Review Article

Role of Yogic Practices in Enhancing Reaction Time: A Narrative Review

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ABSTRACT

Background: Reaction time (RT), the interval between stimulus onset and voluntary motor response, is a fundamental measure of sensorimotor efficiency and central nervous system (CNS) function. Prolonged RT is associated with neurological impairment, fall risk, and reduced occupational performance, making its enhancement a clinically relevant objective. Yoga, has demonstrated beneficial effects on cognitive function, attention, and psychomotor performance across diverse populations. Despite growing individual study evidence, findings remain dispersed across varied populations, intervention modalities, and methodological approaches. This review aimed to synthesise available evidence on the effects of yogic practices on visual and auditory reaction times, identify the most effective yoga components, and elucidate the underlying physiological mechanisms. **Materials and Methods:** A structured narrative review was conducted using PubMed, Google Scholar, ResearchGate, Consensus, and Perplexity. Studies published from 1990 onwards reporting quantitative RT outcomes following yogic interventions were eligible for inclusion. A total of 22 references were identified after screening against predefined inclusion and exclusion criteria. **Results:** Most studies reported significant reductions in both visual reaction time (VRT) and auditory reaction time (ART), with improvements ranging from 10% to 33%. Pranayama, particularly bellows-type and fast breathing techniques (Mukh Bhastrika, fast pranayama), produced the most pronounced RT improvements. Asana-based practices enhanced RT through neuromuscular and proprioceptive refinement, while meditation improved RT through prefrontal attentional strengthening and autonomic regulation. Integrated multicomponent yoga programmes demonstrated the broadest benefits across populations. **Conclusions:** Yogic practices are effective, safe, and accessible interventions for enhancing psychomotor performance. Their integration into educational, athletic, occupational, and clinical settings is supported by current evidence. Future research should employ standardised protocols, neuroimaging tools, and adequately powered randomised controlled trials to strengthen the evidence base.

Key words: Yoga, Reaction Time, Meditation.

Reaction time (RT) is defined as the duration between the onset of a stimulus and the commencement of a voluntary motor response by an individual. It serves as a quantifiable index of the speed at which the nervous system perceives, processes, and acts upon external information. As described by Luce and Welford, RT is classified into three types: simple RT, recognition RT, and choice RT [1]. RT is a key indicator of sensorimotor efficiency, reflecting the integrated functioning of the sensory, cognitive, and motor systems. It predicts vital motor abilities, including gait, balance, and fall risk across age groups. Clinically, prolonged RT is associated with neurological and cognitive impairment, including stroke, dementia, and traumatic brain injury.

It also serves as a sensitive marker of psychomotor slowing in neurodegenerative and sleep disorders. Beyond medicine, RT is widely applied in sports science, aviation safety, and driving evaluations, making it a reliable index of central nervous system (CNS) function and overall cognitive performance [2]. RT is shaped by a range of biological, cognitive, and environmental factors, including age, sex, cognitive ability, fatigue, medications, stimulus complexity, practice, and measurement conditions [3]. Auditory stimuli typically produce faster RTs than visual stimuli due to shorter neural pathways, with auditory signals reaching the cortex 8–10 ms faster than visual signals (20–40 ms) [1]. Yoga, the ancient Indian discipline, integrates physical postures (asanas), breathing regulation (pranayama), and meditative practices (dhyana) to cultivate mind-body unity. It has been demonstrated to improve cognitive function, information processing speed, and voluntary motor response through improvements in CNS efficiency, attention, and arousal regulation. Given the simplicity, adaptability, and non-invasive nature of yogic practices, they represent a suitable intervention for psychomotor enhancement across diverse age

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groups and occupational contexts [4]. Despite a growing body of individual studies examining the relationship between yoga and RT, evidence remains dispersed across varied populations, intervention modalities, and methodological designs. A structured synthesis is therefore needed to consolidate this evidence, articulate the physiological mechanisms involved, and provide evidence-based recommendations for applying yoga in psychomotor performance enhancement. The present review was done to examine how yogic practices influence visual and auditory RT, to identify which yoga component confers the most significant RT benefit, to elucidate the physiological mechanisms underlying yoga-induced RT improvement, and to outline clinical, educational, and occupational implications.

MATERIALS AND METHODS

A structured narrative review was conducted following standard review methodology principles. No formal registration (e.g., PROSPERO) was required, given the narrative design. Literature was identified through comprehensive searches of PubMed, ResearchGate, and Google Scholar. AI-assisted tools were used for literature identification only; all data were independently verified by authors. Reference lists of retrieved articles were further screened to identify additional eligible studies. The study selection is demonstrated in Figure 1.

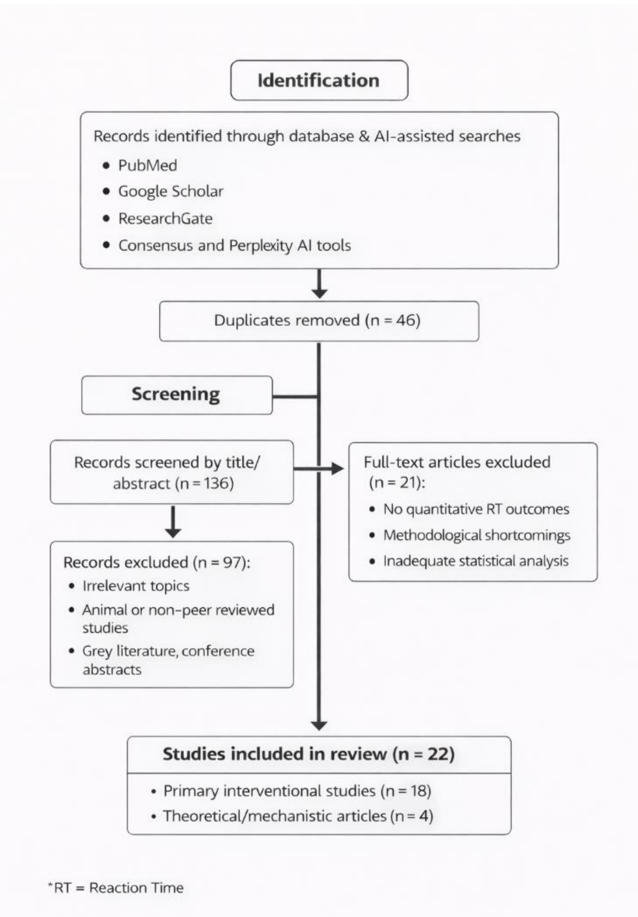

Figure 1: Study Selection Flow Diagram

2.1 Search Keywords: Searches were conducted using the following terms individually and in Boolean combination (AND/OR): "Yoga," "Reaction Time," "Visual Reaction Time," "Auditory Reaction Time," "Asana," "Pranayama," "Meditation," "Dhyana," "Psychomotor Performance," "Cognitive Function," "Attention," "Neuromuscular Coordination," and "Sensorimotor Performance."

2.2 Inclusion Criteria: Human studies (Randomised controlled trials (RCTs), quasi-experimental, observational) reporting quantitative VRT and/or ART outcomes; peer-reviewed journal articles with full-text availability; English-language publications from 1990 onwards; studies with clearly defined methodology and appropriate statistical analysis. Foundational classical texts were included for conceptual explanation.

2.3 Exclusion Criteria: Animal studies; non-peer-reviewed articles, conference abstracts, grey literature, and dissertations; studies lacking quantitative RT data or adequate statistical reporting; studies with insufficient methodological detail.

2.4 Study Selection and Quality Assessment: Records were screened by title and abstract for relevance, followed by full-text assessment against eligibility criteria. Study quality was assessed based on methodological clarity, sample size, use of appropriate control groups, and adequacy of statistical reporting. No restriction was placed on the type of yogic intervention. Following iterative screening, a total of 22 references were included, comprising primary interventional studies and selected foundational/mechanistic texts providing theoretical context.

RESULTS

3.1 Physiological Basis of RT

RT is fundamentally determined by the speed and efficiency of nervous system functioning. The RT sequence begins with peripheral stimulus detection, progresses through afferent signal transmission to the CNS for sensory decoding and decision-making, and culminates in efferent motor pathway activation. Neuromuscular efficiency, cerebral oxygenation, cortical arousal, and cardiorespiratory fitness each contribute to the overall RT. Auditory signals reach the cortex approximately 8–10 ms faster than visual signals (20–40 ms), accounting for consistently shorter ART compared to VRT across the literature [1].

3.2 Effect of Yogic Asanas on RT

Asana, defined in Patanjali's Yoga Sutras as "sthiram sukham asanam" (steady and comfortable posture), involves sustained maintenance of specific body positions [5]. Asana practice improves proprioception, neuromuscular coordination, and postural control through repeated engagement of the sensorimotor system [6,7]. Figure 2 shows the mechanism of the RT improvement by yoga intervention.

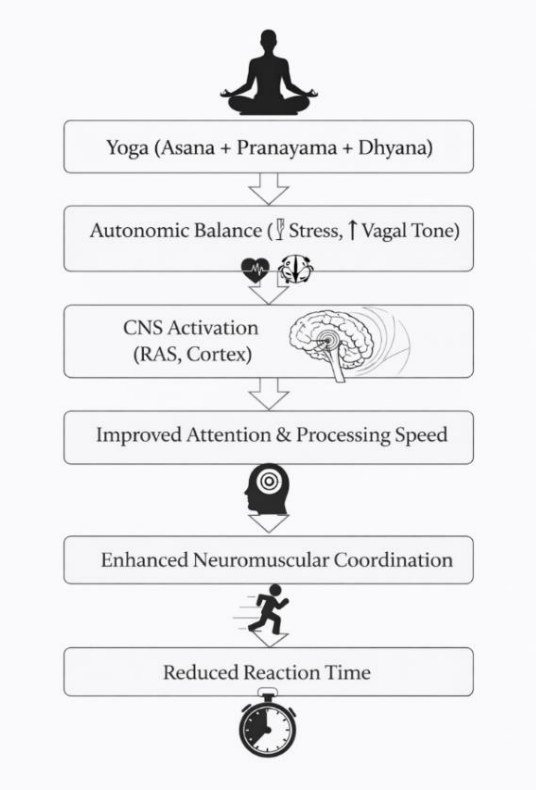

Figure 2. Mechanism of Yoga-Induced RT Improvement

Madanmohan et al. examined 27 healthy male students (18–21 years) who underwent 12 weeks of structured yoga practice, including Mukh Bhastrika, Talasana, Trikonasana, Ardha Matsyendrasana, Supta Vajrasana, Ustrasana, Paschimottanasana, Sarvangasana, Halasana, Navasana, Bakasana, and Shavasana, for 30 minutes daily. VRT decreased significantly from 270.0 ± 6.20 ms to 224.81 ± 5.76 ms and ART from 194.18 ± 6.00 ms to 157.33 ± 4.85 ms ($P<0.001$). Respiratory measures, Maximum Expiratory Pressure (MEP), Maximum Inspiratory Pressure (MIP), Breath Holding Time on expiration (BHTexp), and Breath Holding Time on inspiration (BHTinsp), and handgrip strength also improved significantly, attributed to enhanced sensorimotor integration, isometric loading during postures, and improved concentration [8].

Bhavanani et al. investigated the immediate effects of Suryanamaskar (SN), a dynamic sequence of 12 yoga postures with synchronised breathing, in 21 female participants versus 19 controls. SN produced significant reductions in ART (−14.28%) and VRT (−13.08%), with elevated heart rate, indicating simultaneous sympathetic arousal and enhanced central neuronal processing [9]. Shende and Parekh compared 60 regular yoga practitioners with 60 non-practising controls following over a year of daily asana, meditation, and relaxation practice. Yogic exercisers demonstrated significantly faster ART and VRT than controls, attributed to enhanced concentration, alertness, hand coordination, muscular steadiness, and efficient neuronal transmission [10].

3.3 Effect of Pranayama on RT

Pranayama, derived from "prana" (vital life force) and "ayama" (extension or regulation), refers to systematic control and modulation of respiratory patterns, leading to mental steadiness and enhanced CNS function [11].

Kuppusamy et al. conducted a well-powered RCT in 520 healthy adolescents aged 13–18 years, randomised to Bhramari pranayama (n=260) or no-intervention control (n=260) for six months, practised three days per week. The intervention group demonstrated significant reductions in VRT (267.13 ± 52.65 to 249.87 ± 39.41 ms) and ART (237.42 ± 48.12 to 227.91 ± 34.60 ms), while controls showed no significant change, supporting the influence of Bhramari pranayama on adolescent cognitive performance [12].

Bhavanani, Madanmohan, and Udupa investigated the acute effects of Mukh Bhastrika, a vigorous bellows-type pranayama, on RT in 22 yoga-trained schoolboys. Significant reductions in VRT (244.57 ± 5.86 to 228.15 ± 5.84 ms) and ART (198.82 ± 5.86 to 179.58 ± 6.35 ms) were recorded after nine rounds ($P<0.01$). The authors proposed that forceful respiratory manoeuvres stimulate somatic and splanchnic afferents, activating the reticular activating system (RAS) and enhancing thalamo-cortical transmission [13].

Sharma et al. conducted a three-group RCT on 84 healthy young adults comparing 12 weeks of fast pranayama, slow pranayama, and a control condition. Both pranayama groups demonstrated significant reductions in ART and VRT; however, the fast pranayama group produced significantly greater percentage reductions than the slow pranayama group, indicating that higher-frequency respiratory stimulation confers superior facilitation of neural efficiency and cortical arousal [14].

3.4 Effect of Meditation on RT

Dhyana (meditation) involves sustained, directed attention toward a chosen object or present-moment awareness, cultivating mindfulness and reducing cognitive distractibility [5]. Neuroimaging studies demonstrate that regular meditation strengthens prefrontal cortex activity, improving executive attention, working memory, and response inhibition. Electroencephalogram (EEG) studies consistently report increased alpha-wave power (8–12 Hz), reflecting a state of relaxed alertness optimal for psychomotor performance [15]. Sudsuang et al. compared six weeks of Dhammakaya Buddhist meditation in 52 male college students with 30 non-meditating controls. RT decreased by 16–23% in meditators versus only 5–7% in controls, with concurrent reductions in serum cortisol, blood pressure, and heart rate, indicating broad autonomic and cognitive benefits of meditation [16]. Kumbhar et al. assessed the effect of a five-month multicomponent meditation programme on VRT in 100 first-year medical students, finding significant reductions for both eyes and both stimulus colours (p<0.0001), attributed to enhanced frontal lobe cerebral blood flow and increased alpha-wave activity [17].

Sleimen-Malkoun et al. employed a within-subject RCT design in 42 adults (22 meditators; 20 novices), comparing a single 10-minute mindfulness meditation session with an active control (attentive listening) on the Stroop task RT. Mindfulness meditation produced significantly faster RTs in both congruent and incongruent Stroop conditions with concurrent reductions in heart rate, with benefits observed in both experienced meditators and naive novices [18].

3.5 Integrated Yoga Modules and Comparison with Physical Exercise

Bhavanani et al. (2017) conducted an RCT on 134 nursing students randomised to asana (n=44), pranayama (n=45), or control (n=45) over one week. Both yoga interventions significantly reduced ART and VRT while controls showed no improvement; the pranayama group demonstrated greater inter-group improvements, particularly for VRT, attributed to superior autonomic regulation and direct central arousal pathway engagement [19]. Chobe et al. evaluated a three-week Integrated Yoga and Physiotherapy (IYP) programme in 11 chronic multiple sclerosis patients, reporting significant VRT reductions of 32.89% (p=0.01) and ART improvement of 25.6% (p=0.058, borderline), alongside significant reductions in anxiety and depression [20].

For contextual comparison, Zhu et al. reported yoga to be non-inferior to conventional physical therapy exercise for chronic low back pain outcomes across RCTs, establishing yoga as a credible exercise-equivalent rehabilitation intervention [21]. Sivaramakrishnan et al. demonstrated small-to-moderate improvements in balance, lower limb strength, flexibility, depression, and sleep quality with yoga compared to inactive controls in older adults (mean age ≥60 years), relevant to RT-related fall risk in this population [22].

3.6 Summary of Evidence

Table 1 presents a structured summary of the key interventional studies reviewed, including quality ratings.

Table 1: Summary of Reviewed Interventional Studies

Author [Ref]	Year	n	Intervention	Duration	VRT Outcome	ART Outcome	Design
Madanmohan et al. [8]	1992	27	Hatha yoga asanas, 30 min/day	12 weeks	270.0→224.81 ms (P<0.001)	194.18→157.33 ms (P<0.001)	Pre-post
Bhavanani et al. [9]	2013	40	Suryanamaskar (3 rounds)	Acute	↓13.08%	↓14.28%	RCT
Shende and Parekh [10]	2011	120	Asana, meditation, relaxation (daily)	>1 year	↓ vs. controls (p<0.001)	↓ vs. controls (p<0.001)	Comparative
Kuppusamy et al. [12]	2020	520	Bhramari pranayama, 3×/week	6 months	267.13→249.87 ms	237.42→227.91 ms	RCT
Bhavanani et al. [13]	2003	22	Mukh Bhastrika (9 rounds)	Acute	244.57→228.15 ms (P<0.01)	198.82→179.58 ms (P<0.01)	Pre-post
Sharma et al. [14]	2014	84	Fast vs. slow pranayama vs. control	12 weeks	↓ both groups; fast > slow	↓ both groups; fast > slow	RCT
Sudsuang et al. [16]	1991	82	Dhammakaya Buddhist meditation	6 weeks	↓16–23% (meditators)	↓16–23% (meditators)	Comparative
Kumbhar et al. [17]	2020	100	Pranayama, Omkar, guided meditation	5 months	↓ both eyes/colours (p<0.0001)	Not reported	Pre-post
Sleimen-Malkoun et al. [18]	2023	42	Single 10-min mindfulness meditation	Acute	↓ Stroop RT (both groups)	↓ Stroop RT (both groups)	RCT (within-subj)
Bhavanani et al. [19]	2017	134	Asana vs. pranayama vs. control	1 week	↓ both yoga groups; pranayama > asana	↓ both yoga groups	RCT
Chobe et al. [20]	2016	11	Integrated yoga + physiotherapy	3 weeks	↓32.89% (p=0.01)	↓25.6% (p=0.058)	Pilot

DISCUSSION

The collective evidence reviewed consistently demonstrates that yogic practices. encompassing asanas, pranayama, and meditation, produce significant improvements in both VRT and ART across diverse populations, with RT improvements ranging from approximately 10% to 33%. Both acute effects, observable after single sessions, and sustained effects following weeks to months of structured practice have been documented, indicating that yoga exerts its influence through both immediate neurophysiological modulation and long-term neuroplastic adaptation [8–10,12–14,16–20].

Among the three components, pranayama emerged as the most potent for acute RT enhancement, followed by asana for sustained neuromuscular refinement, and meditation for long-term attentional consistency. The direct comparative RCT by Bhavanani et al. provides particularly valuable evidence, confirming that pranayama confers greater RT improvement than asana within one week, consistent with its more direct engagement of central arousal pathways [19].

However, direct three-way comparative trials across all three components remain limited, and this hierarchy should be interpreted with caution. The physiological mechanisms underlying these improvements are interrelated and complementary. Yoga modulates autonomic balance toward parasympathetic dominance, evidenced by reduced serum cortisol, heart rate, and blood pressure, whilst simultaneously preserving attentional quality and facilitating faster stimulus detection [16]. Pranayama stimulates the RAS through somatic and splanchnic afferents, enhancing thalamo-cortical processing speed and shortening the perception–decision–motor execution sequence [13,14].

Regular practice strengthens prefrontal cortex activity and elevates alpha-wave power (8–12 Hz), reducing decision latency and improving response accuracy [15,17]. Asana refines proprioceptive sensitivity and neuromuscular coordination, shortening motor planning and execution time [6,7,8]. These mechanisms operate synergistically, reflecting yoga's integrated mind-body approach, and collectively account for the consistent RT improvements observed across independent research groups. The possibility of publication bias, whereby studies with non-significant results are less likely to be published, cannot be excluded and should be considered when interpreting overall effect estimates. Methodological limitations include heterogeneity across studies in sample size, yoga protocol composition, intervention duration, and RT measurement instruments; absence of participant blinding; small sample size, predominantly short-term follow-up; and limited direct neurophysiological measurements [13,20].

These factors restrict the certainty of mechanistic conclusions and the generalisability of findings to clinical, paediatric, and elderly populations. Future research should develop standardised yoga intervention protocols, incorporate neuroimaging (functional Magnetic Resonance Imaging (fMRI), EEG) and autonomic biomarker assessments, conduct adequately powered RCTs with active control groups, examine dose-response relationships, and extend investigations to clinical populations including Attention-Deficit/Hyperactivity Disorder (ADHD), mild cognitive impairment, stroke, and Parkinson's disease.

CONCLUSION

Yogic practices, encompassing asanas, pranayama, and dhyana, are effective, non-pharmacological strategies for enhancing VRT and ART across diverse populations, with pranayama demonstrating the most pronounced improvements and integrated multicomponent programmes offering the broadest benefits. These findings have wide applicability across educational, sports, occupational, and clinical rehabilitation contexts, supporting the integration of yoga into health promotion and performance enhancement programmes.

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