таблица 2. Физические показатели участников по результатам тестирования, M±m

Группа / Group	Поднимание туловища за 30 с / Sit-ups (30 s)	Приседания за 1 мин / Squats (1 min)
Мальчики / Boys (n=10)	13,3±0,5	30,8±0,7
Девочки / Girls (n=10)	14,5±0,7	31,1±0,8

Table 3. Parameters of the organization and content of the control and experimental stages of the pedagogical experiment**Таблица 3.** Параметры организации и содержания контрольного и экспериментального этапов педагогического эксперимента

Параметр / Parameter	Контрольный этап / Control phase	Экспериментальный этап / Experimental phase
Период / Period	Сентябрь / September	Октябрь, ноябрь / October, November
Продолжительность / Duration	4 недели / 4 weeks	8 недель / 8 weeks
Содержание / Program content	Стандартная программа / Standard curriculum	Упражнения с темпоритмической структурой движений / Tempo-rhythmic exercises
Оборудование / Equipment	Базовое спортивное оборудование / Basic sports equipment	Координационная лестница / Agility ladder

The study was conducted in two stages (Table 3). During the first stage (4 weeks), the standard physical education curriculum for second-grade students was implemented¹. This programme was aimed at developing fundamental motor skills and physical qualities, including coordination abilities. The main directions for coordination development were developing spatial orientation, improving rhythm perception, training static and dynamic balance, and refining movement differentiation.

The study was conducted in two stages (Table 3). During the first stage (4 weeks), the standard physical education curriculum for second-grade students was implemented¹. This programme was aimed at developing fundamental motor skills and physical qualities, including coordination abilities. The main directions for coordination development were developing spatial orientation, improving rhythm perception, training static and dynamic balance, and refining movement differentiation.

The second stage of the study, lasting 8 weeks, involved the implementation of the developed exercise programme. The methodology included exercises using an agility ladder with the following dimensions: length (L) — 4 m and width (W) — 50 cm.

Three main types of movements were performed on the agility ladder: walking, running, and jumping. The sessions were conducted to rhythmic music at a tempo of 96–112 bpm. The tempo-rhythmic structure of the exercises allowed for individual adjustments to movement technique based on the participants' abilities.

The following standardised tests were used to assess coordination abilities.

1. "Shuttle run 3×10 m". This test assessed dynamic coordination. It involved repeated covering of the distance with changes of direction; the results were recorded in seconds.

2. "Tandem walking". This test was used to assess gait function with complex coordination. Participants walked 5 m along a straight line, placing one foot in a heel-to-toe position; the results were recorded in cm/s.

3. "Backward walking". This test was used to assess mobility and balance maintenance. Participants walked backwards along a line while looking over the right shoulder in the direction of movement; the results were recorded in cm/s.

4. "Modified Romberg test". This test is an indicator of static coordination. Participants assumed a tandem stance (heel-to-toe position) with their arms crossed on the chest; the maximum time for maintaining the position is recorded.

During the study, participants performed the tests. Testing began with a practice attempt, followed by repeated trials until a satisfactory (verifiable) result was achieved. The dynamics of coordination ability development were analysed and expressed as percentages. The results of the "Shuttle run 3×10 m" and "Modified Romberg test" were compared with normative reference values for children aged 6–7 years based on monitoring data². Statistical processing was performed using SPSS 16.0. The paired-sample t-test was used to assess the statistical significance of differences. The level of statistical significance was set at $p < 0.01$.

RESULTS

A comparative analysis of the results was conducted to evaluate the effectiveness of training programme: baseline measurements (T1) were compared with those obtained after the 8-week course of sessions (T2) (Table 4). The programme consisted of exercises with a tempo-rhythmic movement structure performed on an agility ladder and accompanied by music with a progressively increasing tempo.

A comparative analysis of the control exercise results revealed a statistically significant improvement in the participants' physical performance. In the

¹ Work Programme for the Academic Subject «Physical Education» for Grades 1–4 of Primary General Education for the 2023–2024 Academic Year. Available at: <https://co8a.ru/wp-content/uploads/2023/08/1-1.pdf> (accessed: 08.02.2025).

² Educational Social Network. Normative Indicators for Monitoring. Available at: <https://nsportal.ru/shkola/raznoe/library/2016/03/15/normativy-pokazateley-monitoringa> (accessed: 08.02.2025).

Table 4. Dynamics parameters of physical fitness and coordination abilities in the subjects before (T1) and after (T2) the experiment, $M \pm m$ **Таблица 4.** Динамика показателей физической подготовленности и координационных способностей у испытуемых до (T1) и после (T2) эксперимента, $M \pm m$

Показатели / Parameters	T1 (n=20)	T2 (n=20)
Упражнения / Exercise		
Подъем туловища (раз/мин) / Sit-ups (count/min)	21,3 $\pm$ 1,5	24,2 $\pm$ 1,1*
Приседания (раз/мин) / Squats (count/min)	35,8 $\pm$ 2,8	38,5 $\pm$ 1,9*
Тесты / Tests		
Челночный бег 3 $\times$ 10 м, с / Shuttle run 3 $\times$ 10 m, s	11,8 $\pm$ 0,5	10,1 $\pm$ 0,1*
Тандемная ходьба, см/с / Tandem walk, cm/s	27,2 $\pm$ 2,3	30,1 $\pm$ 2,8*
Ходьба спиной вперед, см/с / Backward walk, cm/s	56,0 $\pm$ 2,2	63,9 $\pm$ 4,9*
Тест «Модифицированная проба Ромберга», с / Modified Romberg Test, s	17,1 $\pm$ 0,7	18,1 $\pm$ 0,8*

* Differences are significant at the level of significance ($p < 0,001$).* Различия достоверны на уровне значимости ($p < 0,001$).

“sit-ups” test, the mean number of repetitions increased by 3 (+11.9%). Similar dynamics were observed in the “squats” exercise, where the number of repetitions increased by a mean of 3 (+7.1%).

The results of the “shuttle run 3 $\times$ 10 m” test showed a 13.4% improvement compared with baseline data. This corresponded to a 1-point increase on a 3-to-4-point scale.

Analysis of data from the “tandem walking”, “backward walking”, and “modified Romberg test” revealed positive dynamics across all results. The mean speed in the “tandem walking” and “backward walking” tests increased by 9.6 and 12.3%, respectively. The difference between the results of the “modified Romberg test” was 5.5%, which also corresponds to a 1-point increase from 3 to 4.

A comparative analysis of the changes observed across the four coordination ability tests revealed specific patterns. The use of exercises with a tempo-rhythmic movement structure using the agility ladder had a pronounced effect on the development of dynamic coordination. This is supported by the greatest improvements being observed in the “shuttle run” test (a 1.7-second decrease in time) and the “backward walking” test (a 2.9 cm/s increase in speed), indicating a significant enhancement of motor adaptation ability.

CONCLUSION

The results of the study confirm the effectiveness of tempo-rhythmic exercises in the development of coordination abilities in primary school children ($p < 0.001$). However, differential patterns of improvement were observed depending on the type of motor task.

The observed increase in the number of repetitions in the sit-ups and squats exercises may be associated with the development of endurance under the

influence of the increasing tempo of the agility ladder exercises. The greatest progress was observed in tests assessing dynamic coordination and motor control (shuttle run 3 $\times$ 10 m and backward walking). This result is presumably a consequence of synchronising cyclic movements with the musical tempo. The improvement in the tandem walking and modified Romberg test results was less pronounced, as the skills assessed require a high level of precision and static stability. These parameters of motor control, unlike cyclic movements, develop more slowly and are less responsive to musical rhythm.

Thus, exercises with a tempo-rhythmic movement structure contribute to the development of coordination abilities by improving both complex coordinated movements (reaction time and movement speed) and static parameters (movement precision and postural maintenance). This conclusion is supported by the test results obtained from primary school children in this study.

ADDITIONAL INFORMATION

Authors' contribution. All the authors made a significant contribution to the development of the concept, research and preparation of the article, read and approved the final version before publication.

Competing interests. The authors declare the absence of obvious and potential conflicts of interest related to the publication of this article.

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