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YOGA PRACTICES AND PSYCHOMOTOR COORDINATION IN SCHOOL-GOING STUDENTS: A NARRATIVE REVIEW OF REACTION TIME AND STEADINESS

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ABSTRACT

Background: *Psychomotor coordination is important for children to develop, to do tasks like sports, educational performance, and functional daily activities. The reaction time and steadiness are two crucial parameters of neuromuscular efficiency, sensorimotor integration, and cognitive processing.*

Objective: *This narrative review aims to review the effects of yoga practices on reaction time and steadiness among school-going students.*

Methods: *A narrative review was performed using published literature from major electronic databases. Research contained evidence from school-going children and adolescents was included. Study focused on yoga interventions, including asanas, pranayama, meditation, relaxation, and Surya Namaskar. Various data about reaction time, equilibrium, balance, eye-hand coordination, and muscle performance-related ability were critically examined and integrated.*

Results: *The literature surveyed in the above study reveals that repeated practice of yoga helps improve reaction time, steadiness, static and dynamic balance, eye-hand coordination, and psychomotor performance. Benefits seem associated with better neuromuscular co-ordination, proprioceptive awareness, autonomic regulation, attentional control, and sensorimotor integration. Programs that integrate yoga techniques often achieve greater results than isolated techniques. Nevertheless, the available evidence is constrained by the different intervention protocols employed, small sample sizes, short duration of interventions, and limited follow-up in the long term.*

Conclusion: *The practice of Yoga is a safe, cost-effective, and practical intervention for enhancing psychomotor coordination of school-aged children. The inclusion of structured programs in schools may improve motor, cognitive functioning, and overall well-being. There is a requirement for future multicentre randomized controlled trials that involve the use of standardized yoga protocols and objective psychomotor assessments.*

KEYWORDS: *Yoga, Psychomotor Coordination, Reaction Time, Steadiness, School-going Students, Balance, Neuromuscular Coordination, Physical Education.*

1. INTRODUCTION

During the stages of childhood and adolescence, the nervous, musculoskeletal, and sensory systems all develop rapidly. This development facilitates the acquisition of psychomotor abilities needed to participate in school work, sports, daily functioning, and socialising. The ability to learn motor skills through practice is called psychomotor ability. The coordinated execution of movement in response to sensory input involving cognitive processing and muscular response is called Psychomotor skills (Kaufman et al., 1987; Schmidt & Wrisberg, 2000; Changiz et al., 2021). The ability to master oneself from a particular action has been defined as a psychomotor ability. Even though it has an innate basis, the newly emerging evidence suggests that it can be enhanced with training as the brain is capable of neuroplastic adaptation (Shumway-Cook & Woollacott, 2007; Chang, 2014).

Psychomotor coordination consists of reaction time, manual dexterity, balance, hand-eye coordination, and steadiness (Fleishman & Reilly, 1992; Edwards, 2010; Changiz et al., 2021). Among them, reaction time and steadiness are commonly viewed as significant measures of the efficient functioning of the CNS and muscle control.

In other words, reaction time relates to a physical or mental stimulus. Steadiness is the capacity to maintain a position still and maintain control over body and limb movements (Schmidt & Lee, 2013; Magill & Anderson, 2016). The skill sets of writing, learning in class, sports, balance, and other functional activities are taught to school children.

Further, it highlights the neurophysiological mechanisms that may underlie these benefits, the methodological limitations of the included studies, as well as suggestions for future research to enable yoga to be useful within school health and physical education programmes.

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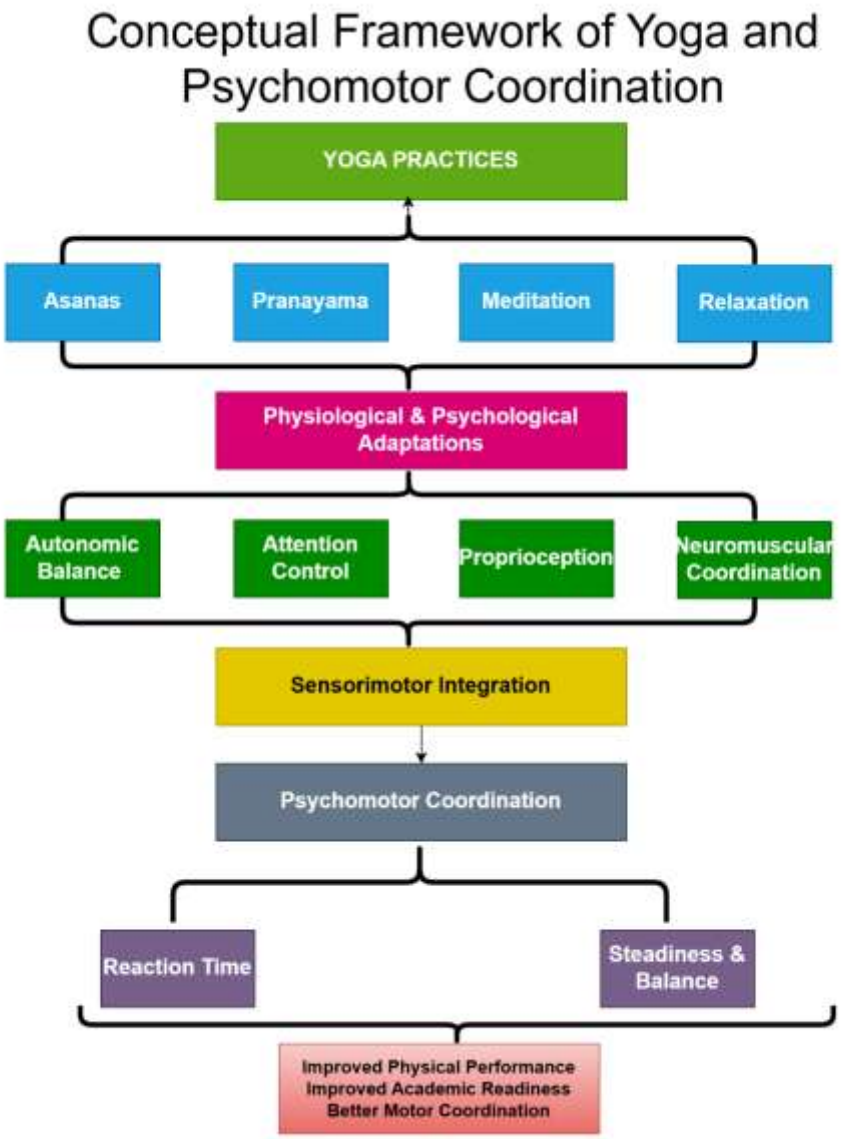

Figure 1. Conceptual Framework of Yoga and Psychomotor Coordination

2. METHODOLOGY

2.1 Review Design

Narrative review of evidence on yoga and psychomotor coordination in school-going students. Focused on reaction time and steadiness. Included heterogeneous study designs (RCTs, experimental, quasi-experimental, observational studies, and reviews). Literature identification guided by **PRISMA-ScR** principles to improve transparency and reproducibility.

2.2 Literature Search Strategy

- **Databases searched:** Google Scholar, PubMed/MEDLINE, Scopus, Web of Science, and CrossRef(2020-2026).
- **Search period:** 1987- 2026.
- Keywords combined using Boolean operators
  - *"Yoga" AND "Reaction Time"*
  - *"Yoga" AND "Psychomotor Coordination"*
  - *"Yoga" AND "School Children"*
  - *"Yoga" AND "Balance"*
  - *"Yoga" AND "Steadiness"*
  - *"Yoga" AND "Neuromuscular Coordination"*
  - *"Pranayama" AND "Reaction Time"*
  - *"Asanas" AND "Motor Coordination"*
  - *"Yoga" AND "Physical Education"*
  - *"School Students" AND "Yoga"*
- Limited to English-language, peer-reviewed publications with assigned DOIs where applicable.

2.3 Inclusion Criteria

- Yoga interventions (asana, pranayama, meditation, relaxation, or integrated yoga).
- School-going children and adolescents (primary population).

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- Studies assessing reaction time, steadiness, balance, coordination, or related psychomotor outcomes.
- Experimental, RCTs, quasi-experimental, observational studies, and relevant reviews.
- Peer-reviewed English-language publications.
- Supporting studies on healthy young adults were included only for mechanistic evidence.

2.4 Exclusion Criteria

- Conference abstracts, dissertations, editorials, letters, and opinion papers.
- Duplicate publications.
- Non-yoga interventions.
- Studies assessing only psychological outcomes without psychomotor measures.
- Non-English articles.

2.5 Study Selection

- Literature was screened according to predefined eligibility criteria.
- The selection process is summarized using a **PRISMA-ScR flow diagram (Figure 2)**.
- **Final studies included: 43**.

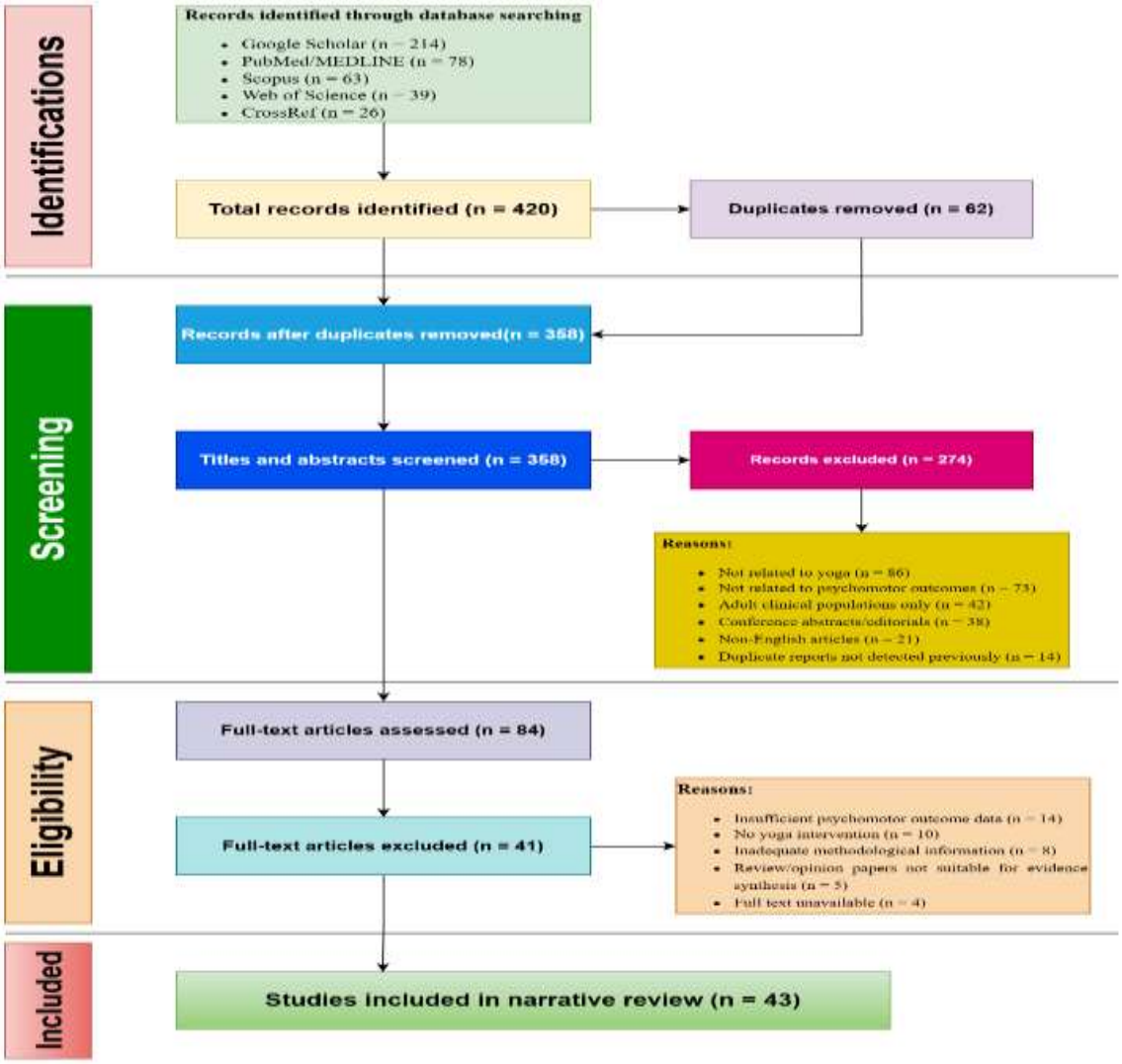

Figure 2. PRISMA-ScR flow diagram

2.6 Data Extraction

The following information was extracted:

- Author and publication year.
- Country and study design.
- Participant characteristics and sample size.
- Yoga intervention and duration.
- Outcome measures.
- Key findings.
- Methodological limitations.

2.7 Quality Appraisal

Studies were evaluated based on:

- Study design.
- Sample size.
- Randomization and control group.
- Intervention standardization.
- Outcome measurement.
- Follow-up.
- Risk of bias.

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- Greater emphasis was given to randomized controlled and well-designed experimental studies.

3. PSYCHOMOTOR COORDINATION: CONCEPTS AND COMPONENTS

Psychomotor coordination refers to the effective combination of cognition, perception, and action, allowing a person to carry out precise, intelligent, and efficient movement. Engaging in physical activity is crucial for daily life, academic studies, sports involvement, and motor learning in childhood and adolescence. Psychomotor ability is an individual's innate capacity to learn motor skills, while psychomotor skills are movements that a person learned and practiced as a result of experience (Kaufman et al., 1987; Changiz et al., 2021). Thus, motor proficiency depends on innate ability and repetitive practice. Continuous training facilitates continuous improvement through the development of neuroplasticity in the CNS (Chang, 2014; Shumway-Cook & Woollacott, 2007).

Among these, reaction time and steadiness during school age are regarded as reflecting central nervous system efficiency and the optimal function of the neuromuscular control system. The time taken to initiate a motor response after stimulus presentation is called reaction time. The efficiency of processing sensory stimuli, decision-making, and motor response is measured by reaction time. Steadiness means that you're able to exert stable and accurate muscular control while performing a stationary or moving task. Steadiness affects balance, posture, ability to write, and performance in other fine motor tasks (Schmidt & Lee, 2013; Magill & Anderson, 2016). The skills form the basis for classroom learning, laboratory activities, physical education, and all daily activities that require speed and precision.

Recent findings indicate that individuals have different psychomotor abilities due to possessing different motor strengths and weaknesses (Changiz et. al, 2021). As such, interventions aimed at improving psychomotor performance must address multiple motor domains rather than one component. This approach forms a strong theoretical foundation for holistic practices such as yoga, which uses a combination of movement, breathing, balance, and attentional control to enhance overall psychomotor coordination of school-going children and adolescents (Table 1).

Table 1. Characteristics of Included Studies

Author (Year)	Country	Study Design	Participants	Yoga Intervention	Duration	Main Outcome(s)
Madanmohan et al. (1992)	India	Experimental	Healthy students	Yoga training (Asanas + Pranayama)	Several weeks	Reaction time, respiratory endurance, and muscle strength
Bhavanani & Udupa (2003)	India	Experimental	Healthy volunteers	Mukh Bhastrika Pranayama	Acute session	Auditory and visual reaction time
Telles et al. (2011)	India	School intervention	School-going children	Integrated Yoga	Multiple weeks	Attention, cognition, psychomotor performance
Maheshkumar et al. (2016)	India	Experimental	Adolescents	Bhramari Pranayama	Single session	Reaction time improvement
Bhavanani et al. (2017)	India	Comparative study	Healthy adults	Asanas vs Pranayama	Short-term	Differential effects on reaction time
Arjun & Sunitha (2019)	India	School intervention	High-school students	Yoga programme	6 weeks	Static balance, dynamic balance, eye–hand coordination
Kuppusamy et al. (2020)	India	Randomized controlled trial	Healthy adolescents	Bhramari Pranayama	Multiple sessions	Simple reaction time
Naik (2021)	India	Experimental	Healthy participants	Yogic relaxation	Short-term	Auditory and visual reaction time
Goothy et al. (2022)	India	Intervention study	MBBS students	10-day Yoga Programme	10 days	Reaction time and perception towards yoga
Singhdeo (2025)	India	School-based intervention	School students	Integrated Yoga Module	12 weeks	Reaction time and psychomotor coordination
Hooi et al. (2025)	Malaysia	Experimental study	Healthy adults	Mindfulness breathing meditation	8 weeks	Improved cognitive function, HRV, attention, and eye-tracking performance
Campelo et al. (2025)	Malaysia	Scoping review	Adults	Yoga-based interventions	Multiple studies	Neural, cognitive, psychological, and physiological benefits of yoga
Artchoudane et al. (2026)	India	Randomized controlled trial	Individuals with Autism Spectrum Disorder (6–25 years)	Yoga Therapy	6 months	Improved visual reaction time, handgrip strength, sensorimotor integration, and behavioral functioning

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Arslan & Ardic (2026)	Türkiye	Cluster randomized controlled trial	High-school adolescents (n = 120)	Yoga-based Stress Management Programme (Yin Yoga + CBT)	4 weeks	Reduced stress, anxiety, and depression; improved psychological well-being and yoga self-efficacy
Devipriya et al. (2026)	India	Prospective pre–post study	Healthy young adults (n = 60)	Bhramari Pranayama	Single 10-minute session	Significant improvement in auditory and visual reaction time
Manojkumar & Ramajayam (2026)	India	Experimental study	Children with special needs	Yoga Asana Training	Several weeks	Improved flexibility, balance, and social skills
Ayaz et al. (2026)	Türkiye	Experimental intervention	Children with Autism Spectrum Disorder	A physical activity programme including psychomotor training	Multi-week	Improved psychomotor and psychosocial characteristics

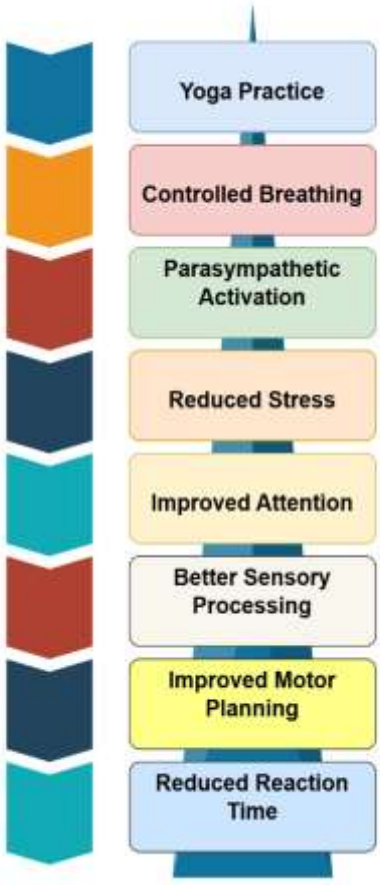

Figure 3. Neurophysiological Mechanism

4. REACTION TIME AS A COMPONENT OF PSYCHOMOTOR PERFORMANCE

The efficiency with which the nervous system detects, processes, and responds to external stimuli is reflected in reaction times, which are vital aspects of psychomotor activities. It is the period that transpires between the presentation of sensory stimulation and the commencement of a suitable voluntary motor response that is suitable. According to Schmidt and Wrisberg (2000), as well as Schmidt and Lee (2013), and Magill and Anderson (2016), because of the integration of sensory perception with cognitive processing, decision-making, and motor execution, reaction time is a common measure of sensorimotor integration, hence considered a good measure of neuromuscular efficiency/psychomotor functioning.

As classified by Fleishman and Reilly, one of the core psychomotor abilities underlying skilled performances is reaction time (Fleishman & Reilly, 1992). Changiz et al. (2021) defined reaction time as the velocity with which an individual starts an assigned movement after a stimulus appears.

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Movement speed indicates how quickly we complete an action after it has started. In contrast, reaction time is how long it takes before we move. Efficient reaction time requires not only the best possible functioning of the muscles but also rapid decoding by the senses.

Factors such as age, experience, attention, dominant hand, and task complexity (Changiz et al., 2021) affect the reaction time. In school-going children, it aids classroom learning, handwriting, taking part in sports, performing computer-based activities, and anything else that requires quick perception and coordinated movement. The assessment of reaction time is therefore a very useful psychomotor developmental assessment tool to assess learning and to detect training candidates (Stefanidis et al., 2006). Due to the measurability and trainability of reaction time, increased attention is being given to movement, breathing, attention, and mindfulness interventions such as yoga, which may enhance the psychomotor abilities of children and adolescents (Table 2).

Table 2. Characteristics of Yoga Interventions Used Across Studies

Study	Asanas	Pranayama	Meditation	Relaxation	Surya Namaskar	Primary Target
Madanmohan et al.	✓	✓	—	✓	—	General psychomotor function
Bhavanani & Udupa	—	✓	—	—	—	Reaction time
Telles et al. 201	✓	✓	✓	✓	✓	Cognitive & psychomotor performance
Maheshkumar et al.	—	✓ (Bhramari)	—	—	—	Reaction time
Arjun & Sunitha	✓	✓	✓	✓	✓	Coordination and balance
Kuppusamy et al.	—	✓ (Bhramari)	—	—	—	Simple reaction time
Naik	—	—	✓	✓	—	Auditory & visual reaction time
Goothy et al.	✓	✓	✓	✓	✓	Reaction time
Singhdeo	✓	✓	✓	✓	✓	Psychomotor coordination
Hooi et al. (2025)	—	✓ (Mindfulness breathing)	✓	✓	—	Attention, stress regulation, cognitive function
Campelo et al. (2025)	✓	✓	✓	✓	✓	Neural, cognitive, and physiological health (Scoping review)
Artchoudane et al. (2026)	✓	✓	✓	✓	—	Neurophysiology, reaction time, and sensorimotor integration in ASD
Arslan & Ardic (2026)	✓ (Yin Yoga)	✓	✓	✓	—	Stress management and psychological well-being
Devipriya et al. (2026)	—	✓ (Bhramari)	—	—	—	Immediate auditory and visual reaction time
Manojkumar & Ramajayam (2026)	✓	—	—	✓	—	Flexibility, balance, and social skills

Note. ✓ = Component included in the intervention; — = Not included

5. STEADINESS AND POSTURAL CONTROL AS COMPONENTS OF PSYCHOMOTOR COORDINATION

The ability to maintain positions when adjusting the strength and the control of the limbs without needing any additional movement of the body or the limbs is called steadiness. Steadiness refers to the quality or the precision of conscious motor acts, while reaction time measures the initiation of a movement. Certain human movements depend on the continuous integration of sensory information, central nervous system processing, and coordinated muscular activity. As such, the coordination of movements is a good indicator of neuromuscular control and functional motor performance (Fleishman & Reilly, 1992; Schmidt & Lee, 2013; Magill & Anderson, 2016).

The whole-body steadiness has a physiological basis of integration of visual, vestibular, and proprioceptive inputs. We gain orientation from visual input; proprioceptors tell us where our body parts are and how they move; and our head position/balance is regulated by the vestibular system. According to Shumway-Cook & Woollacott (2007) and Chang (2014), the cerebellum and other neural structures integrate these signals to produce smooth, coordinated muscular responses and maintain postural stability.

Steadiness is built progressively through motor learning and practice. The native psychomotor ability creates a foundation for movement control; however, organised practice improves the accuracy of movement parameters by reducing extraneous muscular activity and improving muscular coordination via neuronal plastic changes (Kaufman et al., 1987; Changiz et al., 2021). The practice of improved steadiness in childhood and adolescence contributes to the quality of handwriting, participation in activities, participation in sports, and other daily functional activities. As a result, tests of balance, manual dexterity, and motor precision are useful for assessing psychomotor development and evaluating the results of interventions (Changiz et al., 2021). Because yoga fuses controlled postures, breathing, balance practices, and mindful focus, it has a strong theoretical base for increasing steadiness, postural control, and other psychomotor coordination parameters of a school-going child (Table 3).

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Table 3. Effects of Yoga on Reaction Time

Author (Year)	Outcome Measure	Main Findings	Conclusion
Madanmohan et al. (1992)	Visual & auditory reaction time	Significant reduction in reaction time following yoga training	Yoga improves sensory-motor processing and neuromuscular efficiency
Bhavanani & Udupa (2003)	Auditory & visual reaction time	Immediate reduction in reaction time after Mukh Bhastrika Pranayama	Enhanced neural responsiveness and cortical activation
Telles et al. (2011)	Visual reaction time, attention	Improved attention and faster psychomotor responses after integrated yoga	Yoga enhances cognitive and psychomotor performance
Maheshkumar et al. (2016)	Simple reaction time	Significant reduction following Bhramari Pranayama	Improved psychomotor efficiency through autonomic regulation
Das et al. (2016)	Psychomotor performance	Significant improvement in psychomotor speed, attention, and self-efficacy	Yoga-based personality development enhances cognitive-motor performance
Bhavanani et al. (2017)	Auditory & visual reaction time	Both asana and pranayama significantly improved reaction time; pranayama showed greater immediate effects.	Yoga enhances nervous system function and information processing.
Kuppusamy et al. (2020)	Simple reaction time	A randomized controlled trial demonstrated significant improvement following Bhramari Pranayama.	Strong evidence supporting yoga-induced improvement in reaction time
Naik (2021)	Auditory & visual reaction time	Yogic relaxation significantly reduced auditory and visual reaction times	Improved cognitive processing speed and attention
Goothy et al. (2022)	Auditory & visual reaction time	Significant pre–post improvement after a 10-day yoga programme	Short-term yoga effectively enhances reaction time in students
Singhdeo (2025)	Reaction time	A twelve-week school yoga programme significantly reduced reaction time among school-going students.	Supports integration of yoga into school physical education programmes
Hooi et al. (2025)	Eye-tracking, cognitive processing, heart rate variability	Mindfulness breathing improved attention, cognitive performance, and autonomic regulation associated with faster responses	Mindfulness-based breathing positively influences neurocognitive processing and reaction performance
Campelo et al. (2025)	Evidence synthesis of cognitive and physiological outcomes	Scoping review concluded that yoga consistently improves cognitive processing, executive function, attention, and neural efficiency	Strong evidence supporting yoga as a neurocognitive intervention
Devipriya et al. (2026)	Auditory & visual reaction time	Significant immediate reduction in both auditory and visual reaction times after 10 minutes of Bhramari Pranayama	Bhramari Pranayama rapidly enhances psychomotor responsiveness and neural processing.
Artchoudane et al. (2026)	Visual reaction time	Six-month yoga therapy significantly improved visual reaction time and sensorimotor integration in individuals with Autism Spectrum Disorder.	Long-term yoga intervention improves neurophysiological functioning and psychomotor performance.
Arslan & Ardic (2026)	Psychological outcomes	Yoga reduced stress, anxiety, and depression while improving psychological well-being; reaction time was not directly assessed.	Improved psychological functioning may indirectly facilitate cognitive and psychomotor performance.

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6. YOGA PRACTICES AND PSYCHOMOTOR COORDINATION: EVIDENCE FROM PREVIOUS STUDIES

Yoga has received much attention for being a mind–body activity that enhances psychomotor coordination through the implementation of postures (asanas), breathing (pranayama), relaxation, meditation, and mindfulness. Yoga helps to improve neuromuscular control, attention, balance, and emotional regulation all at once, in contrast to regular exercise. So it can benefit school-going children and adolescents greatly. The traditional purpose of yoga is to attain a state of harmony between the body and the mind. New research suggests that yoga helps in better concentration and motor coordination as well as readiness to learn (Singhdeo 2025; Telles et al. 2011).

Yoga also helps us with steadiness, balance, and coordination. Practice of balancing postures like Tadasana, Vrikshasana and Garudasana would not only challenge postural stability but strength proprioceptive feedback and vestibular function (Tran et al., 2021). According to Arjun & Sunitha (2019), a six-week yoga program conducted in schools benefited students. The six-week yoga intervention improved eye-hand coordination, static balance, dynamic balance, and reaction time more than the control group in school students.

Research by Telles et al. (2006), Ali et al. (2014), and Hart (2008) found similar results.

Yoga has numerous positive effects, which are validated by different neurophysiological mechanisms. When a person moves their body in a coordinated way while controlling their breath and mind, this improves his/her sensorimotor integration, attentional regulation, proprioceptive awareness, and autonomic balance, which leads to an enhancement of motor control and efficiency of cognition (Joshi et al., 1992; Telles et al., 1994; Pawlow et al., 2002). Although the overall findings were positive, many studies involved small sample sizes with short intervention periods and wide variations in yoga protocols, making it harder to compare studies. In the future, larger randomized controlled trials, standardization of interventions, and longer follow-up periods should be employed to provide stronger evidence for the long-term impact of yoga on the psychomotor coordination of school-going students(Table 4).

Table 4. Effects of Yoga on Steadiness and Balance

Study	Static Balance	Dynamic Balance	Eye–Hand Coordination	Steadiness	Overall Finding
Arjun & Sunitha (2019)	↑	↑	↑	↑	Significant improvement in coordinative abilities
Telles et al. (1993)	↑	—	—	↑	Improved static motor performance following yogic training
Telles et al. (2011)	↑	↑	↑	—	Better psychomotor coordination and cognitive performance
Das et al. (2016)	↑	↑	↑	↑	Improved psychomotor performance, motor coordination, and self-efficacy among school children
Integrated School Yoga Programme	↑	↑	↑	↑	Improved postural control and coordination
Tran et al. (2021)	↑	↑	—	↑	Enhanced proprioception and balance
Bhavanani et al. (2017)	↑	—	—	↑	Improved neuromuscular coordination and postural stability
Maiti et al. (2016)	—	↑	↑	—	Significant improvement in eye–hand coordination among university sportspersons
Pise et al. (2018)	↑	↑	↑	↑	Yoga improved psychomotor abilities and motor coordination in intellectually disabled children.
Hooi et al. (2025)	—	—	↑	—	Improved attention, eye-tracking performance, and cognitive control following mindfulness breathing
Campelo et al. (2025)	↑	↑	↑	↑	Scoping review reported improvements in motor coordination, balance, neural function, and physical performance following yoga interventions.
Artchoudane et al. (2026)	↑	↑	↑	↑	Six-month yoga therapy significantly improved sensorimotor integration, postural stability, motor coordination, and neuromuscular function in individuals with ASD.
Manojkumar & Ramajayam (2026)	↑	↑	—	↑	Yoga asana training significantly improved balance, flexibility, and functional motor performance in children with special needs
Ayaz et al. (2026)*	↑	↑	↑	↑	Structured physical activity significantly improved psychomotor and psychosocial characteristics in children with ASD.
Rosado et al. (2025)	↑	↑	↑	↑	Creative movement and psychomotor intervention improved coordination, rhythm, balance, and motor performance in older adults

Note. ↑ = Improvement reported; — = Not assessed

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7. EFFECTS OF YOGA ON REACTION TIME IN SCHOOL-GOING STUDENTS

A sensitive measure of psychomotor performance is the reaction time, which indicates efficiency of sensory processing, cognitive decision-making, and motor execution. The nervous system keeps growing and developing during childhood and adolescence. Thus, after the age of five, school-going students are very responsive to practices that enhance neuromuscular coordination and cognitive functioning through rhythmic gymnastics and music. Yoga has become an efficient non-pharmacological intervention because it incorporates postures that affect body and mind (asanas), breath control (pranayama), meditation, and relaxation, which improve physical and mental performance (Madanmohan et al., 1992; Telles et al., 2011).

New evidence strengthens these findings further. A structured yoga programme (12-weeks) involving Surya Namaskar, selected asanas, pranayama, Trataka, Yoga Nidra and relaxation induced a significant reduction in Nelson Hand Reaction Time among adolescents aged 14–16 years as compared to controls. The adaptations were due to enhanced mind–body awareness, proprioception, breathing regulation and attentional focus. The same benefits were noted among university students, indicating that yoga improves the reaction time of students (Goothy et al., 2022; Naik, 2021).

Despite consistently positive findings, yoga studies are limited by relatively small samples, short duration, heterogeneous yoga interventions, and mixed assessment methods. Going forward, studies should involve more extensive randomized controlled trials, standardized yoga modules, and objective measures. Overall, current evidence suggests that yoga is effective in decreasing reaction time among school-going students by improving sensory processing, cognitive control, and neuromuscular coordination. Thus, yoga should be included in the school health and physical education programme.

8. EFFECTS OF YOGA ON STEADINESS AND BALANCE IN SCHOOL-GOING STUDENTS

Steadiness and balance are essential components of psychomotor coordination, enabling children to maintain posture, move accurately, and adapt to the changing demands of a situation. Coordination of these abilities depends on the harmonic action of the visual, vestibular, proprioceptive, and neuromuscular systems and allows for handwriting, sports, daily activities, and classroom activities. Yoga combines postures for steadiness, breathing, relaxation, and movement control, thereby improving both physical and cognitive aspects of motor control (Telles et al., 2011). Due to this, yoga has become an effective intervention for dealing with steadiness.

Studies of school-based interventions have consistently shown the positive effects of yoga on balance and coordination. A six-week yoga program for high-school students significantly improved static balance, dynamic balance, eye–hand coordination, and reaction time over those in a control group that continued normal school activities (Arjun & Sunitha, 2019). According to the authors, coordinating your body movements with intentional controlled breathing can enhance neuromuscular coordination, vestibular functioning, and central nervous system efficiency. According to the findings, yoga enhances several dimensions of psychomotor coordination rather than merely affecting one dimension of physical fitness.

Despite promising results, however, most studies were conducted on a small scale for a short period using different assessment methods, making it difficult to compare studies directly. Future studies are recommended to involve larger randomized controlled designs with similar standard yoga interventions. Further, such studies should also incorporate objective balance assessment and follow-up after longer periods. Currently available evidence indicates that yoga can be a useful tool for enhancing the steadiness and balance of school-going students as a result of enhanced proprioception, neuromuscular coordination, sensory integration, and regulation of attention. As such, it can be incorporated with confidence in the school health and physical education programme.

9. NEUROPHYSIOLOGICAL MECHANISMS UNDERLYING THE EFFECTS OF YOGA ON PSYCHOMOTOR COORDINATION

The overall improvement of reaction time, steadiness, balance, and psychomotor co-ordination due to yoga has been attributed to several different pathways intervening in neurophysiological systems. While the behavioural outcomes were mainly focused on in the intervention studies, neuroscience and motor learning research currently provides an explanation on a biological explanation for the yoga psychomotor performance enhancement effect. This might mean that these mechanisms directly contribute to the effectiveness of balance training. There are six notable mechanisms involved in the process of balance training.

Enhanced neuromuscular coordination is another key mechanism. The deliberate, slow, and synchronized body movements with conscious breathing that characterize yoga enhance the communication between the central nervous system and the musculoskeletal system. The precision and coordination of movement and postural control are improved with these adaptations. The balancing postures, which include Tadasana, Vrikshasana, Garudasana, Ardha Chandrasana, further aid in enhancing proprioception and vestibular functions as they continuously challenge body alignment and balance (Tran et al., 2021; Arjun & Sunitha, 2019).

Relaxation and meditation exercises, such as Yoga Nidra, Trataka and Gayatri Mantra, are also known to reduce mental fatigue, enhance attention span, and improve cognitive efficiency (Joshi et al., 1992; Telles et al.,1994; Pawlow et al., 2002; Swathi et al., 2021). Combined, these practices help facilitate sensory processing and motor planning.

The overall effect of yoga may improve psychomotor coordination through the combined effect of physiological, cognitive, and physical changes.

Yet, most studies attributed these mechanisms to improved behavior rather than to physiological measures directly. Future studies should include objective measures such as heart rate variability, electromyography, electroencephalography, force-platform studies, and neuroimaging of the brain to elucidate the neurophysiological pathways that underlie yoga-related improvements in psychomotor performance.

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10. CRITICAL APPRAISAL OF EXISTING LITERATURE

10.1 Overall Evidence

The above review highlights that yoga makes students react quickly, become better balanced, steady, and improve psychomotor coordination. There was a significant improvement in neuromuscular coordination, attentional control, and motor performance after doing yoga. This was reported in studies by Madanmohan et al. (1992); Bhavanani (2003); Telles et al. (2011); Maheshkumar et al. (2016); Arjun and Sunitha (2019); Kuppusamy et al. (2020); Goothy et al. (2022). The present findings indicate that yoga can be integrated into education systems for promoting psychomotor development.

10.2 Limitations of Study Design

Most of the intervention studies compared yoga with routine school activities or no intervention, rather than comparing it with active control groups receiving alternative exercise or attention-matched programmes. Thus, some of the benefits may reflect non-specific effects, such as increased motivation or instructor attention, rather than yoga-specific mechanisms. Furthermore, few studies carried out long-term follow-up or employed objective physiological measures such as electromyography, electroencephalography, heart rate variability, or force-platform analysis to validate the proposed neurophysiological mechanisms.

10.3 Future Research Directions

A bigger inclusion of children, women, and cultural diversity should also be made. The transparency of future meta-analyses could be enhanced by reporting standardized effect sizes, funding sources, and conflicts of interest. On the whole, the current evidence strongly supports the positive impact of yoga on psychomotor coordination, although there is a need for further rigorous and standardised studies in order to strengthen its applications to school health and physical education programmes.

11. RESEARCH GAPS AND FUTURE DIRECTIONS

There are many reported benefits of yoga on reaction time, steadiness, and psychomotor coordination; however, there are some research gaps. A small number of studies with small sample sizes, short intervention periods, and single-centre designs raise doubts about their generalizability. Subsequent investigations should implement larger multicentre randomized controlled trials in diverse school populations to enhance the evidence base (Arjun & Sunitha, 2019; Kuppusamy et al., 2020). Lack of standardization of yoga protocols is another key limitation. Existing studies differ significantly in the type of asanas, pranayama, as well as meditation practices, the length of the session, and the duration of the programme. Creating school-based yoga modules that are standardized and suitable for various ages would enhance reproducibility and encourage evidence-based implementation (Telles et al., 2011). Most studies are conducted on reaction time, and fewer on steadiness, balance, proprioception and eye–hand coordination. Further studies should utilize broad psychomotor assessment batteries along with objective physiological measures such as electromyography, electroencephalography, force-platform analysis, and/or heart rate variability to further clarify the mechanisms underpinning the yoga-induced adaptations (Shumway-Cook & Woollacott, 2007; Chang, 2014). In the end, it is necessary to conduct future studies over the long-term to evaluate if improvements in psychomotor coordination will last and if these will also improve academic performance, classroom behaviour issues, and psychosocial development. If evidence were available to show an effect of this type of study, it would support the argument to include structured yoga programmes in school health and physical education curriculum.

12. CONCLUSION

This narrative review concludes that yoga is an effective and holistic intervention for improving psychomotor coordination of school-going students. Reaction time and steadiness are the psychomotor activities that can be improved by yoga. Regular research has confirmed that structured yoga programs consisting of asanas, pranayama, Surya Namaskar, relaxation, and meditation improve coordination, balance, postural control, attention, and cognitive response. (i.e., Madanmohan et al., 1992; Telles et al., 2011; Arjun and Sunitha, 2019; Goothy et al., 2022). According to the research, the positive effects of yoga may be due to improved control of the body's autonomic nervous system, proprioception (or body awareness), vestibular functioning (balance), sensorimotor integration (body mapping), and attentional control; that is, yoga practices probably enhance motor performance and readiness for learning. Nevertheless, the existing evidence is flawed or compromised by atypical intervention protocols, small sample sizes, heterogeneous outcome measures, poor reporting of effect sizes, and no long-term follow-up. In addition, much of the research was done in India, which needs to be done elsewhere, too. Yoga is a safe, low-cost, and feasible method to enhance psychomotor development and overall well-being in children and adolescents. To build a more robust evidence base, future multicentre randomized controlled trials need to employ standardized yoga protocols, objective psychomotor assessments, longer follow-ups, etc. Including evidence-based yoga programs in the physical education and health curriculum in schools may enhance movement skills, enhance readiness for learning, improve physical fitness, and encourage healthy lifelong behaviours.

Declarations

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