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Early Gains in Motor Learning Measured Through Two Coordination Tests: A Retrospective Analysis of Gender Differences

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Abstract

Motor skills can be improved through rapid on-the-job training or slower multi-session learning. The objective of this study was to determine the rapid learning differences between male and female university students during the execution of two motor coordination tests. Available data from 716 female and 331 male college students were retrospectively analyzed. The female participants had a mean age (±SD) of 19.6 (±1.55) years, while the male participants recorded a mean age of 19.8 (±1.87) years. Data were collected using two motor coordination tests, each performed in triplicate. The statistical method used in this analysis was mixed-model ANOVA. The interaction effect of gender and number of attempts was statistically significant for both motor coordination tests ($F=12.446$; $p<0.01$; $\eta^2p=0.13$ & $F=11.169$; $p<0.01$; $\eta^2p=0.01$). Post-hoc testing showed that males performed better at the tasks in all three runs, and both genders improved their performance in subsequent trials. However, females showed a larger relative improvement from trial to trial than did males. The two coordination tests yield similar results. The observed differences in improvements in the coordination tests may be attributed to different motor learning strategies and cognitive processing between the sexes.

Keywords: *motor adaptation, gross motor ability, neuroplasticity*

Introduction

Motor learning is defined as a set of processes associated with practice that leads to relatively permanent changes in the capability for motor response (Schmidt, 1988). Acquiring new motor skills necessitates learning the process, which is associated with the activity of different brain regions, and having the ability to transfer accomplished movements to new conditions and task variants (Seidler, 2010). Such a hierarchical organization of motor control means that no movement is performed in a completely identical manner (Profeta & Turvey, 2018). Outcomes of the motor learning process can be derived from the progress, stability, consistency, and adaptability observed in motor performance. When motor performance embodies all these qualities, it exhibits the characteristics of a well-honed motor skill (Magill & Anderson, 2013). Coordination, which rests at the core of every movement, is a complex, multistructural, and qualitative motor ability. It is influenced by the mechanism for the regulation of movement, that is, its subordinate mechanism for structuring movement, and it permeates almost all motor abilities (Bruton & O'Dwyer, 2018). A high level of coordination allows movements to be controlled and adjusted in real-time to meet performance goals, and it is achieved by triggering a motor program developed based on previously assimilated abilities (Iorga, Jianu, Gheorghiu, Crețu, & Eremia, 2023). The more developed coordination a person has, the better and more successful he will be in sequencing movements or actions, i.e., his ability of motor planning will be at a higher level, which will then help solve motor tasks or problems (Kimura, Yokozawa, & Ozaki, 2021). Some of the factors influencing the acquisition of new motor skills include: 1) relevant prior knowledge and skills; 2) attentiveness, concentration, and distractibility; 3) interests and acquired pref-

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erences; 4) motivation and competitiveness; 5) self-confidence and optimism; 6) other aspects of temperament and personality; 7) enthusiasm and energy level; 8) fatigue and anxiety (Howe, Davidson, & Sloboda, 1998).

Differences in coordination between genders are noticeable from early childhood (Adriyani, Iskandar, & Camelia, 2020; Morley, Till, Ogilvie, & Turner, 2015). Males outperform females in fundamental motor skills during young adulthood (Díaz, Rojas, & Morera, 2015). Movements involving precision, which require coordination, are more strongly genetically determined in women, whereas movements involving strength and speed are more genetically determined in men (Iorga et al., 2023). Significant differences between men and women were found in accuracy (Moreno-Briseño, Díaz, Campos-Romo, & Fernandez-Ruiz, 2010), but there were no significant differences in the phase of adaptation between the sexes. This suggests that learning mechanisms may contribute differently in men and women. Motor learning consists of two types. Fast learning is defined as motor knowledge acquired through a single training session or activity, whereas slow motor learning is achieved through consecutive training sessions over time (Costa, Cohen, & Nicolelis, 2004). A recent systematic review highlighted the need for research on motor skill acquisition to develop new strategies for motor learning (Newell, 2020). Sex-based differences in motor skills have been the subject of numerous studies (Díaz et al., 2015; Gromeier, Koester, & Schack, 2017; Kokštejn, Musalek, & Tufano, 2017; Dinkel & Snyder, 2020; Zheng, Ye, Korivi, Liu, & Hong, 2022), however the nuances of fast motor learning, especially among young adults, remain relatively unexplored. Many studies have concentrated on preschool or school children, focusing on motor skill differences but not specifically on the rapid acquisition of these skills. While differences in both gross and fine motor skills have been identified (Rodrigues, Ribeiro, Barros, Lopes, & Sousa, 2019), scant evidence on how minor disparities in childhood may influence the acquisition of motor skills in young adulthood. For such a population, it is essential to account for both biological and environmental differences, the latter stemming from diverse societal expectations for boys and girls. Furthermore, a significant portion of existing research does not clearly distinguish between fast and slow motor learning, often broadening its scope to include a range of age groups. The importance of understanding fast motor learning becomes evident when considering its applications in athletic training, rehabilitation, or daily activities requiring swift adaptability. This is particularly relevant for young adults, such as university students, who frequently face new motor challenges. However, empirical insights on gender-specific teaching methodologies for this age group are limited. Addressing this gap, this study delves into the differences in fast motor learning between male and female university students. The goal is to inform about how motor skills are taught across genders, while also investigating the inherent neuromotor differences. If there are neuromotor differences in fast motor acquisition between sexes, such differences could have exists an impact on how males and females are taught motor skills to accommodate different strategies. This study explored the sex-based differences in coordination improvement using repeated motor tests. It operates on the premise that the repeated administration of these tests, typically three times, triggers short-term motor learning, subsequently affecting test scores by influencing their improvement rates. Therefore, the main goal of this study was to determine the fast-learning differences between male and female university students when performing two motor coordination tests.

Methods

Participants

This study was conducted retrospectively using motor coordination test data routinely collected during physical education classes at the university level over the period of ten years. The results of two tests measuring motor skills (crawling and jumping over obstacles and the backward polygon test) were processed to determine whether there was a sex difference in polygon performance speed in each attempt depending on gender.

The sample consisted of 716 female and 331 male first-year physiotherapy students. The mean age (±SD) for the female participants was 19.6 (±1.55) years, while for the male participants, the mean age was 19.8 (±1.87) years. The use of retrospective data was reviewed and approved by the Ethics Committee of the university where the data were collected (KL:602-03/22-18/386; URBR:251-379-10-22-02). Mean male and female participants' height was 181.33 (±7.04) and 165.87 (±17.0) cm respectively, while average mass was 80.5 (±13.3) and 62.6 (±12.7) kg, respectively. Participants with physical or mental disabilities that could potentially influence the test results were excluded. Students who were professional athletes were excluded from the study.

Procedure

Before any of the tests, the students warmed up properly and a demonstration of both tests was provided. Two experienced researchers, a kinesiologist and physiotherapist, conducted the tests. A hand stopwatch was used to monitor test timing. Two standardized coordination tests used in student population at elementary, high school and university levels with high levels of reliability, homogeneity and sensitivity were conducted – MBKPOP (crawling and jumping over obstacles) and MREPOL (backwards polygon test) (Neljak, Sporiš, Višković, & Markuš, 2012). The values of the test reliability level are satisfactory under the assumption that the reliability of 0.90 is satisfactory (Hopkins, 2000).

Measurements

The first test (MBKPOP) consisted of four obstacles spaced equidistantly at a distance of 10 m. The participants were required to jump over the 1st and the 3rd obstacle, crawl under the 2nd and the 4th obstacle, turn back, and then jump over and crawl back to the starting line.

The second test (MREPOL) consisted of two obstacles, the 1st one at 3 m and the 2nd one at 6 m from the starting point. The participants had to scuttle backward with their hands and feet, move across the 1st obstacle and under the 2nd obstacle, and then scuttle back 3 m to the finish line. The goal of both tests was to run an obstacle course as quickly as possible.

The participants performed both tests three times; they were given verbal instructions and visual demonstrations but were not permitted a trial run. The participants had 5 min between test attempts to rest.

Statistical analysis

Before proceeding with formal statistical analysis, the assumptions of normality of residuals, homoscedasticity, sphericity, and absence of extreme outliers were verified. A mixed-model ANOVA was used to examine differences in coordination. After analysis of the interaction model, post-hoc paired sample t-tests were conducted to compare test attempts segregated by sex. To quantify the effect size, both the partial eta-squared and Cohen's d tests were used. Cohen's guidelines were used to interpret effect size (Cohen, 1988). Bootstrapping was used to simulate a 95% confidence interval for Cohen's d. To adjust for possible type I error inflation, the Benjamini-Hochberg correction was applied to p values (Benjamini & Hochberg, 1995). The probability of a type I error was set at 5% (p<0.05). All analyses were performed using R statistical software, version 4.2.1 developed by R Core Team and the R Foundation for Statistical Computing.

Results

Table 1 presents the data from both motor coordination tests for all three attempts in both sexes. The MBKPOP test was performed on 662 females and 316 males, and the MREPOL test was performed on 716 females and 331 males. This difference in test sample size was due to erroneous testing and time constraints. A mixed-model ANOVA (Table 2) showed a significant interaction between gender and test attempts (Figure 1 and 2). According to the partial eta-squared statistic, the effect size was medium (η^2p=0.13) for the MBKPOP test and

Table 1. Descriptive statistics of coordination tests

Variables	$\bar{x}$	SD	Min	Max	n
Females					
MBKPOP 1	19.24	3.85	8.25	32.8	662
MBKPOP 2	17.53	3.41	8.63	32.05	
MBKPOP 3	17.04	3.48	9.05	30.06	
MREPOL 1	12.58	2.76	6.55	22	716
MREPOL 2	11.68	2.47	6.1	21.5	
MREPOL 3	11.42	2.36	6.37	19.78	
Males					
MBKPOP 1	15.88	2.9	9.08	27.4	316
MBKPOP 2	14.65	2.87	9.22	25.6	
MBKPOP 3	14.25	2.98	7.64	24.2	
MREPOL 1	9.3	1.86	5.92	15.02	331
MREPOL 2	8.69	1.77	5.43	16.23	
MREPOL 3	8.52	1.74	8.33	14	

Note. MBKPOP: crawling and jumping over obstacles; MREPOL: backward polygon test. x: mean; SD: standard deviation; n: sample size

Table 2. Mixed-model ANOVA

	Test attempt			Gender			Interaction		
	F	p	η^2p	F	p	η^2p	F	p	η^2p
MBKPOP	453.42	<0.01†	0.317	190.96	<0.01†	0.164	12.446	<0.01†	0.13
MREPOL	246.29	<0.01†	0.189	450.56	<0.01†	0.302	11.169	<0.01†	0.01

Note. MBKPOP: crawling and jumping over obstacles; MREPOL: backward polygon test. F: F ratio; η2p: partial eta squared (effect size); †p < 0.05

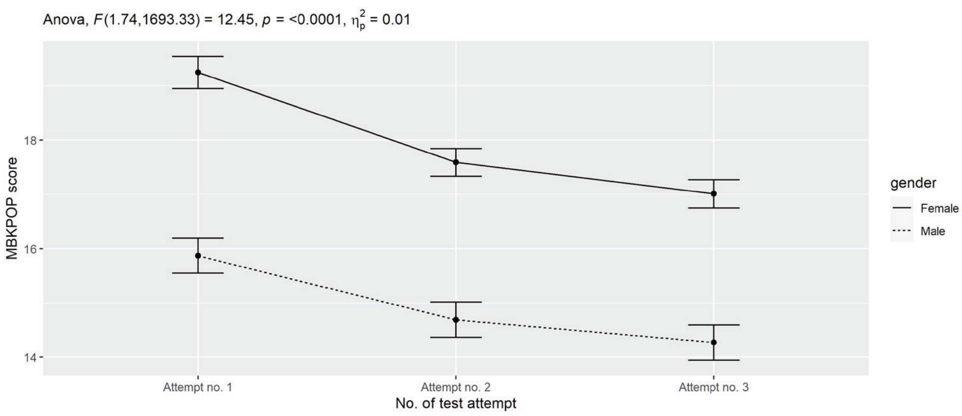

FIGURE 1. Interaction plot of MBKPOP (crawling and jumping over obstacles) motor test
Note: Error bars represent 95% confidence intervals; F: F ratio; η^2p: partial eta squared (effect size)

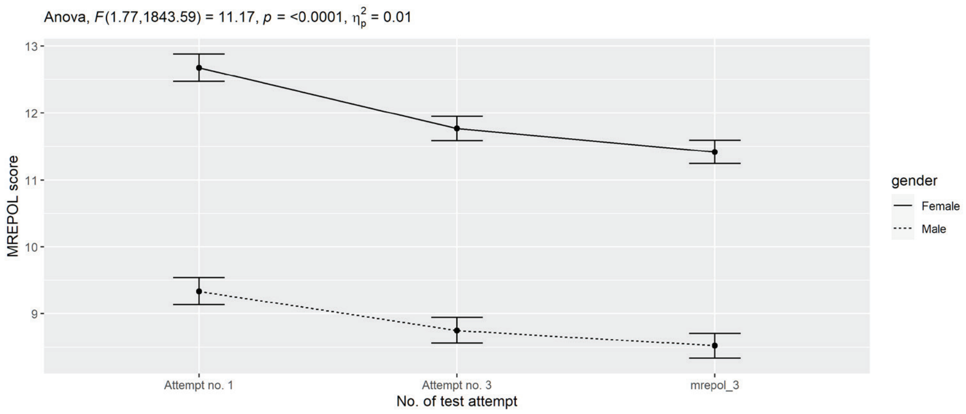

FIGURE 2. Interaction plot of MREPOL (backwards polygon test) motor test
Note: Error bars represent 95% confidence intervals; F: F ratio; η^2p: partial eta squared (effect size)

small (η^2p=0.01) for the MREPOL test. Post-hoc paired t-tests (Table 3) showed that female and male participants improved the MBKPOP and MREPOL test scores in subsequent tests.

For females, Cohen's d showed that the effect size of the difference between the first and second MBKPOP tests was large (d=0.86), and the difference between the second and third tests was small (d=0.36). The effect size of the difference between the first and second MREPOL tests was medium (d=0.57) and the difference between the second and third tests was small (d=0.30), similar to the previous test.

Table 3. Post-hoc paired t-test

	Female				Male			
	t	p	d	95% CI	t	p	d	95% CI
MBKPOP 1-2	22.0	<0.01†	0.857	0.76; 0.95	12.4	<0.01†	0.7	0.55; 0.88
MBKPOP 2-3	9.35	<0.01†	0.364	0.28; 0.45	4.41	<0.01†	0.249	0.13; 0.4
MREPOL 1-2	15.3	<0.01†	0.571	0.5; 0.66	8.43	<0.01†	0.464	0.33; 0.61
MREPOL 2-3	7.88	<0.01†	0.295	0.22; 0.37	3.52	<0.01†	0.194	0.09; 0.3

Note. MBKPOP: crawling and jumping over obstacles; MREPOL: backward polygon test. t: t – statistic; d: Cohen's d (effect size); 95% CI:95% confidence interval; †p< 0.05

For males, the effect size between the first and second MBKPOP tests was medium (d=0.70), and the difference between the second and third tests was small (d=0.25). The effect size of the difference between the first and second tests was medium (d=0.46), and the difference between the second and third tests was virtually negligible (d=0.19).

Discussion

This study demonstrated a sex-based difference in the progression of test scores; males showed greater progress between the first and second measurements, whereas females displayed consistent progress across all three measurements.

The initial phase of motor skill learning typically develops quickly across various experimental procedures and then slows as additional demands are placed in subsequent sessions. This pattern has also been observed in children older than 10 years who begin displaying adult-like learning patterns (Adi-Japha, Berke, Shaya, & Julius, 2019). Motor learning is largely driven by practice, and the acquisition of new skills is reflected in novel combinations of muscle activation that improve performance. The absence of performance improvement through repetition indicates the retention phase of motor skills (Constantino Coledam, 2020). Adapting to a new motor task requires appropriate actions in response to incoming information, such as the environment (e.g., a moving target) or sensor inputs from the body. Bianco et al. (Bianco et al., 2020) suggested that females tend to favor cautious cognitive processing, while males lean towards a more reactive and faster cognitive process.

From this perspective, it can be inferred that men employed their existing motor skills and capabilities to perform optimally during their initial attempts, leaving minimal room for substantial progress in subsequent measurements. In contrast, female participants approached the tests more cautiously, relying on learning from each run, thereby achieving relatively more improvements across runs.

There is little experimental data concerning the differences in motor learning between genders especially in young adult population. One study comparing children aged 7 and 8 years old using Movement Assessment Battery for Children Test found difference in acquisition of motor skills in subtest scores concerning manual dexterity and ball skills but no difference in total impairment and balance scores (Junaid & Fellowes, 2006). Another study comparing adults averagely aged 39.2 (SD=13.5) found expected difference in throwing accuracy between genders, no difference in adaptation to constraints imposed by the researchers, but it showed that women had retained larger after effects adaptation after experimental constraints were removed, indicating that females exhibit a deeper internal recalibration of their motor-visual relationship in this specific task (Moreno-Briseño et al., 2010). With regards to our study this implies that while men might have an initial performance advantage due to factors like strength or prior exposure, women seem to exhibit a faster rate of improvement, possibly due to a combination of deeper cognitive engagement, a propensity towards spatial alignment in motor learning, and the specific demands of the coordination tests. This difference in learning strategy and adaptation showcases the importance of individualized training approaches and the potential to harness these inherent strengths across genders.

There are more studies examining gender differences in coordination in general, but they have mixed results. For instance, (Lyakh, 2021) in a study comparing 90 parameters of motor coordination, found negligible sex differences in most of the parameters among kickboxing and taekwondo athletes aged 18-27 years. However, Stelmach et al. (Stelmach, Rydzik, & Ambroży, 2020) found that male swimmers aged 14-16 years demonstrated higher coordination efficiency than their female counterparts. The findings of the current study revealed significant differences in the coordination tests between male and female students, echoing the results of Stelmach et al.'s study, although their focus was on adolescents. It is posited that physiological factors such as strength and training years could contribute to higher coordination efficiency in males than in females. This study draws a comparison with a student group aged 9-10 years, considering the absence of similar studies on young individuals.

This study offers a unique contribution to the assessment of the student population by bridging the gap in existing studies. Variations in repeated motor task approaches are likely best elucidated by neuromotor and physiological differences, as supported by research conducted by (Roivainen, Suokas, & Saari, 2021).

Limitations and future recommendations

It was challenging to ascertain bias in this research based on the timing of data collection. Nonetheless, the findings will undoubtedly contribute to a better understanding of the sex-based differences in coordination between students. However, it is crucial to recognize the inherent limitations of this study. Considering the results of previous research, anthropometric characteristics, and data on prior involvement in any form of nonprofessional athletic activities of students were not included in this research. In future research, it would be beneficial to consider the anthropometric measurements of participants and their previous participation in athletic activities. Future research should include more tests that cover coordination and retention measurements and additional tests that indicate changes in movement efficiency, such as the analysis of oxygen consumption, heart rate, or muscle activity. In addition, a lack of age-appropriate tasks was noticed, which warrants designing age-appropriate tasks. It is also suggested that participants be given a brief questionnaire as a manipulation check, which would help assess their comprehensive understanding of the coordination task, level of focus during the performance, emotional state (e.g., potential fear of increasing speed), and overall motivation.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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References:

Adi-Japha, E., Berke, R., Shaya, N., & Julius, M. S. (2019). Different post-training processes in children's and adults' motor skill learning. *PLOS ONE*, *14*(1), e0210658. https://doi.org/10.1371/journal.pone.0210658

Adriyani, R., Iskandar, D., & Camelia, L. S. (2020, February 19). *Gender Differences in Motor Coordination and Physical Activity*, 122–126. Atlantis Press. https://doi.org/10.2991/ahsr.k.200214.034

Benjamini, Y., & Hochberg, Y. (1995). Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society. Series B (Methodological)*, *57*(1), 289–300. JSTOR. Retrieved from JSTOR.

Bianco, V., Berchicci, M., Quinzi, F., Perri, R. L., Spinelli, D., & Di Russo, F. (2020). Females are more proactive, males are more reactive: Neural basis of the gender-related speed/accuracy trade-off in visuo-motor tasks. *Brain Structure & Function*, *225*(1), 187–201. https://doi.org/10.1007/s00429-019-01998-3

Bruton, M., & O'Dwyer, N. (2018). Synergies in coordination: A comprehensive overview of neural, computational, and behavioral approaches. *Journal of Neurophysiology*, *120*(6), 2761–2774. https://doi.org/10.1152/jn.00052.2018

Constantino Coledam, D. (2020). Assessment of physical fitness among non-athlete adolescents: Effect of familiarization sessions article details. *Baltic Journal of Health and Physical Activity*, *12*, 47–57. https://doi.org/10.29359/BJHPA.12.4.05

Costa, R. M., Cohen, D., & Nicolelis, M. A. L. (2004). Differential corticostriatal plasticity during fast and slow motor skill learning in mice. *Current Biology: CB*, *14*(13), 1124–1134. https://doi.org/10.1016/j.cub.2004.06.053

Díaz, J. J., Rojas, W. S., & Morera, M. (2015). Age and gender differences in fundamental motor skills (original version in English). *Pensar en Movimiento: Revista de Ciencias del Ejercicio y la Salud*, *13*(2), 1–16. https://doi.org/10.15517/pensarmov.v13i2.18327

Dinkel, D., & Snyder, K. (2020). Exploring gender differences in infant motor development related to parent's promotion of play. *Infant Behavior and Development*, *59*, 101440. https://doi.org/10.1016/j.infbeh.2020.101440

Gromeier, M., Koester, D., & Schack, T. (2017). Gender Differences in Motor Skills of the Overarm Throw. *Frontiers in Psychology*, *8*. Retrieved from https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00212

Hopkins, W. G. (2000). Measures of reliability in sports medicine and science. *Sports Medicine (Auckland, N.Z.)*, *30*(1), 1–15. https://doi.org/10.2165/00007256-200030010-00001

Howe, M. J. A., Davidson, J. W., & Sloboda, J. A. (1998). Innate talents: Reality or myth? *Behavioral and Brain Sciences*, *21*(3), 399–407. https://doi.org/10.1017/S0140525X9800123X

Iorga, A., Jianu, A., Gheorghiu, M., Crețu, B. D., & Eremia, I.-A. (2023). Motor Coordination and Its Importance in Practicing Performance Movement. *Sustainability*, *15*(7), 5812. https://doi.org/10.3390/su15075812

Junaid, K. A., & Fellowes, S. (2006). Gender Differences in the Attainment of Motor Skills on the Movement Assessment Battery for Children. *Physical & Occupational Therapy In Pediatrics*, *26*(1–2), 5–11. https://doi.org/10.1080/J006v26n01_02

Kimura, A., Yokozawa, T., & Ozaki, H. (2021). Clarifying the Biomechanical Concept of Coordination Through Comparison With Coordination in Motor Control. *Frontiers in Sports and Active Living*, *3*. Retrieved from https://www.frontiersin.org/article/10.3389/fspor.2021.753062

Kokštejn, J., Musalek, M., & Tufano, J. (2017). Are sex differences in fundamental motor skills uniform throughout the entire preschool period? *PLoS ONE*, *12*. https://doi.org/10.1371/journal.pone.0176556

Lyakh, V. (2021). Differences in the level of development and proficiency in coordination motor abilities among female and male athletes of selected combat sports. *Journal of Kinesiology and Exercise Sciences*, *31*, 11–23. https://doi.org/10.5604/01.3001.0015.7373

Magill, R., & Anderson, D. (2013). *Motor Learning and Control: Concepts and Applications* (10th edition). New York, NY: McGraw-Hill Education.

Moreno-Briseño, P., Díaz, R., Campos-Romo, A., & Fernandez-Ruiz, J. (2010). Sex-related differences in motor learning and performance. *Behavioral and Brain Functions*, *6*(1), 74. https://doi.org/10.1186/1744-9081-6-74

Morley, D., Till, K., Ogilvie, P., & Turner, G. (2015). Influences of gender and socioeconomic status on the motor proficiency of children in the UK. *Human Movement Science*, *44*, 150–156. https://doi.org/10.1016/j.humov.2015.08.022

Neljak, B., Sporiš, G., Višković, S., & Markuš, D. (2012). *Cro-fit norme*. Retrieved from https://www.bib.irb.hr/578943

Newell, K. M. (2020). What are Fundamental Motor Skills and What is Fundamental About Them? *Journal of Motor Learning and Development*, *8*(2), 280–314. https://doi.org/10.1123/jmld.2020-0013

Profeta, V. L. S., & Turvey, M. T. (2018). Bernstein's levels of movement construction: A contemporary perspective. *Human Movement Science*, *57*, 111–133. https://doi.org/10.1016/j.humov.2017.11.013

Rodrigues, P., Ribeiro, M., Barros, R., Lopes, S., & Sousa, A. (2019). Performance on the movement assessment battery for children: A systematic review about gender differences. *RICYDE. Revista Internacional de Ciencias Del Deporte*, *XV*(55), 72–87.

Roivainen, E., Suokas, F., & Saari, A. (2021). An examination of factors that may contribute to gender differences in psychomotor processing speed. *BMC Psychology*, *9*(1), 190. https://doi.org/10.1186/s40359-021-00698-0

Schmidt, R. A. (1988). *Motor control and learning: A behavioral emphasis, 2nd ed* (pp. xi, 578). Champaign, IL, England: Human Kinetics Publishers.

Seidler, R. D. (2010). Neural Correlates of Motor Learning, Transfer of Learning, and Learning to Learn. *Exercise and Sport Sciences Reviews*, *38*(1), 3. https://doi.org/10.1097/JES.0b013e3181c5cce7

Stelmach, P., Rydzik, Ł., & Ambroży, T. (2020). Sexual dimorphism in the level of special coordination ability of swimmers of the Sports Championships Schools. *Journal of Human Sport and Exercise*, *17*. https://doi.org/10.14198/jhse.2022.171.13

Zheng, Y., Ye, W., Korivi, M., Liu, Y., & Hong, F. (2022). Gender Differences in Fundamental Motor Skills Proficiency in Children Aged 3–6 Years: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *19*(14), 8318. https://doi.org/10.3390/ijerph19148318