

Chapter 1

---

# Introduction

---

## 1.0 INTRODUCTION

Yoga, an ancient Indian tradition, is aimed at all-around personality development (Taimni, 2010). The practices in the discipline of Yoga include *yama* and *niyama* (moral and ethical conduct), *āsana* (physical postures), *prāṇāyāma* (regulated breathing), *dharānā* and *dhyāna* (meditation) as well as *ṣaṭkrīya* (six cleansing practices). *Trāṭaka* is one of the *ṣaṭkrīya* (six cleansing techniques) mentioned in *Hatha yoga pradipika* and *Gheraṇḍa saṁhitā*. The precise meaning of *trāṭaka* is to gaze steadily at an object without blinking the eyes till tears roll out. The practice of *trāṭaka* has two distinct phases, *antaranga* and *bahiranga*. The practice of *bahiranga trāṭaka* involves fixing the gaze on an external object such as a candle flame, whereas the *antaranga trāṭaka* leads to internalization of the vision and visualization of the candle flame with closed eyes at the eyebrow center. Thus, even though *trāṭaka* is a cleansing technique, the final stage of *antaranga trāṭaka* leads to a meditative mental state (Muktibodhananda, 1999; Saraswati, 2012).

The earlier studies of *trāṭaka* assessed the immediate effect on critical flicker fusion (CFF) in thirty healthy volunteers. There was a significant increase in CFF immediately after *trāṭaka* sessions indicating better visual perception (Mallick & Kulkarni, 2010b). In another study, the effect of *trāṭaka* on cognitive functions in the elderly population showed significant improvements in cognitive functions (Jagannathan et al., 2014). Another study demonstrated better performance on the Stroop colour-word test following *trāṭaka* compared to a control session (Raghavendra & Singh, 2016). A recent study demonstrated

the effectiveness of *trāṭaka* in improving cognitive performance and reducing anxiety among adolescents (Sherlee & David, 2020).

Changes in heart rate variability and breath rate were assessed in 30 healthy volunteers (Raghavendra & Ramamurthy, 2014). There was a significant reduction in breath rate and an increase in the high-frequency component of HRV, indicating a trend of relaxation and parasympathetic activity following the practice. A pre-post study showed a significant decrease in systolic and diastolic blood pressure, respiratory rate, intra-ocular pressure in both eyes, and fasting blood glucose in type 2 diabetes mellitus (Ismail et al., 2021). Another recent study of *trāṭaka* showed a significant reduction in Insomnia Severity Index (ISI) and the Pittsburgh Sleep Quality Index (PSQI) in people with Insomnia (Shathirapathiy et al., 2022).

The current scientific literature indicates the beneficial role of *trāṭaka* on cognitive functions, mental framework as well as autonomic activity. However, there are no studies on *trāṭaka* assessing the autonomic functions during the practice, and also the effect of the practice on reaction time, working and spatial memory as well as visual fatigue and mind-wandering.

Heart Rate Variability (HRV), along with other indicators such as blood pressure and galvanic skin response is a standard assessment tool for autonomic functions. HRV is widely used in several yoga studies (Tyagi & Cohen, 2016). Various yoga-based interventions are tested using HRV. Studies using yoga interventions assessing the autonomic functions include studies on breathing techniques such as *kapālabhāti* and *nāḍīśuddhi* (Lee & Ghiya, 2012; Raghuraj et al., 1998; Telles et al., 2011) *śiṛṣāsana* (Manjunath & Telles, 2003), Yoga *nidrā* (Markil et al., 2012) as well as meditation techniques (Patra & Telles, 2010; Vempati

& Telles, 2002). In general, yoga-based techniques are known to bring autonomic balance by reducing sympathetic arousal and increasing vagal tone (Saoji et al., 2019; Tyagi & Cohen, 2016). Such observations are consistent in clinical populations of patients with low back pain (Telles et al., 2016) as well as type II diabetes (Patil et al., 2019). Besides, yoga practices were found to influence HRV measures better than swimming (Sawane & Gupta, 2015). After seven days of *Prāṇāyāma*, the *Prāṇāyāma* group shown significant changes in GSR compare to non- *prāṇāyāma* group (Tarunakar et al., 2013). *Trāṭaka* may positively influence the autonomic functions during and following the practice.

Simple reaction time, the minimal time needed to respond to a stimulus is a basic measure of processing speed (Stebbins, 2007). There are several factors which are influencing reaction time like age, gender, right and left hand, exercise, fasting, distractions, illness etc. (Kosinski, 2013; Woods et al., 2015). And this reaction time is one of the indicators of cognitive function. The earlier studies on Yogasana and *prāṇāyāma* have shown a significant decrease in visual reaction time (VRT) and auditory reaction time (ART) (Madanmohan et al., 1992, 2005; Malathi & Parulkar, 1989). *Bhastrikā prāṇāyāma* (Bellows breathing) showed a significant reduction in the number of anticipatory responses compared to pre in yoga group (Bhavanani et al., 2003; Telles et al., 2013). Another study on *Sūrya namaskāra* (SN) showed an immediate decrease in ART and VRT (Bhavanani et al., 2013). Considering earlier studies of yogasanas and reaction time, we hypothesize that *trāṭaka* may positively influence visual reaction time.

With the dawn of technological advancement, the use of digital displays in the form of computer screens, and smartphones has become common. After the initial years, when digital displays were limited to professional purposes, it has now percolated into personal

and social lives. With the thrust on digital/e-learning, users from all age groups are using digital displays extensively. The use of such displays has increased rapidly due to the current COVID-19 pandemic, where a large number of people were confined to working/learning from home. Although the use of technology has many advantages, such prolonged usage leads to health implications. Visual strain or eye strain is a subjective symptom of ocular fatigue, discomfort, lacrimation and headache, blurry vision, and sensitivity to light (Laurence, 2018). Prolonged and improper usage of visual displays leads to irritation, dryness, eye strain, tiredness, burning sensation, redness, and blurred vision (Gowrisankaran & Sheedy, 2015). Visual fatigue and discomfort are associated with the usage of smartphones (Kim et al., 2017). There was a significant correlation between ocular pain and tiredness, eye-related tiredness, and eye-related pain with increased orbicularis oculi muscle load blood flow during computer work (Thorud et al., 2012). Prolonged computer or smartphone usage can also lead to musculoskeletal discomfort of the neck, lower back, and upper limbs, as well as psychosocial problems (Hales et al., 1994; Koh et al., 1994). Increased digital screen time, near work, and limited outdoor activities were associated with myopia's onset and progression (Wai Wong et al., 2020).

Besides, prolonged use of digital screens harms psychosocial well-being and decreases performance in adolescents (Skoric et al., 2009; Van et al., 2018). The usage of smartphones is known to affect learning, memory, and recall (Tanil & Yong, 2020). There is a tendency for mind-wandering due to prolonged smartphone usage (Markowitz et al., 2019).

Mind-wandering impairs task performance (Stawarczyk et al., 2011). It is connected with unpleasant emotions, negative mood, and depression (Smallwood et al., 2009). Also, stress and anxiety lead to mind-wandering, which impacts cognitive function (Boals & Banks, 2020; Gonçalves et al., 2018). It also leads to poor scholastic performance among

students (Desideri et al., 2019).

Due to the digital revolution, it is not possible to skip the usage of screen time. Thus, strategies for reducing the effects of digital display usage need to be emphasized. A review on visual discomfort management stated that 90% of display device users experience digital eye strain symptoms. The study suggested a few strategies to overcome the symptoms and enhance productivity at work, such as intermittent blinking and eye exercises, the use of lubricant eye drops, digital color filters, etc. (Coles-Brennan et al., 2019). However, there is a need for a holistic approach to reducing visual strain.

In recent years, yoga has evolved as multidisciplinary holistic mind-body practice, positively impacting health and disease (Saoji et al., 2019; Swathi et al., 2020). There are very few studies evaluating the effects of yoga practices on vision. A study evaluated a combination of yoga practices on visual discomfort using a self-rated questionnaire. After sixty days of intervention, the yoga group showed a reduction in visual discomfort than the waitlisted group (Telles et al., 2006). The nursing and optometry students showed decreased eye fatigue scores after the 30-60min practice of yogic eye exercise (Gupta & Aparna, 2020; Kim, 2016). Eye movements can bring a state of relaxation and a level of wakefulness (Hedstrom, 1991). Yoga-based meditation and yogic breathing also were beneficial in reducing mind wandering and anxiety and increasing attention (Anusuya et al., 2021; Saoji et al., 2018). Mindfulness practices are effective and efficient techniques to improve cognitive function and reduce mind wandering (Mrazek et al., 2013). Thus, yoga practices might have a potential role to play in managing visual strain and its consequences.

Traditional texts narrate the practice to be useful for eye disorders, fatigue, and insomnia (Muktibodhananda, 1999). Studies done on *trāṭaka* report a beneficial role in eye disorders but failed to elicit objective changes in refractive errors (Gopinathan et al., 2012;

Tiwari et al., 2018). There is a paucity of scientific studies on *trāṭaka* in visual strain, for which it may potentially have a positive impact on the condition. Thus, we undertook a study to evaluate the effect of *trāṭaka* in reducing visual strain and promoting psychological well-being.

Scientific research in recent times has explored the positive impact of yoga practices on various domains of physiology and psychology in healthy and therapeutic settings (Field, 2016). One major area of interest in Yoga research has been the effects of yoga practices on cognition and performance. Yoga practices appear to prevent neurodegeneration and enhance neuroplasticity by influencing specific brain areas involved with domains of cognition such as the hippocampus, amygdala, prefrontal cortex, insula, and default mode network (Gothe et al., 2019, Marciniak et al., 2014). A meta-analysis that included fifteen RCTs and eight acute exposure studies indicated the beneficial effect of yoga on cognition, attention, processing speed, and memory (Gothe and McAuley, 2015). Various aspects of cognition such as spatial and visual memory scores (Garg et al., 2016; Gupta et al., 2019; Joshi & Telles, 2008), verbal memory (Naveen et al., 1997), executive functions, attention, and concentration (Chattha et al., 2008), working memory (Subramanya & Telles, 2009) and response inhibition (Rajesh et al., 2014), visual attention (Jarraya et al., 2019) and task switching (Anusuya et al., 2021) were found to be positively influenced through yoga practices such as Yogasanas, *prāṇāyāma* as well as meditation techniques. Yoga practice was found to be better than physical exercises in improving cognitive functions in school children (Vhavle et al., 2019). The classical texts of *Hathayoga* describe the profound impact of the six cleansing techniques on various aspects of one's personality, which are also validated through empirical studies (Muktibodhananda, 1999; Swathi et al., 2020). *Trāṭaka* (Yogic Visual concentration) is one of the cleansing techniques considered to

enhance vision and positively influence cognitive processes. Since the process of *trāṭaka* involves focused attention on a candle flame, the practice leads to the mind becoming one-pointed and arouses inner vision (Muktibodhananda, 1999). Earlier studies on *trāṭaka* and cognition have demonstrated enhanced performance in Stroop Task (Raghavendra & Singh, 2016; Sherlee & David, 2020). Six Letter cancellation and Trail making tasks (Talwadkar et al., 2014), and Critical Flicker Fusion (Mallick & Kulkarni, 2010). Considering the earlier studies on *trāṭaka* and cognition, we hypothesize that *trāṭaka* may positively influence the domains of cognition such as spatial and working memory. Corsi Block Tapping Task (CBTT) is a neuropsychological test that measures visuospatial short-term and working memory. The task can be performed using a computer to collect the data with precision (Kessels et al., 2000; Siddi et al., 2020). Considering the wide use and ease of administration of CBTT, the current study was designed to evaluate the effect of *trāṭaka* on the performance in the CBTT.

### **Need Of the Study**

There is a paucity of scientific studies about the effects of *trāṭaka* on autonomic and cognitive functions and visual strain and psychological functions. All these domains could be potentially influenced positively through the practice of *trāṭaka*. Thus, we undertook studies to evaluate the effect of *trāṭaka* to understand autonomic changes during the *trāṭaka* and on Visual Reaction Time; performance in CBTT (for working and spatial memory) and to evaluate the effect of *trāṭaka* on the visual strain and promoting psychological well-being.