

**EFFECT OF SIRSASANA ON PSYCHOPHYSIOLOGY AND  
NEUROPSYCHOLOGY: A SINGLE CASE STUDY**

*A Dissertation submitted by*

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Under the Guidance of

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*Towards the partial fulfillment of*

**Masters of Science (YOGA)**

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(Declared as Deemed University under Section 3 of the UGC Act, 1956)

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## **CERTIFICATE**

This is to certify that **KAVIYARASAN G** who has got registration for the degree of **Master of Science in Yoga Therapy** with start from August 01, 2017 by **Swami Vivekananda YogaAnusandhana Samsthana(S-VYASA), Deemed to be University**, Bangalore, under the division of yoga and life sciences, has successfully completed the required training in acquiring the relevant background knowledge in Yoga Therapy and has completed the M.Sc. course of two years to submit this research project entitled “**EFFECT OF SIRSASANA ON PSYCHOPHYSIOLOGY AND NEUROPSYCHOLOGY: A SINGLE CASE STUDY**” as per the regulations of the University.

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Date:

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## **DECLARATION**

I, hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandhana Samsthana (S-VYASA), Bengaluru, under the guidance of Dr. Judu Ilavarasu and Dr. Raghavendra Bhat, S-VYASA University Bengaluru.

I also declare that the subject matter of my dissertation entitled “**EFFECT OF SIRSASANA ON PSYCHOPHYSIOLOGY AND NUEROPHYSIOLOGY- SINGLE CASE STUDY**” has not previously formed the basis of the award of any degree, diploma, or similar titles.

Date:

Place: Bengaluru

**KAVIYARASAN G**

## **A C K N O W L E D G E M E N T**

I hereby acknowledge my regards to Swami Vivekananda Yoga Anusandhana Samasthana (SVYASA) University for providing me the opportunity to study Master of Science in yoga (MSc Yoga). My sincere thanks to my guide Dr. Raghavendra Bhat and all the members of faculty. I am grateful to Guruji, Dr. Nagarathna didi, Dr. Ramachandra Bhat, Dr. Sudheer Deshpande for their motivation. I thank our coordinator Dr. Sony kumari, Dr. Balaram Pradhan, Dr. Sanjib Kumar Patra for their support.

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Finally, I salute the supreme consciousness, with whose guidance and blessing I have accomplished this work.

Date:

Place: Bengaluru

**KAVIYARASAN G**

**STANDARD INTERNATIONAL TRANSLITERATION CODE USED TO  
TRANSLITERATE SANSKRIT WORDS**

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

## ABSTRACT

### EFFECT OF SIRASANA ON PSYCHOPHYSIOLOGY AND NEUROPSYCHOLOGY: A SINGLE CASE STUDY

#### **Background**

*Sirsasana* is an inverted or anti-gravitational *asana*. *Sirsasana* considered by some to be the most important inversion pose. Always follow *Shavasana* after invert pose. Rest until the breath and heartbeat are completely normal, then practice the recommended counterpose.

Sexual energy gets sublimated and transformed into spiritual energy by practicing inverted pose traditionally. The aim of the practice to stimulate *chakra* and activate the *Sushumna Nadi* and raise the *Kundalini Shakti* to bring the psychic awakening. inverted postures undoubtedly improve the quality of meditation and concentration.

While doing *sirsasana* blood in our body flow down to the head. 40-45 % of blood flow to the leg is stopped and flow towards the head region. But the brain has an auto regulator blood circulation, which stops the excess blood flow to the brain and make it flow to the facial region, arm, hand, shoulder, and abdomen. While doing a headstand, oxygen supply to the brain will increase. Skin tone will increase by practicing headstand. Some study concluded that practicing *sirsasana* will improve the memory level.

#### **Objectives**

The objective of the current study is to investigate the changes that happen in physiological and psychological in mind and body, such heart rate, breath rate, attention, memory, responds time, decision making, and planning capacity.

#### **Result**

The long duration practice of *sirsasana* brought considerable changes in physiological attributes as follows: decrease in breath rate, decrease of sympathetic nervous system activity, increase of parasympathetic activity, decrease of LF / HF ratio. Changes of Psychological variables are such as, increase in memory capacity, increase in attention level, increase in visual working memory level, increase in planning ability and improve the real life decision making skill by practicing *sirsasana* for 30 minutes.

## **Conclusion**

In psychological domains, various psychological variables' efficiency is increased. In physiological domain, all variables show the normal range. So, practicing *sirsasana* for longer time is not harmful to the body. The systematic practice of *sirsasana* for a long time will not adversely affect the body and mind. So it can be suggested through this research that we can practice *sirsasana* for longer time with systematic, consistent and gradual increase in the practice duration.

## Table of Contents

<b>INTRODUCTION</b> .....	1
NEED AND SCOPE OF THE STUDY .....	2
<b>LITERATURE REVIEW</b> .....	4
ANCIENT LITERATURE REVIEW .....	4
MODERN LITERATURE REVIEW .....	10
<b>AIM AND OBJECTIVE</b> .....	15
AIM .....	15
OBJECTIVE.....	15
RESEARCH QUESTION .....	15
HYPOTHESIS.....	15
NULL-HYPOTHESIS.....	15
<b>METHOD</b> .....	16
SAMPLE .....	16
DESIGN OF STUDY .....	16
INTERVENTION .....	16
ASSESSMENT .....	16
ASSESSMENT TOOL.....	20
RECORDING PROCEDURE.....	20
<b>RESULT</b> .....	23
<b>DISCUSSION</b> .....	41
<b>CONCLUSION</b> .....	43
<b>REFERENCE</b> .....	44
<b>APPENDIX</b> .....	46



## INTRODUCTION

Yoga is an ancient practice and spiritual discipline originated from India which gives tranquility between both mind and body. In Indus Valley, Stone-carved symbols of yoga postures founded it belongs to 3000 B.C. It showing the practices and original poses of yoga. The word yoga is derived from root 'yuj' meaning 'to join' or 'to yoke' or 'to unite' which is Sanskrit. *Moksha* is the ultimate goal of yoga.

In modern days, yoga practices consisting of various *asanas*, a flowing sequence called *vinyasas*, some breathing practices and followed by ending with relaxation or meditation. But in ancient time *asanas* play little role in yoga. Nowadays, yoga is used as an alternative medical treatment to cure various problem such as back pain, migraine, stress, etc. Which gives a good result also to the patients. So, Now it's highly valued as a mind-body medicine in the west (Hector & Jensen, 2015).

The basic principle of yoga are given in Indian classical texts like *Patanjali's yoga sutra*, *Hatha yoga pratipika*, *Gheranda Samhita* and so on. But in this Sage *Patanjali* given one of the ultimate definition for yoga. *Yama*, *Niyama*, *Asana*, *Pranayama*, *Pratyahara*, *Dharana*, *Dhyana* and *Samadhi* are eight limbs of yoga which are comes under the *astanga yoga*

*Asana* is a body posture which is in the third limb of the *ashtanga yoga* which means "seat", and in *Patanjali's Sutras* refers to the seated position used for meditation. But later in hatha yoga and modern yoga, adding reclining, standing, inverted, twisting, and balancing poses to the meditation places. In *Yoga Sutras* of *Patanjali* define "*asana*" as "[a position that] is steady and comfortable". Posture is a reflection of your mind. So, if you make the body stable, the mind will follow (Swami, 2012).

*Sirsasana* is an inverted or anti-gravitational *asana*. In English, *Sirsasana* referred to as headstand. *sirsasana* is a Sanskrit word *Sirsa*, meaning "head" and *asana* meaning "pose" or "posture". *Sirsasana* is nicknamed the king of all *asanas*. The body is completely inverted and held upright supported by the forearms and the crown of the head. Similarly, emotional and psychic levels change into the normal patterns by practicing invert pose, throwing new light on

old patterns of behavior and being. *Sirsasana* considered by some to be the most important inversion pose. Always follow *Shavasana* after invert pose. Rest until the breath and heartbeat are completely normal, then practice the recommended counterpose.

Sexual energy sublimate and transform into spiritual energy by practicing inverted pose traditionally. The aim of the practice to stimulate *chakra* and activate the *Sushumna Nadi* and raise the *Kundalini Shakti* to bring the psychic awakening. inverted postures undoubtedly improve the quality of meditation and concentration (“Headstand,” 2019); (“Headstand benefits,” 2015).

While doing *sirsasana* complete blood in our body flow down to the head. 40-45 % of blood flow to the leg stopped and flow towards the head region. But the brain has auto regulator blood circulation which stops excess blood to flow to the brain and make it flow toward the facial region, arm, hand, shoulder, and abdomen. While doing a headstand, oxygen supply to the brain will increase. Skin tone will increase by practicing headstand. Some study concluded that practicing *sirsasana* will improve the memory level (Manjunath & Telles, 2003).

## NEED AND SCOPE OF THE STUDY

Even though a number of studies have been done illustrating the effects of *sirsasana*, one-session long duration practice effects of this *asana* are not done yet. As propounded by the *Patanjali*, *asana siddhi* attainment of postural perfection is said to happen when a practitioner practices a particular pose for a considerably longer duration. It is our general observation that commonly practiced *asanas* are not maintained more than a few minutes, in general setup, especially in therapy setups. Long term maintenance of a posture may have the following phases: 1) Initial phase of comfortably holding the posture (a few minutes which is commonly practiced), 2) Next phase of uncomfortable adjustment, where the practitioner adjusts to the new enhanced time limit of maintaining the posture, 3) next phase of deeper stability due to long term sustenance of the posture. Accordingly to the sage *Patanjali*, it is the third phase which must be strived for by any practitioner.

As a general practice, *asanas* are maintained for a couple of minutes during a session, and it is rare to get practitioners who maintain the posture for a long duration, more than 30 minutes, at the least. The author of this dissertation (Kaviyaran), has been practicing *Sirsasana* for more

than one hour comfortably with more than 4 years of regular practice. Total hours of *Sirsasana* practice are approximately, 170 hours till now. The author also holds an India book of records for the longest headstand for a duration of two hours. Hence it was decided to study the effects of one-session long duration holding of *sirsasana* on a competent practitioner.

A study of long duration practice effects would give us stable changes in our physiology and also in psychology. In this single case study, we focused on physiological changes and psychological changes. This dissertation is a report of the comprehensive assessment of various physiological and psychological effects of 30 minutes of *sirsasana* practice.

In this *sirsasana* study, we are going to check different variables in psychology and physiology aspects. In physiology study, heart rate and respiration rate of a participant will record the entire practice of *sirsasana*

for 30 mins and going to analysis what are the change happens in those variables.

In psychology study, respond time, attention level, memory capacity, planning level, and decision-making capacity those variables which are going to check that practice of *sirsasana* for 30 minutes will increase or decrease that variable.

We believe the study would pave a path to a better understanding about common and stable pathways of changes due to the long-duration practice of *asana*, as suggested to be perfected by *Patanjali*.

# LITERATURE REVIEW

## ANCIENT LITERATURE REVIEW

### ASANA

स्थिरसुखमासनम् ॥४६॥

*sthirasukhamāsanam* ||46||

#### **Steady and comfortable in posture.**

*Asana* is not merely a physical or dynamic exercise to perform, it is a meditative posture. To perform meditation we do *asana*, a steady and comfortable posture. For example *siddhasana*, *padmasana*, *vajrayana*, *sukhasana*, *swastikasana* so on. It necessarily not may be only these *asanas*, we can choose advance *asana* such as *sirsasana* also. Performing the posture with a steady and calm mind in a comfortable position is yoga. Though *sirsasana* is not included in the *Patanjali yoga sutra* it can be practiced. It does not cause harm for our body. By practicing *asana* our body will be in an equilibrium state. (The equilibrium state is not mentioned in *Patanjali yoga sutra*)

How to master *asana*?

प्रयत्नशैथिल्यानन्तसमापत्तिभ्याम् ॥४७॥

*prayatnaśaithilyānantasamāpattibhyām* ||47||

#### **By loosening of effort and meditation on the serpent *Ananta*, *asana* is mastered**

We do *asana* to meditate, maintaining the posture steadily and comfortably, only then we can meditate. By practicing this we can release our stress, anxiety and chaos in our mind. One should do the *asana* effortlessly. Our mind should be concentrated *Anantha* (meaning endlessness or bliss). While practicing *asana* one should be focused on their *mooladhara chakra*, which gets activated *kundalini* by mastering the *asana*. While performing the *asana* we should be so relaxed and effortless that no external forces should affect our posture, one should not get disturbed. We

should not feel the pain in our muscles or nervous system. Few of the effortless *asana* used for meditation usually is *padmasana*, *siddhasana*, *swastikasana*.

ततो द्वन्द्वानभिघातः ॥ ४८ ॥

*tato dvandvānabhighātaḥ* ||48||

**There by the pairs of opposites cease to have any impact.**

Pairs of opposite, physical or mental level won't get affected. Any environmental changes won't affect the person, (for ex. If the climate is too hot or cold, either of the extremities won't affect the person who has mastery over *asana*. Mental state – our emotional level will get balanced. Too much happiness or sadness will be perceived equally. The mind will be balanced regarding emotions. All these are possible by following *Yama*, *niyama*, and *asana*. If we have to overcome all these (pairs of the opposite) our practice of meditation should be undisturbed. The body should not react to heat and cold. Firstly we should be both mentally and physically in equilibrium. (distractions and mood swings should not occur). Resistance play - we should avoid being around diseased people in the family and surroundings, which will reduce our body resistance power and thinking about it also will make us mentally weak. Personality – having low self-esteem about one's own personality will make us mentally weak. to overcome this one should get in touch with spiritual assistance. By practicing the *asana* resistance will be increased (Swami, 2012).

HATHA YOGA PRATIPIKA, VERSES

अत्याहारः प्रयासश्च प्रजल्पो नियमग्रहः ।

जनसंगश्च लौल्यं च षड्भिर्योगो विनश्यति ॥१५॥

*atyāhāraḥ prayāsaśca prajalpo niyamagrahaḥ* ।  
*janasaṅgaśca laulyam ca ṣaḍbhiryogo vinaśyati* ||15||

There are three *nadis* present *Ida*, *Pingala*, and *Sushumna*. The Union of these *nadis* is necessary i.e. uniting the two energy forces in the body (pranic and mental energy flowing in them). Usually, these two forces do not operate simultaneously. Either the *Ida* or *Pingala* dominates. In *Sushumna Nadi* the flowing rate doesn't exceed more than one to four minutes. By regular practicing of balancing, technique equilibrium can attain. These three *nadis* terminate in *ajana chakra*. Through the practice of yoga *Ida* and *Pingala* are equalized and *Sushumna* gets activated and *ajana chakra* is awakened. *Ida* is connected to the left nostril and belongs to the right brain hemisphere. *Pingala* is connected to the right nostril and belongs to the left brain hemisphere. The main objective of this practice is to activate *Sushumna Nadi* functioning and increase the duration and flow and the period when both nostrils flow simultaneously so that balance is created in mental and physical functions.

Failure Factors :

*Atyahara* ( overeating)- we should eat more food than the appetite. A yogi should forfeit this habit. *Prayasa* (exertion)- a yoga practitioner should have limits in labor, whether it is physical or mental or oral. *Prajapati* (talkativeness): exceeding our limiting speech should be avoided. *Niyamagraha* ( adhering to rules): one should stick rules and regulations like our daily habits of eating, bathing, etc. If the habits are not followed properly then the practice of yoga is hindered. This is an important impediment in the path of yoga. *Janasangha*- being in people's company disturbs a yogi, as the common people's company arouses feelings like lust, anger, love, hate, misery and ego which disturbs our practice. *Laura* (fickle-mindedness)- there are ten senses in a human being. Having inconsistency in anyone of the senses or in all the senses is a cause of disturbance for a yogi. That instability interrupts the intellect and steadiness of a practitioner.

उत्साहात्साहसद्वैर्यात्तत्त्वज्ञानाश्च निश्चयात् ।

जनसंगपरित्यागात्षड्भिर्योगः प्रसिद्ध्यति ॥१६ १ ॥

*utsāhātsāhasāddhairyāttattvājñānāśca niścayāt |*  
*janasaṅgaparityāgātṣaḍbhiryogaḥ prasiddhyati ||16 (i)||*

The goal of this yoga practice is self-realization, self – discipline.

Success Factors:

Enthusiasm (*utsaha*)- we should have a positive attitude, inspiration and the idea of attaining perfection. Courage (*sahasa*)- the courage to face the inner visions and realizations. Perseverance (*dhairya*)- no matter what happens one should practice under all circumstances. Discriminative knowledge (*tattva jnana*)- every aspect of our life should be conducive to our *sadhana*. Determination (*nischaya*)- resolve to carry on the practice under all circumstances. Aloofness from the company (*janasangha parityaga*)- we should stay away from social interactions and negative influences, but do not consider others to be inferior.

HATHA YOGA PRATIPIKA, VERSE 78,79

VIPARĪTAKARAṆĪ MUDRĀ  
(REVERSING ATTITUDE)

अथ विपरीतकरणी मुद्रा

तत्रास्ति करणं दिव्यं सूर्यस्य मुखवचनम् ।

गुरूपदेशतो ज्ञेयं न तु शास्त्रार्थकोटिभिः ॥ ७८ ॥

*tatrāsti karaṇam divyaṁ sūryasya mukhavañcanam |*  
*gurūpadeśato jñeyaṁ na tu śāstrārthakoṭibhiḥ || 78 ||*

There is a wonderful means by nectar is falling into the opening of the sun. This is obtained by the guru's instructions and not from the hundreds of *shastras* (treatises).

ऊर्ध्व-नाभेरधस्तालोरूर्ध्वं भानुरधः शशी ।

करणी विपरीताखा गुरु-वाक्येन लभ्यते ॥ ७९ ॥

*ūrdhva-nābheradhastālorūrdhvaṁ bhānuradhaḥ śaśī |*  
*karaṇī viparītākḥā guru-vākyaena labhyate || 79 ||*

With the navel region above and the palate below, the sun is above and the moon below. It is called *viparītakaraṇī mudrā*, the reversing process. When given by the guru's instructions it is fruitful.

Due to the natural body processes, nectar falls into the sun which emits by the moon. The moon not only represents *bindu* but also consciousness. The sun not only signifies *Manipura* but also *prana*, the body. From this, it can also be understood that the consciousness streams into the

body and is wasted through the sense organs. There are various *asanas* which can also affect this, but the two most effective are of *viparītakaraṇī mudrā* and *sirsasana*. However, the effects of *viparītakaraṇī mudrā* differ from *sirsasana* as it creates pressure in the throat 363 which stimulates the thyroid and awakens *ishuddhi chakra*. *Sirsasana* directly affects the cerebrum and *Sahasrara chakra*. *viparīta* is also a simpler posture than *sirsasana* but it should be learned from the guru directly.

नित्यमभ्यासयुक्तस्य जठराग्निविवर्धिनी ।

आहारो बहुलस्तस्य सम्पाद्यः साधकस्य च ।

अल्पाहारो यदि भवेदग्निर्दहति तत्क्षणात् ॥८०॥

*nityamabhyāsayuktasya jaṭharāgnivivardhinī ।*  
*āhāro bahulastasya sampādyah sādhakasya ca ।*  
*alpāhāro yadi bhavedagnirdahati tatkṣaṇāt ॥80॥1*

Digestion is strengthened by continual, regular practice and therefore the practitioner should always have sufficient food.

अधःशिराश्चोर्ध्व-पादः क्षणं स्यात्प्रथमे दिने ।

क्षणाच्च किञ्चिदधिकमभ्यसेच्च दिने दिने ॥८१॥

*adhahśirāścordhva-pādaḥ kṣaṇam syātprathame dine ।*  
*kṣaṇācca kiñcidadhikamabhyasecca dine dine ॥81॥*

If one takes only a little food, the heat produced by the digestion will Destroy the system. Therefore, on the first day, one should only stay a moment with the feet up and head down

*viparétakaraëé mudrā* initial benefit is an increased capacity to digest and assimilate food. It increases Digestive secretions and appetite. Food should be taken after practicing Hatha yoga. If food is not taken, if you fast, the gastric acids and digestive enzymes will burn the lining stomach and duodenum. However, it is unlikely to happen when *viparétakaraëé mudrā* is practiced for a few minutes Regularity of meal timings and quantities are necessary for the advancing Hatha yogi, and fasting is contraindicated.



Powerful draining influence on the visceral organs. Due to force of gravity, the lower of these two pool blood, and the body fluids also aggregate in the dependent parts of the pelvis and legs. *Viparétakaraëé mudrā* dependent parts, returning pooled to the circulation. This cannot be induced in the upright or lying position, and this is why inversion is so powerful physiologically. Inversion of the body also contracts visceroptosis (protrusion of the abdominal organs), hemorrhoids, varicose veins, and hernia, all of which are mediated by the gravity. The inverted position, while draining the lower body, simultaneously enhances blood flow to the brain, especially the cerebral cortex and the intracranial glands i.e. the pituitary and pineal. Cerebral insufficiency and senile dementia are counteracted. However, elderly people are not advised to commence inversion in later life.

वलितं पलितं चैव षण्मासोर्ध्वं न दृश्यते ।

याममात्रं तु यो नित्यमभ्यसेत् स तु कलजित् ॥ ८२ ॥

*valitaṁ palitaṁ caiva ṣaṅmāsordhvaṁ na dṛśyate ।  
yāmamātraṁ tu yo nityamabhyaset sa tu kalajit ॥ 82 ॥*

The practice should be done daily, gradually increasing the duration. After six months of practice, grey wrinkles become inconspicuous. One who practices it for Yama (three hours) conquers death *viparétakaraëé mudrā* should be done daily at the same time, preferably in the morning. Hold the final position for a few minutes in the beginning or until discomfort arises. Over the period of a few months slowly increase the duration of practice. When pressure builds up in the head, slowly come down. Count the number of respirations taken during the practice and increase by an extra breath each day.

According to the *śloka*, if it is performed for three hours, death can be overcome, but do not practice for such a long duration on the basis because the body will be unable to cope with its influence. It takes years of *sadhana* to reach this stage. Most important is that during the practice the position is perfect and concentration is one-pointed (swami muktibhodaṇanda, 2006).

## MODERN LITERATURE REVIEW

TITLE/YEAR	A rare case of branch retinal vein occlusion following <i>Sirsasana</i> (2016)
AUTHORS	Anugraha balamurugan, Krishnagobal srikanth
SUBJECT	48 year old male smoker
INTERVENTION/ ASSESSMENT	Headstand yoga posture for 2mins/day. Intra ocular pressure was measured by non-contact tonometer.
RESULT/CONCLUSION	Branch retinal vein occlusion in a hypertensive patient who is a yoga practitioner for its infrequency and for the potential visual difficulties. Published literature recommends against headstand in hypertensives. Analysis of a large population of yoga practitioners may provide ultimate co-relation between the headstand and retinal venous occlusion. Moreover, the prior medical calculation is necessary to prevent yoga-related ill effects, which can dull the good image of yoga asanas.

TITLE/YEAR	The geometric curvature of the spine during the sirshasana, the yoga's headstand (2016)
AUTHORS	Mário Hebling Campos, Nayane Martins Giralde, Paulo Gentil, Claudio Andre Barbosa de Lira, Carlos A. Vieira & Marcelo Costa de Paula
SUBJECT	six males and five females participants

INTERVENTION/ ASSESSMENT	Orthostatic position, gait, and <i>sirsasana</i> . first participants asked to stand on a stopped treadmill in an upright position. After that, the gait of participants have to analysis, so they asked for y walked on the treadmill for 5 min at 5.0 km · h <sup>-1</sup> . Finally, the participant has to perform <i>sirsasana</i> . Illuminators with four 3 W white power light LEDs were constructed and placed around the lenses of three camcorders (Mini-DV–Panasonic NV-GS320, Japan) used to record the back at 60 Hz during all tasks (gait, orthostatic position, and yoga).
RESULT/CONCLUSION	To study on lumbar and thoracic spine biomechanical aspects during <i>sirsasana</i> . Lumbar lordosis decreased and thoracic spine lateral deviations increased during <i>sirsasana</i> when compared to orthostatic position and gait. metabolite transport in the intervertebral discs will improve because of The less extended lumbar spine position. scoliosis could be aggravated during headstand.

TITLE/YEAR	<i>Sirsasana</i> (headstand) technique alters head/ neck loading: Considerations for safety (2014)
AUTHORS	Rachel Hector, M.S. , Jody L. Jensen, PhD*
SUBJECT	45 participants (18-60 years old), Three matched groups of 15 each
INTERVENTION/ ASSESSMENT	All 45 practitioners performed 3 headstands such as single, double bend, double straight. Kinematics and kinetics were assessed to locate the highest force acting on the head loading rate, a center of pressure (COP) and cervical alignment
RESULT/CONCLUSION	Maximum 40–48% body weight loaded in the head while doing <i>sirsasana</i> . While doing <i>sirsasana</i> with straight leg together may reduce the load on the head and rate of change of that load.

TITLE/YEAR	Rapid Changes of Body Weight after a Headstand: A Metrological
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	Analysis (2015)
AUTHORS	Alejandro Acuña-Espinoza, Luis Fernando Aragón-Vargas
SUBJECT	17 sedentary adult men participants (66.0±6.7 kg, 22.5±3.4 years, 173.7±4.7 cm)
INTERVENTION/ ASSESSMENT	Headstand has to maintain minimum for 30 sec participant randomly assigned into two groups. One group has to do normal standing posture and another group has to perform a headstand. Body weight checked for both group before and after the intervention. Each participant weight checked up to 4 times. the platform calibrated areas used to check weight and Raw data were exported to a Microsoft Excel spreadsheet to determine the average value.
RESULT/CONCLUSION	A 30 sec of headstand has no effect on changing the body weight. The small differences found were due to equipment-associated measuring errors. This experiment helps in the elimination of this unjustified practice among the wrestling community.

TITLE/YEAR	Intraocular Pressure Changes and Ocular Biometry during <i>Sirsasana</i> (Headstand Posture) in Yoga Practitioners(2006)
AUTHORS	Mani Baskaran, DO, DNB,1 Krishna Raman, MD,2 Krishna Kumar Ramani, MPhil (Opt),1 Joseph Roy, MSc,1 Lingam Vijaya, MD,1 Sengamedu S. Badrinath, FRCS (C), Dip AB
SUBJECT	75 participants from the yoga training institute ((50 Asian Indians and 25 Caucasian)
INTERVENTION/ ASSESSMENT	Headstand posture for all participants. Tonopen used to calculate the intra ocular pressure in the eye before and after the headstand.
RESULT/CONCLUSION	A baseline of IOP is increased immediately after the <i>sirsasana</i> . A constant 2-fold increase in the IOP during <i>Sirsasana</i> , which was maintained during the posture in all age groups unrelatedly of the ocular biometry and ultrasound pachymetry. the risk factor causal to glaucoma show any correlation with the magnitude of IOP raise

	during the headstand posture.
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TITLE/YEAR	Respiratory responses to headstand posture(1968)
AUTHORS	Shanker rao
SUBJECT	Six subjects age between 18 to 22 with a mean weight of 55kg and 167cm height and who are all nonsmoker.
INTERVENTION/ ASSESSMENT	Headstand posture for all participants. To assess the frequency of breathing and all major subdivisions of the lung volume.
RESULT/CONCLUSION	During <i>sirsasana</i> , VT is increased due to this ventilation increased as no substantial l change blood, by an advance on the pulmonary air space, sets a volume limit to the maximal inspiratory effort and gives toward reducing the VC in the head down position. The amount of blood shared in the thoracic section is larger in the resting than in the upright position, and also larger in headstand posture than the horizontal position.

TITLE/YEAR	Effects of <i>sirsasana</i> (headstand) practice on autonomic and respiratory variables
AUTHORS	Manjunath NK, Telles S.
SUBJECT	40 subjects (age 19-36). Two groups each have 20 participants
INTERVENTION/ ASSESSMENT	<i>Sirsasana</i> for 2minutes. One group has to do <i>sirsasana</i> in the traditional way and another group with wall support <i>sirsasana</i> . To assess the heart rate variability along with the nonspecific autonomic measure.
RESULT/CONCLUSION	One group had an increase in the power of the low-frequency component (LF) and a decrease in the high-frequency component (HF) of the HRV spectrum, increased LF/HF ratio, and decreased heart rate. Who is practicing <i>sirsasana</i> in traditional way increase in the skin conductance level.

TITLE/YEAR	The effect of lower body negative pressure and rotating-table simulated push-pull effect in flight on cardiovascular function(2001)
AUTHORS	Yao YJ, Zhao ZG, Liu TS, Shi J, Hou BK, Yang CB.
SUBJECT	8 participants randomly in two groups
INTERVENTION/ ASSESSMENT	One is a yoga group and another is the control group. In yoga group, subjects have to perform head up stand for 1 minute, head down stand for 30 sec and again head up stand for 10 minutes. In the control group, only head up stand for 10 minutes. Electrical impedance instrument used to assess the changes of heart rate (HR), blood pressure (BP), basic impedance (Z0), stroke output (SO), cardiac output (CO) and total peripheral resistance (TPR)
RESULT/CONCLUSION	After headstand, head-up stand combining LBNP produced cardiovascular function run down, the degree was larger than simple head-up stand combining LBNP. The LBNP rotating-table can be used to replicated the push-pull effect.

## **AIM AND OBJECTIVE**

### **AIM**

To understand the physiological and neuropsychological changes by performing *sirsasana* for 30 minutes

### **OBJECTIVE**

To find what are the changes that happen in physiology and psychology, such as heart rate, breath rate, attention, memory, responds time, decision making, and planning capacity.

### **RESEARCH QUESTION**

Does practicing *sirsasana* for 30 minutes have any changes in heart rate, breath rate, attention, memory, responds time, decision making, and planning capacity.

### **HYPOTHESIS**

Breathing rate will reduce, heart rate will reduce, attention level will increase. The memory will be improved, response time will be reduced, decision making will be improved, planning capacity will be improved.

### **NULL-HYPOTHESIS**

Breathing rate will not reduce. Heart rate will reduce. Attention level will not increase. The memory will not improve, responds time will not reduce, decision making will not improve, planning capacity will not improve

## METHOD

### SAMPLE

The participant was a 23-year-old male who was studying the MSC Yoga therapy in svyasa university. He was practicing yoga for the last 10 years. Especially he was practicing *sirsasana* for the last 4 years to achieve the record of longest headstand in the world. Now he able to do *sirsasana* for more than 2 hours and also his name has officially entered in INDIA BOOK OF RECORD for longest headstand in India. As well as he is the author and participant of this study.

### DESIGN OF STUDY

A single case study design

### INTERVENTION

In physiology study, the participant was asked to lie down on his yoga mat and for first 10 minutes complete relaxation on *savasana* was given. After 10 minutes, the participant slowly went to do *sirsasana* after attaining the final posture he would maintain it for 30 minutes continuously without changing the pose. After completing 30 minutes of *sirsasana*, he slowly comes to *savasana* and relaxes his body completely in *savasana* for 10 minutes.

In neuropsychological study, the participant asked to do *tadasana* for 2 minutes. After 2 minutes later, the participant slowly going to do *sirsasana* after attaining the final posture he should maintain it for 30 minutes continuously without changing the pose. After completing 30 minutes of *sirsasana*, he slowly gets down from *sirsasana* and was asked to perform 2 minutes *tadasana* again.

### ASSESSMENT

Measuring heart rate, breath rate continuously throughout the practice were attempted. There are three trials in physiology task.

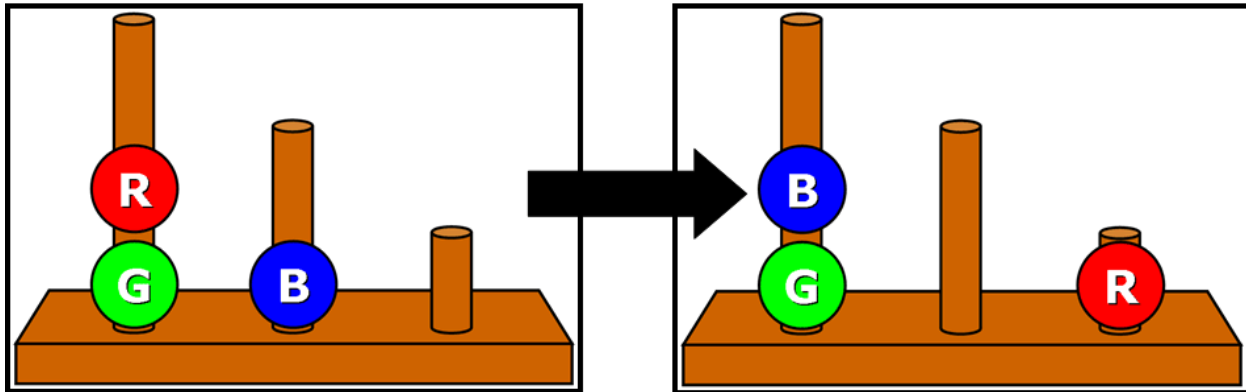
Neuropsychological tasks such as reaction timing, rapid visual timing, tower of London, ANT, corsiblock, Iowa task, and digit span visual task were administered. There are seven tasks in the Neuropsychology study, each task has three repeated trials.



## 1. Reaction timing

Reaction timing task is used to measure the response time of participant to stimulus. There are two types one is auditory reaction timing and visual reaction timing (“reaction time,” 2018).

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However, there are some rules you need to follow to complete the task:

- You can only move one ball at a time.
- You are not allowed to pick up more than one ball at any time.
- You cannot place balls anywhere else other than the three pegs.
- You can only place a ball on the left peg, on the middle peg, and on the right peg.
- Finally, you need to make the new pattern in a special number of moves.

The allowed number of moves for each pattern will be displayed in the upper right corner of the screen. To pick up one of the balls, click on it with the mouse. Move the ball to a peg with at least one free spot on it and click again to release it.

If you make a mistake, you can press the 'Reset' button to put the balls back to the starting pattern and try again. You have attempted to solve each problem in the number of prescribed moves.

If you feel that you cannot solve one of the problems, you can press the 'Next' button to move on to the next pattern.

#### 4. Attention network task

The Attention network task is designed to test three attention network such as alerting, orienting and executive control in children and adults. The efficiency of the alerting network is examined by changes in reaction time resulting from the warning signal (“Attention network task,” 2016).

In this experiment, investigation attention. Put your index finger on the ‘E’ and the ‘I’ keys on your keyboard.

You will be shown an arrow on the screen pointing either to the left or right (for example -> or <-). On some trials, the arrow will be flanked by two arrows to the left and two arrows to the right (for example ->->->->-> or ->-><-->->)

Your task is to respond to the direction of the CENTRAL arrow,

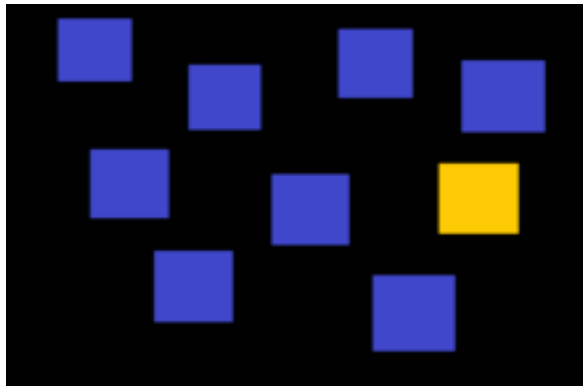
\*press ‘E’ if the central arrow points to the left or

\*press ‘I’ if the arrow points to the right

Make your response as quickly and accurately as possible because your reaction time and accuracy will be recorded

#### 5. Corsi block task

Corsi block task is a tapping task which is used to assess the visuospatial short term memory. There are two types one is forward Corsi block and another one is backward Corsi block (“Corsi block task,” 2019) .

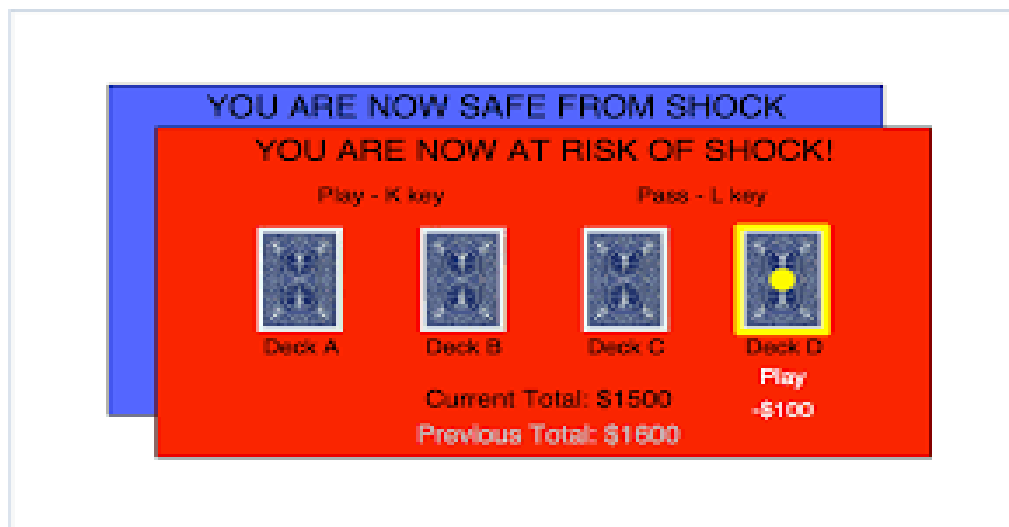


You will see nine blocks on the screen. On each trial, several blocks will light one at a time. Your job is to remember their exact sequence. As soon as the sequence is finished, you must repeat the sequence by clicking on the block in the same order they were presented

But for backward Corsi block, your job is to remember in sequence in REVERSE ORDER. As soon as the sequence is finished, you must repeat the sequence by clicking on the block in the reverse order they were lit.

#### 6. Iowa gambling task

Iowa gambling task is psychology task which used to assess the real-life decision making (“Iowa gambling task,” 2019).



In this experiment, you will be asked to repeatedly select a card from one of the four decks. You can select a card by clicking the mouse on one of the decks. With each card, you can win some money, but you can also lose some. Some decks will be more profitable than others. Try to choose cards from most profitable decks so that your total winning will be as high as possible.

You will get 100 chances to select a card from the decks that you think will give you the highest winnings and your total earning and the number of cards will be displayed on the screen. You start with \$2000.

### 7. Visual digit span task

Digit span is a task when a number is used to measure the short term memory of the brain. There are two digit span visual and auditory. You are performing here visual digit span. In these two types forward and backward visual digit span. Backward digit span is more challenging variation which involves recalling items in reverse order (“visual digit span task,” 2019).

In this experiment first you have to perform forward visual digit span, each trial some numbers will display on the screen one by one. Your job is to remember the number in the same sequence and have to type. As much as possible, try to remember the maximum numbers.

But in the backward visual digit span, your job is to remember the sequence in reverse order and type the number in reverse order it was quite difficult to compare to forward visual digit span.

### ASSESSMENT TOOL

In physiology study, we used power lab AD instruments, Australia.

For psychology study, we used INQUIST software which is a library of the psychological tasks and enables measuring all the data in milliseconds. Data were collected in the respective computer, internet access was not needed and test environment is tightly controlled.

### RECORDING PROCEDURE

In physiology study, Electrocardiogram (ECG) and respiration were recorded using a 16-channel human physiology system (Power Lab 16/35, AD Instruments, Australia). Respiration was

recorded using a volumetric pressure transducer fixed around the trunk about 8 cm below the lower coastal margin.

The ECG was acquired using chest leads. The electrodes were placed on the chest and right abdomen. ECG was digitized using a 16bit analog to digital converter at a sampling rate of 1 KHz and was analyzed offline to obtain the HRV spectrum. Frequency domain and time domain analysis of HRV data were carried out using Lab Chart 8 (AD Instruments, Australia) software. Check all the equipment connected to the body before going to do *sirsasana*. first 10 minutes *savasana*. Then slowly come to sitting position *vajrasana* and go to *sirsasana* slowly after attaining the proper position be stable in it for 30 minutes. 30 minutes later, slowly get down and come sitting position *vajrasana*. Again 10 minutes *savasana* after 30 minutes *sirsasana*. heart rate and respiration rate recording continuously going on entire trial.

In psychological studies, before going to do *sirsasana* we have to perform psychology task which is pre-data. After performing that task 2 minutes *tadasana* then slowly coming to sitting position *vajrasana* and go to *sirsasana* final posture maintain it for 30 minutes. 30 minutes later, slowly come to sitting position *vajrasana* and come to standing position *tadasana* for 2 minutes. After finishing practice again have to perform the same psychology task which performed before. Each task has three trials.



# RESULT

## Study of Psychological Variables

### 1) REACTION TIME

The Reaction timing task is used to measure the response time of participant to stimulus. There are two types one is auditory reaction timing and visual reaction timing.

#### a) Auditory Reaction Time

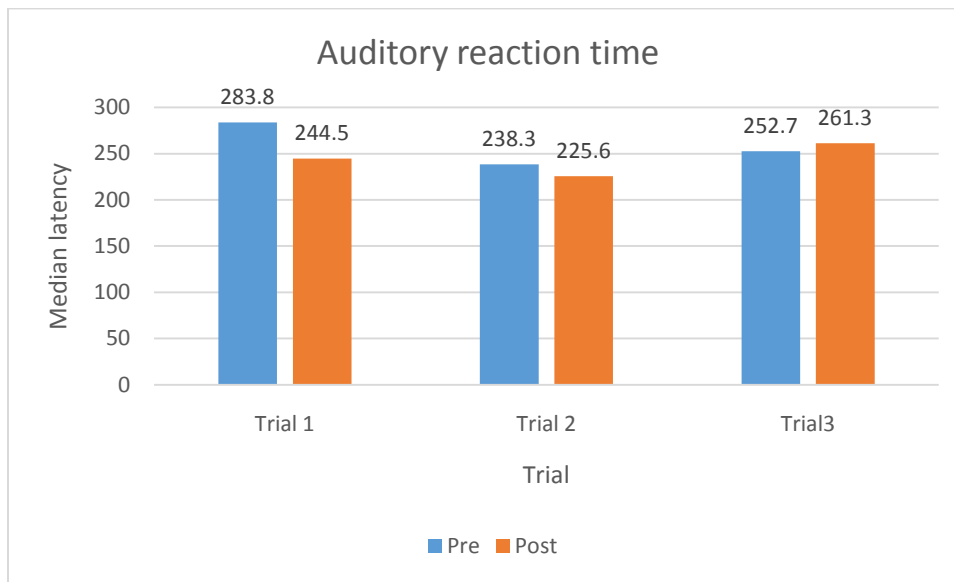


Figure 1: Median latency of auditory reaction time task

From the above graph, we can understand that the median pre auditory reaction time is very high compared to the post auditory reaction time task. The median reaction time is used, as reaction time generally follows a skewed distribution. In all the three trials the trend of change was found to be uniform. Hence we can assume that, *sirsasana* practice increases the auditory processing speed.

b) Visual Reaction Time

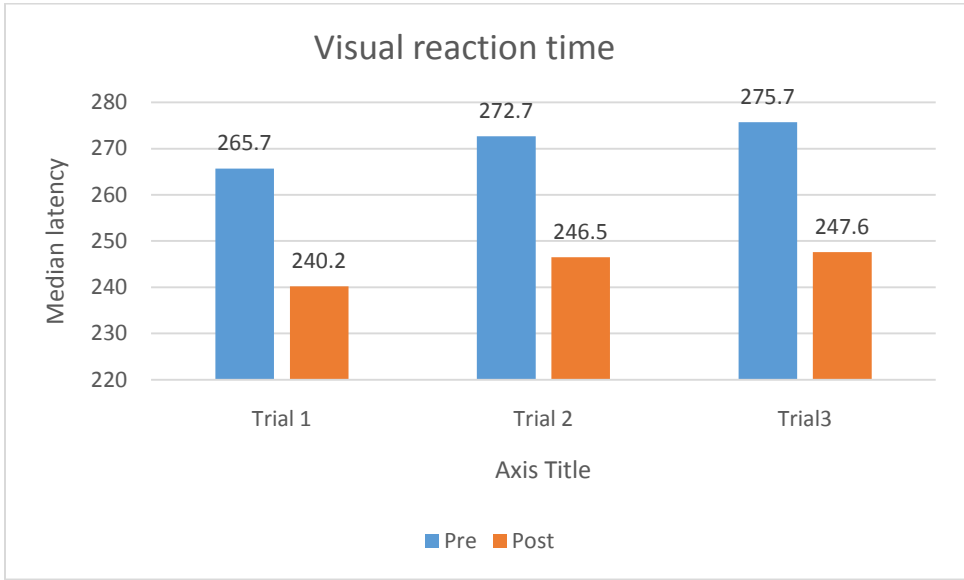


Figure 2: Median latency of visual reaction time task

From the above graph, we can understand that the median pre visual reaction time is very high compared to the post visual reaction time task. The median reaction time is used for the same reason as mentioned earlier. In all the three trials the trend of change was found to be uniform. Hence we can assume that, *sirsasana* practice increases the visual processing speed.



## 2) ATTENTION NETWORK TASK

The Attention network task is designed to test three attention network such as alerting, orienting and executive control in children and adults. The efficiency of the alerting network is examined by changes in reaction time resulting from the warning signal.

### a) Orienting Effect

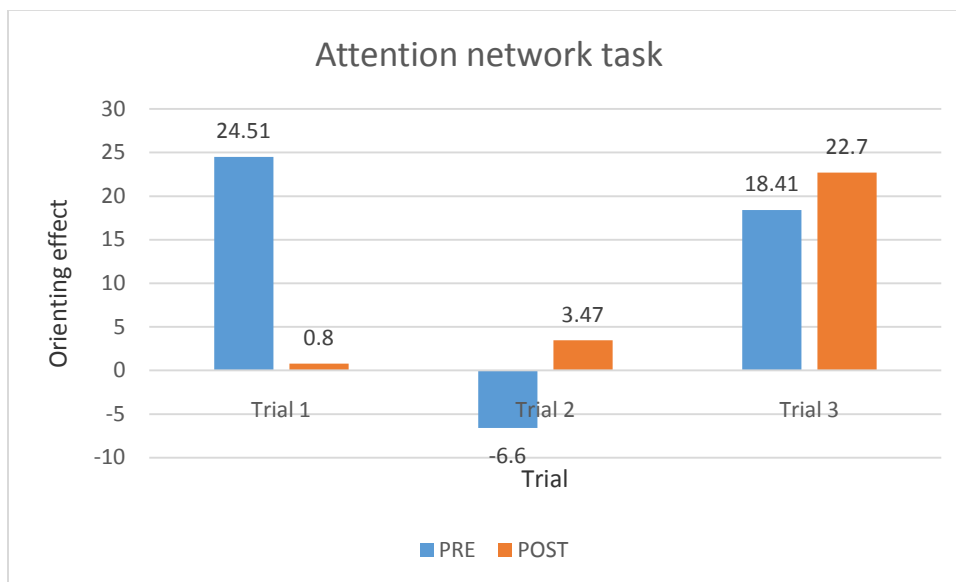


Figure 3: Orienting effect of attention network task

Orienting is inspected by changes in the reaction time that accompany cues indicating where the target will occur.

From the above graph, we can understand that orienting effect is inconsistent across all three trials. Hence we can assume that, *sirsasana* randomly influences the orienting effect of the Attention Network Task.

## b) Alerting Effect

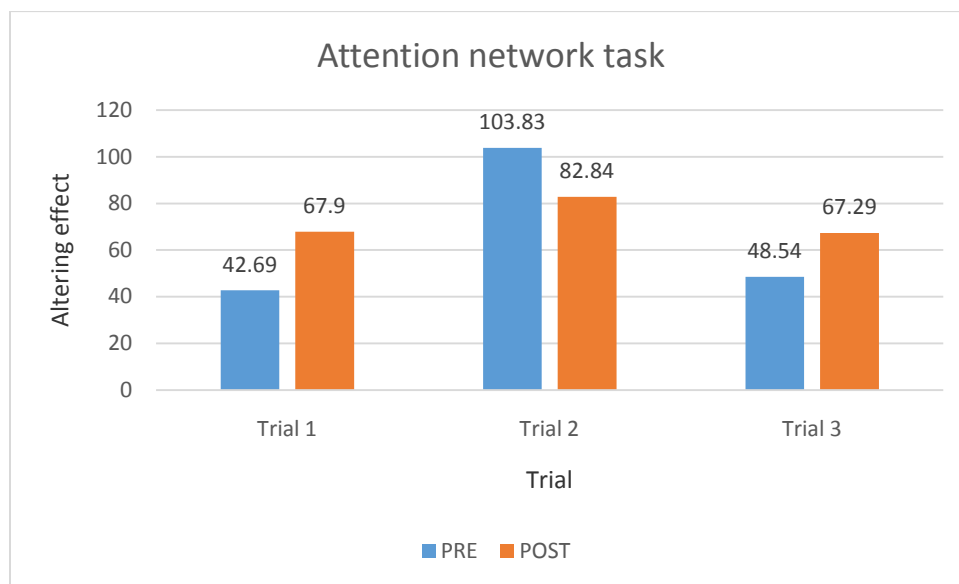


Figure 4: Altering effect of attention network task

The alerting effect is checked by changes in reaction time

From the above graph, we can understand that practice effect might have influenced the second trial's higher values. However, results of all trials put together suggest that alerting effect may increase. Hence we can assume that, *sirsasana* increases alerting effect.

c) Conflict Effect

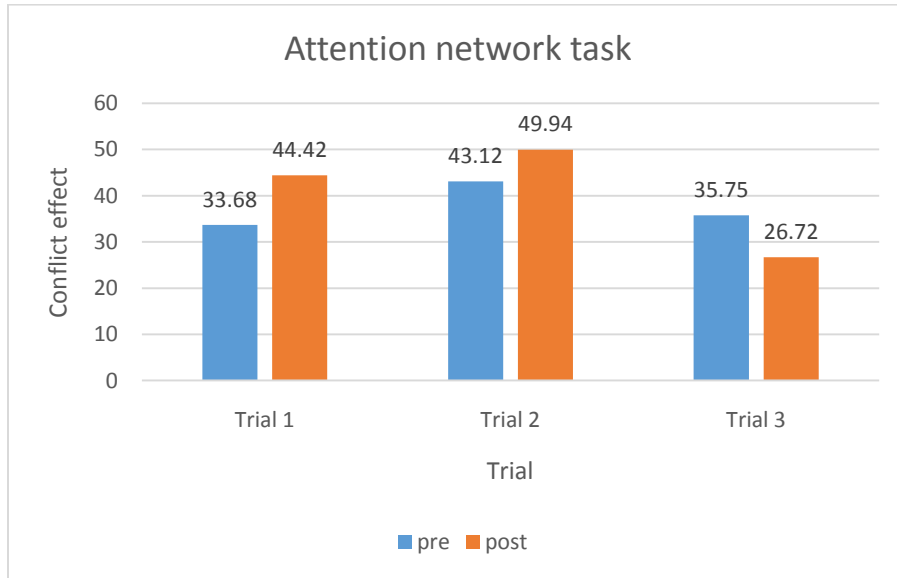


Figure 5: Conflict effect of attention network task

Conflict effect is defined as the clash of interest toward the work.

From the above graph, we can understand that across all the three trials, mean of pre conflict effect is lesser than mean of post conflict effect. Hence we can understand that, *sirsasana* may increase conflict effect. However, the difference appears to be very minimal, and this requires further trials to verify.

### 3) RAPID VISUAL SCANNING

Rapid visual scanning task means the ability to use vision in a systematic manner such as the right to left, top to bottom which measures your attention on the stimulus.

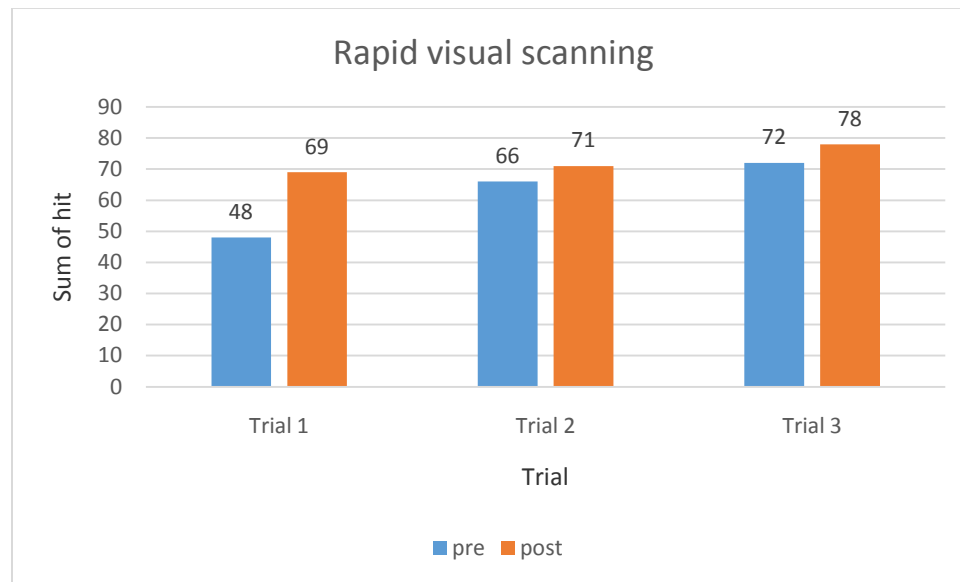


Figure 6: Sum of hit in rapid visual scanning

Sum of hit the variable which indicates the number of times correctly responded. This is considered as a measure of focused attention. From the above graph, we can understand that post sum of hit variable is more compared to the pre sum of the hit, in all three trials. Hence we can understand that, *sirsasana* increases focused attention to the given stimulus.

### 4) TOWER OF LONDON

The tower of London is used in applied clinical Neuropsychology for the assessment of executive functioning, especially to detect deficits in planning.

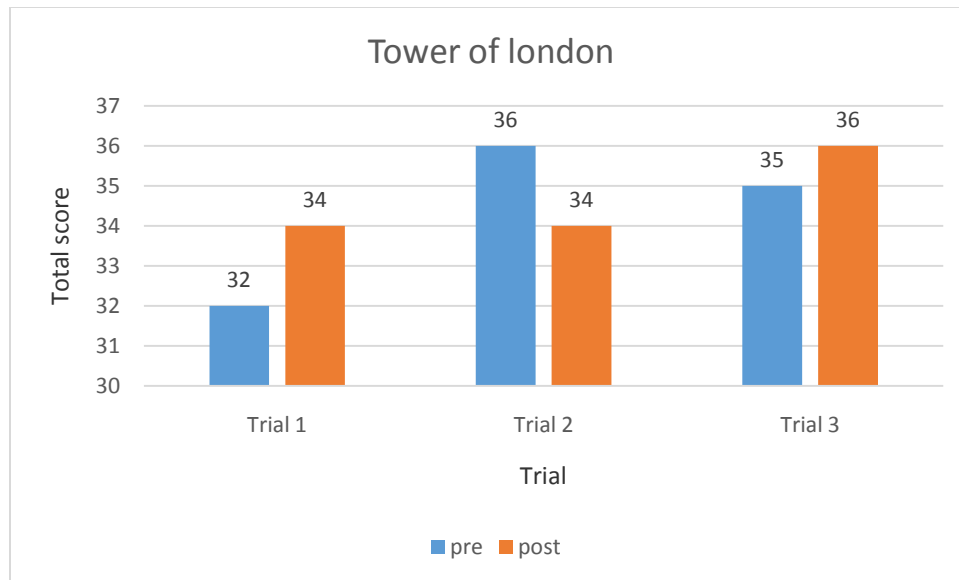


Figure 7: Total score in tower of London

From the above graph, we can understand that practice might have influenced the trial 2's relatively higher score. However, results of all trials put together suggest post total score to be higher compared to pre total score. Hence we can understand that *sirsasana* increase planning ability.

##### 5) CORSI BLOCK

The Corsi block task is a tapping task which is used to assess the visuospatial short term memory. There are two types one is forward Corsi block and another one is backward Corsi block.

a) Forward corsi block

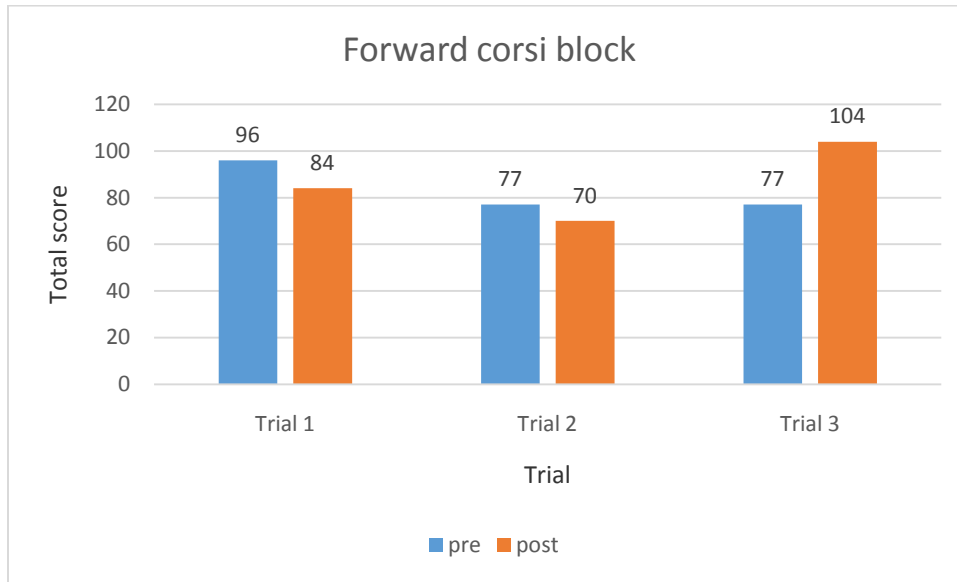


Figure 8, Total score of forward corsi block

From the above graph we can infer that the total score in the forward corsi block test has decreased after the *sirsasana* practice in the first two trials, but in the third trial, surprisingly, the post score has substantially increased. This again would require more trials to ascertain the uniformity of trend.

b) Backward Corsi Block

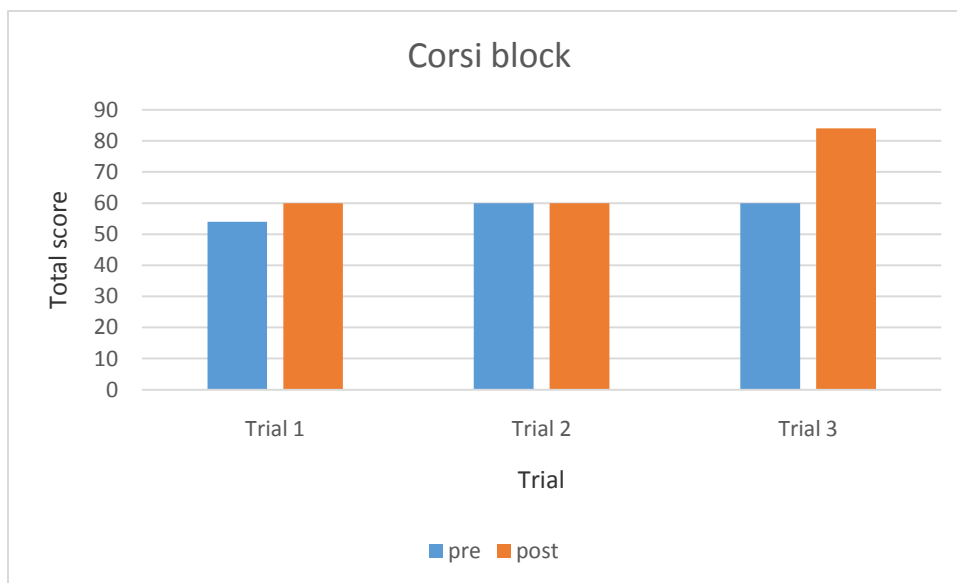


Figure 9, Total score of backward corsi block

From the above graph again we can infer that the total score in the backward corsi block test has increased or remained almost same after the *sirsasana* practice in the first two trials, but in the third trial, like the previous case, the post score has substantially increased. This again would require more trials to ascertain the uniformity of trend. Hence we can speculate that *sirsasana* may increase visuo-spatial short term working memory, but this needs further investigation to confirm this suggested trend of change.

### 6) IOWA GAMBLING TASK

The Iowa gambling task is psychology task which used to assess the real-life decision making

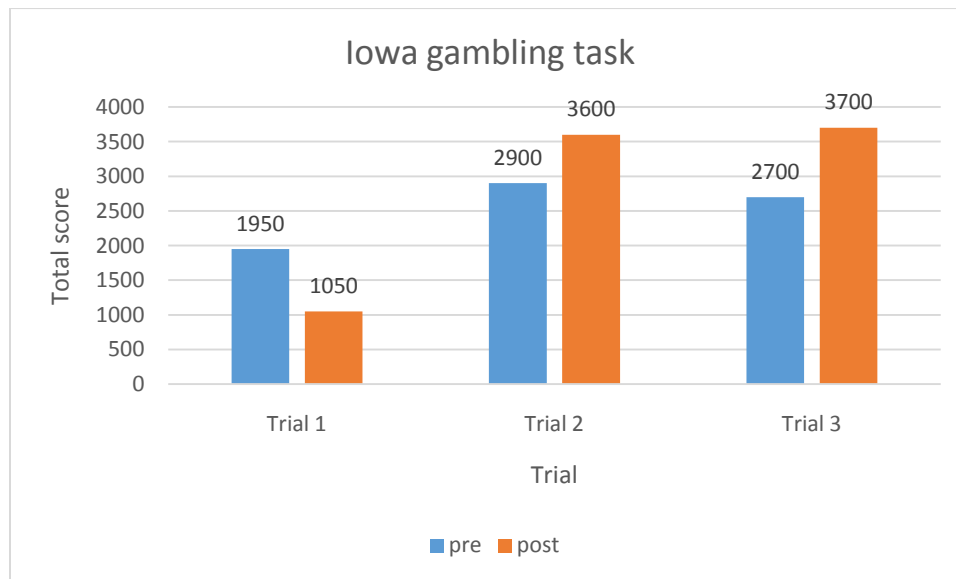


Figure 10: Total score of Iowa gambling task

From the above graph, we can understand that mean post total score is higher compared to mean pre total score. Hence we can understand that *sirsasana* increases capacity to real-life decision making. It was observed that in the first trial, the participant had some difficulty in developing a suitable strategy to play, whereas after getting that insight in the 2<sup>nd</sup> and 3<sup>rd</sup> trials, the participant reported ease of performing the task.

## 7) DIGIT SPAN VISUAL

Digit span is a task when a number is used to measure the short term memory of the brain. There are two digit span visual and auditory. You are performing here visual digit span. In these two types forward and backward visual digit span. Backward digit span is more challenging variation which involves recalling items in reverse order.

### a) Forward Digit Span

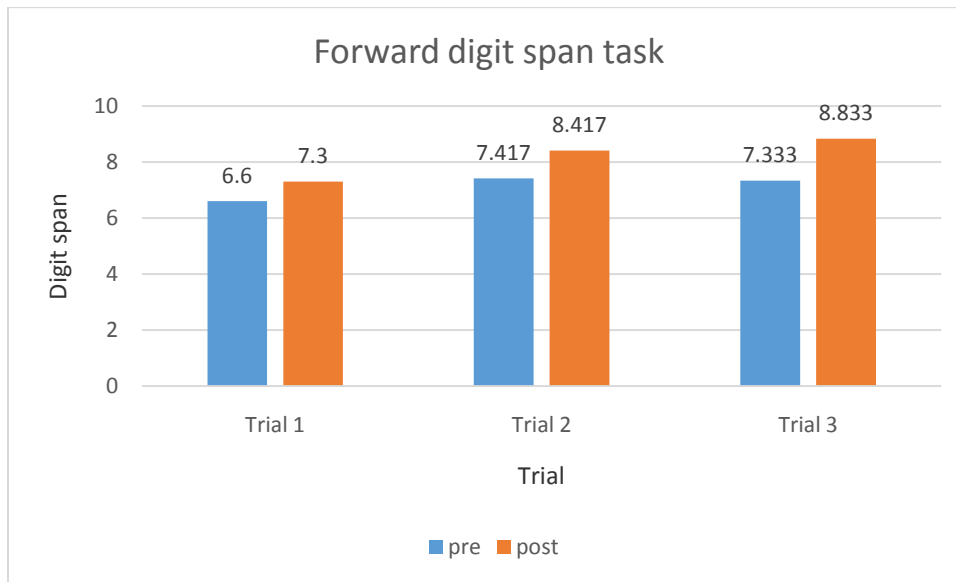


Figure 11: Forward digit span

From the above graph, we can understand that post forward digit span is high compared to pre forward digit span in all three trials. Hence we can understand that *sirsasana* increases working memory span.



## b) Backward Digit Span

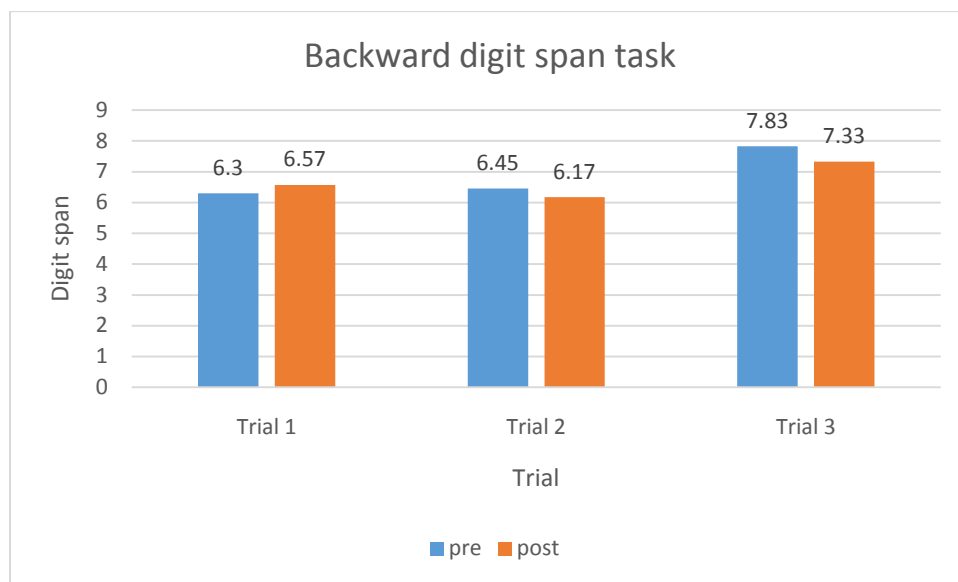


Figure 12: Backward digit span

From the above graph, we can understand that there is not much difference between pre backward digit span and post backward digit span scores. Hence we can understand that *sirsasana* does not much influence backward digit span variable.

## Study of Physiological Variables

### 1) BREATH RATE

Breath rate or Respirational rate which refer number of breath taken by a person in one minutes.

The normal breath rate for adult at rest is 12 to 20 breath per minute (“breath rate,” 2019).

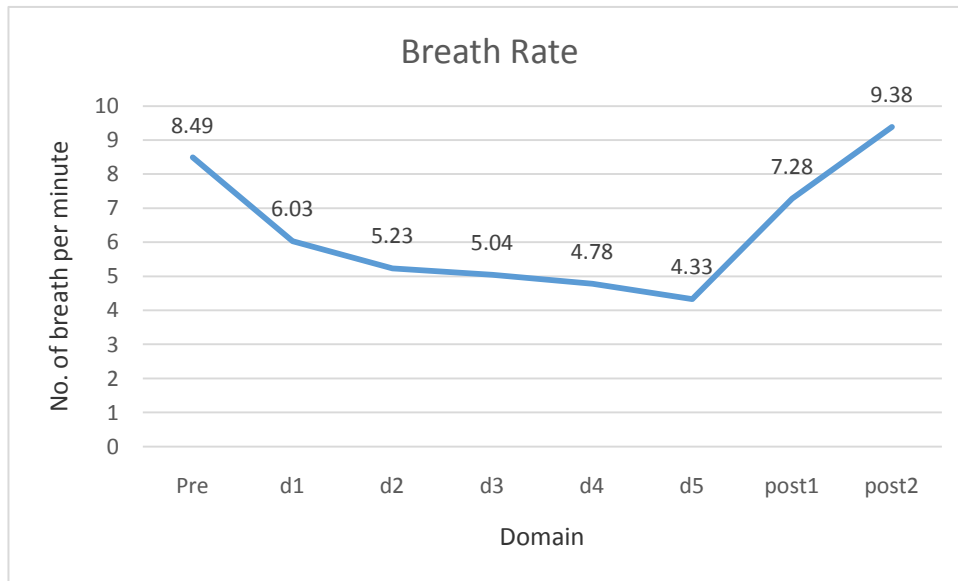


Figure:13 Breath rate

Finally, we can understand that *sirsasana* practice average breath rate is 5 per minute. Breath rate will reduce at the time of practice because Subject taking deep breath during *sirsasana*. But after coming out of the practice, breath rate again coming to the normal rate.

## 2) Heart Rate

Heart rate refers number of beats per minutes by heart. If heart rate is less it shows the efficiency of heart and fitness of cardiovascular system. A normal resting heart rate for adult range from 60 to 100 per minutes (“Heart Rate,” 2019).

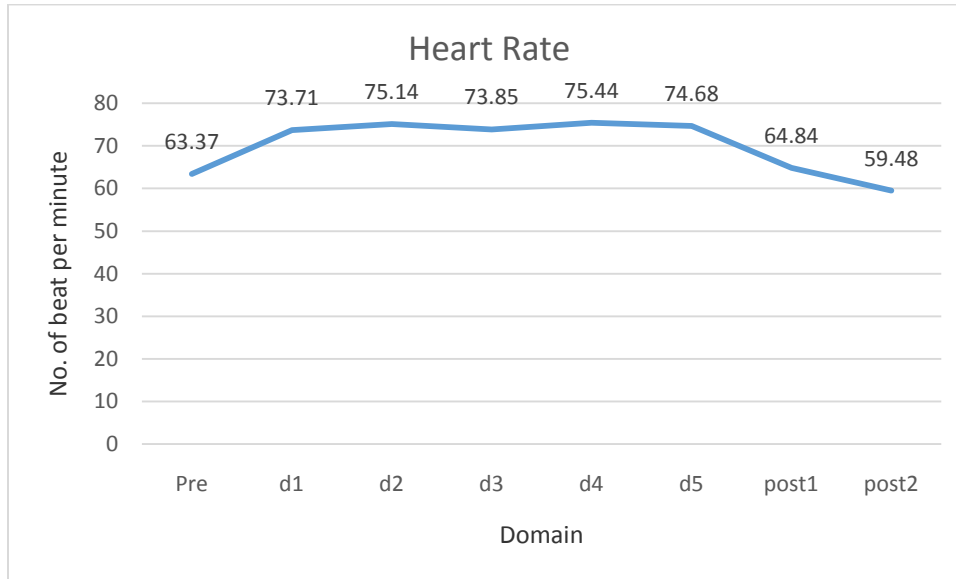


Figure:14 Heart rate

From above graph, heart rate is gradually increasing from 63 to 73 beats per minutes in pre savasana. In sirsasana heart rate is average is 75 beats per minutes. But in post savasana heart rate is gradually decreased from 75 to 60 beats per minutes.

### 3) SDNN

SDNN, the standard deviation of NN intervals. Often calculated over a 24-hour period. SDANN, the standard deviation of the average NN intervals calculated over short periods, usually 5 minutes. SDNN is therefore a measure of changes in heart rate due to cycles longer than 5 minutes (“Heart rate variability,” 2019).

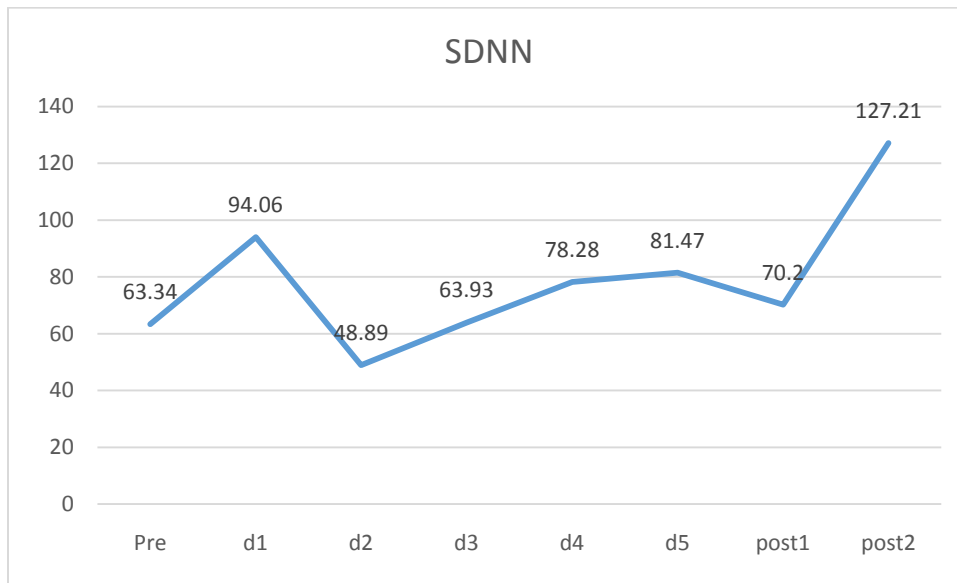


Figure:15 SDNN

From the above graph, heart rate variability is decreased during the practice of *sirsasana*. But after that in relaxation, heart rate variability is gradually increased, but it was in normal limits.

#### 4) RMSSD

RMSSD Root Mean Square of the Successive Differences which is few time domain tool used to assess heart rate variability, the successive difference being neighboring interval of RR. RMSSD used to calculate the short term variation of heart rate (“RMSSD,” 2019).

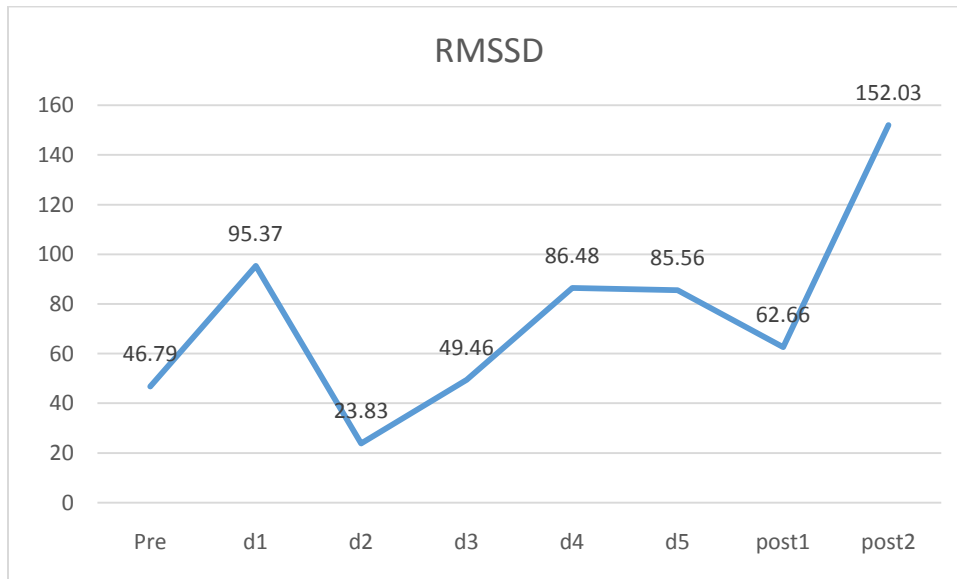


Figure:16 RMSSD

In RMSSD, consistent variations occurred during the practice.

#### 5) pNN50

The pNN50 value is defined as time domain measure of heart rate variability(HRV) (“pNN50,” 2016).

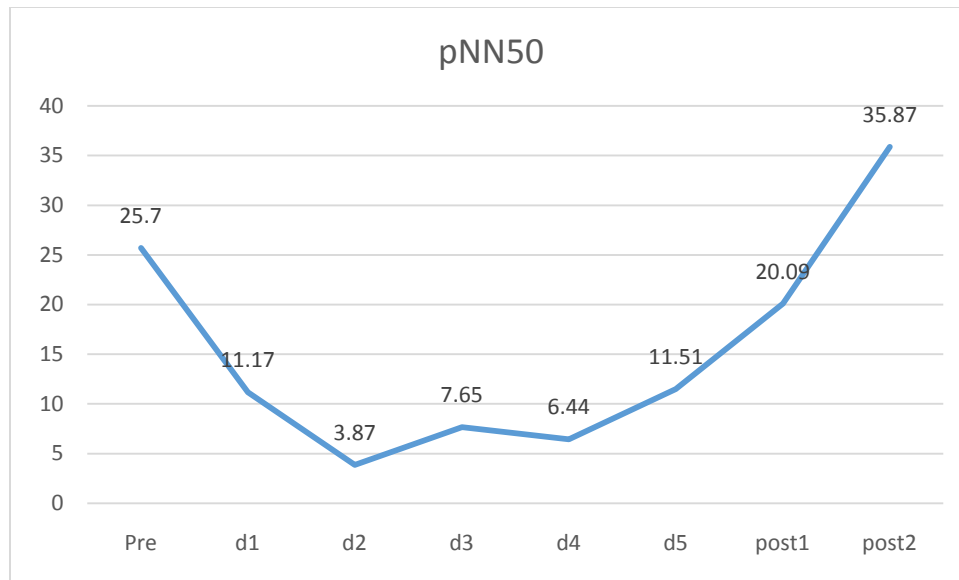


Figure:17 Pnn50

Pnn50 value is gradually decreases in the first half and gradually increases during the second half.

#### 6) LF and HF nu

LF refers sympathetic nervous system which is responsible for fight, flight or freeze response.

HF refers parasympathetic nervous system. Parasympathetic nervous system slow down the heart rate so mind become calm, increase the digestion process and relax the muscles (Shaffer & Ginsberg, 2017).

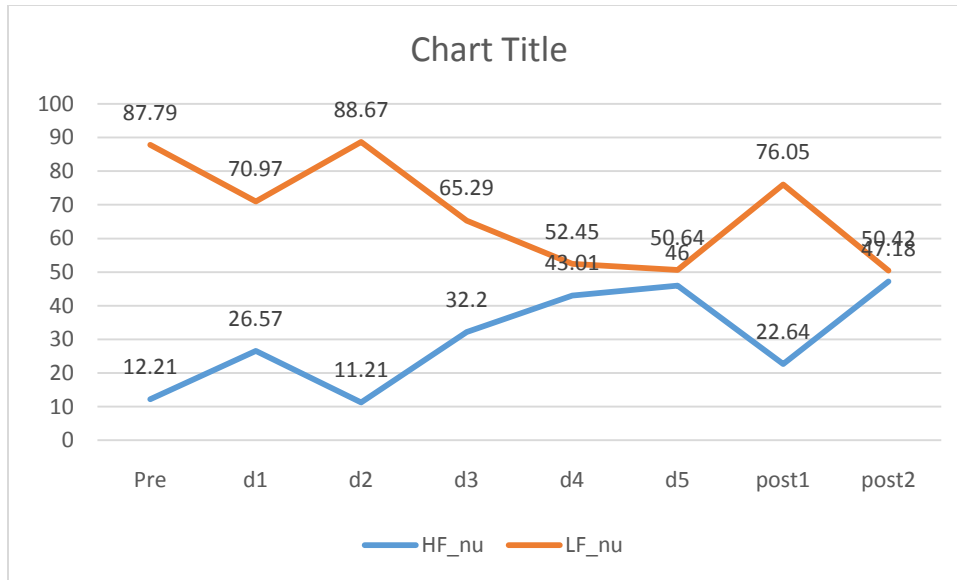


Figure:18 LF and HF nu

Before the practice, sympathetic nervous system is very high because of 30minutes *sirsasana*. Because this is not a normal one so it makes the fight, flight or freeze mode. During practice of *sirsasana* sympathetic nervous system is gradually decrease. Finally, sympathetic and parasympathetic nervous system comes to equilibrium level.

#### 7) Ratio of LF and HF

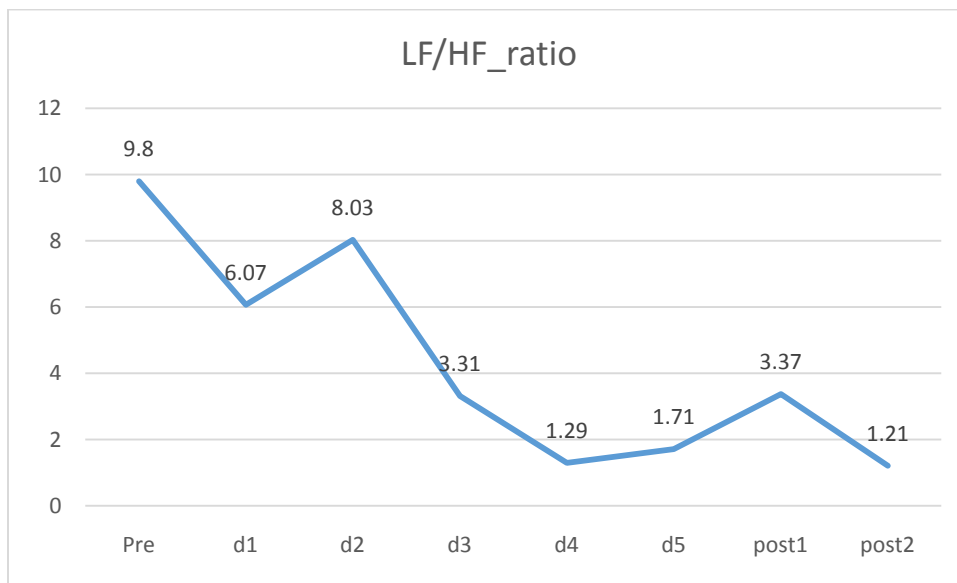


Figure:19 LF/HF ratio

LF/HF ratio is defined as ratio between sympathetic nervous system and parasympathetic nervous system under the control condition (Shaffer & Ginsberg, 2017).

In this study, LF/HF ratio is gradually decreases



## DISCUSSION

*Sirsasana* is an inverted or anti-gravitational *asana*. The body is completely inverted and held upright supported by the forearms and the crown of the head. In this study, we studied physiological and psychological changes that happen to the subject. And we have checked that the subject is under normal condition or not during performing *sirsasana* for a longer duration. In one of the previous studies about *sirsasana* for 2 minutes, they mentioned that heart rate is increased, LF power is increased, HF power is decreasing and then LF/HF ratio also increased (Manjunath & Telles, 2003). But, long term effect of meditation increases the parasympathetic nervous system and decreases sympathetic nervous system (Soni & Muniyandi, 2018). In this study, the result is completely different because of longtime practicing *sirsasana* for 30 minutes which is also like meditation. Since the subject is holding *sirsasana* for a long time, it can give meditation benefits also when *sirsasana* is practice for a long time. Heart rate was moreover, constant, and no changes were found during *sirsasana*. Here also LF is initially high and it gradually decreased during the practice and finally, LF and HF reaches mostly same range or are almost equal. LF/HF ratio also decreases gradually. Breath rate also decreases. Physiological change is in normal range only. So, the subject was normal. There is no previous paper related to the effect of headstand in psychological changes but some papers were found related to the effect of yoga in reaction time, visual short term memory etc (Gothe, Pontifex, Hillman, & McAuley, 2016; Madanmohan et al., 1992). Those studies have concluded that the effect of yoga decreases reaction time, increases memory power, executive skill and also psychomotor activities. Specifically, practicing Sudarshan yoga kriya minimizes the energy loses and improves working memory capacity by changing brain rhythms (Brunner, Abramovitch, & Etherton, 2017; Chandra, Sharma, Mittal, & Jha, 2015). Combination of yoga posture and supine rest in CM decreases anxiety score and increases the memory score (Subramanya & Telles, 2009). Any psychological improvement is also reflected in the physiology. Like in this study, as the subject's mind is in the calm state, the parasympathetic nervous system is increased. So, he can easily and comfortably able to perform the psychological task and increases visual working memory, attention level, planning capacity and improve the real-life decision making. In most of the studies it has been emphasized that headstand practice will lead to glaucoma or increased intraocular pressure in the eye. And also the continuous practice of *sirsasana* will cause

permanent blindness to the practitioner. But in this case, the subject did not report any problem and upon checkup, his eye'd intraocular pressure was found to be in the normal range (Baskaran et al., 2006; Shah & Shah, 2009).

## CONCLUSION

In psychological domains, various psychological variables' efficiency is increased. In physiological domain, all variables show the normal range. So, practicing *sirsasana* for longer time is not harmful to the body. The systematic practice of *sirsasana* for a longer time will not adversely affect your body and mind. So it can be suggested through this research that we can practice *sirsasana* for longer time with systematic, consistent and gradual increase in the practice duration.

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## APPENDIX

### Physiology Data

Trial 1	Breath rate	Heart rate	SDNN	RMSSD	Pnn50	LF_nu	HF_nu	LF/HF ratio
Pre	4.78	70.06	54.36	27.64	3.249	94.06	6.01	15.65
Domain1	5.71	75.51	174.1	229.7	15.85	37.07	56.01	.6619
Domain2	4.53	78.73	43.17	21.7	3.342	87.63	12.24	7.157
Domain3	3.18	75.73	66.98	52.76	9.92	67.09	30.77	2.18
Domain4	3.41	76.9	101.7	127.6	7.388	40.84	54.46	0.7498
Domain5	2.63	78.97	65.44	47.55	7.455	80.27	20.5	3.915
Post 1	8.32	65.8	180.5	251.4	5.959	75.06	22.74	2.02
Post 2	8.10	61.64	95.	92.31	32.13	65.21	32.29	2.018

Trial 2	Breath rate	Heart rate	SDNN	RMSSD	Pnn50	LF_nu	HF_nu	LF/HF ratio
Pre	8.15	57.75	76.06	63.23	41.05	78.56	21.65	3.629
Domain1	5.71	71.35	52.01	30.82	12.46	83.46	16.25	5.137
Domain2	5.69	73.57	48.55	25.57	4.38	87.62	11.9	7.362
Domain3	6.49	72.78	61.61	69.25	6.11	39.72	53.12	0.7477
Domain4	5.40	74.32	57.79	59.91	3.80	57.68	37.5	1.538
Domain5	5.66	70.65	97.8	116.2	21.58	37.39	57.1	0.6548
Post 1	6.40	56.41	82.14	57.57	30.67	75	23.65	3.171
Post 2	6.23	56.04	101.7	90.49	26.82	45.8	49.83	0.9192

Trial 3	Breath rate	Heart rate	SDNN	RMSSD	Pnn50	LF_nu	HF_nu	LF/HF ratio
Pre	12.53	62.31	59.94	49.5	32.79	90.77	8.977	10.11
Domain1	6.69	74.13	56.06	25.6	5.21	92.39	7.44	12.42
Domain2	5.46	73.13	54.94	24.14	3.88	90.77	9.475	9.58
Domain3	5.47	73.03	63.2	26.37	6.93	89.05	12.71	7.008
Domain4	5.52	75.09	75.34	71.92	8.13	58.82	37.08	1.586
Domain5	5.61	74.42	81.18	92.93	5.48	34.27	60.33	0.568
Post 1	7.13	59.85	61.97	44.1	23.63	78.08	21.53	3.626
Post 2	13.81	56.59	99.44	114.2	48.65	40.24	59.42	0.6773



## Physiology Data

### 1) Reaction time

#### Auditory reaction time

	Pre	Post
Total mean latency		
Trial 1	283.88	244.5
Trial 2	238.27	225.63
Trial 3	252.68	261.3

#### Visual reaction time

	Pre	Post
Total mean latency		
Trial 1	265.73	240.25
Trial 2	272.73	246.48
Trial 3	275.69	247.61

### 2) Attention Network Task

	Pre	Post
expressions. alertingeffect		
Trial 1	33.68	44.42
Trial 2	43.12	49.94
Trial 3	35.75	26.72

	Pre	Post
Expressions .orientingeffect		



Trial 1	24.51	0.8
Trial 2	-6.6	3.47
Trial 3	18.41	22.7

expressions. alertingeffect	Pre	Post
Trial 1	42.69	67.9
Trial 2	103.83	82.84
Trial 3	48.54	67.29

### 3) Tower of London

Total score	Pre	Post
Trial 1	32	34
Trial 2	36	34
Trial 3	35	36

### 4) Rapid Visual Scanning

	Pre	Post
Trial 1	48	69
Trial 2	66	71
Trial 3	72	78

### 5) Corsi Block

Backward corsi block

Total score	Pre	Post
Trial 1	54	60
Trial 2	60	60
Trial 3	60	84

Forward corsi block

Total score	Pre	Post
Trial 1	96	84
Trial 2	77	70
Trial 3	77	104

6) Iowa Gambling

Current total	Pre	Post
Trial 1	1950	1050
Trial 2	2900	3600
Trial 3	2700	3700

7) Digit span Visual

Forward digital span visual

Value.MS	Pre	Post
Trial 1	6.59	7.3
Trial 2	7.42	8.42
Trial 3	7.33	8.33

Backward digital span visual

Value.MS	Pre	Post
Trial 1	6.29	6.56
Trial 2	6.45	6.16
Trial 3	7.83	7.33

