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An In-depth Analysis of Multisensory Reaction Time Disparities between Yogic and Non-Yogic Practitioners

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Abstract

Background. Auditory and visual reaction time refers to the duration between the introduction of a sound or light and the onset of a response. It is an important aspect of human behaviour, influencing performance in various activities ranging from daily tasks to sports and emergency situations.

Objectives. The purpose of this study was to investigate reaction time (auditory and visual) as a component of skill-related fitness between male college students practicing yoga and those who do not.

Materials and methods. A total of forty male college-going students (N = 40) were randomly selected to participate in this study. Out of the total, twenty participants (n = 20) were dedicated yoga practitioners actively involved in district and state-level yoga competitions. The remaining twenty individuals (n = 20) followed a sedentary lifestyle and were not involved in yoga practices. The subjects' ages ranged from 17 to 25 years, encompassing a cohort of young adults. The data pertaining to visual reaction time (VRT) and auditory reaction time (ART) was collected using an audio-visual reaction timer. Each participant performed the task thrice, and the mean score was used to indicate the experimental reaction time in milliseconds (ms). Descriptive statistics and the independent samples t-test were subsequently conducted to evaluate the significance level, with a predetermined threshold set at $p < 0.05$.

Results. The results showed that the comparison between VRT and ART of yoga and non-yoga practitioners revealed that for yoga practitioners, $t_{(38)} = 2.91$, and $p < 0.006$, whereas for non-yoga practitioners, $t_{(38)} = 3.55$, and $p < 0.001$. Regarding VRT between yogic and non-yogic practitioners, $t_{(38)} = 1.99$, and $p > 0.054$, and for ART between yogic and non-yogic practitioners, $t_{(38)} = 2.12$, and $p < 0.041$.

Conclusions. The findings suggest that both yogic and non-yogic practitioners demonstrated significantly lower level of ART compared to VRT. Further results indicate that hand speed in terms of VRT is nearly identical between yogic and non-yogic practitioners, but the ART of yogic practitioners was observed to be faster than that of non-yogic practitioners. Yoga has been associated with various physical and mental health benefits, and studies suggest that it may have a positive impact on reaction times.

Keywords: simple reaction time, visual reaction time, auditory reaction time, yogic practitioner, non-yogic practitioner.

Introduction

Reaction time refers to the period between the presentation of a stimulus and the initiation of a response. In various fields such as psychology, sports training, and physiology, reaction time is measured to assess how quickly an individual can respond to a specific stimulus. It is a crucial parameter in understanding cognitive and motor skills, as well as the efficiency of sensory and neural processes. The significance of reaction time in performance is paramount, acting as a dependable gauge of an individual's sensorimotor coordination and overall attentiveness (Balakrishnan et

al., 2014). This assessment of how quickly information is processed in the center and how well-coordinated movements are in the periphery relies on the nervous system's ability to detect stimuli. Neurons send signals to the brain and spinal cord before directing actions to the hands and fingers through motor neurons to execute a suitable response. Reaction time indicates how quickly an organism responds to particular stimuli and is affected by factors like age, gender, handedness, visual concentration, practice, fatigue, fasting, breathing rhythms, personality traits, physical activity, and cognitive capabilities (Jain et al., 2015). In the context of events, reaction time pertains to the ability to swiftly and effectively respond to stimuli such as sound or light, demonstrating quick and suitable posture and control (Reza et al., 2018; Singh & Singh, 2024). Auditory and visual reaction time, vital in this context, denotes the time interval from the introduction of a sound or light stimulus to the commencement of the corresponding response.

Reaction time is a key component in the skill-related aspects of physical fitness, distinct from agility but holding unique significance within the spectrum of physical fitness components. It plays a significant role in various sporting scenarios, with experienced players in soccer demonstrating quicker reaction times compared to their less-experienced counterparts (Theofilou et al., 2022). In sports like basketball, and tennis, rapid reaction times are crucial for adapting promptly to opponents' movements or shots (Bourgase, 2009; Debrousse, 2023). In cricket, for instance, a swift reaction to an edge results in a skillful slip catch. Reaction time is particularly indicative of sprinting ability, where a quick response to the starting signal can significantly impact the outcome of a close race (Jackson, 2017). Athletes dedicate years to training, aiming to enhance reaction time as milliseconds can be the game-changer between victory and missed opportunities. Improving reaction time can lead to heightened on-court efficiency, swifter responses to stimuli, and a decreased likelihood of injuries (Debrousse, 2023). In various activities, spanning from everyday tasks to engagements in sports and emergency situations, optimal performance is associated with improved reaction time in specific situations.

Dutch physiologist Franciscus C. Donders led the way in measuring reaction time in a lab, challenging the prior belief before 1865 that mental processes were too rapid to be measured. Donders (1868), found it intriguing to quantify the duration of fundamental mental processes. The emphasis on precise measurement of reaction time laid the foundation for contemporary psychological experiments, influencing research methodologies to this day (Vinupradha, 2016). The length of cognitive processes is frequently measured in experimental psychology using reaction time (Yadav et al., 2013). Within the realm of cognitive psychology, reaction time serves as a metric for assessing the duration it takes an individual to process information. It has been demonstrated that pharmacological and physiological variables affect reaction time (Mohan et al., 1984; Malathi et al., 1990). According to Annett (1981), the left hemisphere governs motor function in the right hand, while the right hemisphere regulates motor function in the left hand. The mind serves as the motivating factor for actions, as it commands and directs the movements of the limbs in the human body (Rahman & Islam, 2021a). Despite this, the majority of hand patterns are still right-handed, accounting for around 90% of the human population (Scharoun & Bryden, 2014). Researcher has looked into three different kinds of reaction time: simple, recognition, and choice reaction time (Luce, 2008). For assessing routine reaction time in humans, the practicality of utilizing visual, auditory, and tactile neural pathways has been identified (Godlove et al., 2014; Jain et al., 2015).

The holistic approach of yogic practices, as defined by Patanjali, integrates the mastery of the mind and the regulation of stress in individuals (Sonwane & Mishra, 2016). This ancient discipline covers a range of techniques like asana, pranayama, and meditation, all aimed at syncing up your mind and body for optimal harmony (Bagya et al., 2018; Kuppusamy et al., 2017). Through practices like meditation, individuals cultivate mindfulness and awareness, reducing distractions and enhancing their ability to perceive stimuli promptly. Regular participation in yoga leads to improvements in mental well-being, central nervous system processing, and sensorimotor performance (Kuppusamy et al., 2020). The mindful movement, breath control, and mental concentration in yoga positively influence reaction time and overall skill-related fitness. Research shows that yoga enhances sensory-motor conduction velocity, information processing, and concentration, resulting in decreased visual and auditory reaction times (Madanmohan et al., 1992; Madanmohan et al., 2012; Andreou, 2017). The practice of yoga reduces mental fatiguability and increases performance quotient by improving arousal and concentration (Andreou, 2017). Pranayama techniques contribute to heightened concentration and alertness, crucial for faster reactions, as seen in Bhramari pranayama improving cognitive function (Kuppusamy et al., 2020). Yoga poses not only improve coordination and balance but also body awareness and flexibility. It can increase a player's mental and physical relaxation, promote the development of body awareness (Rahman & Islam, 2020), and provide quick responses to external stimuli. Mountain Pose and Warrior I, emphasizing attention to breath, posture, and alignment, contribute to this awareness (Kulkarni, 2023). Visualization techniques and sensory awareness exercises condition the mind and body to react swiftly. Neuroplastic changes induced by yoga lead to improved body awareness, heightened attention, and enhanced present-moment awareness (Castro, 2020). Additionally, the decrease in stress, anxiety, and depression observed after hatha yoga practice optimizes brain function, enhancing cognitive processing and reaction times (Shohani et al., 2018). Practitioners employ concentration techniques during yoga poses, enhancing attentiveness and decreasing reaction time, which holds significance in activities requiring quick responses, such as sports. Thus, the interplay of mindfulness, breath control, and physical postures in yoga creates a holistic foundation for improving reaction time and overall skill-related fitness. Utilizing yogic interventions like integrated yoga, meditation, and pranayama can enhance brain wave activity and cognition, offering an alternative medicine approach to boost performance in games and sports (De & Mondal, 2020; Islam, 2021).

Yoga can have positive effects on cognitive functions, including attention, concentration, and overall mental well-being. Understanding the potential effects of yoga on auditory and visual response time may contribute valuable

insight into the broader cognitive benefits associated with yoga practice. By comparing the reaction times of yogic and non-yogic practitioners, the study seeks to provide empirical evidence of how yoga may or may not affect sensory-motor responses. Therefore, the research aims to explore and examine thoroughly whether individuals engaged in yoga practice exhibit differences in auditory and visual reaction times compared to those who do not practice yoga.

Materials and Methods

Selection of Subjects

A cohort of forty (n = 40) male college-going students from the University of Delhi were selected at random to partake in this study. Among them, twenty individuals (n = 20) were yoga practitioners at the Indira Gandhi Institute of Physical Education and Sports Sciences (IGIPESS), actively participating in district and state-level yoga competitions. The remaining twenty participants (n = 20) were non-yogic practitioners from the School of Open Learning (SOL) and led a sedentary lifestyle. The subjects' ages ranged from 17 to 25, and the data was gathered at the yoga lab of IGIPESS, University of Delhi, India. All participants had normal vision, were free from acute or chronic illnesses and medication use, and abstained from smoking or alcohol consumption during the tests. These undergraduate students volunteered for the study, and it's noteworthy that all participants were right-handed.

Table 1. The characteristics of the Participants (Mean ± SD)

Variables	Yogic Practitioner (n=20)	Non- Yogic Practitioner (n=20)
Age (yr)	21.80 ± 2.16	22.50 ± 1.55
Weight (kg)	59.60 ± 5.67	64.00 ± 4.74
Height (m)	1.67 ± 0.05	1.69 ± 0.06
BMI (kg/m^2)	21.86 ± 1.79	22.70 ± 1.84

Instrument and Tools

The study utilized the Medisystems audio-visual reaction (AVR) timer in India, which is ISO 9001:2015 (QMS) certified. This timer comes with dual functionality, catering to both the researcher and the subject. Each side has four switches and four lights. The switches on the researcher's side control the lights, while those on the subject's side are used to turn off the lights. Additionally, there is a mode featuring four different melodies or tones. The researcher initiates a sound, and the subject's task is to promptly turn it off in the shortest time possible. This setup allows the researcher to assess reaction times using both visual and auditory stimuli. The reaction time of the subject, measured in milliseconds, is considered indicative of their performance (Medi Systems India, n.d.).

Test Administration

The Audio-Visual Reaction (AVR) timer was placed on a table, with subjects comfortably seated in chairs. ART and VRT were quantified in a serene, acoustically controlled environment to optimize focus and eliminate distractions. The reaction time task was conducted between 9 am and noon, an hour after a light breakfast, to maintain consistent conditions. Participants maintained contact between their right index finger and the AVR timer switch while performing tasks. Visual reaction time (VRT) was assessed in response to illuminated lights, while auditory reaction time (ART) was gauged through reactions to low- and medium-pitched sounds. The test administrator, seated across from the subject, controlled the AVR machine, creating lights or sounds of the same amplitude. The AVR timer's LCD display showed reaction time in milliseconds. Each subject repeated the task three times, and the average score represented the experimental reaction time.

Statistical Analysis

After subjecting the data to Levene's test, the researchers confirmed a normal distribution. Statistical analysis involves calculating descriptive statistics, such as the mean and standard deviation (SD). An independent t-test was then performed to determine the significance level, using a pre-established threshold of $p < 0.05$.

Results

Table 2 descriptive analysis of reaction times among yogic and non-yogic groups revealed notable differences. In the yogic group, the mean and SD of VRT were 18.50±1.72, while the ART was 17.20±1.02. On the other hand, the non-yogic group exhibited a higher mean VRT of 19.65±1.93, with a mean ART of 17.90±1.07.

Table 2. Descriptive statistics of reaction time for yogic and non-yogic practitioners

Groups and Parameters		Descriptive		
		Mean (ms)	Std. Deviation	Std. Err. Mean
Yogic	VRT	18.50	1.72	0.38
	ART	17.20	1.02	0.23
Non-Yogic	VRT	19.65	1.93	0.43
	ART	17.90	1.07	0.24
VRT	Yogic	18.50	1.72	0.38
	Non-Yogic	19.65	1.93	0.43
ART	Yogic	17.20	1.02	0.23
	Non-Yogic	17.90	1.07	0.24

In Table 3, the comparison between VRT and ART of yoga and non-yoga practitioners reveals that for yoga practitioners, $t_{(38)} = 2.91$ and $p = 0.006$ (2-tailed). Similarly, for non-yogic practitioners, $t_{(38)} = 3.55$ and $p = 0.001$ (2-tailed). The findings suggest that both yogic and non-yogic practitioners displayed significantly lower ART in comparison to VRT. According to VRT between yogic and non-yogic practitioners, $t_{(38)} = 1.99$, and $p = 0.054$ (2-tailed), and ART between yogic and non-yogic practitioners, $t_{(38} = 2.12$, and $p = 0.041$ (2-tailed). The results show that

Table 3. Reaction time using an independent t-test of yogic and non-yogic practitioners

Groups and Parameters		Mean Difference	Std. Err. Diff.	t	df	Sig. (2-tailed)
Yogic	VRT ART	1.30	0.45	2.91	38	0.006*
Non-Yogic	VRT ART	1.75	0.49	3.55	38	0.001*
VRT	Yogic Non-Yogic	1.15	0.58	1.99	38	0.054
ART	Yogic Non-Yogic	0.70	0.33	2.12	38	0.041*

*Significance at the .05 level

the VRT between yogic and non-yogic practitioners' hand quickness is almost the same, and the ART of yogic practitioners was found to be faster than that of non-yogic practitioners.

Discussion

The findings presented in Table 3 highlight a significant difference in visual reaction time (VRT) compared to auditory reaction time (ART) among both yogic and non-yogic practitioners. This observation aligns with consistent research indicating that individuals engaging in yogic practices tend to have notably shorter ART in comparison to VRT. A noteworthy yoga training program demonstrated a significant decrease in both ART and VRT, with ART experiencing a more pronounced reduction (Ramanathan & Bhavanani, 2020). Further supporting this trend, Şenel and Eroğlu (2006) found significant distinctions between auditory and visual reaction times in male players, with auditory reaction time being superior. The study by Rahman and Islam (2021b) on male university team branch athletes and non-athletes revealed that ART exhibited greater statistical significance compared to VRT in both auditory and visual domains. The physiological aspect of these findings is reflected in the time taken for stimuli to reach the brain, with auditory stimuli taking approximately 8-10 ms and visual stimuli requiring 20-40 ms (Kemp, 1973; Marshall et al., 1943). Consistent with these temporal differences, research by Pain and Hibbs (2007), Shelton and Kumar (2010), and Ghuntla et al. (2014) supports the notion that auditory reaction time surpasses visual reaction time in terms of speed. Researchers Jain et al. (2015) further contributed to this body of knowledge by concluding, based on their study of college students, that auditory reaction time is generally quicker than visual reaction time.

The results of this study indicate that the VRT in terms of hand quickness is nearly identical between yogic and non-yogic practitioners. However, the auditory reaction time (ART) of yogic practitioners was observed to be faster than that of their non-yogic counterparts. This aligns with existing research, such as a study suggesting that yoga practices can significantly improve reaction times, both visually and auditorily (Madanmohan et al., 1992). A meta-analysis further supports the positive impact of yoga on auditory and visual reaction times (Ghuntla & Dholakiya, 2023). Other studies have demonstrated that short-term yoga training can effectively reduce baseline values of auditory, visual, and cutaneous reaction times in healthy individuals (Begum et al., 2012). Additionally, a study implementing a deep relaxation technique reported a notable decrease in both auditory and visual reaction times (Naik, 2021). Contrastingly, studies on visual simple reaction times among different team sports show no significant variations (Reza et al., 2023). Interestingly, hand quickness in simple visual reaction time was found to be similar between university athletes and sedentary students in the population (Rahman et al., 2020). Notably, research has consistently indicated that individuals who do not engage in sports tend to exhibit poorer auditory response times compared to athletes participating in various sports (Atan & Akyol, 2014; Palashikar et al., 2014; Kaplan et al., 2019). The observed reduction in ART and VRT within the yoga group suggests enhanced sensorimotor skills and an improved processing capacity of the central nervous system among individuals practicing yoga (Shobana et al., 2021).

The findings demonstrate that yoga has a positive impact on reaction times, enhanced sensorimotor skills, and improved central nervous system processing capacity due to yoga practice.

Conclusions

In summary, the investigation found that both yogic and non-yogic practitioners exhibited notably reduced auditory reaction time (ART) when compared to visual reaction time (VRT). Additionally, the outcomes suggest that the speed of hand reaction concerning VRT is almost indistinguishable between yogic and non-yogic practitioners. However, it was observed that the ART of yogic practitioners was faster than that of their non-yogic counterparts. The results indicate that regular yoga practice positively influences reaction times, improves sensorimotor skills, and enhances central nervous system processing capacity.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Поглиблений аналіз відмінностей у тривалості мультисенсорної реакції серед осіб, які практикують та не практикують йогу

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

Реферат. Стаття: 7 с., 3 табл., 49 джерел.

Історія питання. Час слухової та зорової реакції означає тривалість між поданням звуку або світла і початком реакції. Це важливий аспект людської поведінки, що впливає на ефективність у різних видах діяльності (від повсякденних завдань до спорту та надзвичайних ситуацій).

Мета дослідження. Метою цього дослідження було вивчити час реакції (слухової та зорової) як складової фізичної підготовленості між студентами чоловічої статі, які практикують йогу, та тими, хто не займається даною практикою.

Матеріали та методи. Для участі в цьому дослідженні методом рандомізації було відібрано сорок студентів чоловічої статі (N = 40). Із загальної кількості двадцять учасників (n = 20) були досвідченими практиками йоги, які брали активну участь у змаганнях з йоги на районному та державному рівнях. Решта двадцять осіб (n = 20) дотримувалися малорухливого способу життя і не були залучені до виконання практик йоги. Вік досліджуваних осіб становив від 17 до 25 років, що охоплює когорту молодих дорослих. Дані, що характеризують час зорової реакції (ЧЗР) та час слухової реакції (ЧСР), було зібрано за допомогою аудіо-візуального таймера реакції. Кожен учасник виконував завдання тричі, а середній бал використовувався для визначення експериментального часу реакції в мілісекундах (мс). Для оцінки рівня значущості використовували описову статистику та t-критерій для незалежних вибірок із заздалегідь встановленим пороговим значенням $p < 0,05$.

Результати. За результатами дослідження, порівняльний аналіз рівня ЧЗР та ЧСР між тими, хто практикує і не практикує йогу, показав, що для осіб, практикуючих йогу, значення $t_{(38)} = 2,91$ і $p < 0,006$, тоді як для тих, хто не практикує йогу, рівень $t_{(38)} = 3,55$ і $p < 0,001$. Що стосується ЧЗР між особами, які практикують і не практикують йогу, спостерігалися наступні показники — $t(38) = 1,99$ і $p > 0,054$, а для ЧСР між практикуючими та не практикуючими йогу, рівень $t_{(38)} = 2,12$ і $p < 0,041$.

Висновки. Результати дослідження свідчать про те, що особи, які займаються йогою, і ті, хто не практикують дану техніку, продемонстрували значно нижчий рівень ЧСР порівняно з ЧЗР. Подальші результати вказують на те, що швидкість руху рук при вимірюванні ЧЗР у практикуючих і непрактикуючих йогу майже однакова, однак показники ЧСР у практикуючих йогу були вищими, ніж у осіб, які не практикували йогу. Заняття йогою пов'язують з різними перевагами для фізичного та психічного здоров'я, тому дослідження вказують на те, що така практика може позитивно впливати на час реакції.

Ключові слова: час простої реакції, час зорової реакції, час слухової реакції, особа, яка практикує йогу, особа, яка не практикує йогу.

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