IMMEDIATE EFECT OF BHASTRIKA PRANAYAMA ON COGNITIVE FUNCTION OF HEALTHY ADULTS

Dissertation

Submitted Towards Partial Fulfillment of

Master of Yoga

By

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CERTIFICATE

This is to certify that **AYUSHI BANZAL** who has got MSc registration with start from August 01, 2018 by Swami **Vivekananda Yoga Anusandhana Samsthana, deemed to-be University**, has successfully completed the required training in acquiring the relevant background knowledge in Yoga Therapy and has completed the M.Sc. course of 2 years to submit this research project entitled **"Immediate effect of bhastrika pranayama on cognitive functions of healthy adults"**

Dr. VIKAS RAWAT

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Date:

Place: Bengaluru

DECLARATION

I hereby declare that the subjected study was conducted by me at **Swami Vivekananda YogaAnusandhana Samsthana (S-VYASA),** Bengaluru, under the guidance of **Dr. VIKAS RAWAT**.

I also declare that the subject matter of my dissertation entitled **"Immediate effect of bhastrika pranayama on cognitive functions of healthy adults"** has not previously formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles.

DATE:AYUSHI BANZAL
PLACE: Bengaluru

ACKNOWLEDGEMENT

An Enriching learning experience can be possible only with the complete support of the Institution, teachers, Family and friends.

So, I am extremely thankful to **Swami Vivekananda Yoga Anusandhana Samsthana (SVYASA)** for offering me the opportunity for an enriching learning experience of Yoga research by preparing us for this study and completing the study successfully .

I am whole heartedly thankful to my research guide **Dr. VIKAS RAWAT**for suggesting this topic, and the technical and emotional support extended by guiding me all through the process of research .His guidance has proved to be highly useful and without him the study may not have been possible.

I am also thankful to my research co guide **Dr. Rajesh S.K., Dr. Judu** for guiding us regarding the study design , assessment tools and also making all the concepts of scientific writing very clear

I would like to take this opportunity to extend the gratitude to my family and friends and whosoever helped me with their inspiration and support in making this research a wonderful learning experience.

DATE: AYUSHI BANZAL

PLACE: Bengaluru

STANDARD INTERNATIONAL TRANSLITERATION CODE USED TO TRANSLITERATE SANSKRIT WORDS

Standard International Transliteration Code
(used to transliterate Sanskrit words in the text)

अ	=	**a**	ड	=	**ḍa**
आ	=	**ā**	ढ	=	**ḍha**
इ	=	**i**	ण	=	**ṇa**
ई	=	**ī**	त	=	**ta**
उ	=	**u**	थ	=	**tha**
ऊ	=	**ū**	द	=	**da**
ऋ	=	**ṛ**	ध	=	**dha**
ए	=	**e**	न	=	**na**
ऐ	=	**ai**	प	=	**pa**
ओ	=	**o**	फ	=	**pha**
औ	=	**au, ou**	ब	=	**ba**
अं	=	**m**	भ	=	**bha**
अः	=	**ḥ**	म	=	**ma**
क	=	**ka**	य	=	**ya**
ख	=	**kha**	र	=	**ra**
ग	=	**ga**	ल	=	**la**
घ	=	**gha**	व	=	**va**
ङ	=	**ṅa**	श	=	**śa**
च	=	**ca**	ष	=	**ṣa**
छ	=	**cha**	स	=	**sa**
ज	=	**ja**	ह	=	**ha**
झ	=	**jha**	क्ष	=	**kṣa**
ञ	=	**ña**	त्र	=	**tra**
ट	=	**ṭa**	ज्ञ	=	**jña**
ठ	=	**ṭha**			

ABSTRACT

Immediate effect of Bhastrika Pranayama on cognitive functions of healthy adults.

Background

There are several types of voluntarily regulated yoga breathing techniques, all of which are considered to influence the mental state. Bhastrika or bellows-type of breathing which is a yogic technique in which the breath is actively blasted out in multiple 'whooshes' with forced abdominal contractions.Cognition means high level processing of specific information including thinking, memory, perception, motivation, skilled movements and languages.Although the range of cognitive problems can be diverse ranging in various cognitive domains like executive function, attention and information processing and working memory which appears to be at higher risk. Yoga Practice has been shown to be effective in improving mood and decreasing stress and depression. During exercise alpha waves are increased in the brain (increase calmness) and blood level of cortisol decreases which is a stress hormone. In pranayama practice when person intentionally focus on breathing at different frequencies of respiration and intend to relax, attention is drawn away from extraneous distracting stimuli. With continuous pranayama practice, the person's ability to concentrate is enhanced and the changes in mental processing (e.g., focused attention and reduced stress) are rapidly expressed in the body via the autonomic and neuro endocrine systems.

Objective:

The objective of the study is to investigate the immediate effect of bhastrika pranayama on various cognitive function like reaction time, working memory, divided attention and vigilance and their influence on psychological responses after a slow paced 5 minutes continuous bhastrika pranayama on healthy adults.

Materials and Methods:

86 healthy adults ((f)n=45, (m)n=41) were taken for the study from SVYASA university, Banglore, aged between 19 to 28 years who are practitioners of yoga for at least 6 months. It was a two days study Participants were randomized into self as control group. To eliminate the practice effect of the

inquisit tests, they were randomized as one group were given the bhastrika intervention first and performed the tests and then on second day performed same tests but without bhastrika and similarly other group performed the tests without intervention on the first day and on second day after practicing the bhastrika pranayama.

Result:

Bhastrika pranayama has produced significant results when analyzed with the Wilcoxon sign rank test gave p value < 0.05 for almost all the parameters showing immediate effect of slow paced bhastrika pranayama on cognitive functions with reaction time divided attention showing highest significant results, on working memory showing moderately significant results and on vigilance showing least significant results.

Conclusion:

The investigations in this study suggests that bhastrika pranayama has showed significantly high immediate effect on reaction time, divided attention and working memory and not much significant effect on sustained attention or vigilance. From this study a conclusion from the results can be derived that bhastrika pranayama helps in triggering or activating the sympathetic nervous system of the brain by improving the response rate and reducing the latency periods of the responses.

CONTENTS

1. INTRODUCTION

COGNITION: Cognition means high level processing of specific information including thinking, memory, perception, motivation, skilled movements and languages. Cognitive psychology has become an important part in the research of a number of psychiatric disorders(Jung, 316AD). Researches in various areas of neurocognition has revealed many underlying secrets of psychopathology and issues related to it, outcomes and treatment strategies(Sweller, 1988). Although the range of cognitive problems can be diverse ranging in various cognitive domains like executive function, attention and information processing and working memory which appears to be at higher risk(Chai, Ismafairus, Hamid, Abdullah, & Elliott, 2018).

Gestalt approach and structuralism together led to the concept cognitive perspective which focuses on how we know the world. Cognition is the process of knowing and includes thinking, understanding, perceiving, memorization, problem solving and host of other mental processes by which our knowledge of the world develops and making us able to deal with the environment. Some psychologists view human mind as an information processing system just like computer. Just like computer our mind receives, processes, transforms, stores and retrieve information(Trivedi, 2006). The hippocampus of our brain contains the neural circuitry crucial for cognitive functions like learning and memory which refers to the perceptual and intellectual aspects of mental functioning(Gould et al., 2012). And among the specific functions that may be assessed in determining the intactness or adequacy of cognition are orientation, the ability to learn necessary skills, solve problems, think abstractly, reason and make judgements, the ability to retain and recall events, mathematical ability and other forms of symbol manipulation, control over primitive reactions and behavior language use and comprehension, attention, perception. Also cognitive deficits may result in the inability of the following(Hughes, 2008a)(Rothenhäusler, Ehrentraut, Stoll, Schelling, & Kapfhammer, 2001):

1. Paying attention
2. Processing information quickly
3. Remember and recall information
4. Responding to information quickly

5. Critical thinking, planning, organizing and solving problem
6. Also initiating speech

WORKING MEMORY: Working memory is the brain system that provides temporary storage and manipulations of the information necessary for complex cognitive tasks for e.g., language comprehension, understanding, reasoning and learning and the guidance of decision making(Trivedi, 2006). Working memory function is assumed to be a network of temporary memory systems. It is the ability to hold the stimuli for short period of time and then either use it directly after a short delay or mentally process or manipulate it to solve cognitive and behavioral tasks(Rathore & Lom, 2017). The general consensus regarding working says that the working memory is extensively involved in goal directed behaviors where information must be retained and manipulated to ensure successful task execution.

Recent studies have subsequently implicated the roles of subcortical regions (such as the midbrain and cerebellum) in working memory. Aging also appears to have modulatory effects on working memory; age interactions with emotion, caffeine and hormones appear to affect working memory performances at the neurobiological level(Andersson & Lyxell, 2007). Moreover, working memory deficits are apparent in older individuals, who are susceptible to cognitive deterioration. Another younger population with working memory impairment consists of those with mental, developmental, and/or neurological disorders such as major depressive disorder and others(Ransdell & Hecht, 2003).Working memory is a multicomponent system that manipulates information storage for greater and more complex cognitive utility. The three subcomponents involved are phonological loop (or the verbal working memory), visuospatial sketchpad (the visual-spatial working memory), and the central executive which involves the attentional control system as proposed by Baddeley and Hitch(Baddeley & Hitch, 1974). Then another component was introduced in the model termed as episodic buffer regarded as temporary storage system that modulates and integrates different sensory information(Larson et al., 2015). Instead of seeing working memory as merely an extension and a useful version of short-term memory, it appears to be more closely related to activated long-term memory, as suggested by Cowan, who emphasized the role of attention in working memory(Cowan, 2007, 2008).

ATTENTION (SUSTAINED ATTENTION/VIGILANCE AND DIVIDED ATTENTION):

The process through which certain stimuli are selected from a group of others is generally referred to as attention. Other than selection attention also refers to several other properties like alertness, concentration and search(Hughes, 2008a). Alertness is an individual's preparedness to deal with the stimuli that appears before him. Concentration is focusing on or awareness on certain specific object while ignoring or excluding others for a moment. While in search an individual/observer search of specified object among a set of objects. Attention has mainly two types that are 1) selective attention and 2) sustained attention and the third type which is as important as the other two as divided attention is a cognitive ability that is very important in our daily lives because it makes it possible to carry out tasks quickly and efficiently(Pan, Wang, Lei, Wang, & Li, 2019).

Selective attention is concerned mainly with the selection of a limited number of stimuli or objects from a large number of stimuli. And there many factors like internal, external, motivational and cognitive factors which affects the selection of stimuli(Trivedi, 2006).

Sustained attentionis concerned with concentration. It refers to ability to maintain attention on an object or event for longer durations and is also known as **vigilance.**Sometimes people have to concentrate on a particular task for many hours(Harber et al., 2019). Air traffic controllers and radar readers provide us with good examples of this phenomenon(Dolder, Strajhar, Vizeli, Odermatt, & Liechti, 2018). They have to constantly watch and monitor signals on screens. The occurrence of signals in such situations is usually unpredictable, and errors in detecting signals may be fatal. Hence, a great deal of vigilance is required in those situations(Markovic, Schult, Elg, & Bartfai, 2020). There are several factors which facilitate or inhibit the performance on tasks o sustained attention. They are:

1) Sensory modality: performance is found to be superior when the signals are auditory than the visual.
2) Stimuli clarity: long lasting stimuli facilitate sustained attention and results in better performance.
3) Temporal uncertainty: if stimuli is given at regular intervals of time, they are attended better as compared to the given at irregular intervals.
4) Spatial uncertainty: stimuli at a fixed place are readily attended as compared to those appearing at random locations which are difficult to attend(Kovess-Masfety et al., 2016).

In Divided attention wherecorrectly carrying out tasks implies more than one perceptive, and motor, or cognitive activity at the same time depends directly on our divided attention. As in our day to day life we come across many such events where we find we are doing several things at the same time for e.g. people driving car and also talking to a friend sitting next to him. Here we will notice that actually that they are still allocating the most of the effort or attention to driving as compared to other activities. By this we can say that on some occasions attention can be allocated to more than one thing at the same time called as divided attention(Fernandas & Moscovitch, 2000). However it is possible only with highly practiced activities as they become almost automatic and requires less attention to perform than new or slightly practiced activities which we call as **automatic processing** which is an important part of divided attention. Automatic processing has three main components that is: 1) it occurs without intention 2) it takes place unconsciously and 3) it involves very little (or no) thought processing(Gould et al., 2012). Although Results suggest that when attention is divided at retrieval, interference is created only when the memory and concurrent task compete for access to word-specific representational systems; no such specificity is necessary to create interference at encoding. During encoding, memory and concurrent tasks compete primarily for general resources, whereas during retrieval, they compete primarily for representational systems(Sweller, 1988).

RECTION TIME: In simple words reaction time is the amount of time it takes to respond to a stimulus. Also reaction time is the time required by the sensory organs to adapt and the brain to process, deciding what to do and then transmitting the information to the proper body parts. Reaction time is a simple form of speed which depends mainly on the nervous system. It's the time interval between a signal and a reaction to it. The signal is perceived by the sensory system and the reaction evolves in the brain that runs to the spinal cord to the muscles resulting in contraction. Average reaction time to sounds and visual information is 0.13-0.18 seconds, without considering the speed of sound(Reduction, 2008). It can be determined by genetic factors and age and can be changed with sufficient efforts. For e.g. its values can decrease/improve with loading and is impaired by fatigue. Simple reaction time (SRT)(reaction to certain stimuli) of an average individual is 0.16-0.2 seconds and can be improved by training and constant practice and can even go below 0.1s. SRT is the reaction time to certain stimulus whereas complex reaction time (CRT) is the reaction to the right stimulus selected for many stimulus and it increases reaction time(Telles, Pal, Gupta, & Balkrishna, 2018).

Also Reaction time is the interval time between the presentation of stimulus and the initiation of muscular response to the stimulus. The central nervous system is responsible for selecting, combining, and weighting available sensory information for optimizing balance control, depending on the task, environment, and functional integrity of the sensory organs(Bhavanani, Ramanathan, & Harichandrakumar, 2012a).Movement time involves execution of a subsequent motor task response, and is included in many reaction time tests. SRT assessed at the time taken to respond to a single stimulus with a single response, slows from 30s marked further slowing down beyond 60 years of age(S., A., & S., 2016). Even greater age related changes are found for CRT tasks for e.g. those requires greater cognitive processing and/or more complicated motor responses. Fast and accurate responses are important for responding to postural challenges and adapting gait to avoid late noticed trip or slip hazards. Slow reaction time is associated with poor functional performances and increased SRT is also a risk factor for fall in populations of older of varying functional ability(Bhavanani, Madanmohan, & Udupa, 2003).

YOGA AND PRANAYAMA:

Yoga mean Sanskrit word yuj which mean union. Union of oneself (jivatma) with universal self (parmatma) Swami Vivekananda emphasized the role of yoga as the means to accelerate the rate of evolution of an individual. Evolution is a natural process but through yoga we can speed up this process through conscious effort. One can get liberated from the cycle of birth and death in single birth it. Also Sri Aurobindo said that yoga is a conscious method towards self- development to bring out the inherent potential of the individual. He emphasized on all round personality development; at physical mental intellectual emotional and spiritual levels. He means that yoga is a process by which limitations and imperfections can be washed away resulting in a super human race.And according to patanjali, yoga is to gain mastery over mind(Hughes, 2008b).

The word Prāṇāyāma is comprised of two components: ‘prāṇa’ and ‘āyāma’. Prāṇa means ‘vital energy’ or ‘life force’. Āyāma is defined as ‘extension’ or ‘expansion’. Thus, the word Prāṇāyāma means ‘extension or expansion of the dimension of prāṇa’. In the Prāṇāyāma practices, there are four important aspects of breathing such as (1) Pūraka (inhalation), (2) Recaka (exhalation), (3) Antaḥ kumbhaka (internal breath retention), and (4) Bahiḥ kumbhaka (external breath retention). An advanced stage of Prāṇāyāma which occurs during high states of meditation is called as kevala kumbhaka (spontaneous breath retention)(Rajak, Rampalliwar,

&Mahour, 2012). Expansion of Individual energy to cosmic energy is also called pranayama. Pranayama can be practiced as either fast or slow pranayamas. Both fast and slow pranayamas are beneficial, but their physiological responses are different in a healthy person. Pranayma practice helps to reap maximum benefits by controlling the life force in a superior and extraordinary way by harmonizing body, mind, and spirit(Hughes, 2008b).

BHASTRIKAPRANAYAMA:

Bhastrika involves a rapid and forceful process of inhalation and exhalation powered by the movement of the diaphragm. The movement of air is accompanied by an audible sound. One inhale and exhale equals one round of bhastrika, and it's going to be repeated for several consecutive rounds. Swami Sivananda describes the process: "inhale and exhale quickly ten times just like the bellows of the blacksmith. Constantly dilate and contract. When you practice this Pranayama a hissing sound is produced. The practitioner should start with rapid expulsions of breath following each other in rapid succession. When the specified number of expulsions, say ten for a round, is finished, the ultimate expulsion is followed by a deepest possible inhalation. The breath is suspended as long because it might be through with comfort. Then deepest possible exhalation is done very slowly. The end of this deep exhalation completes one round of Bhastrika (Hughes, 2008b).

YOGA FOR COGNITION:

Stress, anxiety and depression are known to be significant factors in the onset and progression of a wide spectrum of illness ranging from cardiovascular diseases, asthma, cancer, to HIV-infection. Yoga practices are time–honored stress management/health promotion techniques whose health benefits are being validated by modern medical science. Independent research has shown that significantly reduced levels of cortisol reduce the level of stress, relieve anxiety, depression, increase anti – oxidant production, enhance brain function, enhance the sense of well – being and peace of mind(Sharma et al., 2014). The health benefits are scientifically proven with researchers reporting that pranayama is beneficial in treating a range of stress

related disorders. Improving autonomic functions, and reducing sign of oxidative stress. Regular practice of breathing exercise (pranayama) increases parasympathetic tone, decreases sympathetic activity, improves cardiovascular and respiratory functions, decreases the effect of stress and strain on the body and improves physical and mental health.
Yoga Practice has been shown to be effective in improving mood and decreasing stress and depression. During exercise alpha waves are increased within the brain (increase calmness) and blood level of cortisol decreases which may be a stress hormone. Vagal tone increases and sympathetic tone decreases after yoga practice. Yogic practices can be used as psycho-physiologic stimuli to release endogenous secretion of melatonin, which, in turn, might be responsible for improved sense of well-being. Also Executive functions refer to cognitive processes that regulate, control, and manage other cognitive processes. Executive functions include memory, concentration span, scanning and retrieval of stored information and mental flexibility, i.e., the power to shift from one criterion to a different in sorting or matching tasks(Rajak et al., 2012). Perceived stress features a negative impact on executive functions. According to the traditional wisdom yoga, pranayama is the key in bringing psychosomatic integration and harmony. Specifically, research have found that a big reduction in perceived stress and improvement within the following cognitive domains: attention, visuo-motor speed and memory retention capacity in both fast and slow pranayama. Prefrontal cortex regulates physiological functions by integrating information from ongoing cognitive processes, emotional processes and current stress level. Perceived stress alters normal patterns of prefrontal cortex activation during cognitive tasks, leading to enhanced autonomic arousal. The reduced stress in both pranayama groups could have enabled their improved cognitive functions(Bhavanani, Ramanathan, & Harichandrakumar, 2012b).
The bottom-up mechanisms of pranayama practice could also be induced through the stretch of respiratory muscles, specifically the diaphragm. During above tidal inhalation (as was seen in Hering Breuer's reflex), stretch of lung tissue produces inhibitory signals in the vagus nerve, which ultimately shifts the autonomic nervous system into parasympatho-dominance, that leads to a relaxed and alert state of mind. In pranayama practice when person intentionally specialize in breathing at different frequencies of respiration and shall relax, attention is drawn faraway from extraneous distracting stimuli. With continuous pranayama practice, the person's ability to concentrate is enhanced and therefore the changes in mental processing (e.g., focused attention and reduced stress) are rapidly expressed within the body via the autonomic and

neuro endocrine systems(Sharma et al., 2014). This reorganizes neural representation within the CNS and improves bidirectional communication between the cerebral cortex and the limbic, autonomic, neuro endocrine, emotional, and behavioral activation. Also studies have shown that fast breathing practices or pranayama has shown greater beneficial effects on managing stress and improving cognitive functions also fast pranayama has additional effects on sensor-motor performance i.e. faster auditory and visual RT(Rajak et al., 2012).

2.0 ANCIENT LITERATURE REVIEW

As stated in second paad sadhana paad of Patanjali yoga sutra pranayama is(Sutras, n.d.):

tiSmn! sit ñsàñsyaegRitivCDed> àa[ayam>.49.

tasmin sati çvasapraçvasayorgativicchedaù präëäyämaù||49||

Controlling the motion of the exhalation and the inhalation follows after this.
Pranayama the controlling of the vital forces of the body. Prana is not breath, though it is usually so translated. It is the sum-total of the cosmic energy. It is the energy that is in each body, and its most apparent manifestation is the motion of the lungs. This motion is caused by Prana drawing in the breath, and is what we seek to control in Pranayama. We begin by controlling the breath, as the easiest way of getting control of the Prana.

bý_yNtrStMÉiìiÄ> dezklsNOyiÉ> piriÔòae id"RsaeKZm>.50.

bahyabhyantarastambhavrittiù deçakalasankhyabhiù paridriñöo dirghasookçmaù||50||

Its modifications are either external or internal, or motionless, regulated by place, time, and number, either long or short.

The three sorts of motion of this Pranayama are, one by which we draw the breath in, another by which we throw itout, and the third action is when the breath is held in the lungs, or stopped from entering the lungs. These, again, are varied by place and time. By place is meant that the Prana is held to some particular part of the body. By time is meant howlong the Prana should be confined to a certain place, and so we are told how many seconds to keep on motion, and how many seconds to keep another. The result of this Pranayama is Udghata, awakening the Kundalini.When you retain the breath you are stopping nervous impulses in different parts of the body and harmonizing the brain wave patterns. In pranayama, it is the duration of breath retention which has to be increased. The longer the breath is held, the greater the gap between nervous impulses and their responses in

the brain. When retention is held for a prolonged period, mental agitation is curtailed. Actually, Patanjali defines pranayama as the gap between inhalationand exhalation. Pranayama is usually considered to be the practice of controlled inhalation and exhalation combined with retention. However,technically speaking, it is only retention.Inhalation/exhalation are methods of inducing retention. Retention is most important because it allows a longer period for assimilation of prana, just as it allows more time for the exchange of gases in the cells, i.e. oxygen and carbon dioxide. Patanjali further says that retention of breath after expirationremoves the obstacles to yoga. Yoga is the union of the two poles of energy within us. In mundane awareness these poles are separate from each other. In transcendental awareness these poles come closer together, and during retention the poles come closest together. Breath retention must be developed in order to stop the fluctuations of the brain and mind so that a more expansive type of experience can develop.

According to Srimad Bhagwat Gita pranayama is:

Apane jÞit àa[< àa[e=pan< twapre,

àa[apangtI éÏa àa[ayampray[a>.4,29.

apäne jahvati präëaà präëe'pänaà tathäpare|

präëäpänagaté ruddhä präëäyämaparäyaëäù||4|29||

Others practice control of the life-airs by offering the in-going breath into the out-going breath and out-going breath into the in-going breath, and thus restrain both. Others offer their life airs by controlling the intake of food.

According to Hatha yoga pradipika(Svatmarama, 2002), it states that:

cle vate cl< icÄ< iníle iníl< Évet!,

yaegI Swa[uTvmaßaeit ttae vyu< inraexyet!.2.

cale väte calaà cittaà niçcale niçcalaà bhavet |
yogé sthäëutvamäpnoti tato vayuà nirodhayet||2||

When prana moves, chitta (the mental force) moves. When prana is without movement, chitta is without movement. By this (steadiness of prana) the yogi attains steadiness and should thus restrain the vayu (air).

Prana and mind are intricately linked. Fluctuation of one meansfluctuation of the other. When either the mind or prana becomes balanced the other is steadied. Hatha yoga says, control the prana and the mind is automatically controlled, whereas raja yoga says, control the mind and prana becomes controlled. These are two paths of yoga. The mind is equated with a wild monkey, jumping here and there.Because of this inborn tendency it is very difficult to hold it still. Hatha yoga says let the mind be, concentrate on the autonomic body functions and vital energy, and the mind will become quiet by itself. When the nervous impulses are steady and rhythmic, the brain functions are regulated and the brain waves become rhythmic. The breathing process is directly connected to the brain and centralnervous system and it is one of the most vital processes in the body system. It also has some connection with the hypothalamus, the brain center which controls emotional responses. The hypothalamus is responsible for transforming perception into cognitive experience. Erratic breathing sends erratic impulses to this center and thus creates disturbed responses. There are also certain areas of the nasal mucous membrane which areconnected to the visceral organs. When impulses coming from the nose are arrhythmic, the visceral organs, particularly those connected to the coccygeal plexus, respond in the same manner, arrhythmically. Being disturbed, these organs again send irregular impulses to the brain and cause more disharmony and imbalance. This cycle is continuous.By becoming aware of the nature of the breath and by restraining it,the whole system becomes controlled.

According to Gherand Samhita pranayama is(Gheraṇḍa & Niranjanananda Saraswati, n.d.):

àa[ayamat! oecrÅv< àa[ayamadœ raegnaznm!,

àa[ayamadbaexyeCDi´< àa[ayamaNmnaeNmnI,

}anNdae jayte icÄe àa[ayamI suoI Évet!.57.

präëäyämät khecarattvaà präëäyämäd roganäçanam|

präëäyämädabodhayecchaktià präëäyämänmanonmané|

jïänando jäyate citte präëäyämé sukhé bhavet||57||

By pranayama is attained the power of levitation (khichri shakti), by pranayama diseases are cured, by pranayama the Shakti (spiritual energy) is awakened, by pranayama is obtained the calmness of mind and exhalation of mental powers (clairvoyance etc.,); by this , mind becomes full of bliss; verily by practitioner of pranayama is happy.

According to shiva Samhita pranayama is(Rai Bhahadur Srisa Chandra Vasu (translation), 1914):

ttae yweòa zi´> Sya*aeignae vayuxar[e,

yweò< xar[Öayae> k…MÉk> isXyit Øuvm!.

kevle k…MÉke isXde ik< n Syaidh yaeign>.39.

tato yatheñöä çaktiù syädyogino väyudhäraëe|

yatheñöaà dhäraëadväyoù kumbhakaù sidhyati dhruvam||

kevale kumbhake sidhde kià na syädiha yoginaù||39||

When the yogi can, of his will, regulate the air and stop the breath (whenever and how long) he likes, then certainly he gets success in kumbhaka, and from the success in kumbhaka only, what things cannot the yogi command here?

Shiv Samhita is one of the most important texts of hatha yoga which is a conversation between lord shiva and goddess parvati which unfolds the secrets and path of salvation through the practice of hatha yoga and guides us to the ultimate truth, the ultimate reality. In this there are many ways and stages of practicing pranayama to reach the state of levitation and then nadi suddhis and then attaining various siddhis by controlling the various vayus.

BHASTRIKA PRANAYAMA ACCORDING TO VARIOUS ANCIENT SCRIPTURAL TEXTS:

According to gherand Samhita:

ÉôEv laehkara[a< ywa³me[s<æmet!,

twa vayu< c nasa_yamuÉa_ya< caLyeCDnE>.75.

bhastraiva lohakäräëää yathäkrameëa sambhramet|

tathä väyuà ca näsäbhyämubhäbhyää cälyecchanaiù||75||

@v< i;<zit;ar< c k«Tva k…yaRí k…MÉkm!,

tdNte calyeÖayu< puvaeR´< c Ywaivix.76.

iÇvar< saxyeden< Éiôkak…MÉk< suxI>,

n c raegae n c ¬ez AaraeGy< c idne idne.77.

evaà ñiàçatiñäraà ca kåtvä kuryäçca kumbhakam|

tadante cälayedväyuà purvoktaà ca ythävidhi||76||

triväraà sädhayedenaà bhastrikäkumbhakaà sudhéù|

na ca rogo na ca kleça ärogyaà ca dine dine||77||

75. As the bellows of the ironsmith constantly dialate and contract, similarly let him slowly draw in the air by both the nostrils and expand the stomach; then throw it out quickly (the wind making sound like bellows).

76-77. Having thus inspired and expired quickly twenty times, let him perform kumbhaka; then let him expel it by the previous method. Let the the wise one perform this bhastrika(bellow-like) kumbhakas thrice: he will never suffer any disease and will be always helathy.

According to hatha yoga pradipika:

ywa lgit ý‰Tk<Q kpalavix sSvnm!,

vegen pUrye½aipý‰TpÒavix maétm!.61.

punivRrecyeÄÖTpUrye½ pun> pun>,

ywEv laehkare[Éôa vegen caLyte.62.

yathä lagati hyatkaëöhe kapälävadhi sasvanam|
vegena pürayeccäpihyatpadmävadhi märutam||61||
punarvirecayettadvatpürayecca punaù punaù|
yathaiva lohakäreëa bhasträ vegena cälyate||62||

And again the air should be quickly inhaled up to the heart lotus. Accordingly, the resounding is felt from the heart and throat up to the cranium.In that way it (the breath) is inhaled and exhaled repeatedly, with the same motion as a pair of bellows being pumped.

ivixvTk…<Ék< k«Tva recyeidfyainlm!,
vatipÅðe:mhr< zrIrai¶ivvxRnm!.65.

vidhivatkumbhakaà kåtvä recayediòayänilam|
vätapittçleñmaharaà çarérägnivivardhanam||65||

Having performed (pranayama and) retention systematically, exhale through the left nostril. Thereby imbalances of wind, bile and mucus are annihilated and the digestive fire increased.

Bhastrika is the name of the pranayama which imitates the action ofthe bhastra or ‘bellows’ and fans the internal fire, heating the physical and subtle bodies. Bhastrika pranayama is similar to vatakrama kapalbhati, but in bhastrika, inhalation and exhalation are equal and are the result of systematic and equal lung movements. The breath has to be sucked in and pushed out with a little force. In kapalbhati, inhalation is the result of forced exhalation. Bhastrika should not be done so forcefully that the nostrils are suckedin with inhalation. The air creates a sound as it passes in and out of the nose, but it should not be a heavy sound. It should come from the nose and not the throat.

k…<flI baexk< i]à< pvn< suod< ihtm!,
äünafImuoe s<Swk)a*gRlnaznm!.66.
sMyGgaÇsmuÑƒt¢<iwÇyivÉedkm!,

ivze;e[Ev ktRVy< ÉôaOy< k…<Ék<iTvdm!.67.

kuëòalé bodhakaà kñipraà pavanaà sukhadaà hitam|
brahmanäòémukhe saàsthakaphädyargalanäçanam||66||
samyaggätrasamudbhütagranthitrayavibhedakam|
viçeñeëaiva kartavyaà bhasträkhyaà kumbhakantvidam||67||

This (bhastrika) quickly arouses kundalini. It is pleasant and beneficial, and removes obstruction due to excess mucus accumulated at the entrance to brahma nadi.This kumbhaka called bhastrika enables the three granthis (psychic/ pranic knots) to be broken. Thus it is the duty of the yogi to practice bhastrika.

The most important physiological effect of bhastrika is on the brainand heart. Bhastrika stimulates the circulation of cerebral fluid and increases the compression and decompression upon the brain, creating a rhythmic massage. The rhythmic pumping of the diaphragm and lungs stimulates the heart and blood circulation. Accelerated blood circulation and rate of gas exchange in each cell produces heat and ‘washes out’ waste gases. Hyperventilation begins to occur and excites the sympathetic nerves in the respiratory center, but because there is an increased release of carbon dioxide, the center is subsequently relaxed and hyperventilation does not take place. If exhalation were to become less than inhalation, then there would be hyperventilation. Therefore, in bhastrika inhalation and exhalation must remain equal. The rapid and rhythmic movement of the diaphragm also stimulatesthe visceral organs and this creates a massaging effect throughout the whole system. Bhastrika is the most dynamic and vitalizing pranayama techniques. Bhastrika heats the nasal passages and sinuses, clearing away excessmucus and building up resistance to colds and all respiratory disorders. Therefore, it is useful in the yogic management of chronic sinusitis, pleurisy, asthma and bronchitis. Bhastrika improves digestion and stimulates a sluggish system. It increases the appetite, accelerates the metabolic rate and strengthens the nervous system. Bhastrika also helps in cases of tuberculosis, constipation, sciatica, spondylitis, arthritis, rheumatic problems, cancer and physical arid mental tension. Pranic movement, particularly in the coccygeal, navel, thoracic andbrain centers, is accelerated by the practice of bhastrika and this increases physical vitality and bestows clarity of mind. The tremendous heat generated by the practice clears sushumna nadi and prepares it for the ascent of kundalini.

3. SCIENCTIFIC LITERATURE REVIEW:

3.1. SUMMARY TABLE OF SCIENCTIFIC RESEARCH:

S.no.	Title, Author And year	Sample And Sample size	Study Design	Result	conclusion
1	The effects of child abuse and neglect on cognitive functioning in adulthood, Felicia Gould, Jennifer Clarke, Christine Heim, Philip D Harvey, Matthias Majer, Charles B Nemeroff , 2012 Feb 14	93 subjects (60 with ELS(early life trauma) and 33 without)	Canonical Correlation study design	Significant associations between ELS status and CANTAB measures of memory and executive and emotional functioning were found.	These data suggest that exposure to ELS results in a cascade of neurobiological changes associated with cognitive deficits in adulthood that vary according to the type of trauma experienced.
2	Trauma –related deficits in working memory; Wissam El-Hage and Philippe Gaillard; year: 2006	63, Patients with trauma history (n = 33) were compared to patients without such a history (n = 30)	Comparative pre post design	Analysis of cognitive data revealed specific trauma related deficits in working memory. Moreover, the	These findings confirmed the trauma-related impairments in working memory and the paramount importance

				trauma-exposed subjects scored higher on anxiety/depression scales, and lower on processing speed tests.	for these impairments of reduced processing speed rather than emotional factors.
3	Is time spent playing video games associated with mental health, cognitive and social skills in young children?; Viviane Kovess-Masfety, Katherine Keyes, Ava Hamilton, Gregory Hanson, Adina Bitfoi, Dietmar Golitz, Ceren Koc¸, Rowella Kuijpers, Sigita Lesinskiene, Zlatka Mihova, Roy Otten, Christophe Fermanian, Ondine Pez; year: 2016	youth ages 6–11, n = 3195	Multivariable logistic regression	20 % of the children played video games more than 5 h per week. Having a less educated, single, inactive, or psychologically distressed mother decreased time spent playing video games.	The results of the present study suggest that video game use is not associated with an increased risk of mental health problems instead beneficial for cognitive function to some extent.
4	The relationship between cognitive performance and employment and health status in long-term survivors	46 ARDS patients who survived after getting	Correlational study	23.9% (n511) of the patients showed cognitive	Long-term ARDS survivors exhibit impaired health

	of the acute respiratory distress syndrome: results of an exploratory study; Hans-Bernd Rothenh usler, M.D., Sigrid Ehrentraut, M.D., Christian Stoll, M.D., Gustav Schelling, M.D., Hans-Peter Kapfhammer, M.D., Ph.D.; year: 2001	admitted to Department of Anesthesiology at the Klinikum Grosshadern		impairments. Disability was found in 41.3% (n519) of the patients. All ARDS survivors with cognitive deficits were disabled, whereas only 22.9% (n58) of the cognitively not impaired patients gave evidence of disability.	status and the presence of cognitive deficits is associated with disability and considerable impairments in HRQOL.
5	Working memory capacity: In Search of the Magic Number Nelson Cowan (2005).	--------	Book review	A theory of working memory must have something to say about why working memory is capacity limited, and eventually it will have to offer a scale	The main message learned from reading "Workingmemory capacity" is that capacity must be defined as a theoretical concept, and therefore can

				on which to measure it, and put a number to it.	only be defined in the context of a theory of working memory.
6	What are the differences between long-term, short-term, and working memory? Nelson Cowan; year 2008	----------	Book review	There are clearly differences between simple serial recall tasks that do not correlate very well with aptitude tests in adults, and other tasks requiring memory and processing, or memory without the possibility of rehearsal, that correlate much better with aptitudes.	The efficiency of attentional system and its use in working memory seem to differ substantially across individualsas well as improving with development in childhood and declining in old age.
7	Divided Attention and Memory: Evidence of	Participants were 24	ANOVA	If the consolidation	DA at encoding

	Substantial Interference Effects at Retrieval and Encoding Myra A. Fernandas and Morris Moscovitch; year: 2000	undergraduate students at the University of Toronto		process were truly disrupted, we would not expect participants to remember additional words, even on a recognition test that provides more external cuing and retrieval support. Currently investigating these possibilities.	leads to a relatively larger interference effect than DA at retrieval, and the magnitude of that effect does not depend on the material specificity of the concurrent task.
8	Beneficial effects of early attention process training after acquired brain injury: a randomized controlled trial Gabriela Markovic, Marie Louise SCHULT et al, Year : 2020	Patients with acquired brain injury (n = 59) within 4 months' post-injury in interdisciplinary re-	Randomized controlled trial.	Both groups improved ($p < 0.001$), although a higher number of patients improved with attention process training ($\chi 2$	The results indicate that attention training is promising early after acquired brain injury and that Attention Process Training

		habilitation		(1, n = 59) = 5.93, p = 0.015)and the variability was significantly decreased.	boosts functional improvement.
9	Cognitive and Typing Outcomes Measured Simultaneously with Slow Treadmill Walking or Sitting: Implications for Treadmill Desks; Michael J. Larson, James D. LeCheminant et al. year : 2015	final study enrollment included 75 participants —38 (17 female) assigned to the sitting group and 37 (23 female) assigned to the treadmill walking group	RMANOVA	Rey Auditory Verbal Learning Test was worse. The main effect was significant ($F(1,73)=4.75$, $p=0.03$, $\eta p^2=0.06$);short- and long-delay recall performance didnot differ between groups ($p>0.05$). For PASAT the main effect was significant ($F(1,73)=4.97$, $p=0.03$, $\eta p^2=0.06$).treadmill walking	Walking on a treadmill desk may result in a modest difference in total learning and typing outcomes relative to sitting, but those declines may not outweigh the benefit of the physical activity gains from walking on a treadmill.

				group performed significantly worse.	
10	The altered early components and the decisive later process underlying attention bias modification in social anxiety: evidence from event-related potentials; Dong-ni Pan, Yi Wang et al. year: 2019	63 college students with social anxiety. Participants were assigned to the attention modification program (AMP, n=20), the attention control condition (ACC, n=20) and the passive waiting group (PW, n=23)	(Pre-Post) Two way ANOVA	Results showed that the two training groups (AMP and ACC) produced comparable emotional improvements and both showed a decrease in negative bias compared with the PW group.	We found a dissociable mechanism underlying ABM in social anxiety. While the unique manipulation that is characteristic of ABMmainly modulated the early stage ofattentional processing.
11	Changes in reaction time after yoga bellows type breathing in healthy female volunteers; Shirley telles, shushma	The sample consisted of 25 healthy females, aged between 19	RMANOVA	The time taken to obtain a correct response reduced significantly	The results suggest that different interventions may optimize performance

	pal, Ram kumar gupta, Acharya balkrishna; year: 2018	and 32 years		after 18 min of BAW (P < 0.05) and CTL (P < 0.05). However, no changes were seen in the RT after BHK.	in tasks requiring attention in females compared to males.
12	Working memory deficit in children With mathematical difficulties: A general or specific deficit? Ulf Andersson, Björn Lyxell; year: 2007	A total of 138 children attending 21 schools in the southeast province of Sweden participated in this study. Of these participants, 23 were in their second year of schooling, 60 were in their third year of schooling, and 55 were in their fourth year	ANCOVA & ANOVA	MD children's scores on the animal dual task (ANCOVA, pD.062). Correlation between counting span and animal dual task the MD group (rD.43), it seems reasonable to assume that the MD children have a deficit in relation to the animal dual task as well.	These findings indicate that the MD children and the children with comorbid mathematical and reading difficulties have a specific central executive deficit restricted to simultaneous processing and storage of numerical information and probably also verbal

		of schooling			information.
13	Acute Effect of Mukh Bhastrika (A Yogic Bellows Type Breathing) on Reaction Time; Ananda Balayogi Bhavanani, Madanmohan, K aviraja Udupa; year: 2003	22 healthy schoolboys who were practicing yoga for the past three months were recruited for the present study	Pre post design (self as control group)	Mukh bhastrika produced a significant (P < 0.01) decrease in VRT as well as ART. A decrease in RT indicates an improved sensory-motor performance and enhanced processing ability of central nervous system.	This is of applied value in situations requiring faster reactivity such as sports, machine operation, race driving and specialized surgery. It may also be of value to train mentally retarded children and older sports persons who have prolonged RT.
14	Immediate effect of mukha bhastrika (A bellows type pranayama) on reaction time in mentally challenged adolescents; Ananda Balayogi Bhavanani, Meena Ramanathan, Harichandrakumar Kt; year: 2012	34 mentally challenged adolescents studying in a school for Special Needs were recruited as	Pre post design(self as control group)	There was a statistically significant decrease in VRT (P < 0.0001) from 296.15ms +/- 13.49 to	Mukha bhastrika may be altering afferent inputs from abdominal and thoracic regions, in

		they have been receiving yoga training once a week for more than 3 years.		263.59ms +/- 12.53 and ART (P < 0.0001) from 247.88 ms +/- 14.33 to 217.35 ms +/- 11.36 following mukha bhastrika.	turn modulating activity at ascending reticular system and thalamo-cortical levels. Suggested that mukha bhastrika be used as an effective means of improving neuromuscular abilities in special children
15	Effect of Fast and Slow Pranayama Practice on Cognitive Functions in Healthy Volunteers; Vivek Kumar Sharma, rajajeyaKumar m et al. ; year: 2014	84 participants who were in self-reported good health, who were in the age group of 18-25 years, who were randomized to fast	Inter–group comparison was done by one way ANOVA and intra-group comparison was done by	Executive functions, PSS and reaction time improved significantly in both fast and slow pranayama groups, except reverse digit span, showing improvement	Both types of pranayamas are beneficial for cognitive functions, but fast pranayama has additional effects on executive function of manipulation

		pranayama, slow pranayama and control group with 28 participants in each group.	paired t-test	only in fast pranayama group. Reduction in reaction time was significantly more in the fast pranayama group.	in auditory working memory, central neural processing and sensory-motor performance.
16	A study of combined effect of yoga (Yogic exercises, pranayama & meditation) on hyper-reactivity to cold pressor test in healthy individuals; Chanda Rajak, Sanjeev Rampalliwar, Jitendra Mahour; year : 2012	The study group comprised 75 healthy subjects of 25-45 years age group	Simple pre post design	Regular 6 months of yoga practice significantly reduces the cardiovascular hyper-reactivity in basal blood pressure, rise in blood pressure after one minute of cold stress, pulse rate, & rate of respiration.	Regular practice of yoga for six months reduced the Cardiovascular hyper-reactivity to cold pressor test in subjects hyper reactive to cold stress.
17	Efficacy and Safety of Ashwagandha (Withania	A prospective,	Comparative pilot	Memory Scale III subtest	Ashwagandha may be

	somnifera (L.) Dunal) Root Extract in Improving Memory and Cognitive Functions; Dnyanraj Choudhary, Sauvik Bhattacharyya; year: 2017	randomized, double-blind, placebo-controlled study was conducted in 50 adults	study	scores for logical memory I (p = 0.007), Mackworth Clock test (p=0.009)	effective in enhancing both immediate and general memory in people with MCI as well as improving executive function, attention, and information processing speed
18	Acute effects of lisdexamfetamine and D-amphetamine on social cognition and cognitive performance in a placebo-controlled study in healthy subjects; Patrick C. Dolder, Petra Strajhar et al. ; year: 2018	24 healthy volunteers	a randomized placebo-controlled, double-blind, cross-over design	D-Amphetamine and lisdexamfetamine had small effects on measures of social cognition. There were no effects on emotion recognition on the FERT and DS. D-Amphetamine	Single, high, equimolar doses of D-amphetamine and lisdexamfetamine enhanced certain aspects of cognitive performance specially vigilance in healthy non-sleep-deprived subjects. Both amphetamines

				and lisdexamfetamine increased cognitive performance.	also slightly altered aspects of social cognition.
19	Time and resource limits on working memory: Cross-age consistency in counting span performance; Sarah Ransdell and Steven Hecht; year: 2003	100 children tested in grade 2 and again in grades 3 and 4.	Longitudinal study (ANOVA)	Results were similar for math calculation with age accounting for 31% of the variance and counting span accounting for a further 34% of the variance.	It is becoming increasingly clear that memory capacity no longer can be offered as the sole reason for performance in working memory tasks.
20	Meta-Analysis of Neuropsychological Studies in Panic Disorder Patients: Evidence of Impaired Performance during the Emotional Stroop Task; Lillian Harber, Reza Hamidian et al.; year: 2019	Papers between the year 1980 to 2015	A systemic literature search and meta-regression analysis.	No significant difference between verbal memory and executive functions in PD patients and controls. However There is no robust	The paucity of studies evaluating neurocognition in PD suggests the need for further research in this field in order to draw meaningful

				evidence of impairment of memory function in PD. When considering the emotional Stroop task, it was found that PD patients per- formed slower ($p < 0.01$) than healthy controls for all three types of stimuli (neutral, negative, positive).	conclusions.

4. AIMS ANDOBJECTIVES

4.0 AIMS OF THESTUDY:

The main aim of the study is to find that how and whether bhastrika immediately affects the cognitive functioning of the brain in healthy adults.

4.1 OBJECTIVES OF THESTUDY:

The objective of the study is to find:

i) The immediate effect of bhastrika pranayama on reaction time.
ii) The immediate effect of bhastrika pranayama on divided attention.
iii) The immediate effect of bhastrika pranayama on vigilance/ sustained attention.
iv) The immediate effect of bhastrika pranayama on working memory.

4.2 RESEARCH QUESTIONS:

Does practice of Bhastrika pranayama immediately affects the cognitive functioning of the brain?

4.3 HYPOTHESIS AND NULLHYPOTHESIS:

HYPOTHESIS:

There is an immediate effect of Bhastrika pranayama on cognitive function.
There is an immediate effect of Bhastrika pranayama on working memory.
There is an immediate effect of Bhastrika pranayama on divided attention.
There is an immediate effect of Bhastrika pranayama on vigilance.
There is an immediate effect of Bhastrika pranayama on reaction time.

NULL HYPOTHESIS:

There is no immediate effect of Bhastrika pranayama on cognitive function.

There is no immediate effect of Bhastrika pranayama on working memory.

There is no immediate effect of Bhastrika pranayama on divided attention.

There is no immediate effect of Bhastrika pranayama on vigilance.

There is no immediate effect of Bhastrika pranayama on reaction time.

5 METHODS

5.0PARTICIPANTS:

Total number of final participants taken for the study were 86 out of which F(n=45) and M(n=41) with 0 dropouts.

Source of Subject

Eighty six students those who were pursuing their graduate and post- graduate degree course in yoga therapy from Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore, of both genders in age range 18 – 28 years were selected for this study

5.0.1 Inclusion criteria

1) The participants should be healthy.
2) The participants should be empty stomach.
3) The participants should have previous knowledge about the bhastrika pranayama itself.
4) Those who are into any kind of yoga at least since from 6 months.

5.0.2 Exclusion criteria:

1) The participants with any cardiac problem, vertigo or not in a healthy position like seasonal cough cold fever.
2) The participant with heavy stomach.
3) Those who are novice to the practice of bhastrika pranayama.
4) Those who are novice to yoga itself.

5.0.3 Ethicalconsideration:

All the participants were informed about the study purpose and assured of keeping their personal information confidential. Participants had the brief introduction of the intervention before starting of the actual intervention. Signed information consent has been obtained from the participants and their respective coordinators. At any point of time any of the participant want to withdraw from the study, they were allowed to do so.

5.1 DESIGN OF THESTUDY:

A randomized self-as-control within subjects designwas implemented for this study. All the subjects underwent two condition experimental condition (Bhastrika panayama) and control session (Deep breathing) for 5 minutes. All the sessions were conducted at the same time on two different days to diurnal variation.

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5.2 VARIABLESSTUDIED:

Independent Variables: Bhastrika pranayama

Dependent Variables: working memory, divided attention, vigilance, reaction time, Assessment tools (PASAT (Paced auditory serial addition test), Counting spank task, Emotional Stroop test, Mackworth clock vigilance test.)

ASSESSMENT TOOLS:

A computer software called "millisecond.com – Makers of Inquisit" has been used for testing the various parameters of cognitive function in this study. This software is a precision psychometric testing for cognitive, neurophysiological, and online research. It contains variety of test on various domains which could be performed on the computer itself and data can also be automatically save and can easily be retrieved. We tested various parameters of cognitive function in our study like working memory, divided attention, vigilance and reaction time.

From inquisit test library for working memory we used counting span task and for working memory and divided attention both we used PASAT (paced auditory serial addition test), for measuring reaction time we used emotional Stroop task and for vigilance we used Mackworth clock vigilance test. Also there are trial tests for all the tests before the actual tests start.

PASAT:

Participants hear a sequence of single digit numbers (1-9) presented at a constant speed and are asked to mentally sum the last 2 digits (NOT a running total).Participants then select the current

sum from a circle of numbers 1-18 (= nonverbal response), this goes for 4 consecutive levels with every time the gap between the two numbers that can be heard reduces, with one trial practice of default speed of 4000ms and default speed set in first level is 2400ms with every time reduction of 400ms in each consecutive levels. The Inquisit way calculates percentiles based on the norms published by Wingenfeld et al (1999) who ran a fairly similar set up to the default Inquisit script. However, whereas the Inquisit way collects the response in the form of a selected number from a provided circle of numbers, Wingenfeld et al (1999) collect verbal responses that are later scored for accuracy. It is possible, for example, that by reporting the sums verbally, suppression failures (aka suppressing the previous sum when adding the new digit to the previous digit) are more likely than with the set up used in this script. This might be the case as the verbal sum might interfere to a greater degree with the verbal digits than the non-verbal response of simply selecting the sum from a provided circle of digits. However, Wingenfeld report that errors typically were simple addition errors rather than suppression failures even with verbal responses. On the other hand, having to find the correct response button might take more time than simply saying the response out loud. The whole test takes approximately 10 mins to complete.

Counting span task:

This Counting Span Test is performed to the computer with keyboard input. Participants are presented cards with green and yellow dots and are asked to count the number of green dots on each card and press the corresponding keyboard key. After a certain amount of cards (starting with a span size of 1 and going up to 5), participants are asked to remember the number of dots they counted for each card, starting with the first card and going in order. The responses are typed into free recall boxes, and the task will take approximately 8 minutes to complete. For span 1 only one card will be displayed, for span 2 two cards will be displayed, in span two after calculating the green dots in 1st card and pressing the same number on the keyboard as that in the presented card only then the next card will be displayed and each span has three round and after every round for suppose in span two round 1 two cards will be displayed and after end of that round question text boxes will appear for both the cards one after the other in which you have to remember and fill the number of green dots in sequential order of the cards, likewise it goes upto 5 spans. Also it move on to next span size if the sums of at least 1 of the 3 sets of a particular span size were recalled correctly. Also there is a trial practice before the actual test.

Emotional Stroop task: (with keyboard input)

Participants are presented words from 5 different categories (aggression, neutral, positive, negative, color word) in four different colors (blue, red, yellow, green) and are asked to press one of four response keys that are j, d, k, f respectively to indicate the color of the words regardless of their meaning. This task implements an Aggression Themed Emotional Stroop task. The classic Stroop paradigm demonstrates the interference of word meaning on naming the color in which the words are written as measured by reaction time differences to color-meaning congruent and color-meaning incongruent combinations. The Aggression Stroop takes advantage of this basic Stroop interference effect by comparing reaction times to aggression related words, positive and negative words and neutral words. And the task takes approximately 5 minutes to complete excluding the trial practice.

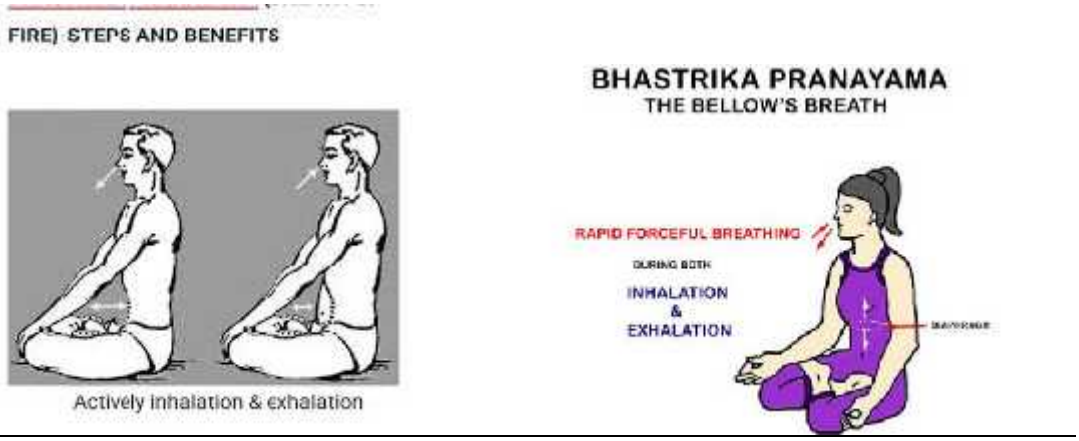
Mackworth Clock vigilance test:

This task implements the Mackworth Clock Vigilance Test; a go/no go test to measure a person's ability to sustain attention in the face of monotonous stimulation. Participants watch a red dot jump from one circle position to next position in a clockwise fashion at constant speed. Occasionally, the red dot skips a position. Participants are asked to press the Spacebar whenever they notice such a skipped event (go event). The default set-up of the script takes approximately 1.5 minutes to complete. A circle, with 24 equally spaced "slots" (as represented by the empty space between two "+" marks), is presented on the computer screen. A red dot starts from the 12'o clock position and flashes in turn in each slot. The dot stays visible for 0.65 sec and so there is an interval of 0.65 sec between each flash. The signal event is when the dot skips a position.The outcomes measured were the elapsed time and the number of total hits which is actually the number of correct responses.

5.3 INTERVENTIONS:

5.3.1. Experimental condition

Subjects were asked to perform 5 mins of continuous bhastrika pranayama in a slow pace so as to continue for 5 mins without break. They were asked to sit erect for the whole time during the intervention, eyes remain closed and palms on their knees while adopting chin mudra in their both hands. After completing the intervention they were asked to remain silent in the same state for 1 more minute.



5.3.2 Control condition

In this condition subjects were asked to do 5 mins of deep breathing. After completing the deep breathing they were asked to remain silent in the same state for 1 more minute. They were asked to sit erect for the whole time during the intervention, eyes remain closed and palms on their knees while adopting chin mudra in their both hands.

6.DATAEXTRACTION AND ANALYSIS:

6.0 DATA COLLECTION PROCEDURE:

Data was extracted as per the procedure quoted in the user manual of the inquisit test library and for pre data was collection(before starting the practice session) participants were made to understand the four inquisit tests which are Mackworth clock test, emotional Stroop task, counting span test and PASAT. Each test had the trial session before starting the final one.

Post data collection (after completing the practice session) also took place in the same way but taken after giving the intervention.

The data was simultaneously getting stored for every subject in the inquisit library from where it was extracted all together once the data collection was finished and was entered into excel files and were reviewed and verified in iteration method.

6.1 ANALYSIS

Data was analyzed for normality using shapiro-Wilk test. Statistical significance was assessed using paired sample t-test. Statistical analysis was performed using Wilcoxon sign rank test for within group assessment. Also there were no outliers but few extreme values which were not tampered and data was analyzed with them as the result made not much difference without them.

7. RESULTS

For the Mackworth clock test, after first being checked for the Shapiro-Wilk normality test the p value came was p-value < 2.2e-16for elapsed time and p-value = 0.1905 for total hits which are the major parameter for checking the vigilance and reaction time and as the p value came out to be less than 0.05 due to which we performed the non-parametric test that is Wilcoxon sign rank test. The result shows significant results with the elapsed time but non-significant results for number of total hits due to which overall result cannot be predicted as significant for vigilance or sustained attention.

Table 1.

Mackworth clock variables	**mean±sd**	**P value**
Pre elapsed time	70841.08±14307.62	0.02543
Post elapsed time	74426.52±50529.76	
Pre totalhits	2.91±1.44	0.1905
Post totalhits	3.16±1.38	

For emotional Stroop task, the Shapiro-Wilk normality test gave p-value<0.001 for elapsed time as well as mean latencies for correct responses for all 5 categories separately and so we performed non parametric within group t-test that is Wilcoxon sign rank test. This test mainly focused on reaction time and because of which took the mean latencies of the correct responses and as compared to pre data the low latency response is recorded for post data which in turnsgive highly significant result.

Table2

Emotional Stroop variables	**Mean±sd**	**P value**
Pre elapsed time	287410.91±61964.16	
Post elapsed time	222901.06±46039.85	2.48E-11
Pre mean latency neutral	897.52±249.88	
Post mean latency neutral	818.54±219.71	3.19E-05

Pre mean latency aggression	932.19±328.91	
Post mean latency aggression	820.13±227.85	4.60E-07
Pre mean latency color	962.82±333.76	
Post mean latency color	831.51±244.67	1.89E-07
Pre mean latency for negative	903.89±255.13	
Post mean latency for negative	837.05±281.99	0.0001956
Pre mean latency for positive	896.67±240.15	
Post mean latency for positive	799.38±250.26	2.12E-07

Then we performed Shapiro-Wilk normality test for the next assessment task that is counting span task which was mainly done to test the effect on working memory of the intervention. As for the normality test the p value<0.001 due to which performed non parametric Wilcoxon sign rank test on the variable like elapsed time and highest counting span which again showed mixed results with elapsed time showing highly significant results but not the highest counting span.

Table3

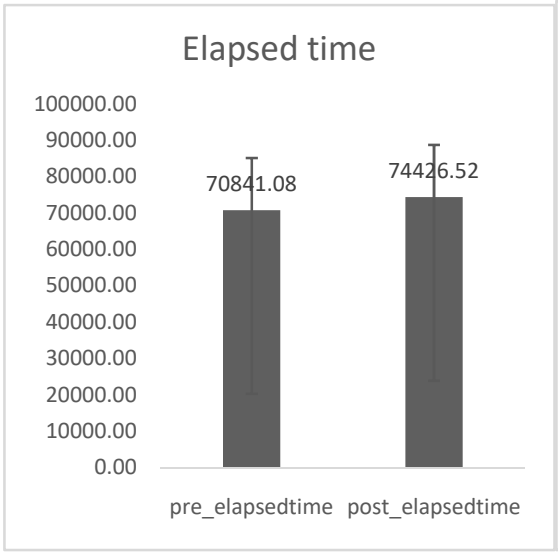
Counting span variables	**mean±sd**	**P value**
Pre elapsed time	574338.84±141508.97	5.95E-11
Post elapsed time	372519.00±93167.65	
Pre highest span	4.63±0.95	
Post highest span	4.67±0.82	0.7983

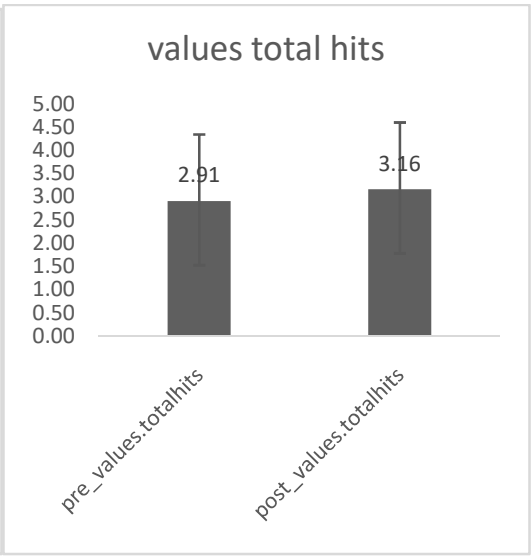
Last test which was performed was paced auditory serial addition test which consisted of three levels excluding trials. It was a more decisive test in which elapsed time, level1 correct values, level2 correct values and level3 correct values were assessed to test effects on divided attention and working memory and normality test was performed on all the variables separately resulting p values< 0.001 leading to perform non-parametric Wilcoxon sign rank test giving highly significant results for all four variables.

Table4

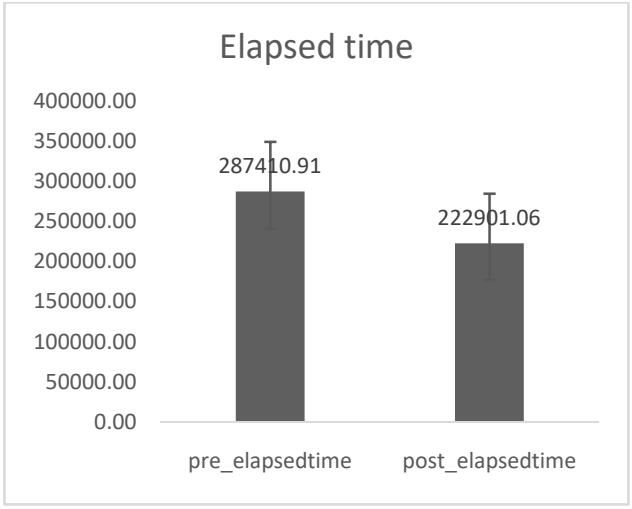
PASAT Variables	**Mean±sd**	**P value**
Pre elapsed time	694234.65±135421.69	2.25E-13
Post elapsed time	511104.43±58311.02	
Pre level1 correct values	27.05±14.47	2.47E-07
Post level1 correct values	33.10±15.60	
Pre level2 correct values	12.31±7.77	3.48E-07
Post level2 correct values	16.99±10.86	
Pre level3 correct values	6.19±4.13	0.0002328
Post level3 correct values	8.31±6.35	

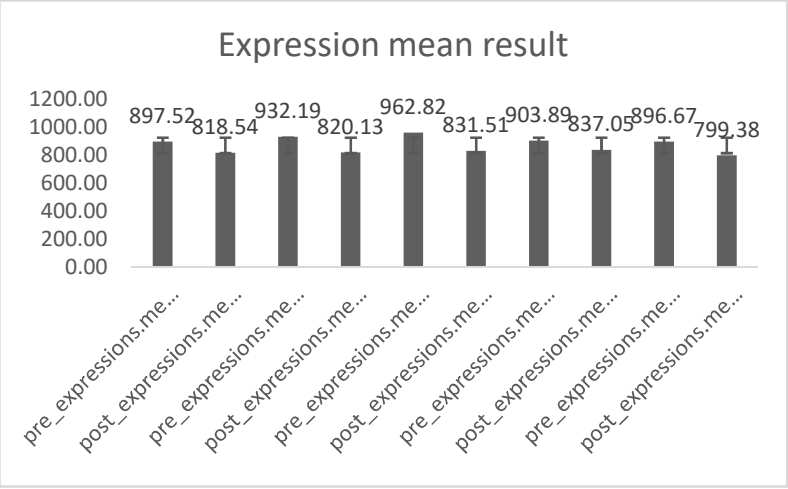
MACKWORTH CLOCK TEST



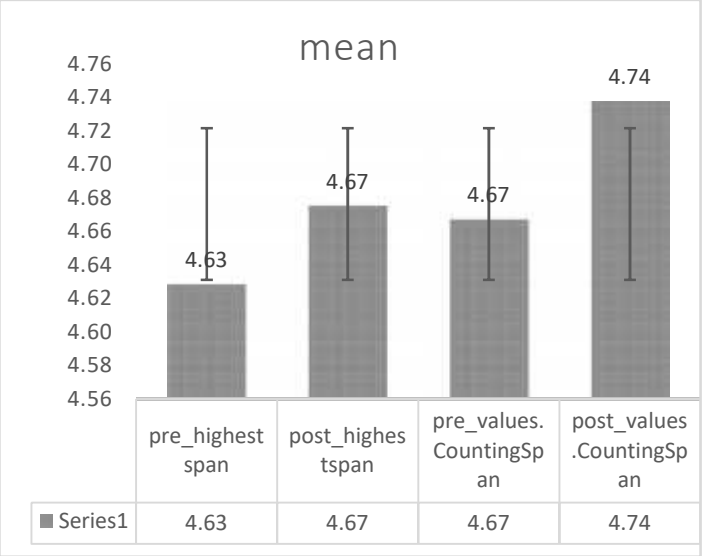


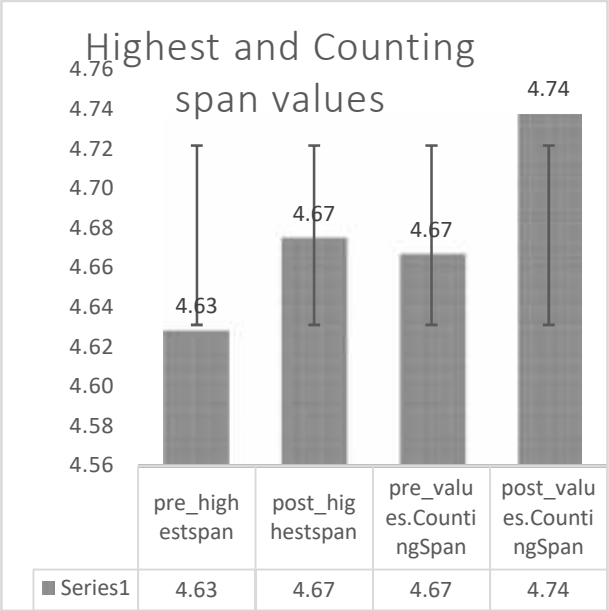
EMOTIONAL STROOP TASK



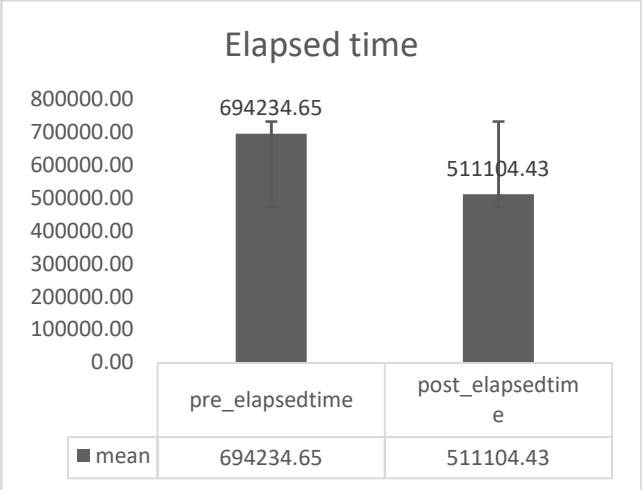


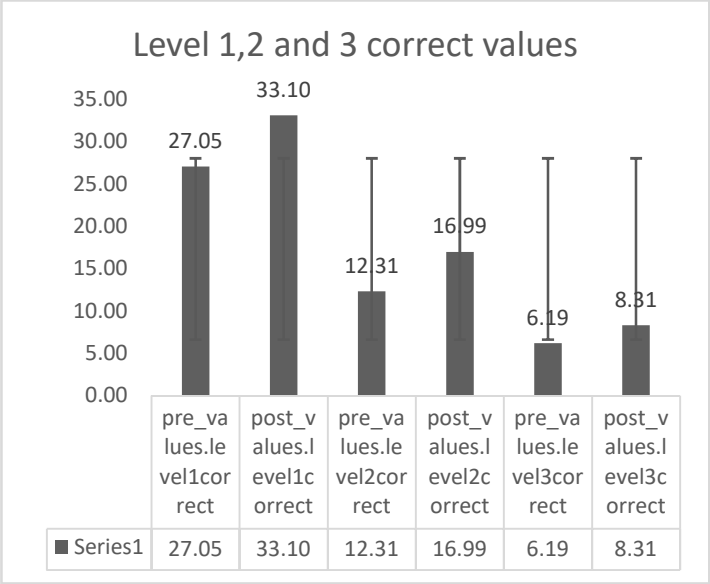
COUNTING SPAN TEST




Highest and Counting span values
4.76
4.74
4.72
4.70
4.68
4.66
4.64
4.62
4.60
4.58
4.56
4.63
4.67
4.67
4.74
pre_highestspan
post_highestspan
pre_values.CountingSpan
post_values.CountingSpan
Series1
4.63
4.67
4.67
4.74

PASAT


Elapsed time
800000.00
700000.00
600000.00
500000.00
400000.00
300000.00
200000.00
100000.00
0.00
694234.65
511104.43
pre_elapsedtime
post_elapsedtime
mean
694234.65
511104.43


Level 1,2 and 3 correct values
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
27.05
33.10
12.31
16.99
6.19
8.31
pre_values.level1correct
post_values.level1correct
pre_values.level2correct
post_values.level2correct
pre_values.level3correct
post_values.level3correct
Series1
27.05
33.10
12.31
16.99
6.19
8.31

8. DISCUSSION

Highlights of findings

The present study focuses on the psychological well-being in today's world where stress is affecting every group and levels of the society, no matter physically healthy or unhealthy person. Nowadays Right from the childhood till old age individual goes through one or the other kind of stress affecting him psychologically as well as physiologically at some point of time. It immediately affects the cognitive functioning of our brain, weakening our working memory, attention skills, executive functioning, decision making ability and many other such cognitive functions. The results for this study showed very significant immediate results improving the reaction time, vigilance, working memory and divided attention measured by various psychological tests on computers.

Comparison with earlier findings

Many hatha yoga texts which is one of the method to attain raja yoga says that to control the mind breath is required. Only breath control can control the unsteady mind. For breath control there are many pranayamas techniques mentioned and all of these are considered to influence the mental state. This bhastrika pranayama also called as mukh bhastrika used in this study has consistently been found to influence the reaction time (RT) though be a visual reaction time (VRT) or auditory reaction time (ART). A decrease in RT indicates an improved sensory-motor performance and enhanced processing ability of central nervous system. This may be due to greater arousal, faster rate of information processing, improved concentration and/ or an ability to ignore extraneous stimuli.

In a study where 22 healthy schoolboys who were practicing yoga since 3 months were assessedfor immediate effect of 9 rounds of mukha bhastrika on reaction time. Mukh bhastrika produced a significant ($p<0.01$) decrease in VRT as well as ART.(Bhavanani et al., 2003). In one study immediate effect of bhastrika on reaction time was assessed in mentally challenged adolescents. Mukha bhastrika produced an immediate and significant decrease in both VRT and ART. There was a statistically significant decrease in VRT ($P<0.0001$) and ART ($P<0.0001$).(Bhavanani et al., 2003). A comparison between participants who had experience in yoga and those who were naive-to-yoga was carried out on two groups of healthy males average age 29 years. The yoga group had

two experimental sessions as follows: (i) a session of bhastrika pranayama practiced for 18 min and (ii) a session of breath awareness. For 18 min of bhastrika pranayama, there was a significant reduction in the number of anticipatory responses (The Cohen's *d* was <0.05 though the change was statistically significant)(Telles, Yadav, Gupta, & Balkrishna, 2013).

In a clinical trial 11 MS patients were taken and received integrated yoga and physical therapy for 3 weeks which also included bhastrika pranayama.There was significant improvement in visual reaction time (p=0.01), depression (p=0.04), and anxiety (p=0.02) scores at the end of 3 weeks as compared to the baseline. Auditory reaction time showed reduction with borderline statistical significance (p=0.058)(Chobe, Bhargav, Raghuram, & Garner, 2016). In a study where 84 healthy adults were recruited to see the effect of slow and fast pranayamas on cognitive function. Among fast pranayamas bhastrika was also included. Both the pranayamas were beneficial for the cognitive function but fast pranayama has an additional percentage reduction in reaction time and influential effect on executive functioning of manipulation in auditory working memory, central neural processing and sensory-motor performance (Sharma et al., 2014).

Hence findings from many previous studies have shown that there is a significant effect of pranayamas, mainly bhastrika pranayama on most of the cognitive functions, mainly targeting the reaction time (VRT and ART both). From this we can conclude that reduction in reaction time and increased rate of response of working memory, also significant increase in attention skills is mainly due to the increased sympathetic activation of the brain making it more active, aware and quick with responses to the stimulus.

Limitations of the study:

- Sample size was small.
- Participants were running short with time as they were college students indulged in their hectic schedules and the intervention was an addition to them.
- Short duration of intervention.

Strengths of the study:

- It was not a boring and time taking intervention because of which even being so tightly packed with their schedules, participantsenjoyed being the part of the study.
- As bhastrika pranayama was given for intervention, it made participants felt light, refreshed and energetic after the practice which was again fulfilling the purpose of the study.

Scope for future study:

- A bigger sample can be taken for future studies.
- Various other parameter can also be added for the better and stronger study which can even include various physiological factors.
- Can even be done adults above 30 years of age facing much more stress in their daily life as compared to present study younger participants.
- Higher paced bhastrika pranayama can also be taken for intervention.

Reason for not significant:

Few parameter gave non-significant result mainly related to attention skills. It might be due to various reasons like shorter duration of the intervention. Also some participants were in the very earlymorning or late evening slots where they might have felt slightly higher state of laziness or sleepiness as compared to other slots which would have affected the results.

9. CONCLUSION

The investigations in this study suggests that bhastrika pranayama has showed significantly high immediate effect on reaction time, divided attention and working memory and not much significant effect on sustained attention or vigilance. From this study a conclusion from the results can be derived that bhastrika pranayama helps in triggering or activating the sympathetic nervous system of the brain by improving the response rate and reducing the latency periods of the responses.

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