

**Meditation States and Traits in Australian Yoga
Practitioners: the effect of proficiency and practice
on “sense of self”**

A thesis submitted in fulfillment of the requirements for the degree of
Doctor of Philosophy

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August 2012

DECLARATION

I certify that:

- a) except where due acknowledgement has been made, the work is that of the author alone;
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- c) the content of the thesis is the result of work carried out since the official commencement date of the approved research program;
- d) any editorial work, paid or unpaid, carried out by a third party is acknowledged;
- e) ethics procedures and guidelines have been followed.

John W Thomas

13 August 2012

ACKNOWLEDGEMENTS

Many thanks to my supervisors, Professor Marc Cohen at RMIT University and Dr Graham Jamieson at University of New England; Marc for his continual encouragement for my project and his interest in promoting research into Yoga, Graham for his expertise in EEG and his insightful and rigorous feedback, and both for staying with me over the lengthy period of my candidature. Thanks also to Dr John Fang of Engineering at RMIT University for the purchase of the EEG equipment and initial data analysis.

To my wife, Marg, a huge thank-you for your unfailing support, in many capacities – as EEG technician, research assistant, but most of all for caring for me and enduring the sacrifices this project has entailed. My sincere thanks to all the participants from Satyananda Yoga and Yoga in Daily Life for their willing commitment of time and sharing of personal experience in interview, and particularly those undertaking meditation in an EEG cap and facial electrodes. My special thanks to Swami Kriyatma of Satyananda Yoga Academy, Mangrove for his enthusiastic personal support and generous administrative commitment to the project. Also to Swami Atmamuktananda at Rocklyn and to Swami Shaktimudra for assistance in recruiting participants. My thanks to Yogasiddhi of Yoga in Daily Life for her enthusiastic support of the project and organisation of participation from that tradition.

Many thanks to Rishi Vivekananda for reviewing and proof-reading a number of thesis drafts and to Sannyasi Muditachitta for helpful comments. I would like to express my gratitude to the Swan Research Institute for the Research Grant which assisted with travel expenses for data collection.

Finally, to Swami Satyananda Saraswati for including a commitment to a dialogue with science with his gift of Yoga to the West and to Swami Niranjanananda Saraswati for encouragement to pursue this project.

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ABBREVIATIONS USED

ASC	Altered State of Consciousness
AM	Advanced meditator
ACC	Anterior Cingulate Cortex
BA	Brodmann Area
CSD	Current Source Density
d-ASC	discrete Altered State of Consciousness
DMN	Default Mode Network
ECR	Eyes Closed Rest
EEG	Electroencephalogram
EOR	Eyes Open Rest
FA	Focused Attention meditation
Hz	Hertz
LORETA	Low Resolution Brain Electromagnetic Tomography (s Standardised, e Exact)
LTM	Long-term meditator (5-20 years)
MM	Mindfulness meditation
MPFC	Medial Prefrontal Cortex
NCC	Neural Correlate of Consciousness
NM	Novice meditator (less than 1 year)
NR	Not reported
NS	Not significant
OBE	Out-of-body experience
OM	Open Monitoring meditation
PCC	Posterior Cingulate Cortex
PET	Positron Emission Tomography
REM	Rapid Eye Movement (Stage of sleep)
SPECT	Single-photon Emission Computed Tomography
SoC	State of Consciousness
TM	Transcendental Meditation
SY	Satyananda Yoga
STS	Satyananda Yoga students
SYT	Satyananda Yoga teachers
YDL	Yoga in Daily Life

GLOSSARY OF SANSKRIT TERMS

Abhiniveshah fear of death

Ahamkara self-identity, sense of “I-ness”

Apjapa japa continuous, spontaneous repetition of mantra

Antar inner

Antar karana inner instrument; experienced or manifest mind which includes the four aspects of manas, buddhi, chitta and ahamkara

Antar mouna inner silence, Satyananda Yoga meditative practice involving thought observation

Antaranga internal

Asana a physical posture in which one is at ease and in harmony with oneself

Ashram a residence centred around a teacher and associated community; unlike a Christian monastery, an ashram is open to the constant flow of outside human activity

Asmita state where the ego and the sense of individuality are completely transcended and there is only pure awareness

Atman individual soul; spirit

AUM primordial sound; universal cosmic mantra

Avidya ignorance; lack of conscious awareness; mistaking the non eternal for the eternal; confined cognition

Bandha psychic lock that concentrates the flow of energy in the body

Buddhi the discerning, discriminating aspect of mind; from the root ‘bodh’ to be aware of

Bahiranga external

Bhakti yoga Yoga of devotion, channeling the intellect and emotions towards a higher purpose

Chakra psychic centre in the subtle body; circle, wheel or vortex of energy

Chitta individual consciousness, including the subconscious and unconscious of mind; memory, aspect of mind which receives impressions and stores them as samskaras

Chitta shakti mental force governing the subtle dimensions

Darshana to glimpse; to see; to have a vision; philosophical system

Dharana holding or binding of the mind to one point; concentration

Dhyana meditation, total concentration

Guna attribute, quality or nature of the phenomenal world

Guru: one who dispels darkness; one who teaches, by word and example; one qualified to give authentic initiation to a disciple

<i>Japa</i>	mantra repetition
<i>Jnana</i>	intuitive knowledge
<i>Jnana yoga</i>	yoga of knowledge and wisdom
<i>Jyanendriyas</i>	five sensory organs - ears, eyes, nose, tongue and skin
<i>Karma yoga</i>	yoga of action; action performed with meditative awareness; yoga of dynamic meditation
<i>Karmendriyas</i>	five physical organs of action – hands, feet, vocal chords, tongue, excretory and reproductive organs
<i>Kirtan</i>	singing of mantra
<i>Klista</i>	painful
<i>Kosha</i>	sheath or body
<i>Kriya</i>	action or motion
<i>Kundalini Yoga</i>	path of Yoga which awakens the dormant spiritual force
<i>Mahat</i>	greater mind
<i>Mala</i>	rosary of 108 wooden beads, used in the practice of meditation
<i>Manas</i>	lower mind
<i>Manomaya kosha</i>	mental sheath or body
<i>Mantra</i>	sound or vibration of power, which liberates the mind from bondage
<i>Mudra</i>	psychic gesture, psychophysiological posture, movement or attitude
<i>Nadi</i>	prana flow or channel
<i>Nidra</i>	deep sleep
<i>Nirodha</i>	blocking (the patterns of consciousness)
<i>Niyamas</i>	five inner disciplines; personal codes for self-improvement
<i>Poorna</i>	full
<i>Prajna</i>	knowledge with awareness; the seer who observes the state of nidra
<i>Praktiti</i>	individual nature
<i>Pramana</i>	direct knowledge; knowledge based on direct experience
<i>Prana</i>	vital air or energy force, sustaining life and creation
<i>Pranayama</i>	expansion of the range of vital energy through alterations in breathing
<i>Pratyhara</i>	withdrawal of the mind from the senses
<i>Purusha</i>	totality of consciousness
<i>Rajas</i>	one of the three gunas; dynamism; state of activity
<i>Sadhaka</i>	(advanced) spiritual aspirant
<i>Sadhana</i>	spiritual practice
<i>Samadhi</i>	culmination of meditation; state of unity with the object of meditation and the universal consciousness

<i>Samskara</i>	unconscious memories; impressions that arise from the unconscious to set up impulses and trains of thought
<i>Sankalpa</i>	resolve; positive affirmation
<i>Sannyasa</i>	renunciation, initiation as a disciple of a guru
<i>Sannyasin</i>	one who is initiated
<i>Sattwa</i>	one of the three gunas; pure, unadulterated quality; state of luminosity and harmony
<i>So-ham</i>	psychic sound and mantra of the breath
<i>Sutra</i>	verse
<i>Swamiji:</i>	a respectful form of address or reference towards a guru
<i>Swapna</i>	dream state
<i>Tejasa</i>	the seer who observes the state of swapna
<i>Tamas</i>	one of the three gunas; state of inertia and ignorance
<i>Trataka</i>	meditation practice involving concentration, usually on a candle flame
<i>Turiya</i>	fourth dimension of consciousness; super consciousness; simultaneous awareness of all three states of consciousness
<i>Vaisvanara</i>	the external, waking consciousness
<i>Vasana</i>	impressions from the past imprinted on the mind, unconscious dispositions causing mental conflict
<i>Vijnanamaya kosha</i>	higher mental sheath or body
<i>Vikalpa</i>	fancy; unfounded belief; imagination
<i>Viparyaya</i>	wrong knowledge
<i>Vrittis</i>	circular motion of consciousness; mental modification in Raja Yoga
<i>Yama</i>	self-restraint; first step of ashtanga or Raja Yoga

ABSTRACT

The effects of meditation practice can be divided into changes occurring during the practice (state changes) and those persisting beyond the practice (trait changes), making permanent changes in self-perception and one's 'sense of self'.

This project investigates both effects of Yoga meditation in 'advanced' Yoga teachers and students with 'short-term' experience from two Yoga traditions practised in Australia. A qualitative study charts the personal journey of Australian Yoga practitioners in coming to meditation, their experiences in meditation and its effects on their daily life. Exact low resolution tomography (eLORETA) analysis of participants' EEG data makes new discoveries in the relationship of proficiency and type of practice to the EEG frequency profile and location of brain networks involved in 'state' effects, as well as those linked to long term alterations in the 'sense of self'.

CHAPTER 1 – INTRODUCTION

“I feel the bliss in the head - comes usually quite quickly - that can often move to a state of stillness - more subtlety - it’s very soothing and calming - gives me that sense of inner peace that lasts all day” Qualitative study participant

1.1 Meditation

An extensive review of meditation practices in healthcare prepared by the University of Alberta for the U.S. Agency for Healthcare Research and Quality (Ospina et al. 2007) estimated there were 10 million meditation practitioners in USA and hundreds of millions world-wide representing a wide range of cultural origins. The authors classified the most commonly practiced meditations into five broad categories – mantra, mindfulness, Yoga, Tai Chi and QiGong.

Within their original cultural contexts of India, Tibet, China and Japan, meditation practices were developed for spiritual goals. Where these disciplines have taken root in Western countries, meditation is still practiced by many as part of spiritual practice, but some practices have been modified for secular ‘therapeutic’ use, gaining acceptance as ‘mind-body’ interventions in Western medicine (Arias et al. 2006).

With the introduction of Eastern meditation practices into Western culture, research began to explore the neural activity underlying meditation, both during the meditation state and in more permanent alterations of brain function, termed ‘neuroplasticity’.

1.2 Meditation states and traits

“Meditation is not a practice; rather it is a state of mind where there is a merging of the experiencer, the experience and the process of experiencing.

It is at this stage that meditation actually becomes a living experience of human consciousness.” Swami Niranjanananda (Saraswati 1997)

This quotation illustrates the distinction between:

- the effects experienced during the actual meditation practice (states of consciousness) and
- those persisting into ‘everyday life’.

These effects have been termed ‘state’ and ‘trait’ respectively by Cahn and Polich (2006).

“State refers to the altered sensory, cognitive and self-referential awareness that can arise during meditation practice”

The authors summarise some of the subjective descriptions of meditation ‘states’ to include:

“a deep sense of calm peacefulness, a cessation or slowing of the mind’s internal dialogue, and experiences of perceptual clarity and conscious awareness merging completely with the object of meditation, regardless of whether a mantra, image or the whole of the phenomenal experience is the focal point” (Cahn & Polich 2006) (p181)

“Trait refers to lasting changes in these dimensions that persist in the meditator irrespective of being actively engaged in meditation”

Subjective descriptions of ongoing ‘trait’ changes include:

“a deepened sense of calmness, increased sense of comfort and a shift in the relationship to thoughts, feelings and the experience of self. States of awareness, sometimes referred to as ‘the witness’ or ‘transcendental experience’, are also claimed to ensue over time” (Cahn & Polich 2006) (p181).

1.3 Effect of meditation on ‘sense of self’

These descriptions include as a central feature an alteration in one’s experience of ‘sense of self’. In meditation ‘states’, as indicated in the above quotation, this may be experienced as a change in the relationship between meditator and meditation object.

‘Trait’ changes are described as involving a shift to more ‘observing’ or ‘witnessing’ sense of self. Two descriptions of this ‘trait’ change, the first from an ‘Eastern’ perspective and the second from a ‘Western’ perspective are:

“a transformation of the individual psyche leading from its ordinary state of conditioned personal identity and conscious/unconscious polarity to a state of unconditioned or transcendent identity characterized by the absence of all duality (i.e. subject/object and conscious/ unconscious)” (Davis 2003) (p1).

and:

“an altered self-identity wherein the separation perceived between the observer and the observed grows even fainter. As the perceived lack of separation develops, the sense of self seems to shift from mental thought centered in the body to an impersonal beingness. This awareness is related to the essential emptiness of a separate and isolated self-identity” (Cahn & Polich, 2006) (p181).

Both descriptions suggest that long term meditation induces a shift from a 'personalised', ego-based awareness of self to that more characteristic of a detached or non-judgmental 'witnessing' observer. A central goal of meditation is the gradual blurring of the distinction between the meditative state and the post-meditative state. In this process, transforming one's baseline mental state into continuous meditation (Lutz, Dunne & Davidson 2007) is seen as converting the changes in 'sense of self' in meditation 'states' into lasting 'traits'.

1.4 Research into meditation

The assumptions underpinning research into meditation 'states' and 'traits' have been listed as:

1. *"It is assumed that each practice induces a predictable and distinctive state (or set of states) whose occurrence is clearly indicated by certain cognitive or physical features or events phenomenally observable to the practitioner.*
2. *The state induced is said to have a predictable effect on both mind and body in such a way that, by inducing that state repeatedly, a practitioner can allegedly use it to enhance desirable traits and inhibit undesirable ones.*
3. *The practices are gradual in the sense that the ability to induce the intended state is supposed to improve over time, such that an experienced practitioner should meditate in a manner that is superior to a novice"* (Lutz, Dunne & Davidson 2007) (p8).

Although formulated with reference to Buddhist practices, Lutz and colleagues contend that these premises provide a useful foundation for meditation research. However, as Cahn and Polich (2006) note, 'state' and 'trait' effects interact and are difficult to separate in a research design. Most research interest has focused on the effect of differing levels of meditator proficiency and different types of meditation practices on brain activity, but the wide variation and lack of accepted classification systems for these variables has hampered progress.

Lutz and colleagues concluded:

"despite a high number of scientific reports and inspiring theoretical proposals, one still needs to admit that little is known about the neurophysiological processes involved in meditation and about its possible long-term impact on the brain" (Lutz, Dunne & Davidson 2007) (p2).

Two approaches to these issues have emerged. One argues that the diversity of meditation practice can be overcome by a focus on the similarities in the mental states experienced during the development in proficiency across different meditation traditions (Fell, Axmacher & Haupt 2010). This approach emphasises the common goals of meditation across traditions

resulting in “common subjective experiences” such as dealing with distractions and the quality of the conscious self-awareness or ‘peaceful state of mind’ (Lehmann et al. 2012).

In distinction, Lutz and colleagues (2007), while not discounting the possibility that techniques from different traditions may lead to similar outcomes, argue that it is best to avoid beginning with this assumption. They contend that ‘meditation’ is too general a term and attempting to apply it to “*such a wide range of diverse practices inevitably trivializes the practices themselves*” (p3). They advocate a closer attention to the distinguishing particularities of practices within each tradition, calling for collaboration between researchers and meditation practitioners to develop a common language encompassing traditional descriptions and measurable aspects of meditation states. The research group at the University of Wisconsin-Madison has a long-standing collaboration with Tibetan Buddhist meditators through the involvement of the Dalai Lama.

1.5 This investigation

This thesis applies the latter approach to the detailed investigation of meditation ‘states’ and ‘traits’ and alterations in ‘sense of self’ within Yoga traditions practised in Australia. The length of time that Yoga has been established in Australia now provides the opportunity for the study of advanced practitioners.

The key research questions were:

- Can the meditation ‘states’ experienced by Australian Yoga meditators be differentiated by level of proficiency or type of practice, using ‘subjective’ experience and ‘brain activity’ measures?
- Are there ongoing ‘trait’ alterations in the ‘sense of self’ reported by advanced Yoga meditators and observable by ‘brain activity’ measures in non-meditation conditions?
- Can these results be related to the conceptual framework of traditional Yoga literature?

These questions were explored by:

- examining the conceptual foundations of meditation states from Yogic and Western philosophical viewpoints
- reviewing the literature on research into meditation states and traits
- conducting a qualitative study of the ‘lived experience’ Australian Yoga meditators
- conducting a number of quantitative studies of Australian Yoga meditators using electroencephalography (EEG).

The traditions studied were 'Satyananda Yoga' formulated by Swami Satyananda of Bihar, India, and 'Yoga in Daily Life', formulated by Swami Maheshwarananda of Rajasthan, India.

To my knowledge this is the first Australian study of Yoga meditation using both a qualitative and quantitative design, exploring meditation 'states' and 'traits' through subjective reports and EEG measures.

The benefits of this research into meditation 'states' may "*contribute to our general understanding of the neural basis of consciousness*" (Lutz et al, 2007, p51) and to determine if some meditation states constitute unique states of consciousness, distinguishable from other mind-body interventions (Fell et al, 2010).

The investigation of 'trait' effects on 'sense of self' may extend our understanding of the underlying mechanisms for the therapeutic benefits of meditation resulting from neuroplasticity (Berkovich-Ohana, Glicksohn & Goldstein 2012).

1.6 Structure of thesis

The thesis is structured into the following chapters:

Chapter 2- Yoga concepts of meditation

The theoretical foundation for Yogic meditation practices and their effects

Chapter 3 – Western concepts of meditation

The theoretical foundation for the Western understanding of meditation states

Chapter 4 – Methodology of meditation research

Framework for reviewing meditation research

Chapter 5 - Literature review of meditation research

Review of variables and results in meditation research

Chapter 6 – Cultural context of Yoga meditation in Australia

How Yoga meditation came to be practiced in Australia

Chapter 7 – Study 1 – Qualitative study of Australian Yoga meditators

Subjective experiences of Yoga training, practices and during meditation

Chapter 8 – Development of subjective measures

Subjective measures for use in quantitative studies

Chapter 9 - Study 2 – EEG study – Comparison of traditions

EEG study using eLORETA tomography to explore performance of similar practices by meditators from different Yoga traditions

Chapter 10 – Study 3 - EEG study – Comparison of proficiency

EEG study using eLORETA tomography to explore the relationship of proficiency to meditation “states” and “traits”

Chapter 11 – Study 4 – EEG study – Effect of practice

EEG study using eLORETA tomography to explore the effects of different meditation practices

Chapter 12 – Study 5 – EEG study – ‘Trait’ effects and DMN

EEG study using eLORETA tomography to explore differences in non-meditation conditions

Chapter 13 – Discussion and conclusions

CHAPTER 2 – YOGA CONCEPTS OF MEDITATION

The scientific investigation of meditation encounters a 'paradigm clash' in the differing underlying assumptions that Western philosophical models and Eastern 'contemplative disciplines' have about the nature of consciousness (Walsh 1980).

An early researcher in the area, Roger Walsh, outlined some of these assumptions:

"Many meditation traditions view consciousness as their central concern and make several claims that run counter to Western assumptions. These include statements that:

- 1) *our usual state of consciousness is severely sub-optimal*
- 2) *multiple states, including true 'higher' states, exist and*
- 3) *these states are attainable through (meditation) training"* (Walsh 1980) (p664).

This chapter outlines some of the philosophical concepts underlying Yoga meditation practice and their relevance for meditation research.

2.1 Philosophy of Yoga

The term 'Yoga' is derived from the verbal root 'yuj', meaning 'to bind together, or yoke', but encompasses many connotations of this concept (Feuerstein 1975). A common interpretation is the desired reunion of the lower or worldly 'self' with the higher or divine 'Self' (Radhakrishnan 1999) (Vol 2), although some scholars consider that Yoga does not necessarily include a theistic philosophy (Pazhayattil 1985).

Although 'Yoga' embraces a rich diversity of philosophical viewpoints, Georg Feuerstein presents the following as concepts basic to all Yoga traditions:

- 1) *"the equation 'existence = suffering'*
- 2) *the doctrine of re-birth in its various interpretations*
- 3) *the doctrine of the possibility and desirability of transcendental knowledge (jnana, prajna)"* (Feuerstein 1975) (p26).

As a philosophy, 'Yoga' is one of the six orthodox (i.e. accepting the authority of the Vedas) Indian philosophical schools (*darshanas*) and is regarded as the practical application of its allied philosophical system – *Samkhya* (Radhakrishnan 1999). Yoga and Samkhya share a common philosophical base (Eliade 1958). For both schools, the ultimate goal is attainment of 'self-realisation', conceptualised as dwelling in a state of universal consciousness, and experiencing the higher 'Self' (Pazhayattil 1985). However, where Samkhya sees the path to

salvation through metaphysical knowledge, Yoga stresses the importance of meditation. Yoga provides the practical methodology required to attain 'self-realisation'.

2.2 Consciousness in *Samkhya* philosophy

According to Radhakrishnan (1999), *Samkhya* derives its principles from a long history of Indian thought, dating from the *Upanishads*, early philosophical texts originating from an earlier oral tradition. As a philosophy, its authorship is identified with the sage Kapila.

Consciousness (*purusha*) is postulated as the fundamental principle of existence and is "passive, eternal and all-pervading", distinct from the body, senses and mind, beyond all change and transformation (Singh 1985). It is identified with an absolute, transcendent notion of 'spirit', 'soul' or universal 'Self' (Eliade 1958).

As a dualistic system, *Samkhya* formulates a complementary principle – that of materiality (*prakriti*). The reality of these two fundamental principles is derived from the law of cause and effect and the distinction between a knowing subject and a known object. *Prakriti* is unconscious but active and is responsible for the myriad forms of material existence, including the human person. The substance of *prakriti* is composed of three inter-related strands or qualities, the *gunas*. The *guna* 'tamas' has the quality of "ignorance and sloth" and the *guna* 'rajas' the quality of "feverish enjoyment and restless effort". Human suffering is considered to result from the interaction of these two *gunas*. Salvation, or release from suffering, becomes possible through the quality of the third *guna* 'sattwa', described as "buoyancy or light" and "potential consciousness" (Radhakrishnan, 1999, Vol2, p263).

Purusha is said to reflect into the discriminative aspect of mind, termed '*buddhi*' - as into a mirror. When *buddhi* is constituted predominantly of *sattwa guna* (refined by meditation) it becomes transparent and one is able to experience the 'pure consciousness' of *purusha*.

Radhakrishnan (1999, Vol2, p287) describes this reflection in the analogy used by the sage Sankara –

*"the crystal vase appears red on account of the red flowers in it,
though it is itself devoid of any taint or tinge".*

Aveling (1991) quotes the following passage from the *Svetasvatara Upanishad* outlining the Yogic method of revealing one's 'true nature':

*"Even as a mirror stained by dust
Shines brilliantly when it has been cleansed*

*So the embodied one, on seeing the nature of the Soul (Atman),
Becomes unitary, his end attained, from sorrow freed.
When with the nature of the self, as with a lamp,
A practitioner of Yoga beholds here the nature of Brahman,
Unborn, steadfast, from every nature free –
By knowing God one is released from all fetters!” (p36).*

Thus our usual ‘unrealised’ experience of consciousness is a limited, clouded one, which is in Walsh’s description “severely sub-optimal”.

2.3 States of consciousness in Yoga philosophy

The journey towards the experience of ‘pure consciousness’ of *purusha* can be viewed as progression through states of ‘lower’ consciousness.

The *Mandukya Upanishad* (dating from the first or second century CE) presents the first detailed description of states of consciousness in Indian philosophical thought (Radhakrishnan, 1999 Vol1), illustrated through the structure of the core meditation practice of ‘AUM’ chanting.

In our ‘normal’ state of wakefulness (*vaisvanara*), the ‘observing self’ is conscious of external objects, perceived at a ‘gross’ or physical level. In the second state, dreaming (*tejasa*), the self perceives a more subtle level of existence, the imaginary form. With the relaxation of wakeful control in this state, suppressed subconscious impressions (*samskaras*) can surface and if witnessed with emotional detachment, can be discharged (Y. Saraswati 1996). In the first two states, one’s ‘sense of self’ is linked to sensory input from the external world or to the imagined world in dream.

The third state is the state of dreamless sleep (*prajna*), where the experience is ‘objectless consciousness’. Although the perceiving self is without an object of perception, it continues to exist in this state.

“The conditions change, not the Self” (Radhakrishnam, 1999 Vol1, p32).

These three states are encapsulated in the letters of the sacred mantra ‘A-U-M’.

The *Mandukya Upanishad*, however, points out that dreamless sleep is not the highest state, but a fourth state (*turiya*), an integration of the other three, represented by the total mantra AUM. This state is described as *“the sole essence of the consciousness of self, the completion of the world, the ever peaceful, all blissful, the one, the Atman”* (Radhakrishnam,

1999, Vol1, p160). This state is represented by the silence following the chant of 'AUM' (Aveling, 1991). The state of *turiya* represents one's true state, in which the 'self' realises its true nature; - the goal of Yogic practice. In this state there is no subject/object, but there is awareness (Y. Saraswati 1996).

2.4 Classical Yoga - Patanjali's Yoga Sutras

The 'classical' system for attainment of 'self-realisation' through Yoga practice is contained in the *Yoga Sutras*. These were distilled from the vast preceding written and oral literature about the mid-3rd century BCE or mid-3rd century CE and identified with the sage Patanjali. The *Yoga Sutras* are generally accepted as the 'classic' compilation of yoga philosophy (Jentoft 2004) and the "oldest textbook of the Yoga school" (Radhakrishnan, 1999, Vol2, p341). They comprise 196 aphorisms (*sutras*) in four chapters: *Samadhi Pada* (on meditation), *Sadhana Pada* (on practice), *Vibhuti Pada* (on psychic powers) and *Kaivalya Pada* (on oneness) (Saraswati 1976).

The *Yoga Sutras* systemise the methods of Yoga using the philosophical framework of *Samkhya* (Y. Saraswati 1996). They provide a systematic program of progression towards 'self-realisation' through an 'eightfold path'. See Appendix 2 for a more detailed exposition.

The first two stages, *yama* (abstentions or 'external' disciplines) and *niyama* (observances or 'internal' disciplines) provide the ethical framework needed for the practice of Yoga. At a practical level, these stages help to reduce the distractions that would hinder progress. The next stage, *asana*, is frequently the entry point for many Western practitioners. It establishes the physical basis for meditation through the development of posture that is steady (*stira*) and comfortable (*sukha*).

Control of the movement of the breath (particularly its cessation) is the fourth stage (*pranayama*). The next stage, *pratyahara*, begins the activities usually referred to by the term 'meditation' and marks the transition from the first four 'external' (*bahiranga*) stages to the four 'internal' (*antaranga*) stages. *Pratyahara* involves the withdrawal of awareness from sensory input, to enable an internal focus to develop, sealing the *chitta* from the external realm. It involves the development of internalized attention, rather than just a physical activity of closing the eyes. It develops a sense of detachment from the physical realm, thus limiting the afflictions (*kleshas*) and beginning the inward journey towards self-realisation.

Then the awareness can be made more concentrated in the stage of *dharana* (fixing the consciousness at one point). This leads to true meditation, the seventh stage, *dhyana*, in

which the meditator is absorbed in the steady flow of attention directed towards the meditation object. In the eighth stage, *samadhi*, there is clear perception of one's true self. Although *samadhi* is often translated as ecstasy, Eliade (1958) prefers the term 'enstasy' indicating an internally, rather than an externally- focused process. Jentoft (2004) reports Iyengar's description of *samadhi* as a level of meditation in which the meditator's sense of self-awareness is lost in absorption in the object of meditation. It is equivalent to the *turiya* state described in the *Mandukya Upanishad* (Y. Saraswati 1996).

The stages of *pratyahara*, *dharana* and *dhyana* will be examined in some detail as they are the key stages for Yoga practitioners on their journey of meditation. *Pratyahara* practices are designed to detach the mental focus from the senses, by a process of 'witnessing' the activity of the mind and directing it to an internal focus. *Dharana* practices are designed to develop the ability to focus the mental energy (*chitta shakti*) in a state of concentration. Meditation then becomes a spontaneous process in the stage of *dhyana*.

2.5.1 Pratyahara

Sutra 54, 55 of Chapter 2 of the *Yoga Sutras* describe *pratyahara*:

"*Svavisayasamprayoge chittasynasvarupanukara ivendriyanam pratyaharah*" translated as "*Pratyahara* is as it were the imitation by the senses of the mind by withdrawing them from their respective objects" (Saraswati 1976) (p150).

"*Tata parama vashyatendriyanam*" "There is highest mastery over the sense organs (by *pratyahara*) (Saraswati 1976) (p150).

When the mind is withdrawn from the objects of sense experience, then the senses function according to the mind, not vice versa. The sense organs then get introverted into the mind; "they imitate the mind and follow it inside" (Saraswati 1976) (p150). Rishi Vivekananda defines *pratyahara* as "our closing off to external perceptions and opening up to internal experiences by letting them come into our awareness" (Vivekananda 2005) (p246).

The highest degree of mastery over the senses is illustrated by a passage from the *Katha Upanishad* quoted by Feuerstein (1979) (p94):

*"Know the Self as the chariot-master, the body as the chariot;
Know the wisdom-faculty (buddhi) as the charioteer and the mind as the reins.
The senses, they say, are the horses and the sense-objects are their arena"*

Swami Maheshwarananda, the founder of the 'Yoga in Daily Life' tradition, gives the example of an onion to illustrate *pratyahara*.

"Take an onion as an example. We hold it in our hand and identify it without further consideration as an "onion". Now we remove the outer layers of skin, one by one. This we call the individual parts of the onion, the "onion skins". It is not an onion any more. But what remains of the "onion" now? Is "onion" only a name for the sum of these skins? This cannot possibly be so. An onion, out of which an entire plant comes into being when planted, is something much more comprehensive, more highly organized than the mere fitting together of individual skins! The Atman is also infinitely much more than the mere sum of its parts. The Atman lives within us. It does not need to develop, it is complete. Only the consciousness must be purified and developed so that it is able to recognise its true nature" (Maheshwarananda 2005) (p416).

Swami Satyananda emphasises the importance of *pratyahara* in his commentary on these sutras by stating

"if you can master the technique of pratyahara, then concentration becomes very easy. It is impossible to go to dharana and dhyana unless the field of pratyahara is crossed"
(Saraswati 1976) (p152).

He emphasizes that the change in the sense of self occurring in *pratyahara* is a shift in awareness – the soul does not change – *"the only difference is that our lower self or individualized self becomes aware of that supreme form slowly, step by step"* (p151).

Swami Satyananda's successor, Swami Niranjanananda, (N. Saraswati 1996) divides *pratyahara* into five stages:

"In pratyahara we begin to develop awareness. The classical, traditional description of pratyahara is withdrawal of the senses. It is said that just as a turtle is able to withdraw all its limbs into the body, in the same way a yogi should be able to pull back all the extensions of the senses and mind from outside to inside. This is the description which people give of pratyahara. However, if we apply common logic to this process, we will understand that it is not a simple matter of pulling everything in and shutting ourselves off to the outer world.

Rather it is becoming aware, at first, of what is happening externally and how we are reacting. So, in the first stage of pratyahara, the senses are fully extended outside so that their activity can be fully experienced, whether it is the sense of touch, taste, sight, smell or hearing.

In the next stage we observe our reactions to those sensory stimulations. For example, if there is suddenly the beautiful smell of a rose in the room, most of us sitting here will take a deep breath in and say, "Wow!" It is only a smell, but that smell triggers off many different reactions inside. A feeling, an expression, a recognition is associated with the sense of smell. So many different reactions suddenly manifest altogether at the same time that we are not even aware of all of them. If we smell rotten flesh we will get up, stick our heads out the window and say "Yuck!" The same thing has happened again. If something is soft and cuddly we have a sensation of pleasure. If something is hard and rough we don't want to touch it. These are common reactions, but at the same time there are deeper reactions to the external sensory stimulations. In the second stage of pratyahara, after extension of the senses externally, we have to learn how to maintain our equilibrium, how to develop immunity to the influences of the senses, which are external in nature.

In the third stage of pratyahara, we withdraw our awareness from outer to inner experience of the senses. We begin to see the link that a sensory experience has with our inner mind. How does a smell trigger off memories? How does a smell trigger off sensations of pleasure or aversion? How does it touch or affect a feeling or memory? Recognition and awareness of the mental process associated within the senses is the third stage of pratyahara.

The fourth stage of pratyahara is recognition and harmonization of the inner activity. After having recognized what we are experiencing externally and internally, and after having attained immunity, we come to the fifth stage of pratyahara.

This is the experience of shoonya, nothingness, void, gaining control over the unconscious actions and reactions of the senses and mind, and stopping the interaction. Shoonya is only a transition from one state of meditation to another, from awareness to concentration, and concentration begins with dharana. This is, in brief, to give you an idea about the basics of pratyahara. Once we are able to gain mastery over the process and techniques of pratyahara we can do many things with our mind. The mind becomes awakened, and the awakened mind is a fantastic and beautiful thing to have".

2.5.2 Dharana

The distinction between *pratyahara* and *dharana* is outlined by Swami Satyananda as:

“Pratyahara is that practice in which you are trying to isolate the mind from the sensory channels. Therefore, dharana becomes perfect and complete only if pratyahara has been practised well. When you are trying to isolate the mind from the sensory channels, at first there is a lot of distraction. Every time, the chitta vritti or mental patterns become disturbed because the senses affect the mind, and the mind has become so dependent on the senses that it goes on accepting these disturbances” (Saraswati 1982).

Sutra 1 of Chapter 3 of the *Yoga Sutras* describes *dharana*:

“Deshabandhashchittasya dharana” “Concentration (*dharana*) is binding the mind to one place” (Saraswati 1976) (p155)

In *dharana*, there is confinement of the mind to one point or one object. Perception becomes intense, with the object appearing intensely in the consciousness. For example, in *japa* (mantra meditation), there is awareness of the mantra throughout the practice, but with breaks. When there is no break in concentration, the practice become *dhyana* (Saraswati 1976).

2.5.3 Dhyana and Samadhi

Sutra 2 of Chapter 3 of the *Yoga Sutras* describes *dhyana*:

“Tatra pratyayaikatanata dhyanam” “Uninterrupted stream of the content of consciousness is *dhyana*” (Saraswati 1976) (p157)

Pratyara means the focus of consciousness, the object of meditation. When *dharana* becomes continuous, without break or interruption, it is replaced by *dhyana*. In the stage of *dhyana*, the fluctuations of the mind are stilled, but there is still awareness that one is practising *dhyana* – awareness that one is practising unbroken concentration (Saraswati 1976).

Sutra 3 of Chapter 3 of the *Yoga Sutras* describes *samadhi*:

“Tadevarthamatranibhasam svarupashunyamiva samadhi” “That state becomes *samadhi* when there is only the object appearing without the consciousness of one’s own self” (Saraswati 1976) (p158)

In *dharana*, the consciousness is not continuous, but in *dhyana*, it is continuous, and in *samadhi*, it becomes one with the object of concentration. Only the object of concentration

remains, becoming more and more vivid the deeper one goes into the stages of *samadhi* (Saraswati 1976).

Swami Satyananda describes the states of *samadhi* as “sublime equanimity”. But in order to reach this state, all one’s “muscular, emotional and mental tensions” have to be exhausted.

“if it does not bestow peace, power and enlightenment, if it does not remove your complexes, conflicts, schizophrenia, psychological disorders etc., it is not samadhi”

(Saraswati 2005).

2.6 Culmination of Yoga

This state of *samadhi* or ‘self-realisation’ is the culmination of meditation (Saraswati 1983).

Sutra 5 of Chapter 3 of the *Yoga Sutras* describes the result of *samyama* (*dharana*, *dhyana* and *samadhi*):

“Tajjayatprajnalokah” “By mastering (samyama) the light of higher consciousness dawns”

(Saraswati 1976) (p160)

In the state of *samadhi*, the consciousness of the individual ‘self’ is lost. The object of meditation fills the awareness, with the light of ‘higher consciousness’.

2.7 The ‘self’ in Samkhya philosophy

Although the cause and origin of the association of *purusha* (the universal ‘Self’) and the material *prakriti* is considered unknowable (Eliade 1958), the result is ignorance (*avidya*) of our true nature and a bondage in suffering. Our ‘unrealised sense of self’ then derives from the aspect of mind termed ‘*ahamkara*’, in which our awareness of our personal, individual existence is under the influence of the relative dominance of *tamas* and *rajas* gunas. In this condition, our sense of personal identity is governed by our emotional state and relationship with the material world (Eliade 1958).

The path to liberation, of re-identifying with one’s ‘true self’ is the journey described by the Yoga texts, principally in the classical Yoga Sutras of Patanjali.

2.8 Formulation of Yoga concepts in Western terms

The traditional account of Yoga concepts and practices described in this chapter present some difficulties for the scientific investigation of meditation states and traits. Lutz and colleagues described this problem as one that all meditation researchers must face: *“the need to discern which parts of a traditional account of meditation are useful in formulating a*

neuroscientific research strategy, as opposed to parts that are not suitable for that purpose” (Lutz, Dunne & Davidson 2007) (p6).

To make the concepts used in traditional Yoga texts amenable to scientific investigation, Ulrich Ott proposes that the traditional instructions be reformulated “in the language of cognitive psychology” (Ott 2001). Such a process would enable specific hypotheses about the relationship of meditation states to their neurophysiological signatures to be developed and tested. For example, he suggests that the concepts of *pratyahara* might be translated as ‘sensory deprivation’, *dharana* as ‘sustained attention’ and *dhyana* as ‘sustained attention with identification’.

2.9 Absorption

Although the regulation of attention is a central aspect of meditation practice, Ott regards mainstream Western theories of attention to have limited relevance to meditation. The concept of ‘absorption’, characterised by “*total immersion in the attended object, a lack of meta-cognitions, imperviousness to distraction and an altered sense of reality and self*” is proposed as better suited to describe the experiences during meditation (Ott 2003) (p2). He suggests that the meditation stages of *dharana*, *dhyana* and *samadhi* include a high level of absorption.

‘Absorption’ was originally defined as a personality trait related to hypnotisability (Tellegen & Atkinson 1974). The development of this trait theoretically assists the ability to enter deep meditation states, manifested in “a heightened sense of the reality of the attentional object, an imperviousness to normally distracting events, and an altered sense of reality in general and of the self in particular” (Holzel & Ott 2006) (p181). A later refinement of the concept of ‘absorption’ defined it as the ability to surrender one’s usual “realistic, voluntary and effortful” ‘instrumental’ mental set for an ‘experiential’ set characterised by “effortless deep involvement with the object of consciousness” (Jamieson 2005).

2.10 Implications for this project

This thesis will attempt to use the traditional stages of Patanjali’s *Yoga Sutras* (*pratyahara*, *dharana* and *dhyana*) and their Western formulations (sense withdrawal, concentration and absorption) as the conceptual basis for the subjective data collected in the experimental studies.

CHAPTER 3 – WESTERN CONCEPTS OF MEDITATION

“Consciousness poses the most baffling problems in the science of the mind. There is nothing that we know more intimately than conscious experience, but there is nothing that is harder to explain.” (Chalmers 1995) (p1)

3.1 Western definition of “consciousness”

Although interest in the topic of consciousness has undergone a spectacular revival in Western science, its mainstream conceptual basis differs markedly from that of Yoga and Samkhya philosophy.

Zeman (2001) explores the definition of consciousness, reporting its derivation from the Latin “*conscio*”, meaning “to know”, first appearing in the English language in the 17th century. He distinguishes two principal current meanings for the term:

1. Consciousness as the ‘waking state’ – the ability to “perceive, interact and communicate with the environment” in the state of wakefulness.
2. Consciousness as ‘experience’ – the contents of consciousness, the qualitative and subjective dimension, sometimes referred to as ‘qualia’.

3.2 Western philosophical approaches to consciousness

These two forms of the term ‘consciousness’ can be described as its ‘objective’ and ‘subjective’ aspects. The Australian philosopher David Chalmers divides the challenge of understanding consciousness into the ‘easy’ and the ‘hard’ problem. He sees the former as concerning the ‘objective’ mechanisms of the cognitive system and directly susceptible to the standard method of cognitive science. In distinction, the really ‘hard’ problem is “*how the physical processes in the brain give rise to subjective experience*” (Chalmers 1995). He considers the attempt to outline the physiology of consciousness (following the reductionist approach) as merely working on the ‘easy’ problem, leaving the ‘hard’ problem untouched.

The prevailing Western view is, however, that science will eventually answer both questions.

“There is a widespread opinion that science alone will explain the workings of the world, including our own minds and thus consciousness” (Woodruff Smith 2001) (p58).

Most Western scientific study of consciousness rests on the premise that it is dependent on an adequate level of brain functioning. A summary of “*well-established facts in neuroscience*” included the statement:

“A well-functioning brain is essential for human mental activity and behaviour. Mind and consciousness are functions of a living brain. They cease to exist when the brain fails to function. There is no bio-psycho-physical afterlife. An individual survives only through one’s progeny and personal legacy” (Deshmukh 2006) (p277).

This has been described as ‘brain-bound consciousness’, with all conscious experience coinciding with neural activity (Mukhopadhyay 2004). The cardinal properties of ‘brain-bound consciousness’ are its experience of privacy, unitary nature and intentionality. As described in the previous chapter, this view of consciousness differs radically from that of Eastern philosophies.

There are some dissenting voices, however. Stephen Schwartz argues the reductionist model has not offered an adequate explanation for spiritual experiences, such as those attained through meditation: *“two hundred years of reductive materialism has failed to explain the extraordinary experiences we know as moments of genius, religious epiphany, and psychic insight”* (Schwartz 2010) (p227).

He argues that consciousness includes a ‘nonlocal’ aspect, not limited by time and space. In contrast to the ‘physicalist/materialist model’, which assumes:

1. *“The mind is solely the result of physiological processes*
2. *Each person’s consciousness is a discrete entity*
3. *No communication is possible except through the defined physiological senses*
4. *Consciousness dwells entirely within the time/space continuum”* (p228),

he outlines an emerging “Interconnected Consciousness Model”, challenging these assumptions. This model is characterised by assumptions that:

1. *“Only certain aspects of the mind are the result of physiological processes*
 2. *Consciousness is causal, and physical reality is its manifestation.*
 3. *All consciousnesses, regardless of their physical manifestations, are linked (entangled)*
 4. *Some aspects of consciousness are not limited by the space/time continuum”.*
- (p228)

Schwartz argues that scientific investigation of meditation is one area of research lending support to the ‘non-local’ view of consciousness.

3.3 Concept of ‘sense of self’

The Western concept of ‘sense of self’ has been defined as a

“collection of schemata regarding one’s abilities, traits and attitudes that guides our behaviours, choices and social interactions. The accuracy of one’s sense of self will impact on one’s ability to function effectively in the world” (Johnson et al. 2002) (p 1808).

As described by William James, the ‘self’ provides:

“a source of permanence beneath the constantly shifting set of experiences that constitute conscious life” Quoted in (Farb et al. 2007) (p1).

3.3.1 ‘Narrative’ and ‘experiential’ forms of self-reference

Farb and colleagues report that “William James posited an explanatory term ‘me’ to make sense of the aspect of self, the ‘I’ acting in the present moment”. The continuity of the ‘me’ as a permanent ‘sense of self’ has been related to the “construction of narratives that weave together the threads of temporally disparate experiences into a cohesive fabric” (Farb et al. 2007) (p1). The authors labeled this form of self-reference as “narrative focus”, in distinction to the immediate, shifting experience of the ‘I’, termed “experiential focus”. They suggest the “narrative focus” may be associated with cortical midline neural activity and the “experiential focus” may be derived from neural markers of transient body states.

3.4 Neural correlates of consciousness

Despite the range of philosophical approaches to the explanation of consciousness, “a growing number of investigators believe that the first step towards a science of consciousness is to discover the neural correlates of consciousness (NCC)” (Noe & Thompson 2004) (p3).

Chalmers suggests a working definition of an NCC as

“a minimal neural system such that there is a mapping of states of that system to states of consciousness, where a given state of the neural system is sufficient, under certain conditions, for the corresponding state of consciousness” (Chalmers 2000) (p8).

This first task, termed ‘the matching content doctrine’ by Noe and Thompson is “to uncover the neural representational systems whose contents systematically match the contents of consciousness” (Noe & Thompson 2004) (p4). This doctrine can be stated as:

“For every experience E, there is a neural representational system, N, such that
(i) N is the minimal neural representational system whose activation is sufficient for the occurrence of E, and
(ii) there is a match between the content of E and the content of N”

(Noe & Thompson 2004) (p4)

In addition to this ‘minimally sufficient neural substrate’, Noe and Thompson claim most theorists also apply an ‘isomorphic constraint’ – a requirement for one-to-one mapping from features of the minimal neural substrate to features of the conscious experience (Noe & Thompson 2004). This has been postulated as necessary to improve the explanatory power of the link between neural function and conscious experience beyond that provided by mere correlation.

This protocol has been applied to meditation research to support the proposal that meditation states attained by advanced practitioners are “unique brain/mind states” (Fell, Axmacher & Haupt 2010). The goal of research into meditation states can be viewed as the search for neural signatures mapping isomorphically to phenomenologically distinct meditation states. Advanced meditation practitioners aid the reliability of such comparison by their ability to “robustly reproduce” specific states and to “provide more refined first-person descriptions’ of these states (Lutz 2007) (p45).

3.5 States of consciousness

In contrast to Eastern views, Western science usually takes the waking state as the ‘highest’ (i.e. corresponding to reality) level of consciousness. The subjective experience of decreasing levels of consciousness from wakefulness to deep sleep can be mapped objectively by changes in cortical arousal measured by electroencephalography (EEG) (Tassi & Muzet 2001).

The contrast between deep sleep and the waking state is illustrated in Table 1.

Table 1 – Properties of waking and deep sleep states of consciousness

State	Conscious resting state	Deep sleep
Cause	Neuro-modulation of the cortex by the brainstem	Neuromodulation of the forebrain by the brainstem
Behaviour	Accurate reportability	No reportability
Metabolism	High in frontoparietal cortex	Low in frontoparietal cortex
EEG	Low amplitude irregular high frequency or regular alpha (8-12Hz) waves	High amplitude, regular low frequency delta (<4Hz) waves
Functional connectivity	High and variable	Low between cortical regions, and between thalamus and cortex

Modified from “Brain, conscious experience and the observing self (Baars, Ramsoy & Laureys 2003)

In addition to waking and deep sleep, a third state, the dream state has received increasing recognition. Rich subjective experiences occur during the stage of ‘rapid eye movement’ (REM) dream sleep. Although voluntary control is usually absent, awareness, in the form of dream content can be high and so REM sleep has been termed ‘paradoxical sleep’. A view of

REM sleep is that while the fate of sensory input in the waking state is determined by its relevance to ongoing mindsets, this constraining influence is lacking in the dream state, producing a “*free processing mode operating mostly on previously stored representations*” (Tassi & Muzet 2001) (p183).

Although the existence of vivid dreams, termed ‘lucid dreaming’, has long been known, the doctoral dissertation of Stephen LaBerge in 1980 provided a detailed scientific account of this phenomenon. While fully realising that one is asleep, the lucid dreamer may experience a level of perceived voluntary control over the ‘action’ of the dream, being at the same time an ‘actor’ and an ‘observer’. A recent study found participants reported the same range of cognitive skills in waking and dreaming experiences, including the high-order skills of choice, planning and focused attention (Kahan & LaBerge 2011).

From the point of view of dreaming, then, waking may be considered a ‘lesser’ state, a view similar to Yogic philosophy.

“Waking is nothing other than a dreamlike state modulated by the constraints produced by specific sensory inputs” (Quote from Llinas in Tassi and Muzet, 2001,p182).

3.6 Altered states of consciousness

Beyond this basic classification of states of consciousness, neuroscience is beginning to explore the myriad variations in the phenomena termed ‘altered states of consciousness’ (Vaitl et al. 2005).

William James referred to the existence of altered states of consciousness (ASCs) in his famous quotation:

“Our normal waking consciousness, rational consciousness as we call it, is but one special type of consciousness, whilst all about it, parted from it by the filmiest of screens; there lie potential forms of consciousness entirely different No account of the universe in its totality can be final which leaves these other forms of consciousness quite disregarded. How to regard them is the question – for they are so discontinuous with ordinary consciousness” (James 1929) (p378-9).

The distinction between ‘ordinary’ consciousness and altered states of consciousness was examined in detail by Charles Tart. He proposed the addition of the term ‘discrete’ to more clearly separate the terms ‘state of consciousness’ (SoC) and ‘altered state of consciousness’ (ASC):

“a discrete altered state of consciousness (d-ASC) refers to a discrete state of consciousness (d-SoC) that is different from some baseline state of consciousness. Usually the ordinary (waking) state is taken as the baseline state. A d-ASC is a new system with unique properties of its own, a restructuring of consciousness. ‘Altered’ is intended as a purely descriptive term, carrying no values”. (Tart 1975) (p5).

Tart considered the transition from the baseline state to a d-ASC as a three-step process. The first step is to disrupt the stabilisation of the baseline SoC, by interfering with the positive and negative feedback systems, to the point where the baseline state cannot maintain its integrity. The second operation is to apply ‘patterning forces’ to push the state towards the new pattern of the desired d-ASC, for example by the use of a mandala (or diagram) in meditation. The third step is the formation of the “new, self-stabilising structure” (Tart 1975)

A collaborative review by researchers from a number of European universities attempted to classify the range of ASCs using a multilevel approach, including biological, behavioural, cognitive and subjective domains. An initial classification used the origin of the state, that is, spontaneous, induced or pathological. Table 2 illustrates the classification.

Table 2 – Altered States of Consciousness by origin or method of induction

Origin	Alteration
Spontaneously occurring	States of drowsiness
	Daydreaming
	Hypnagogic states
	Sleep and dreaming
	Near death experiences
Physically and physiologically induced	Extreme environmental conditions
	Starvation and diet
	Sexual activity
	Respiratory maneuvers
Psychologically induced	Sensory deprivation
	Rhythm-induced trance
	Relaxation
	Meditation
	Hypnosis
Disease induced	Biofeedback
	Psychosis
	Coma and vegetative state
Pharmacologically induced	Epilepsy
	Not reviewed

(Vaitl et al. 2005) (p100)

The review concluded:

- Spontaneously occurring ASCs are transient in nature, experienced subjectively as dreamlike, illusionary and stem from changes in cortical activity and arousal.
- The subjective experiences in physically and physiologically induced ASCs differ according to the changes in energy supply to the brain.

- ASCs (including meditation) induced by psychological induction are linked to alterations in brain activity, with research moving towards more experimental paradigms.
- Disease-induced ASCs result from impairment of brain function at different functional levels, from cortical to brain stem.

3.7 Meditation as an altered state of consciousness

“Meditation is a complex neurocognitive process inducing changes in psychic, cortical, and autonomic functions. The aggregate of these changes allows the meditative states occurring to be classified as altered states of consciousness, differing from ordinary wakefulness, relaxation at rest, and sleep” (Aftanas & Golosheikin 2003) (p18).

“There is significant evidence that ASCs may represent a core experiential component of religious and mystical traditions and that practices such as meditation and yoga may induce specific classes of ASC” (Walsh 1993) (p739)

Although these quotations suggest the phenomenological states experienced during meditation may be classified as ASCs, others contend that not all experiences in meditation qualify for this classification and only specific advanced states constitute ‘unique brain/mind states’ (Fell, Axmacher & Haupt 2010). This issue will be explored in the experimental sections of this thesis.

3.8 Brain networks and states of consciousness

3.8.1 Concept of Default Mode Network

The advent of neuroimaging techniques began to reveal that particular brain regions unexpectedly showed deactivation (rather than increased neural activity) when the subject moved from inactivity, e.g. eyes closed rest (ECR) to a task involving cognitive demand (Raichle & Snyder 2007). This led to the identification of a ‘default mode network’ (DMN), comprising “a set of brain regions that are co-activated during passive tasks, show intrinsic functional correlation with one another, and are connected via direct and indirect anatomic projections” (Buckner, Andrews-Hanna & Schacter 2008) (p11).

Anatomically the DMN was found to consist of “two distinct subsystems that converge on a midline core” (Andrews-Hanna et al. 2010). The two subsystems, located in the medial temporal lobe and medial prefrontal cortex strongly correlate with a midline core, with hubs at the anterior medial prefrontal cortex (amPFC) and posterior cingulate cortex (PCC).

3.8.2 Relationship of DMN to meditation states

Buckner et al (2008) suggest that DMN supports “internal mentation that is largely detached from the external world” (p11). The authors consider this to include activities such as: mind-wandering, autobiographical memories, envisioning the future, theorising about the actions of others or reviewing moral decisions.

As early training in meditation involves the ability to shift from an external to an internal focus (*pratyahara*) it might be expected that the DMN would be activated in this transition.

However, to progress to deeper states in meditation, ‘mind-wandering’ activity of the DMN presents a distraction, suggesting that inhibition of DMN activity may be a marker of “successful” mindfulness meditation (Ott, Walter & Gebhardt 2010). Mindfulness training has also been interpreted as decoupling a habitual “narrative” self (associated with the DMN medial prefrontal cortex subsystem) from a right lateralised “experiential” self cortical subsystem.

An additional consideration is ECR (associated with DMN activity) is commonly used as a control state for comparison with meditation states.

3.9 Implications for this project

The states of consciousness induced by meditation practices will be investigated by EEG-derived tomography of brain networks. The influence of meditator proficiency and types of practice will be explored, as well as the relationship of meditation ‘states’ and ‘traits’ to the function of the DMN.

CHAPTER 4 – METHODOLOGY OF MEDITATION RESEARCH

4.1 Introduction

An early review of meditation research in the 1970s concluded:

“The research thus far has not generated an adequate scientific understanding of the specific independent variables and causal relationships that account for meditative phenomena. This is largely because research has thus far investigated the effects of rather specific techniques practiced within a complex framework of expectation, philosophical belief and social influence. To develop acceptable scientific explanations of meditative phenomena, future research must address itself to the development of new methodologies that allow for the systematic isolation and investigation of technical and extra-technical factors that are active in producing psycho-physiological change” (Woolfolk 1975) (p375).

A later review, in the 1980s, echoed these points in recommending a number of directions for meditation research to pursue:

- a more careful look at the context of meditation, particularly the individual’s expectations and the characteristics of the teaching organisation
- a component analysis to separate the effects of the various aspects of meditation – preparation, environment, posture, attention, breathing.
- an examination of the phenomenology of meditation, as the domain in which the contemplative disciplines evolved. (Shapiro 1982)

To date, these recommendations have received little attention. A recent extensive review of neurophysiological studies of meditation states and traits (Cahn & Polich 2006) found that “no clear consensus” had emerged from 50 years of electroencephalographic (EEG) studies. However, some reliable meditation-related EEG effects had been found in Western meditators and neuroimaging studies were beginning to show “possible neural loci for meditation effects”.

Cahn and Polich (2006) summarised some of the methodological difficulties encountered in this field. In addition to the ‘paradigm clash’ of conceptual differences outlined in previous chapters, they considered ‘state’ and ‘trait’ effects of meditation difficult to separate, as experienced meditators tend to maintain a ‘meditative’ witnessing awareness outside of meditation, and find it difficult to engage in ‘non-meditative’ eyes closed rest, a commonly used control condition. Although changes in the ‘sense of self’ were a common experience in

meditation, there were few studies exploring this effect due to the difficulty in quantifying self-experience. Furthermore, the availability of participants seemed to determine the meditation practices used in research rather than their position on cognitive dimensions.

4.2 This review

Cahn and Polich reviewed 69 EEG, 20 event-related potential (ERP) and 12 neuroimaging studies of meditation states and traits conducted up to 2005. As the focus of this thesis is the meditation state, ERP studies are not included in the current review.

The studies reviewed by Cahn and Polich (2006) were taken as the starting database for this review. A search of Science Direct, PubMed and Scopus databases using search fields of “meditation” and “EEG” and “2005 to present” produced 438 results. Search fields “meditation”, “neuroimagery” and “2005 to present” produced 337 results. Of these, 14 were experimental studies of meditation states using EEG or neuroimagery and were added to the review database. This procedure resulted in 45 EEG studies and 22 neuroimaging studies for review.

4.3 Framework for literature review of meditation research

The predominant experimental research design for exploration of meditation states has been a within-subject comparison of psychophysiological measures obtained from participants engaged in a particular meditation practice compared with measures taken in a baseline state, usually ‘eyes-closed rest’(ECR). To estimate ‘trait’ effects, comparisons are made between participants of differing proficiency on non-meditative conditions, usually ECR.

In line with the Western emphasis on ‘objective’ measures, most reports devote the great majority of their content to the technical aspects of psychophysiological data collection and analysis, providing only minimal description of the meditation practice, the phenomenological state or the context in which the practice occurs.

This review will examine the effect of meditator proficiency and type of practice as independent variables on the dependent variables of subjective experience and psychophysiological measures.

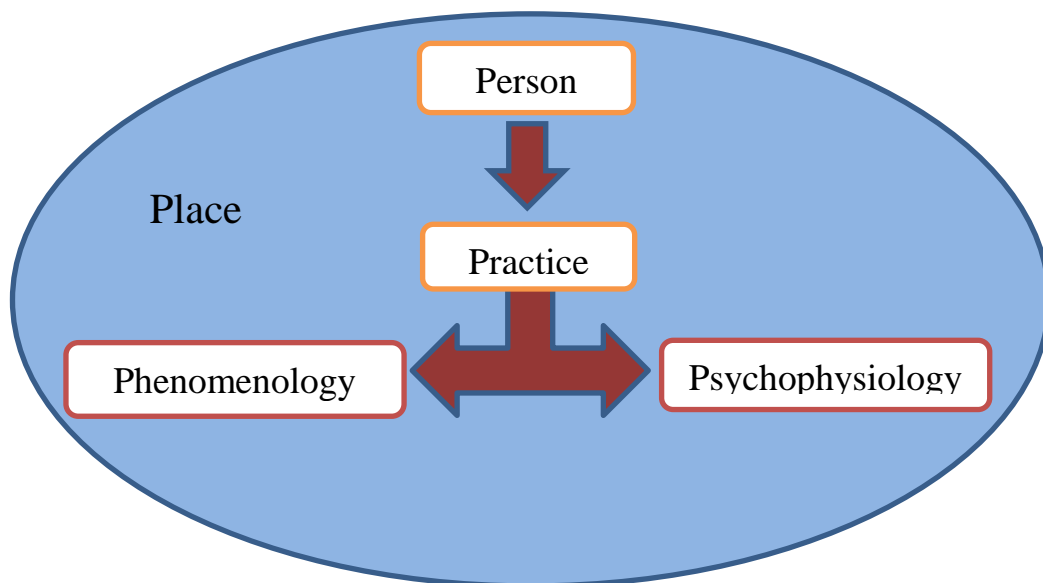
To encompass the great number of potential confounding variables in meditation research, the review will use the following methodological framework:

- Meditation occurs within a cultural context, a domain of variables termed ‘Place’.

- Within this context, the particular meditation tradition provides training in specific meditation practices, a domain termed ‘Practice’
- The individual meditation brings their personal history, a domain termed ‘Person’ to the specific practice
- Producing the outcome variables of subjective experiences of the (altered) state of consciousness, termed ‘Phenomenology’, and their concomitant ‘Psychophysiology’ measures.

The framework is illustrated in Figure 1.

Figure 1 – Framework for literature review



4.4 The ‘Place’ domain

This domain encompasses those variables defining the broad context for the study. At the height of meditation research with Western practitioners in the 1980’s, Arthur Deikman noted that it was

“hard to find a single research paper in this field that mentions the importance of context within which classical meditation was developed and practiced” (p679) (Deikman 1984).

The domain of “Place” may incorporate a number of variables.

4.4.1 Cultural context

Whether the meditation under study is embedded in its original cultural setting or a meditation tradition transposed to a western setting may impact on the results. Charles Tart contends that even our ordinary state of consciousness is in part a product of consensus reality, structured by our cultural context (Tart 1975). He argues that the process of

'enculturation' during childhood development shapes our experience of consciousness. Thus the cultural history of meditation tradition and practice within a particular society may determine the range of experiences available to meditators.

The early studies reviewed used meditators practising within their original cultural context, while most of the research in the 1970's and 1980's used 'transposed' meditation traditions with Western meditators. Later studies, particularly with Tibetan Buddhist meditators, have again had access to meditators still in their culture of origin, although living in Western countries. The implications of cultural context have received little attention in the literature.

4.4.2 Intent of meditator

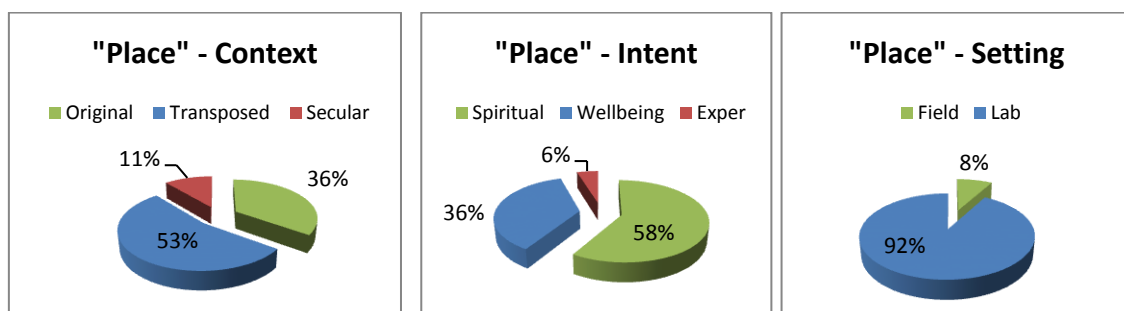
The goals and expectations of the participants in research studies of meditation may be important variables. The same meditation practice, performed as part of a long-standing spiritual practice e.g. (Kasamatsu & Hirai 1966) or for an undergraduate project e.g. (Dunn, Hartigan & Mikulas 1999) may produce very different states.

4.4.3 Physical setting

The physical setting for the recording session may impact on the meditation state attained, affecting the 'ecological validity' of the state attained. Factors affecting the meditation state may include whether the place is regularly used for meditation or a laboratory, the 'sacred' nature of the setting, e.g. the presence of sacred objects, the presence of guru or the presence of others. In laboratory settings, the intrusiveness and discomfort of the psychophysiological equipment may affect the attained meditation state. After the early field studies of the 1960's, the vast majority of studies were conducted in a laboratory setting, usually with unspecified effects on the meditative experience.

Figure 2 summarises the reporting of variables in the "Place" domain in the reviewed studies. See Appendix 3 for details of these studies.

Figure 2 – Summary of reporting of "Place" variables



LEGEND

Context - Green: meditators in original spiritual cultural context

	Blue: spiritual meditation transposed to new culture
	Red: meditation practised for secular goals
Intent -	Green: meditation practised for spiritual goals
	Blue: meditation practised for 'wellbeing' goals
	Red: meditation practices devised for experimental purposes
Setting -	Green: study conducted in 'field' setting
	Blue: study conducted in laboratory setting

The early studies reviewed used meditators practising within the country of original cultural context, while most of the research in the 1970's and 1980's used "transposed" meditation traditions with Western meditators. Later studies, particularly those with Tibetan Buddhist meditators, have used meditators within their original cultural context, but living in Western countries. Overall, the majority of studies have used meditations "transposed" to Western culture.

The majority of studies reported meditation practices undertaken for spiritual purposes, in both original and transposed contexts, but over a third were for personal "wellbeing". Only a few studies used purely experimental practices. After the early field studies of the 1960's, the vast majority of studies were conducted in a laboratory setting, usually with unspecified effects on the meditative experience.

4.5 The 'Person' domain

This domain encompasses variables relating to meditator proficiency, personal history and the nature of the meditation training of participants.

4.5.1 Meditator proficiency

Meditator proficiency is one of the major independent variables used in meditation research, but as yet, there is no accepted measure of proficiency. Years of meditation practice has been the primary index of meditation expertise used in meditation research, but there is no necessary correlation between amount of practice and meditation proficiency. A more accurate proficiency measure, although rarely used, is a rating by the meditator's teacher, e.g. in the study by Kasamatsu and Hirai (1966). Further collaboration between researchers and specific meditation traditions is needed to develop classifications of expertise and levels of training required for proficiency within each tradition.

In addition, descriptive labels for levels of proficiency vary widely in the literature. For studies of Western meditators, the terms 'experienced' or 'long-term' have been applied to participants with mean experience from 1 to 10 years, in TM (Hebert & Lehmann 1977) and Sahaja Yoga (Aftanas & Golocheikine 2001). The label 'advanced' has most frequently been reserved for Buddhist monks or Yogis with more than 20 years' experience.

For this thesis, the following classification of proficiency levels will be used in the literature review:

- Novice (NM) - training or practice less than one year
- Short-term meditators (STM) – experience: 1-5 years
- Long-term meditators (LTM) – experience: 5-20 years
- Advanced meditators (AM) – experience: more than 20 years

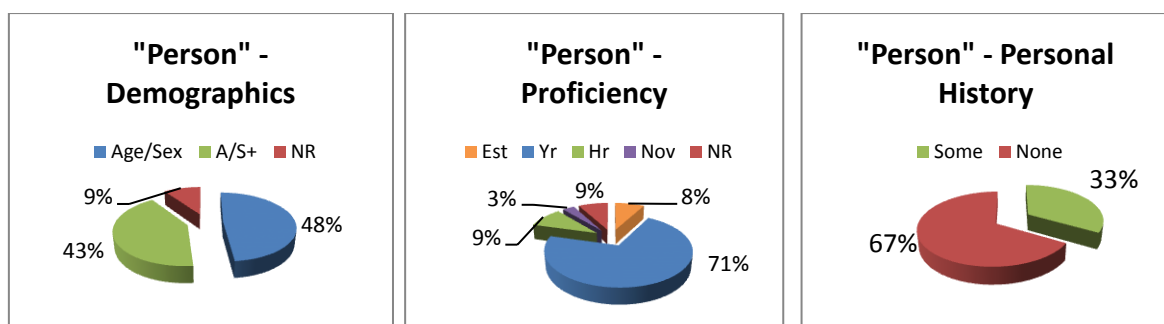
In contrast to traditionally trained meditators, there is some evidence that western meditators may have a more varied journey through their meditation training. A qualitative study of American Zen meditators found they often sampled different teachings before settling into the Zen tradition (Mathis 2005). Reporting of meditation experience may require a more detailed description of personal history than has been the norm in previous research.

4.5.2 Demographics and personal characteristics

Most studies report the age and sex of participants. Although other personal characteristics, including health status, handedness, psychiatric history, lifestyle measures, personality, and spiritual beliefs may impact on both phenomenological and neurological outcomes, they are not routinely reported.

Figure 3 summarises the reporting of variables in the “Person” domain in the reviewed studies. See Appendix 3 for details of the studies.

Figure 3 – Summary of reporting of “Person” variables



LEGEND

Demographics - Blue: only age/sex

Green: age/sex plus additional demographics

Red: no demographics reported

Proficiency -

Orange: proficiency estimated

Blue: years of practice

Green: hours of practice

Purple: novice practitioners

Red: proficiency not reported

Personal history -

Green: some details of meditators' personal history provided

Red: no personal history reported

90% of studies reported at least the age and sex of the practitioners, some adding some details of health, lifestyle. The vast majority used time in “years” as the index of proficiency, with reporting in total “hours” becoming more common in recent publications. Only a third of studies gave any additional information about the personal meditation history of the participants.

4.6 The ‘Practice’ domain

This domain encompasses all the details of the particular meditation practice used in a particular study.

4.6.1 Description of meditation practice

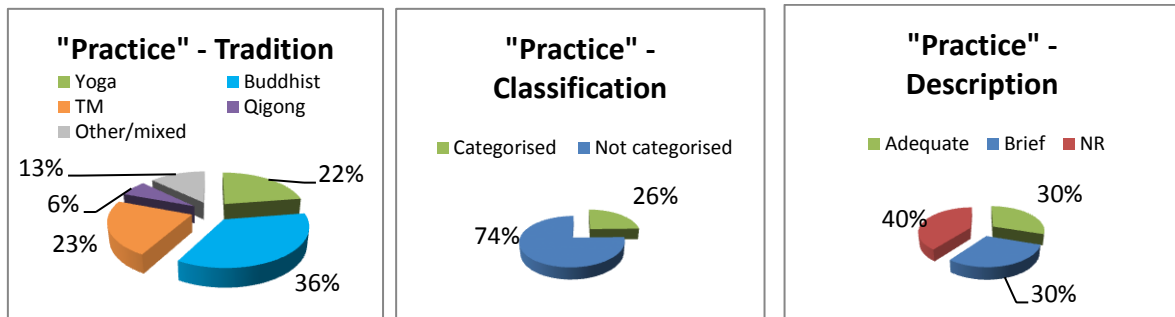
Replication of meditation studies is often difficult due to inadequate descriptions of the practice used. Ideally, the description of the meditation practice should place it within its tradition, with specification of the particular meditation teacher or school. The physical aspects of meditation practice, posture, hand position, eyes open, downcast or closed, all potentially impact on the phenomenological and psychophysiological results, but have received little attention in the literature as yet.

4.6.2 Categories of practice

Based on the Buddhist text, the *Abhidharma*, and on earlier work of Naranjo and Ornstein, Daniel Goleman described the two fundamental attentional strategies in meditation as “concentration” (one-pointed attention on a single focus) and “insight” (full awareness or mindfulness of all contents of awareness) (Goleman 1976). This classification came to be more generally applied, using the terms “concentration” and “mindfulness” (Dunn, Hartigan & Mikulas 1999). The research studies by the University of Wisconsin group (A Lutz et al. 2008) relabeled the categories as “focused attention” and “open monitoring” and provided links to neurophysiological concepts. To accommodate practices such as “Transcendental Meditation” (TM), Travis and Shear (2010) proposed a third category “automatic self-transcending”. These categories are gaining more general acceptance in the literature, but provide only a very broad distinction between practices. They also suffer from the fact that they are not terms used in traditional meditation instructions.

Figure 4 summarises the reporting of variables in the “Practice” domain in the reviewed studies. See Appendix 3 for details of the studies.

Figure 4 – Summary of reporting of “Practice” variables



LEGEND

Tradition - Green: Yoga, Blue: Buddhist, Orange: TM
 Purple: Qigong, Gray: other/mixed traditions
Classification - Green: practice categorised, Blue: practice not categorised
Description - Green: adequate description, Blue: brief description, Red: no description

A variety of meditation traditions were represented, with those deriving from the Buddhist tradition in the majority, followed by Yoga and TM. Only a quarter of the studies used a classification system, usually on the “concentration - mindfulness” dimension. Most studies gave only a brief or no description of the actual practice, usually insufficient to allow replication.

4.6.3 Choice of control condition

Most studies compared meditation ‘states’ with ‘eyes closed rest’ (ECR). As noted in the previous chapter, ECR, as a ‘non-task’ situation has been associated with the activity in the default mode network (DMN). The relationship of the DMN to neural networks active in meditation ‘states’ has yet to be fully revealed, suggesting that the use of ECR as a control state does not provide a neutral comparison.

4.7 The ‘Phenomenology’ domain

Although meditation is “*intrinsically subjective and introspective*” (Shapiro 1982) and its purpose is to bring about “*strong subjective experiences in practitioners*” (Shapiro 1983), subjective descriptions of the meditator’s state of consciousness have received little attention in the meditation research literature.

The phenomenological states induced by meditation have remained largely undefined, with few accepted dimensions for subjective rating scales. Inferences about the phenomenological experience have generally been inferred from the classification of meditation practice related to the dimension of focus of attention.

The linking of first-person phenomenological accounts with neurological measures of the same state of consciousness has been termed ‘neurophenomenology’ (Lutz & Thompson 2003). This methodology is particularly suited to investigation of meditation states as advanced practitioners “*can robustly reproduce specific features in experience as cultivated in given meditation practice*” and “*can provide more refined first person descriptions of their experiences than naïve subjects*” (Lutz, Dunne & Davidson 2007) (p45). This linking of ‘subjective’ and ‘objective’ accounts of the same state of consciousness through ‘mutual constraints’ has been proposed as a response to Chalmers’ ‘hard problem’ (Varela 1996). However, neurophenomenology has not been adopted as a general methodology for meditation state research to date.

4.8 Psychophysiology domain

The earliest field studies of meditation used a number of psychophysiological measures, including heart rate, skin conductance, pulse rate (e.g. (Arambula et al. 2001)). However, this review will focus on measures of brain activity, as indicators of altered states of consciousness. Early studies began with electroencephalography (EEG), with increasing refinement of analysis methods through the 1970s to 1990s. Since 1990, studies using neuroimaging techniques, e.g. functional Magnetic Resonance Imaging (fMRI), have become more frequent. Where EEG provides high temporal resolution, neuroimaging has greater spatial resolution.

4.8.1 EEG

Because of its usefulness in distinguishing states of consciousness and in detecting psychiatric disturbances, great hope was held for EEG to shed light on the processes involved in meditation. The EEG signal is essentially “*a time – and space-averaged electrical potential difference*” (Schwilden 2006) (p32), caused by an electromagnetic field generated by moving electrical charges inside the brain. The amplification of these weak signals adds noise to the signal, filters the signal and affects the phase relationship between its components. The analog signal is converted into a discrete time series by an analogue-to-digital converter. Once artifacts due to eye and muscle movement have been removed, the analysis of the EEG record is the analysis of this time series.

Ott (2001) claims the endeavour of correlating states of consciousness with distinct EEG patterns “*has partly been successful in the sense that the general activation level is indeed mirrored by the dominating EEG band*” (p2). EEG studies of meditation have attempted to identify the EEG signatures of different meditation states according to practitioner proficiency and type of practice.

Various methods of analysis have been applied to the EEG signal in meditation research. These include frequency analysis, which traditionally divides the signal into the following bands (Teplan 2002):

Gamma	(> 30Hz)
Beta	(13 - 30 Hz)
Alpha	(8 - 13 Hz)
Theta	(4 - 8 Hz)
Delta	(0.5 - 4 Hz)

Absolute power is the amount of the EEG signal (calculated as the amplitude squared) in one band without reference to other bands, while relative power is the amount of EEG activity in a band divided by the amount in all bands. Spectral analysis provides a visual presentation of the power in each band of frequency spectrum (Banquet 1973).

The relationship between neural network activities in different brain regions has been estimated by measures of 'coherence' and 'phase synchrony'. Where 'coherence' mixes phase (timing) and amplitude information, 'phase synchrony' refers to amplitude-independent phase locking of one oscillation to another oscillation (Palva, Palva & Kaila 2005).

LORETA (Low resolution brain electromagnetic tomography) is a method for computing the three-dimensional intracranial distribution of the electrical sources of scalp-recorded EEG signals. It produces images of current source density with exact localisation of point sources (as maxima on a source model with maximally smooth spatial distribution) but with otherwise low spatial resolution projected on a realistic head model (Pascual-Marqui 2002). It thus combines the high temporal resolution of EEG with low resolution but accurate localisation of source activity. The software is freely available on the Internet, in two versions: standardized (sLORETA) and exact (eLORETA).

4.8.2 Neuroimaging

Magnetic resonance imaging (MRI) uses a large magnet (M) and a radiofrequency pulse of a highly specific resonance (R) to produce an image (I) from a signal from the brain. Both brain anatomy and neural function can be studied, with a resolution of less than 1mm³. As the technique does not involve ionizing radiation, it is safer than X-rays (Kolb & Whishaw 2003). The finding that functional activity in the brain increases the amount of oxygen in the blood in that area is used in to produce functional magnetic resonance images (fMRIs). When superimposed on the MRI- produced images, functional activity can be attributed to specific structures (Kolb & Whishaw 2003)

Positron emission tomography (PET) photographs the emissions from radioactively labeled metabolically active chemicals injected into the bloodstream or inhaled in a gas. Variations in the image represent areas of differential blood flow, portrayed by the use of different colours. Functional brain activity can be detected in the images (Kolb & Wishaw 2003). Single photon emission computed tomography (SPECT) is similar to PET, but uses gamma rays emitting radioisotopes to construct 2 and 3 dimensional images of active brain regions.

4.9 Implications for this investigation

The above framework will be used to review research studies in the following chapter for the effects of the independent variables of meditator proficiency and type of practice. The framework will also underpin the research studies in the present investigation.

CHAPTER 5 - LITERATURE REVIEW OF MEDITATION RESEARCH

5.1 This review

This chapter will review the database of EEG and neuroimaging studies, examining the relationship between independent variables 'proficiency' and 'practice' to outcome variables of 'phenomenology' and 'psychophysiology', within the differing meditation traditions. The database is that described in the previous chapter, derived from that of Cahn and Polich (2006) with the addition of those published since that review, resulting in 45 EEG studies and 22 neuroimaging studies for review.

5.2 Review of meditation studies

The EEG studies reviewed are presented according to their meditation tradition:

- Table 3 lists the EEG studies from the various schools within the Yoga tradition.
- Table 4 lists the EEG studies conducted by proponents of the "Transcendental Meditation" movement of Maharishi Mahesh Yogi. Although derived from a Yoga context, only one, simple mantra practice is used.
- Table 5 lists the EEG studies conducted within the Buddhist tradition. These include the branches of Theravada and Mahayana Buddhism. The major forms of meditation are *samatha*, *vipassana* and *Ch'an* (*Zen* in Japan). The secular practice of "mindfulness" is derived from Buddhist meditations.
- Table 6 lists the EEG studies from other traditions, including Chinese Qigong.
- Table 7 lists the neuroimaging studies of meditation states.
- Table 8 lists the neuroimaging studies of non-meditative "resting states" designed to measure "trait" effects of meditation practice.

Table 3 – EEG Studies from the Yoga tradition

Study	Person	Practice	Phenomenology	Alpha	Theta	Beta	Gamma	Conclusions
Anand (1961)	4 Adv ? (experience not specified)	Raja Yoga “ <i>samadhi</i> ”? concentrated attention Eyes closed vs ECR	NR	High alpha in ECR Increased alpha amplitude in meditation	NR	NR	NR	Alpha not blocked by external stimuli
Wenger & Bagchi (1961)	14 Adv ? (experience not specified)	Meditation (unspecified) Eyes closed? vs ECR		Alpha activity increased				Alpha activity increased.
Ghista (1976) India	4 STM (regular practitioners) 1 control	30min Ananda Marga breath-synchronized guru mantra with chakra awareness Eyes closed vs ECR	NR	Power increase, frequency decrease, no change for control	NR	NR	NR	Frequency shift index of “therapeutic value”
Elson (1977) USA	11 STM (0.7 – 4yrs) Mean 1.5 years Matched controls	40min Ananda Marga breath-synchronized guru mantra (not described) Eyes closed vs ECR, EOR	NR	Meditators had more non-descending alpha-theta than controls	11 meditators showed theta	NR	NR	Meditators maintained stable alpha-theta state without descending into sleep
Corby (1978) USA	10 STM (mean 4.4 years) 10 STM (mean 2.1 years)	Ananda Marga Breath-synchronised guru mantra Eyes not stated vs rest	Post-session questionnaire, rating of meditation quality on 10 point scale	Most showed power increase	Power increase, expert greatest	NR	NR	Alpha and theta power increased with proficiency.
Lou (1999) Denmark	9 LTM (>5yr)	Yoga Nidra (guided meditation) Eyes closed vs ECR	Post-session validation of state attained	Not different to ECR	Power increase	NR	NR	Meditation distinctly different to sleep
Khare & Nigam (2000) India	30 Yoga, TM Nov (3mth)	Yoga or TM Yoga: attention at eyebrow centre Eyes closed vs ECR	NR	Higher alpha power in meditators	NS	Controls higher percentage of beta		Alpha indicates relaxed state of mind
Kamei (2000) Japan	8 Yoga instructors (experience not stated)	20min breath-synchronised mantra (soham) preceded by asana, pranayama Eyes closed vs EOR	NR	Time in alpha time increased for most	1 subject also showed theta increase	NR	NR	Increased alpha
Aftanas & Golocheikine (2001) Siberia	Sahaja Yoga 11 STM (3-7yrs) 11 Nov (<0.5yrs)	“mental silence” and blissful state Eyes closed vs ECR	Post-session ratings of thought, emotion on 10 point scale	STM: Alpha 1 power increase	STM: greater anterior-posterior synchronization	NR	NR	Theta power correlated with blissful state and absence of thought.
Arambula (2001) USA	1 Adv Japanese Yogi (32 years)	15min Kundalini yoga (not described) Eyes closed vs ECR	Subject validated meditation state attained	Power increase on entering state	Power increase after meditation	NR	NR	Posterior alpha power increase associated with slowed respiration
Ott (2001) Germany	10 LTM (mean 17 years) vs 10 controls	TM or Yoga meditation or breath counting (control) Eyes not stated vs Counting	Post-session interview, questionnaire, depth rating	NR	NR	NR	No differences in gamma found between groups or conditions	Meditation consists of several different states, which must be defined and differentiated.
Aftanas & Golocheikine (2003) Siberia	Sahaja Yoga 16 STM (3-7years) 11 Nov (<0.5years)	Hand mudras, chakra awareness (not described) Eyes closed vs EOR	Button press when “consciousness without thought”	STM: alpha 1 power increase, frequency decrease	STM: frontal midline theta power increase, synchronization	NR	NR	Theta power correlated with blissful state and absence of thought
Baijal & Srinivasan (2010) India	10 STM Sahaj <i>Samadhi</i> teachers (3-7 years) vs 10 controls	Sahaj <i>Samadhi</i> Focus on breath and mantra Eyes closed vs ECR	Post-session interview on experience	NS	Increased theta in right and left frontal-central in middle part of meditation	NS	NS	Enhanced frontal theta activity in “deep” meditation associated with ACC activity Reduced theta power in parietal

Table 4 – EEG Studies with TM meditation

Study	Person	Practice	Phenomenology	Alpha	Theta	Beta	Gamma	Conclusions
Wallace (1970, 71) USA	15 STM (0.5-3yrs)	30min TM Internalised attention Eyes closed vs ECR	NR	Power increase, frequency decrease	Some frontal bursts	NR	NR	TM distinct from sleep
Banquet (1973) USA	12 STM (0.75-5yrs) vs 12 controls (none)	30min TM/R Eyes closed vs ECR	In session signaling of state by push-button code: sensations, imagery, depth, transcendence	Controls: 8 – power increase TM: 10 - frequency decrease - frontal (1 st stage)	TM: 10 - frontal bursts (2 nd stage)	TM: power increase 20Hz (3 rd stage)	TM: 4 – small amplitude power increase 40Hz (3 rd stage)	Alpha power increase not specific to meditation, theta bursts differ from drowsiness, meditation beta differs from awake state
Hebert & Lehmann (1977) USA	78 STM - LTM (2-11yrs) vs 54 controls (none)	25min TM/R Eyes closed vs ECR	Subjective report when theta bursts signaled	NR	TM: 21 – frontal bursts associated with TM, “drifting”	NR	NR	Occurrence of theta bursts related to change of state, not correlated with training.
Morse (1977) USA	12 STM (0.2-5yrs) vs hypnosis/ control	8min TM Eyes closed compared to hypnosis, relaxation	Subjective report of state description	Slow alpha increase similar for all conditions	NR	NR	NR	All methods produced alpha but not for all subjects
Fenwick (1977) USA	10 STM (mean: 3yrs)	20min TM Eyes closed vs music	Post-session report of depth of relaxation	Power increase	Bursts in some	NR	NR	All EEG changes due to drowsiness
Stigsby (1981) Denmark	14STM - LTM (2-8yr)	20min “TM” Eyes closed vs ECR	Post-session questionnaire of drowsiness	TM: Frequency decrease in left frontal	None found	NR	NR	TM stable state between waking and drowsiness
Dillbeck & Bronson (1981) USA	15 Nov (students) (2weeks)	TM Eyes closed vs ECR	NR	Frontal coherence increase	NR	NR	NR	Coherence more sensitive measure than power
Farrow and Hebert (1982) USA	1 LTM (16yrs)	30min TM Eyes closed vs ECR	Button push after “mental quiescence” periods	Power increase during “mental quiescence”	Bursts during “mental quiescence”	Burst following “mental quiet”	NR	Breath suspension and EEG changes mark “mental quiescence”
Badawi (1984) Switzerland	54 STM - LTM (1.5-12yrs) vs 2 control groups	15min TM Eyes closed vs ECR	RS associated with “mental quiescence” by subjective report	Power increase in RS	Power decrease in RS	Power decrease in RS	NR	Global coherence increase in all bands in RS
Gaylord (1989) USA	83 Nov (1 year)	TM Eyes closed vs ECR	NR	Frontal-central coherence increase	Frontal-central coherence increase	NR	NR	No longitudinal change in coherence (poor practice consistency)
Travis and Wallace (1999) USA	20 STM - LTM (1.9-25yr)	10min TM Eyes closed counterbalanced with ECR	NR	Anterior-posterior coherence increase, frontal coherence increase	NR	NR	NR	Coherence better measure of TM than power – “restful alertness” (no change in power)
Rakovic (1999) Yugoslavia	25 STM - LTM (0.2-25yrs) vs 3 control groups	15min TM Eyes closed vs ECR	NR	12 showed slow alpha in temporal.	10 showed power increase, predominantly left frontal	Power increase in prefrontal	NR	Beta ascribed to “increased mental activity”
Travis (2001) USA	30 STM - LTM (0.8-11yr)	15min TM Eyes closed Bell at 5, 10, 15min	Subjective report of state at bell: “transcending” or “other”	“transcending”: alpha power increase, coherence increase	NR	NR	NR	“transcending” state distinct
Hebert (2005) USA	15 Adv (mean 27 years)	TM Eyes closed vs ECR	NR	Increase in alpha phase synchrony primarily anterior-posterior	NR	NR	NR	Long range phase synchrony important for cognitive integration
Travis (2010) USA	19 Nov (10wks)	10min TM “Thinking a mantra” Eyes closed vs ECR	NR	Higher alpha1 power and frontal and parietal alpha1 interhemispheric coherence.	NS	NS	NS	Areas of alpha1 activation overlapped with areas of DMN

Table 5 – EEG Studies from Buddhist tradition

Study	Person	Practice	Phenomenology	Alpha	Theta	Beta	Gamma	Conclusions
Kasamtsu & Hirai (1966) Japan	16 Adv (>20years) 2 other experience groups	Zen Zazen “concentrated regulation of inner mind” without tension Eyes open	Unstructured self-report	Power increase, frequency decrease, moves frontal	Trains in some	NR	NR	Stages: Alpha appears Amplitude increase Frequency decrease, theta trains Correlated with proficiency
Benson (1990) India	2 Adv (>20yrs)	Tibetan Buddhist g <i>Tum-mo</i> Heat generating Eyes not stated vs “rest meditation”	NR	Power increase	No change	Power increase in deep meditation	NR	Beta power increase in deep state
Lehmann (2001) Switzerland	1 Adv	2 min each of five Buddhist meditations visualization, mantra, self-dissolution, reconstruction Eyes half closed	NR	NR	NR	NR	Distinct source locations (LORETA) for different meditations	Different neuronal populations active in gamma for different meditations
Kobota (2001), Murata (2004), Takahashi (2005) Japan	20 students (1 day)	Su-soku (Zen) Counting breath at controlled rate (internalised attention) Eyes open vs regulated breathing	Counting of breath checked	Frontal slow alpha power increase	Frontal fast theta power increase	NR	NR	Alpha power: internal attention, Theta power : mindfulness Independent processes
Lo (2003) Taiwan	2 LTM (9, 11yrs)	40min Zen Buddhist - Attention on Zen chakra “inner light” Eyes closed vs ECR	Button press on seeing “inner light”	Slow alpha	NR	Frontal bursts when “inner light” seen	NR	Low amplitude beta bursts in deep meditation
Faber (2004) Switzerland	1 Adv	3 different 1 Ch’an Buddhist meditations (not described) Eyes half closed	NR	NR	Power increase in all meditations, coherence (LORETA) increased	NR	Power decrease, coherence (LORETA) decreased	
Lutz (2004) USA	8 Adv (15-40yrs) 10 novice controls	Tibetan Buddhist “loving-kindness” Eyes not specified vs ECR	NR	NR	Ratio of gamma to alpha-theta higher in baseline, meditation	NR	Power increase, phase synchrony increase	Gamma power correlated with experience
Huang & Lo (2009) Taiwan	23 STM, LTM (2-12yrs), 23 Novice controls	40min Zen Buddhist -focus on Zen chakra (not described) Eyes closed	Post session questionnaire on feeling, quality and depth of meditation	Frontal power increase	Controls showed power increase	Occipital power increase	NR	Experienced meditators showed generalised beta, controls relaxation
Cahn (2010) USA	16 Adv (mean 20yrs)	Vipassana Scanning of body sensations Eyes closed vs ECR	Post-session rating of depth on 11 point scale	No effect in alpha	Decreased delta power frontal. No effect in theta	No effect in beta	Increased power in parietal/occipital	Vipassana involves enhanced frontal engagement (decreased delta) and enhanced perception (increased) gamma
Yu (2011) Japan	15 Novices (None)	Zen “Tandem breathing” - Slow abdominal Awareness of breath – (FA) Eyes open	Pre and post session rating of mood on 5 point scale (POMS)	Increased alpha activity	Decreased theta activity	NS	NR	Increased prefrontal activity in attention on internal body sensation
Berkovich-Ohana (2011) Israel	12STM: 894hr 12 ITM: 2570hr 12 LTM: 7556hr	15min MM Eyes closed vs cognitive task	Post-session report of successful meditation	NR	NR	NR	Increased right parietal-occipital	MM produces shift from narrative to experiential self-referential processing

Table 6 – EEG Studies from other traditions

Study	Person	Practice	Phenomenology	Alpha	Theta	Beta	Gamma	Conclusions
Zhang et al (1988) China	7 Adv (10- 47yr)	10 min Qigong Eyes closed vs ECR	NR	Increased alpha in anterior, reduced in posterior, shift from alpha2 to alpha1	NS	NS	NS	Qigong differs from ECR
Pan (1994) China	50 Nov, STM, LTM (3mth- 12yr)	Concentrative and non-concentrative Qigong Eyes closed vs ECR	NR	Increased power	Rhythmic theta trains in frontal in some	NR	NR	Frontal midline theta more frequent in concentrative than non-concentrative Qigong
Dunn (1999) USA	10 students (5weeks)	15min CM: breath awareness 15min MM: observing attention Eyes closed vs ECR	Rating of depth on 10 point scale at variable intervals Post-session validation of state	CM: more central/posterior power than MM	MM: more frontal power than CM	MM: more beta1 power than CM	NR	MM and CM differ from each other and from relaxation.
Chan (2008) Hong Kong	19 students (None)	TBRT (audio tape) Mindfulness - attending to thoughts Eyes closed vs music	NR	Left frontal power increase for both TBRT and music	TBRT frontal midline power increase – generator: ACC	NR	NR	Frontal midline theta – internalised attention, left frontal alpha – positive emotion

LEGEND: Adv = Advanced (>20 years); LTM =Long term meditator (5-20years); STM = Short term meditator (1-5 years); Nov = Novice (<1year).

Blue: Self-report (Phenomenology); Green: Alpha band result; Orange: Theta band result; Purple: Beta band result; Red: Gamma band result; NR = Not reported; NS: Not significant; ECR = Eyes Closed Rest; TM = Transcendental meditation; CM = Concentration meditation; MM = Mindfulness meditation; FA= Focused attention; TBRT = Triarchic body-pathway relaxation technique; ACC = anterior cingulate cortex; R = Relaxation; RS = Respiratory suspension; POMS = Profile of Mood States.

Table 7 - Neuroimager studies of meditation states – all traditions

Study	Person	Practice	Phenomenology	Sub-gyral	Frontal	Temporal	Parietal	Occipital	Conclusions
Herzog (1990) Germany PET (CBF)	8 STM (>1yr)	Yoga Meditation: Eyes open focus on “central point of power” vs EOR	Self-report: “Relaxation, peace and detachment”	NR	+3%	NR	-6%	-10%	Bilateral increase in CBF in anterior, decrease in posterior regions
Jevning (1996) USA REG (CBF)	18 LTM (8-12yr) 16 Nov	TM Eyes closed vs ECR	Self-report: increased alertness	NR	+ 17%	NR	NR	+20%	Increased CBF in frontal, occipital consistent with subjective report
Lou (1999) Denmark PET (CBF)	9 LTM (>5yr)	Yoga Nidra (guided meditation) Eyes closed vs ECR	Post-session validation						
			Body sensations	LPaHG	RSFG, RIFG	NR	LPoCG, BSPL	RSOG, BLG	SMA activation
			Abstract sense of joy	BPaHG	LIFG	RMTG, LSTG, LITG	BPoCG	RSOG	Mostly left activation
			Visual imagery	BPaHG, RFuG			BPoCG	BIOG	Visual cortex
			Sense of self				LIPL (40), RSPL (7), LPoCG (3)	Bilateral parietal role in bodily representation	

Lasar (2000) USA fMRI	5 LTM (>4yr)	Kundalini yoga mantra with breath Eyes not stated vs list of animals	NR	ACC (24) Midbrain LPaHG (35)	NR	NR	NR	NR	Meditation activates structures for attention, and arousal		
		Late vs early stage	NR		LSFG (8), LMFG (9), RMFG (10) RPrCG (4)	RSTG (39), RMTG (21)	BSPL (7) LIPL (40) LPoCG (3)	NR	Extended meditation enhances activation in many structures		
Baerentsen (2001) Denmark fMRI	5 LTM (7-23yr)	Unspecified Eyes not stated vs Rest	NR	ACC (24)	LFG (11) LPCG(4)	RMTG(21) LMTG(22)	LIPL(40)	Deactivation in ROG (17, 18, 19)	Predominantly frontal system in start of meditation		
Newberg (2001) USA SPECT	8 LTM (>15yr)	Tibetan Buddhist: visualized image Eyes closed vs ECR	NR	ACC, Th	PFC, IFG OFG	Deactivation LITG	Deactivation BSPL		Activation of frontal lobes, deactivation in parietal = altered sense of space		
Lehmann (2001) Switzerland LORETA	1 Adv Buddhist Lama (>30yr)	Tibetan Buddhist: visualizing Buddha, mantra, self-dissolution, self-reconstruction	Post-session validation						Visual imagery, right posterior		
			Visualisation vs verbalisation								
			Verbalization vs visualisation	LIns							Linguistic, left anterior
			Self-dissolution vs verbalisation		RMFG(6)						Right prefrontal cortex involved in self-consciousness
		Self-reconstruction vs verbalisation				RMTG(21)			Areas for body schema		
Ritskes (2003) Denmark fMRI	11 LTM-Adv (15-25yr)	Zen –counting breath vs random thoughts	Self-report validating state attainment	Deactivation ACC (32)	RMFG (10)			Deactivation SOG	Decreased ACC and occipital – loss of sense of self		
Holzel (2007) Germany	15 LTM (2-16yr) and 15 controls	Vipassana (breath awareness) Eyes closed vs mental arithmetic Eyes open	Self-report and rating of attention and distraction	Meditators greater ACC	Meditators greater MPFC				Greater expertise in attention regulation associated with ACC activation and emotional regulation with MPFC		
Brefczynski-Lewis (2007) USA fMRI	14 Adv (10000 - 54000 hr) 16 Nov (1 wk)	Tibetan Buddhist: visual focus Eyes open vs EOR	NR		LMFG (45, 46) LPrCG(6) LRG(11)	LMTG(20, 21) RMTG (21,22)	RSPL(7) LIPL(7)	RCu(17)	LTM less effortful concentration than novices		
Lutz (2008) USA fMRI	16 Adv (10000-50000hr) vs 16 Nov	Tibetan Buddhist “loving-kindness” Eyes open	Post-session rating of intensity. “compassion” on 10 point scale		BMFG LPrCG RIFG	BSTG, BMTG	RAG, RSuMG, RIPL LPoCG	PC	Expertise associated right temp-parietal junction and right inferior frontal gyrus		
Cohen (2009) USA	4 Novice	Pre and post 12 weeks Iyengar Yoga, relaxation meditation vs baseline Eyes closed	NR		RDMFG RIFG RSFG				Higher overall activation in right hemisphere compared to left during meditation		
Travis (2010) USA eLORETA	38 Nov (10wks)	TM Eyes closed vs ECR	NR		Higher frontal alpha power		Higher parietal alpha coherence		TM activation areas overlap with DMN, related to self-referential experience		
Ott (2010) Germany fMRI	10 Nov, 10 STM (4.5yr) 10 LTM	Sensations at nostrils (mindfulness) vs mind wandering Eyes not stated	NR	Deactivation PCC (posterior DMN)	Deactivation of MFC (anterior DMN) decrease				Both DMN reduced in mindfulness, anterior suppressed more by experienced		
Manna (2010) Italy fMRI	8 Adv Buddhist monks (15750hr) vs 8 novices	6 min Samatha (FA) Eyes closed	Post-session validation of state FA: focus on breath at nostrils vs ECR	Deactivation LIns (13) Activation BACC(24)	Deactivation RIFG(46) Activation RMFG(10)	Deactivation LTTG		Deactivation LPC (7)	Associated with right medial frontal and reduced left lateral prefrontal.		
		6 min Vipassana (OM) Eyes closed	OM: mindfulness vs ECR		Activation LMFG(10)	Activation LSTG(22)	Activation LSPL/LP (7)		Resembled ordinary resting state, associated with bilateral prefrontal activation		

Wang (2011) USA Perfusion based fMRI	10 Adv Kundalini (>30yr) (20000hr)	“focus-based” sounds/finger vs counting to 4	Ratings of stress, depth, connectedness on 11 point scale	Increased CBF: LCau	Increased CBF: BMPFC		Decreased CBF: LIPL	Decreased CBF: LSOG, RIOG	Activates forebrain areas
		“breath-based” Exhale/sounds vs counting to 4 Eyes not stated		Increased CBF: BIns, LPaH		Increased CBF: LSTG	Decreased CBF: LSPL	Decreased CBF: LAG, RMOG	Activates deeper limbic structures
Travis (2011) eLORETA	26 Adv (mean 25 years)	10 min TM vs TM-Siddhi	“pure consciousness” vs “connecting aspects of personality to pure consciousness”	Higher alpha1 and beta1 power in TM-Siddhi vs TM in R PaHG		Higher alpha1 and beta1 power in TM-Siddhi vs TM in R FuG (37), RITG (20) RMTG (21)			Single meditation practice may incorporate a number of effects.
Lavallee (2011) sLORETA	7 STM (mean 4 years) vs controls	15 min concentration on breath	NR	Increased beta1 in ACC (33), beta3 in left precuneus (31)			Decrease in gamma in right IPL (40)		Results overlap with DMN, but distinct from TM findings

LEGEND

Study: PET = Positron emission tomography, CBF = Cerebral blood flow; REG: Rheoencephalography; fMRI = Functional magnetic imaging; SPECT = Single photon emission computed tomography; LORETA: Low resolution Electromagnetic Tomography;

Person: Adv = Advanced (>20 years); LTM = Long term meditator (5-20years); STM = Short term meditator (1-5 years); Nov = Novice (<1year);

Practice: Orange: Yoga studies; Light orange: TM studies; Green: Buddhist studies

EOR: Eyes open rest; ECR: eyes closed rest; TM: Transcendental Meditation; MBSR = Mindfulness based stress reduction; NDE: Near death experience; FA: Focused attention; OM: Open monitoring;

Phenomenology: Light blue: self-report; NF = narrative focus; EF = experiential focus

Brain regions: Yellow: frontal; Red: temporal; Green: parietal; Dark blue: occipital; L = Left; R = Right; B = Bilateral; PoCG = Postcentral gyrus; PrCG = Precentral gyrus; SPL = Superior parietal lobule; SOG = Superior occipital gyrus; MOG = Medial occipital gyrus; LG = Lingual gyrus; SMA = Supplementary motor area; PaH = Parahippocampal gyrus; IFG = Inferior frontal gyrus; MTG = Middle temporal gyrus; STG = Superior temporal gyrus; ITG = Inferior temporal gyrus; IOG: Inferior occipital gyrus; FuG = Fusiform gyrus; IPL = Inferior parietal lobule; Ins = Insula; ACC = Anterior cingulate gyrus; OFG = Orbital frontal gyrus; Th = Thalamus; PFC = Prefrontal cortex; dmPFC = dorsomedial prefrontal cortex; Cu = Cuneus; AG = Angular gyrus; SuM = Supramarginal gyrus; PC = Precuneus; ParOp = Parietal Operculum; TTG = Transverse temporal gyrus; PCC = Posterior cingulate cortex; DMN = Default mode network; Cau = Caudate

Numbers in parentheses - Brodmann Areas – see Figure 5 for location

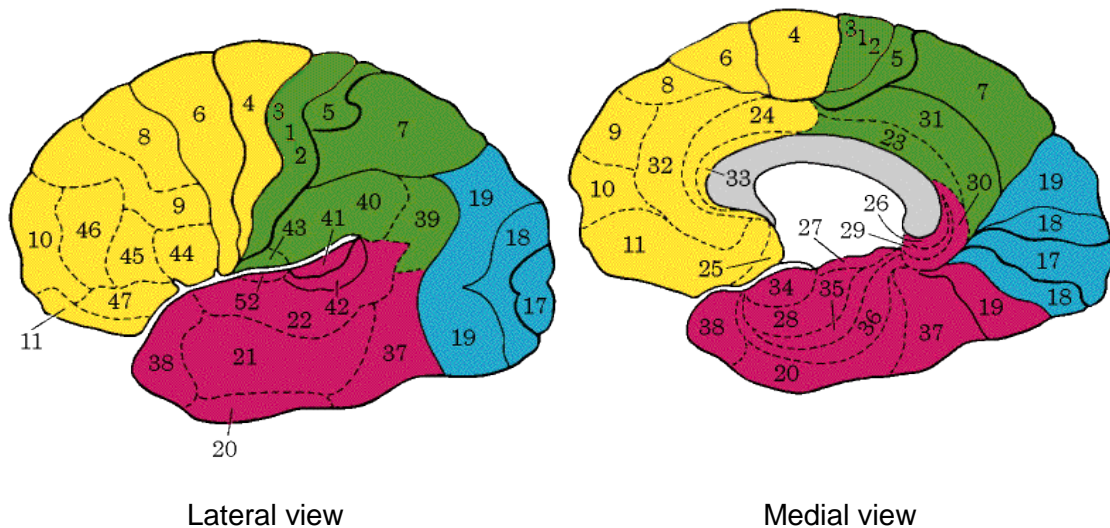
Table 8 - Studies of meditation “traits” – comparisons of non-meditation states

Study	Person	Practice	Phenomenology	Sub-gyral	Frontal	Temporal	Parietal	Occipital	Conclusions
Farb (2007) Canada fMRI	20 Nov (8 wks MBSR) vs 16 no training	Narrative focus vs Experiential focus Eyes open	Post session rating of state		NF: BMFG (8/9/10) LPFC (44/45) RIFG (47) RPrCG (4) EF: RPF (45/46)	NF: LMTG (21)	EF: LIPL (39)	NF: BCu (19)	NF: Consistent with verbal mediated mode EF: Suppression of left frontal, increase in right frontal/parietal
Holzel (2008) MRI	20 LTM (mean 8years) Vipassana vs controls	NR	NR	Higher grey matter concentration in R hippocampus , R insula		Trend to higher grey matter in left inf temp gyrus			Grey matter conc in left temporal correlated with hours of training R Insula involved in interoception awareness (mindfulness)
Tei (2009) Japan LORETA	10 LTM Qigong (mean 11.5 years) vs controls	EOR/ECR	NR	Stronger delta in ACC (BA32)	Stronger delta in prefrontal (9, 10, 11, 44, 45, 46, 47) Weaker delta in BA4, 6	Weaker delta in left BA22, 39, 40		Weaker delta in BA18, 19	Greater inhibition of appraisal systems (higher delta) related to detachment. Activation of temporo-parietal junction (weaker delta) related to experience of body in space
Tang (2009) China SPECT	20 Novice (5 days IBMT) vs 20 relaxation	Resting state	“forgetting my body or myself”	Increased activity in ACC (32, 25), PCC, left insula				Increased activity in right precuneus	Increase in DMN activity
Cohen (2009) USA	4 Novice (12 weeks Iyengar Yoga)	Pre and post comparison of baseline Eyes closed rest	NR	Increased activity in ACC	Dorsal MFG	STG			Increased left sided activity in baseline following training
Newberg (2010) USA SPECT	12 LTM (>15 years focus based practices) vs controls	ECR	NR	Higher CBF in thalamus, putamen, caudate, cerebellum, brainstem, left insula	Higher CBF in prefrontal cortex	Higher CBF in inferior temporal	Higher CBF in parietal		Long term meditation results in higher activity in midline frontal area. Contrary to hypothesis, higher baseline parietal activity found.
Kilpatrick (2011) USA fMRI	12 Nov (8wks MSBR) vs 8 controls	Mindful awareness of sound in MRI Eyes closed	MAAS questionnaire prior to scan Mindful awareness	L(30)	RdmPFC (9, 32)		LParOp	L(17)	Increased functional connectivity in auditory/salience and medial visual networks, greater reflective awareness of sensory input
Jang (2011) Korea fMRI	35 STM (mean 40mths BWV) vs controls	Resting state in darkness Eyes not specified	NR		Meditators showed heightened connectivity in MPFC (DMN)				Meditation may result in neuroplasticity changes in DMN from practice in inhibiting mental rumination

LEGEND

Adv = Advanced (>20 years); LTM = Long term meditator (5-20years); STM = Short term meditator (1-5 years); Nov = Novice (<1year);
 SPECT = Single photon emission computed tomography; IBMT = Integrative body-mind training; CBF = Cerebral blood flow; BWV = Brain-wave vibration meditation;
 NR = Not reported;
 MPFC = Medial prefrontal cortex; DMN = Default mode network
Numbers in parentheses - Brodmann Areas – see Figure 5 for location

Figure 5 – Location of Brodmann areas



LEGEND: Brodmann area locations:

LOBES: Yellow: Frontal, Green: Parietal, Red: Temporal, Blue: Occipital

MajorFunction	Brodman Area
Vision	
primary	17
secondary	18, 19, 20, 21, 37
Audition	
primary	41
secondary	22, 42
Body Sensation	
primary	1, 2, 3
secondary	5, 7
Sensation, tertiary	7, 22, 37, 39, 40
Motor	
primary	4
secondary	6
eye movement	8
speech	44
Motor, tertiary	9, 10, 11, 45, 46, 47

From (Kolb & Whishaw 2003) (p66)

5.2.1 Review of studies from the Yoga tradition

5.2.1.1 Effect of proficiency

Yoga meditation practices vary widely, but the most commonly studied have been ‘concentrative’ or ‘focused attention’ meditations, where the focus is on mental repetition of a mantra, sometimes combined with breath awareness.

Two Indian EEG studies with practitioners with short-term meditators (less than five years’ experience) found power increases in the alpha (8-12Hz) band in different forms of

'concentrative' practice (Ghista et al. 1976; Khare & Nigam 2000) compared to matched control subjects. The former study used Ananda Marga 'intuitional practice' of concentration on *chakra* and mantra, and the latter used both TM and a 'concentrative' form of Yoga meditation.

Some studies of short-term (1-5 years) meditators reported power increases in the theta band in addition to alpha, compared to controls in 'concentrative' practices. Two studies of Ananda Marga mantra meditation (Elson, Hauri & Cunis 1977; Corby et al. 1978) found the amount of theta activity increased with meditator proficiency. Midline frontal theta was found to correlate with proficiency in the 'bliss' and 'thoughtless awareness' states of Sahaja Yoga meditation (Aftanas & Golocheikine 2001; Aftanas & Golosheikin 2003). A recent study of Sahaja Samadhi meditation (attention on breath and mantra) found increased theta in midline frontal regions but decreased theta in left parietal and occipital areas (Baijal & Srinivasan 2010). The authors suggest the increased frontal theta activity is associated with attentional processing and the decreased posterior theta activity with suppression of distracting input from the environment, leading to a sense of 'timelessness'.

Although the role of theta band oscillations in meditation is yet to be fully explained (Baijal & Srinivasan 2010), frontal midline theta activity is believed to originate in the anterior cingulate cortex (Burgess & Ali 2002) and has been found to correlate negatively with activity in the default mode network (DMN) (Scheeringa et al. 2008).

There have been very few EEG studies of Yoga meditation states with advanced or long-term practitioners. The early field studies of advanced Yoga meditators in India (Anand 1961; Wenger & Bagchi 1961) provide little useful information, beyond reports of increased alpha band activity in unspecified 'concentration' or '*samadhi*' meditation practices. The level of proficiency is uncertain, no subjective reports were obtained and the EEG data was obtained on portable equipment with unknown frequency acquisition. Of interest, though, is the observation by Wenger and Bagchi (1961) that some subjects were 'bothered by the apparatus' and did not achieve their deepest meditation states. The only other study of an advanced Yoga meditator (Arambula et al, 2001) is also of limited value, the EEG being recorded from only two electrodes (O2 and P4) and the signal filtered for results only in alpha (7-13Hz) and theta (3-7Hz). The meditation practice was not described, but slower abdominal breathing during the practice was associated with the increase in alpha activity. The authors speculated that the theta activity observed following meditation may be associated with pleasurable activity.

The exploratory EEG study by Ott (2001) of a mixed group of 10 TM and 2 Yoga meditators with a mean of 17 years' experience had the limitations of recording from only one electrode (Cz) and the signal filtered to display only the gamma range (36-44Hz). The form of meditation practiced by the Yoga participants was not described. The lack of significant differences between conditions and groups was attributed to the possible rarity of attaining deep meditation in a laboratory setting and the possible limited expertise of 'Western' meditators. The multi-dimensional nature of 'meditation depth' was explored.

5.2.1.2 Effect of type of practice

There have been only a few studies of Yoga meditation in which the same participants practised a number of meditations. The relaxation/meditation Yoga Nidra (a Satyananda Yoga practice, see Appendix 7b for details) is a guided meditation with a number of distinct stages. A combined EEG/PET study (Lou et al. 1999) with practitioners of more than 5 years' experience found increased theta band (4-8Hz) power in all stages of Yoga Nidra, but with different locations of neural activation for different stages. Awareness of body sensations was found to activate the supplementary motor area (SMA) as well as parietal and superior frontal regions; sensations of joy activated the left hemisphere parietal and occipital activation; and visual imagery the visual cortex and parietal regions. The authors speculate that the lack of prefrontal and anterior cingulate cortex (ACC) activation (expected in a focused attention practice) may be due to the guided (lower volitional) nature of the meditation. Interpretation of the findings, however, is compounded by the inclusion of two hours of intensive Kriya Yoga prior to the Yoga Nidra practice. In contrast to the study of Yoga Nidra, an EEG investigation of concentrative meditation (attention focused on the breath and mental repetition of a mantra) (Bajjal & Srinivasan 2010) did report increased theta band activity in right and left frontal- central regions, including the ACC, in meditators (3 to 7 years' experience) compared to eyes closed rest (ECR) (Bajjal & Srinivasan 2010).

An fMRI study compared Kundalini Yoga meditation (breath awareness and mental mantra repetition) with a control state of mentally generating a list of animals (Lazar 2000) using meditators with at least four years' experience. The contrast showed increased activation in neural structures involved in attention (frontal and parietal cortex), arousal (ACC, amygdala, and hypothalamus) and pre- and post-central gyri. Activity in frontal (left Brodmann Area 8, 9, right BA10), parietal (left BA7, 40, right 39) and temporal (right BA21) cortices increased during the course of the meditation (last 2 minutes compared to first 2 minutes of 12 minute meditation). The authors suggest the differences from previous studies may be attributable to different meditation practices and an active control condition in place of ECR.

The first direct comparison of two different Yoga meditation practices ('focused-based' and 'breath-based') with advanced Western meditators (more than 30 years' experience) was conducted only recently (Wang et al. 2011). The 'breath-based' meditation compared to the 'focused-based' showed greater cerebral blood flow primarily in deeper limbic and forebrain structures in the left hemisphere, as well as left insula/inferior frontal/superior temporal cortex and the right superior temporal cortex. The 'breath-based' meditation, being less 'focused' also showed less activation in the medial prefrontal cortex/anterior cingulate cortex. Decreased activity was observed in parietal areas (left inferior in the 'focused' meditation and the right superior in the 'breath-based' meditation), the latter practice being subjectively rated as involving more intense 'feelings of connectedness'.

5.2.1.3 Phenomenological measures

Only a few studies included subjective ratings of dimensions of the meditation state. Corby et al (1978) found subjects of different levels of proficiency produced similar ratings on a 10 point scale of 'meditation quality', which correlated negatively with skin conductance, but not EEG results. Aftanas and Golosheikin (2001) used 10 point scale ratings of 'mental activity' and 'positive emotion', finding that the former correlated negatively and the latter positively with frontal theta power.

The fMRI study of Kundalini Yoga by Wang et al (2011) obtained subjective ratings (on an 11 point scale) of 'stress', 'meditation depth' and 'feelings of connectedness'. Stress ratings correlated negatively with meditation 'depth' and 'connectedness', the latter two being positively correlated. The increased blood flow in common areas of activation in the two meditations (left insula, inferior frontal, superior temporal cortex) correlated positively with meditation 'depth'.

5.2.1.4 Summary of Yoga meditation state studies

In summary, there are few firm conclusions with regard to proficiency in Yoga meditation. EEG studies with short-term (less than 5 years' experience) Yoga meditators found an increase in alpha power and increased midline theta band power associated with greater proficiency (Aftanas & Golosheikin 2003; Baijal & Srinivasan 2010) and suggestions of a negative correlation with DMN activity (Scheeringa et al. 2008). A negative finding has been reported so far gamma band activity (Ott 2001), although most studies did not investigate this band.

The neuroimaging studies suggest that 'concentrative' forms of meditation (focus on a mantra) are associated with increased activity in neural networks in the frontal cortex and the

ACC. Decreased activity in parietal regions has been found in both 'concentrative' and 'relaxation' types of meditation, associated with a reduced 'sense of self' and loss of awareness of bodily space. However, increased parietal activity was reported in the guided 'relaxation' Yoga Nidra meditation (with attention directed to bodily sensations) (Lou et al. 1999), and parietal activity also increased with the duration of a 'concentrative' practice (possibly related to a heightened 'sense of self') (Lazar 2000).

Positive correlations were found between subjective measures of meditation "depth" and both EEG power (Aftanas & Golosheikin 2003) and cerebral blood flow (Wang et al. 2011) in meditation states.

5.2.2 Review of studies from the Transcendental Meditation (TM) tradition

Studies undertaken by proponents of TM meditation have been prolific and have the advantage of a single, simple mantra-based practice. However, rather than being a 'concentration' practice, awareness of the TM mantra is reportedly only used for sound value and becomes "spontaneous" and "automatically self-transcending", leading to "pure, content-less awareness" (Travis & Shear 2010; Travis 2011). Significant changes in brain activity are said to occur "after a few months practice" and to be evident in the first minute of performing the meditation (Travis, Haaga & Hagelin 2010).

Most of the early TM EEG studies were conducted with practitioners with less than 10 years' experience. The most frequent findings were power and coherence increases in the alpha band, generally located in frontal regions, interpreted as indicative of the "transcending" experience (Travis 2001). However, a study by non-TM affiliated researchers (Morse et al. 1977) found similar slow alpha band results were obtained for relaxation and hypnosis. TM studies attributed bursts of theta power to suspension of respiration (Badawi et al. 1984), associated with the experience of 'mental quiescence' (Farrow & Hebert 1982). A few studies found the effect extending into the beta band (Farrow & Hebert 1982; Rakovic 1999). One early TM study (Banquet 1973) also found power increases extending into the gamma band. The one TM study with advanced practitioners (Hebert et al. 2005) found long range anterior-posterior phase synchrony in the alpha band in the form of "travelling waves". The results were interpreted by the authors as indicating a reduction in 'content' of consciousness and a shift to "self-referential" activity.

Some innovative recording of phenomenology in meditation states has been included in TM studies. Banquet (1973) used a 5-signal push-button for subjects to indicate: body sensation,

involuntary movement, visual imagery, deep meditation and “transcendence”. The signaling of ‘deep meditation’ was characterised by beta band activity. Other TM studies used coding related to TM concepts: a button push after each experience of ‘pure consciousness’ (Farrow & Hebert 1982) showed a relationship with breath suspension; a classification of state immediately preceding a bell into “transcending” or “other” experiences (Travis 2001).

Only a few neuroimaging studies of TM meditation have been conducted. A cerebral blood flow (CBF) study of long-term TM meditators (Jevning et al. 1996) found significant increases in frontal and occipital regions, indicative of increased alertness and distinct from stage 1 sleep. An eLORETA study with naïve subjects randomly assigned to 10 weeks TM training or a control group (Travis, Haaga & Hagelin 2010) found significant differences between the groups in TM compared to eyes closed rest (ECR). The TM group showed the expected higher alpha1 (8-10Hz) power and parietal alpha1 inter-hemispherical coherence. In contrast, beta1 (13-20Hz) and gamma (30.5-50Hz) power frontal power was lower in TM, with an increase in beta2 (20.5-30Hz) coherence attributable to an eyes-closed effect.

The cortical sources of alpha1 were reported to be located in the cingulate and precuneus networks, overlapping the midline circuits of the Default Mode Network (DMN). As higher activity was found in DMN networks during TM than in ECR (usually associated with self-referential day-dreaming), this was interpreted by the authors as indicating TM differed from “mind-wandering” and was a “foundational” self-aware state of content-less thought.

In summary, the findings of TM studies have found results mainly in the alpha band, with evidence of bilateral and anterior-posterior synchrony. Enhanced alpha activity found during TM in networks overlapping with the DMN suggests a complex relationship of the DMN to meditation (Travis, Haaga & Hagelin 2010).

5.2.3 Review of studies from the Buddhist tradition

5.2.3.1 Effect of proficiency

Similar to Yoga meditation, Japanese EEG studies of Zen meditations with novice practitioners (Kubota et al. 2001; Murata et al. 2004; Takahashi et al. 2005; Yu et al. 2011) found increases in frontal alpha power. While the first three studies of So-soku (breath counting) reported increases in theta activity, the study by Yu et al (2011) of slow abdominal breathing found decreased theta activity.

More EEG studies with advanced practitioners (more than 20 years’ experience) have been conducted with Buddhist meditators than those from other traditions. An early study of 48

Japanese Zen priests and disciples, with a range of experience from novice to advanced (Kasamatsu & Hirai 1966) found a relationship between proficiency and EEG in Zazen, an eyes-open sitting meditation. The novices showed changes in alpha, while the advanced priests exhibited rhythmical theta trains. An EEG field study of two Tibetan Buddhist monks (Benson et al. 1990) also found power increases in alpha, but with effects extending into the beta band in 'deep' meditation.

The first study to record gamma band activity in meditation was a case study of an advanced Diamond Way Buddhist Lama (Lehmann et al. 2001) using EEG-derived Low Resolution Electromagnetic Tomography (LORETA). A study of advanced Tibetan Buddhist monks (Lutz et al. 2004) and more recently, advanced Western Vipassana practitioners (Cahn, Delorme & Polich 2010) also reported significant increases in gamma band power in meditation compared to ECR. The Lutz et al (2004) study of "loving-kindness" meditation found relative gamma power (in relation to slow frequencies, theta and alpha), absolute gamma power and long-distance gamma phase synchrony was higher in meditators than non-meditators and the size of the increase was positively correlated with meditator proficiency.

The Cahn et al (2010) EEG study of Vipassana meditation (scanning body sensations) found increased parieto-occipital gamma (35-45Hz) power, greatest for meditators with more than ten years' experience. In addition, they reported increased frontal theta (4-8Hz) power and decreased bilateral frontal delta (1-4Hz) power. The authors suggest the reason for the posterior location of the gamma activity is unclear but may be specific to the particular practice. As with the previous study, the meditation state gamma increases covaried with meditator expertise. The synchronised activity in the gamma range in advanced meditators has been seen by Fell et al (2010) as highly relevant for neural plasticity and the processes for 'cortical restructuring', associated with specific 'meditation-related states of consciousness'.

Although generation of gamma band activity is associated with "*local binding of cell assemblies into synchronously firing neural sets*" (Ott 2001), its integration and synchronisation across the cortex may be assisted by theta band oscillations and its 'signal to noise ratio' improved by the inhibitory effect of low frequency band oscillations. Functional connectivity in the subjective memory states of "recollection" and "familiarity" in the gamma band was found to vary over time and to be modulated by theta band activity (Burgess & Ali 2002). Burgess and Ali speculate that functional connectivity in gamma is "ultimately derived from hippocampal-neocortical interactions", with a critical pathway through the anterior cingulate cortex (considered a likely source of midline frontal theta).

However, an fMRI study of advanced Theravada Buddhist monks (Manna et al. 2010) found no proficiency-related effects for Vipassana meditation, but reported that increased activity in the left anterior insula (BA13) in a 'focused attention' practice (Samatha) correlated positively with proficiency.

The role of proficiency was addressed in detail in a recent EEG study of mindfulness meditation (a Buddhist-derived practice aimed at "cultivating a non-judgmental awareness of the internal and external stimuli present in each moment") (Berkovich-Ohana, Glicksohn & Goldstein 2012) (p1). This study used three levels of proficiency: short-term (mean 900 hours), intermediate-term (mean 2570 hours) and long-term (7555 hours). Gamma (25 - 45Hz) power was higher in the meditation compared to ECR in frontal-midline regions. In contrast to previous reports of a positive relationship between proficiency and gamma power, the study reported that meditator expertise did not affect the increase in meditation state gamma. The authors suggest a shift in self-reference processing in the DMN from a 'narrative' to 'experiential' focus occurs both as a 'state' during meditation practice and as a 'trait' acquired in the range of hundreds of hours of formal mindfulness practice.

In contrast, an fMRI study of Tibetan Buddhist "one-pointed concentration" meditation using a visual focus found advanced practitioners compared to novices showed an "inverted U-shaped function" for proficiency in relation to brain activity. In agreement with traditional texts, the authors found 'experienced' meditators (with a mean of 19,000 hours practice) showed greater activation in attention-related brain regions than both novices (no experience) and 'advanced' meditators (with a mean of 44,000 hours) (Brefczynski-Lewis et al. 2007).

5.2.3.2 Effect of type of practice

As with Yoga meditation, there are only a few studies directly comparing different Buddhist meditations. The Lehmann et al (2001) case study found different locations of the cortical source generators of EEG activity for five phenomenologically distinct meditations, interpreted as evidence that "altered states of consciousness are associated with different patterns of brain activation depending on the content of consciousness" (p117). Of interest are the comparisons 'mantra' versus 'visualisation' which showed more gamma activity in the left insula, and the reverse comparison showing more gamma activity in the right middle temporal gyrus.

The Manna et al (2010) fMRI study of advanced Theravada Buddhist monks found the brain activity patterns in the 'open monitoring' (OM) practice (Vipassana) "resembled their ordinary resting state", but sharply contrasted with brain activity in the compared to the 'focused attention' (FA) practice (*Samatha*). The authors concluded that FA meditation is "associated with enhanced (predominantly right) medial frontal (BA10) (together with bilateral ACC activation) and reduced (predominantly left) lateral prefrontal activation". OM meditation, compared to FA, is "characterised by a lateral prefrontal activation in both hemispheres, with a more subtle differentiation in medial frontal activity" (p52). In addition, the left precuneus (BA7) was deactivated in FA and activated in OM, with the suggestion it may act as a 'neural switch' from resting to attentional meditation.

5.2.3.3 Phenomenological measures

Cahn et al (2010) found no reliable correlation between self-reported ratings (on an 11 point scale) of 'meditation depth' and either years of practice or hours of daily practice. Ratings of 'meditation depth' did not correlate with EEG results in any frequency band. However, the study by Berkovich-Ohana et al (2011) did find a positive correlation between subjective ratings (on an 11 point scale) of 'meditation depth' and EEG frontal gamma power. Subjective ratings (on an 11 point scale) distinguished meditators from controls on dimensions of attention to task, less difficulty and less boredom.

5.2.3.4 Summary of Buddhist meditation state studies

Similar to Yoga and TM findings, novice Buddhist practitioners showed effects mainly in the alpha and theta bands (Kubota et al. 2001; Murata et al. 2004; Yu et al. 2011). In distinction, advanced Buddhist meditators have shown significantly enhanced power in the gamma band, across a range of Buddhist traditions and practices (Lehmann et al. 2001; Lutz et al. 2004). Gamma activity and brain area activation patterns have been interpreted as indicating an "inverted U-shaped function" of proficiency (Brefczynski-Lewis et al. 2007), although Berkovich-Ohana et al (2011) found only a 'trait' effect, attained with minimal expertise.

FA meditations have been associated with activation in right medial frontal and ACC activation, as well as the left insula. The left precuneus, activated in OM meditation, has been suggested as a 'neural switch', turning on meditative attention networks (Manna et al. 2010).

One study found a correlation between subjective ratings of 'meditation depth' and EEG power (Berkovich-Ohana, Glicksohn & Goldstein 2012), but another did not find a relationship (Cahn, Delorme & Polich 2010).

5.2.4 Review of studies from other traditions

Two studies of Qigong (Zhang, Jing & He 1988; Pan, Zhang & Xia 1994), one with Triarchic Body-pathway Relaxation Technique (TBRC) (Chan, Han & Cheung 2008) and an experimental study (Dunn, Hartigan & Mikulas 1999) found meditation effects mostly in the alpha-theta range, with some differentiation of locality with different practices.

5.2.5 Effect of meditation on ‘sense of self’

5.2.5.1 Meditation state effects

A number of studies have reported changes in the ‘sense of self’ during meditation practice. Activity in the parietal-temporal lobes associated with the awareness of the spatial distribution of the body seems implicated in this alteration in the experience of ‘self’. In the Yoga tradition, the Lou (1999) study of Yoga Nidra with long-term meditators found the abstract “perception of the self: symbolized as a golden egg” was supported by activity in bilateral parietal lobules (left inferior, right superior) and the left postcentral gyrus. This state may induce a heightened, although abstract ‘sense of self’.

Newberg et al (2001) hypothesised there would be a relative decrease in activity in superior parietal regions (associated with an altered experience of space) during meditation. In their SPECT study of long-term Tibetan Buddhist meditators engaged in a visual concentration practice, they found an interaction between decreased superior parietal activity and increased left prefrontal activity that was associated with spatial processing. In a later theoretical paper (Newberg et al. 2003) the authors suggest the role of the posterior superior parietal lobule (PSPL) in generating a three-dimensional image of the body in space may be “critical for distinguishing between the self and the external world”, perhaps in conjunction with altered activity in the temporal lobes. The deactivation of the PSPL would result in a reduced, less ‘body-bound’ sense of self.

In an EEG study of Yoga concentration (mantra) meditation with short-term meditators, Bajjal and Srinivasan (2010) also found increased frontal activity coupled with decreased activity in left parietal-occipital regions, primarily in the theta band. The authors argue that if theta power is associated with enhanced attentional processing, then decreased theta power indicates reduced left parietal processing of temporal and spatial information. This may result in “experiences of timelessness, reduced awareness of one’s surroundings, and peacefulness”, potentially leading to “feelings such as the unity with the self and/or nature”.

Temporal lobe involvement was found in the comparison between a Buddhist 'self-dissolution' meditation, described as "experience of dissolution of the self into a boundless unity (emptiness)" and a 'self-reconstruction' meditation, described as "experiencing the reconstruction of the self" (Lehmann et al. 2001). The location of the comparison 'self-dissolution' versus 'self-reconstruction' was the right superior frontal gyrus (BA6) but for 'self-reconstruction' versus 'self-dissolution' the locus was the right middle temporal gyrus (BA21). The locations for these meditations were more right than for the 'mantra' meditation and more anterior than for the 'visualizing' meditation. The involvement of the right prefrontal cortex in the experience of 'self-dissolution' was noted also to occur in disorders of depersonalization, while the more posterior location of 'self-reconstruction' may involve body schema functions.

A recent study of functional connectivity between brain regions (using LORETA) of experienced meditators from five different traditions (Tibetan Buddhist, Qigong, Sahaja Yoga, Ananda Marga Yoga and Zen) found reduced connectivity in all meditations compared to ECR, particularly in the delta (1.5-6Hz) and beta2 (18.5-21Hz) bands (Lehmann et al. 2012). The observed reduction in cooperative interaction between brain regions was interpreted in relation to subjective changes in the 'sense of self': the curtailing of processing of information coming from other processes leads to a subjective experience described as "non-involvement, detachment and letting go". As well, the 'self' is deprived of information about its internal and external environment, leading to a subjective experience of "expansion of consciousness, dissolution of ego borders and all-oneness".

5.2.5.2 Meditation 'trait' effects and the DMN

The repeated experience of an altered 'sense of self' during meditation practice is postulated to produce enduring 'trait' or neuroplasticity changes beyond the meditation session. Farb et al (2007) found the 'narrative focus' (NF) 'sense of self' was associated with activation of midline prefrontal regions (ventral and dorsal medial prefrontal cortex) and left lateralised linguistic-semantic networks (inferior PFC, middle temporal and angular gyri), regions linked to the DMN. In contrast, the mindfulness meditators in 'experiential mode' (EF) mode showed a pronounced shift away from midline cortices to right lateralised networks, including the insula, secondary somatosensory cortex and inferior parietal lobule. The authors suggest although these two modes of self-awareness are usually integrated, they become dissociated through meditation training, with the 'experiential mode' becoming dominant,

"in which thoughts, feelings and bodily sensations are viewed less as being good or bad or integral to the 'self', and treated more as transient mental events that can simply be observed" (Farb et al. 2007) (p8) .

Long-term mindfulness meditators also showed increased grey matter concentration compared to non-meditators in the right insula and hippocampus, but it was found that hours of practice correlated with grey matter concentration in the left inferior temporal gyrus (Holzel et al. 2008)

The “detached observation of ongoing experience” resulting from meditation training was explored in a LORETA study of long-term Qigong meditators compared to controls in eyes closed rest (ECR) (Tei, Faber & Lehmann 2009). The meditators showed inhibition (indicated by higher delta band activity) of appraisal networks (prefrontal cortex and anterior cingulate cortex) combined with stronger activation (less delta activity) in networks involved in integrating sensory information (left temporal/parietal areas).

The effects on the DMN of ‘mindfulness’ training have been explored in a number of studies. Meditators from different meditation traditions practising ‘mindfulness’ (awareness at nostrils on sensations of breathing) compared to ‘mind-wandering’ rest (Ott 2005; Ott, Walter & Gebhardt 2010) showed reduced activity in both core nodes of the DMN (anterior: medial prefrontal cortex, posterior: posterior cingulate cortex (PCC). Inhibition of the anterior DMN was stronger and more persistent in meditators, interpreted as inhibition of self-referential thoughts and daydreaming required by mindfulness practice of a moment-to-moment experiential focus.

An enhanced ability to focus awareness on the present moment was also found in mindfulness-trained (8 weeks MBSR) subjects, compared to controls in an fMRI scan of “mindful awareness” (Kilpatrick et al. 2011). A shift from DMN network regions supporting “ruminative, narrative-based processing” to those supporting “experiential processing” (BA10, 39, 40) was noted.

Some contrary results have been recorded, although with practices from different Chinese traditions. A study with briefly-trained meditators (5 days Integrative body-mind training (IBMT) (a combination of mindfulness and traditional Chinese medicine) found increased activity in DMN nodes (ACC, PCC) in resting states (Tang et al. 2009). A recent study of ‘Brain wave vibration meditation’ (rhythmic movements with awareness on bodily sensations) using short-term (mean 3 years’ experience) meditators showed heightened activation, compared to controls, in areas associated with the anterior DMN (medial prefrontal cortex (MPFC) in “resting-state functional connectivity” (Jang et al. 2011). The authors speculate that the increased functional connectivity in the anterior MPFC may result from neuroplasticity changes resulting from meditation training focusing on body sensations,

releasing emotions and awareness of energy flow. However, the result may also reflect the inverted 'U-shaped' function of proficiency, with short-term meditators requiring more effort to maintain internalised attention, as found by Brefczynski-Lewis et al (2007).

A SPECT study of advanced meditators from different traditions, but all practising 'focus-based' meditation (mantra or imagery) found increased 'resting state' activity in areas associated with the DMN (medial prefrontal cortex) (Newberg et al. 2010). Contrary to expectation, higher activity was found also in the superior parietal areas.

The deactivation of the DMN in the transition from resting states to an attention-engaging task ('time production') was identified as involving lower gamma power in frontal and midline regions associated with DMN networks (Berkovich-Ohana, Glicksohn & Goldstein 2012). The higher gamma power in mindfulness meditators compared to controls found in right parietal-occipital regions was interpreted as a "long-term trait increase in attention allocation towards interoceptive or external sensory awareness, supporting the idea of neural plasticity in response to meditation training"(p8). The reduction of gamma power in the prefrontal cortex and increase in parietal-occipital is suggested by authors as

"a trait shift from dwelling mentally within the extended self with its engagement in self-processing experience, towards the minimal, momentary and embodied experiencing self" (Berkovich-Ohana, Glicksohn & Goldstein 2012) (p8).

5.2.5.3 Summary of effect of meditation on 'sense of self'

Changes in the experience of 'sense of self' during meditation seem to implicate an alteration in activity in fronto-temporo-parietal networks. In 'concentrative' forms of meditation, an increase in frontal activation (in theta band) and decreased activation of the superior parietal lobule (Newberg et al. 2010) seems associated with an expanded, less 'body-bound' sense of self.

Ongoing 'trait' or neuroplasticity effects of meditation, evident outside of meditation practice, seem to involve a re-setting of the DMN. Mindfulness training resulted in more habitual enhancement of right lateralised networks associated with 'experiential' self-awareness and an ability to attenuate anterior (medial prefrontal) DMN activity associated with the 'narrative' focus of self-referential processing (Farb et al. 2007). On the other hand, training in concentrative practices may enhance anterior DMN function in resting states, although the evidence for this is limited.

5.3 Implications for this project

Studies of short-term meditators from both Yoga and Buddhist traditions have reported state effects in the alpha and theta band, with some indication that midline frontal theta power shows a relationship with proficiency. To date, both advanced Tibetan Buddhist and advanced Western Buddhist meditators have shown significantly enhanced power in the gamma band, across a range of Buddhist traditions and practices. An inverted 'U-shaped' function for the effect of proficiency on brain network activation has been suggested. 'Trait' effects related to proficiency have been found, but with conflicting reports about the degree of proficiency needed to produce a lasting effect.

There are some indications that the distinction between 'concentrative' (FA) and 'mindfulness' (OM) practices has observable neurophysiological effects, the former being associated with central frontal activity and the latter with more lateralised activity in parietal/temporal regions. Activity in these regions has also been implicated in alterations in the 'sense of self'.

Despite the considerable amount of research conducted into meditation, there are still many gaps. The major independent variables, proficiency and type of practice still lack clarification and the acceptance of agreed classification systems for quantitative measurement. Their relationship with outcome variables in the phenomenal experience and neural network activity has only the beginnings of a clear theoretical understanding.

This project will investigate the effect of proficiency with 'advanced' Western Yoga practitioners compared to short-term meditators, in a number of meditation and non-meditation conditions. The investigation will follow the framework set out in Chapter 4, by

- setting out the cultural context of the study
- qualitative study exploring 'place', 'person', 'practice' and 'phenomenology' variables
- quantitative (EEG/eLORETA) studies exploring 'psychophysiology' measures

CHAPTER 6 – CULTURAL CONTEXT OF YOGA MEDITATION IN AUSTRALIA

“The roots of modern Yoga lie in both South Asian and Western forms of culture, belief and imagination. Substantial numbers of those practising modern Yoga nowadays are non-Asians, though many teachers of the early wave (first half of the twentieth century) were Asian. The latter have been followed by a constantly growing number of ‘indigenous’, often ethnic Western teachers: we can now be one, two or even three ‘generations’ down the line of spiritual pupillage from the initial Asian guru”. (De Michelis 2007) (p3-4)

6.1 Introduction of Yoga and meditation to the West

The World Parliament of Religions, in Chicago in 1893, brought the first of the Indian teachers to the West. Swami Vivekananda went on to establish a number of Vedanta ashrams in the USA and was a key figure in the emergence of ‘modern’ Yoga (De Michelis 2007). Buddhist teachers soon followed and introduced the principles of Mahayana and Zen Buddhism. Other visitors to the USA in the 1920’s were Paramahansa Yogananda, Gurdjieff and Krishnamurti.

Curiosity about meditation increased in the 1950’s with the publication of Alan Watts’s ‘*Psychotherapy East and West*’ and interest exploded with the ‘counter-culture’ movements of the 1960’s. A number of socio-political influences merged at the time the post-war ‘baby-boomers’ reached early adulthood. Meditation was introduced to millions through the influence of high-profile entertainment figures and the increasing number of Indian ‘gurus’ visiting the West. The most successful of these in creating a widespread following was Maharishi Mahesh Yogi, who introduced Transcendental Meditation (TM).

6.2 ‘Modern’ Yoga

As De Michelis (2007) notes, ‘modern’ yoga, as practiced in the West could be described as *“hatha yoga recast as a process of health and fitness training underpinned by the moral and spiritual principles of neo-Vedantic Hinduism”* (p5).

It progressed from ‘popularisation’ (1950’s to mid-1970s), to ‘institutional consolidation’ (mid-1970s to late 1980s) to ‘acculturation’ (late 1980s on). Despite the major emphasis given to postures (*asanas*) in most Yoga schools, meditation practices were usually included. Some

traditions, notably TM and International Society for Krishna Consciousness (ISKCON) focused primarily on meditation.

The dialogue between Yoga and Western science began in the 1920s, with the work of Sri Yogendra at the Yoga Institute at Mumbai and Swami Kuvalayananda at Kaivalyadhama, whose laboratory work was published in the journal, '*Yoga Mimamsa*' (De Michelis 2007). International research teams began conducting experiments on Indian Yoga practitioners in the late 1950s, leading to a connection between Yoga and 'relaxation' research, with meditation being construed in 'stress-reduction' terms. In 1975, from work based on meditation practices, Herbert Benson published '*The Relaxation Response*' (Benson 1975) and went on to establish the influential Mind-Body Medical Institute. The cardiologist Dean Ornish advanced the usefulness of a 'yogic lifestyle' (derived from the teachings of Swami Satchidananda) in reversing coronary atherosclerosis (De Michelis 2007).

6.3 Yoga and meditation in Australia

The Theosophical Society, an organisation aimed at encouraging the study of comparative religion and science, opened branches in Australia in 1895 and published the first article on Yoga in 1904, entitled '*The practice of Raja Yoga*'. The organisation brought the Indian philosopher, Jiddu Krishnamurti, to Australia in 1922 to lecture on *Jnana Yoga* (Nolan 2002). Such activities, however, were for the few interested in esoteric matters, with Australia usually being bypassed on the lecture tours of the Indian swamis in the first half of the 20th century.

It was not until post-second world war influx of immigrants that the first yoga school was established. A Chinese-born Russian, Michael Volin, came to Australia after the Chinese Revolution and established the Sydney Yoga School in 1950. In Melbourne, the Gita School was opened by Magrit Segesman in 1954. Both taught an integrated approach to Yoga, combining *asana* (physical postures), *pranayama* (breathing practices) and meditation.

In 1966, Michael Volin and Roma Blair, another Sydney teacher, attended the 3rd International Yoga Convention at Munger, India, becoming disciples of Swami Satyananda Saraswati (a disciple of Swami Sivananda of Rishikesh). On their return to Australia, with a few others, they formed the Yoga Teachers Association, later to be the International Yoga Teachers Association (IYTA). Australia's first National Yoga Convention, organized by the IYTA was held at Richmond, near Sydney in 1968, with Swami Venkatesananda (another disciple of Swami Sivananda) as the major speaker. Swami Venkateshananda made a number of subsequent lecture tours of Australia until 1982.

Combined with the appeal of health and beauty, Roma Blair brought Yoga to new level of recognition through television shows '*Relaxing with Roma*' and '*Wake Up and Live*' which ran for 14 years. The Fijian-born Indian Swami Saraswati, who arrived in Australia in 1966, used the same approach in her long-running TV Yoga show, also marketing her own brand of beauty preparations.

The 2nd National Yoga Convention in 1969 was led by Swami Satyananda Saraswati, of the Bihar School of Yoga, who subsequently made annual visits to Australia.

From early beginnings in the 1950s, Yoga and meditation became associated with the Australian 'counter-culture' of the sixties, although became more 'mainstream' with the Beatles publicizing TM. Maharishi Mahesh Yogi visited Australia in 1962 and 1967. The annual 'alternative' Aquarius festival was held in 1971 in the small New South Wales town of Nimbin. This event led to the formation of numerous 'hippie' communes in the region, often with meditation as part of the culture (Aveling 1991).

Dating from the 1960's, many yoga organisations became established in Australia.

The following is a brief chronology.

- | |
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| <p>1962 Transcendental Meditation (TM) organisation established in Australia and the initiator, Yogi Maharishi Mahesh visited Melbourne.</p> <p>1967 Yogi Maharishi Mahesh's second tour of Australia (Melbourne, Canberra and Sydney) attracted much attention due to his connection with the Beatles.</p> <p>1969 Acharya Upendra Roy, a Tantric monk, arrived in Australia and established the Yoga Meditation Centre in Randwick, Sydney.</p> <p>1970 Swami Muktananda visited Australia and on his second visit in 1974 the Siddha Yoga organisation was set up in Australia.</p> <p>1970s Iyengar - style yoga introduced to Australia – some Australian yoga teachers went to Pune to study with BKS Iyengar and then started teaching his style.</p> <p>1972 Ananda Marga and Sri Chinmoy centres were set up.</p> <p>1974 Satyananda Yoga Ashram established near Sydney (Mangrove Creek)</p> <p>1975 Hare Krishna movement (ISKON), Brahma Kumaris, Raja Yoga and Rama Krishna Vedanta Society of Victoria set up branches in Australia.</p> <p>1980 Sahaja Yoga Organisation was started.</p> <p>1980s Sri Bhagwan Rajneesh (later known as Osho) started centres around Australia.</p> <p>1983 BKS Iyengar invited to Australia by IYTA as the main guest for their National Convention in Melbourne.</p> |
|--|

1985 Iyengar Association formed

1990 'Yoga in Daily Life' established by Swami Maheshwarananda, began teaching in Australia.

Taken from unpublished resource folder for *Yogic History, Philosophy and Culture* unit of Yogic Studies, Satyananda Yoga Academy

The cultural changes in Australian society that brought Yoga and meditation have now become well-established. From its beginnings in the 'counter-culture' of the 1960s, Yoga is now considered a 'mainstream' activity. Training in Yoga teaching in some organisations such as Satyananda Yoga Academy has achieved the level of 'nationally recognised training' in the vocational education sector.

The history of the two Yoga traditions studied in this research project (Satyananda Yoga and Yoga in Daily Life) will be described in more detail. These traditions were chosen as representative of mainstream 'spiritual' Yoga traditions offering an 'integral' programme of Yoga *asana* (postures), *pranayama* (breathing) and meditation.

6.4 Satyananda Yoga

Schools of Yoga in India can be broadly divided philosophically into two traditions. The 'Southern' school (represented by the teachers Krishnamacharya, Deshikachar and Iyengar) follows the '*Hatha*' philosophy of attainment of 'self-realisation' through total physical perfection. The 'Northern' school teaches a more 'meditative' Yoga, based on the 'Yoga Sutras' of Patanjali. Swami Sivananda of Rishikesh was one of the first to bring the teachings of the 'Northern' school to the West.

Swami Sivananda gave his disciple Swami Satyananda the mandate to spread Yoga 'from shore to shore and door to door'. Swami Satyananda established the Bihar School of Yoga at Munger in 1964, attracting students from around the world, including many from Australia, who became *sannyasin* disciples. The first *sannyasa* training course was conducted at Munger in 1970 and the Australians initiated during the 1970s became the first 'cohort' of Australian Satyananda Yogis. A qualitative study found this group to be

"usually under the age of thirty, well-educated, with some religious background in a mainstream Christian denomination, and often single or recently divorced" (Aveling 1991) (p xii).

In a significant departure from the *Dasanami* Yoga tradition, Swami Satyananda modified the concept of *sannyasa*. Traditionally, *sannyasa* was the last stage of life, implying 'total

renunciation' of family and society, devoting one's entire life to "the search for spiritual knowledge". This lifestyle was seen as involving the practices needed to attain the fourth state of consciousness, the *turiya* state (Y. Saraswati 1996). In addition to this full (*poorna*) class of disciple, Swami Satyananda began initiations into 'karma' or 'householder' *sannyasa*, who remained "in the world" of family and employment, but had an internal commitment to a Yogic life.

"With initiation into karma sannyasa, a new meaning, a new philosophy comes into your life. Everything remains the same but the philosophy of relationships with each and every thing you are related to, changes. The change is for the good; it is for a great spiritual purpose" Swami Satyananda initiating Australian karma sannyasins, (Saraswati 1984) (p85)

Swami Satyananda first visited Australia in 1968, then made regular visits until 1983. Mangrove Creek Ashram (NSW) was established in 1974, becoming the major Australian centre, followed by Rocklyn Ashram in Victoria in 1983. The second 'cohort' of Australians, initiated into *poorna* and *karma sannyasa* by Swami Satyananda in Australia between 1980 and 1984, differed from the first cohort in having their experience of ashram life mostly in Australian Satyananda centres. Swami Satyananda retired from public life in 1984. By 1985, there were up to 200 *poorna sannyasins* and perhaps a further 500 *karma sannyasins* in Australia (Aveling 1991). The *poorna sannyasins* provided the majority of the resident Yoga teachers in the Satyananda ashrams in Australia, supported by the community-based *karma sannyasins*.

The movement experienced a severe decline in the late 1980s after the imprisonment of the head teacher at Mangrove on sexual offences, resulting in many *sannyasins* leaving. Numbers increased again in the 'third cohort' when Swami Niranjanananda, anointed as preceptor in succession to Swami Satyananda in 1993, began to conduct initiations. This group, together with some of the second cohort, spent sometimes lengthy periods of time in Rikhia, India, where Swami Satyananda again established an ashram after wandering alone and performing personal *sadhana* (intensive spiritual practice) for a number of years.

Satyananda Yoga has been described as an 'integrated' style of Yoga, encompassing lifestyle, *asanas* (postures), meditation, *pranayamas* (breathing practices), *mudras* (subtle gestures), *bandhas* (muscular locks directing energy), *shatkarmas* (cleansing practices), *seva* (service) and Raja Yoga, Kundalini and Karma Yoga philosophy (Penman 2008). The meditation practices taught in Satyananda Yoga became more formally structured with the

formation of Satyananda Yoga Academy (Australasia) in 1997. They were incorporated into training in 'Yogic Studies', from 2000, as part of the accredited training course for Satyananda Yoga teachers.

6.5 Yoga in Daily Life

The founder of 'Yoga in Daily Life', Paramahans Swami Maheshwarananda traces his lineage through the Yoga tradition of Paramyogeshwar Sri Devapuriji who resided in Sikar District, Rajasthan, Northwest India. He was initiated as a *sannyasin* by his *guru* (teacher) Swami Madhavanandadaji in 1967. Swami Maheshwarananda brought his system of Yoga to Europe, America and to Australia in 1990. He is based in Vienna.

The 'Yoga in Daily Life' system incorporates aspects of Karma Yoga (selfless action), Raja Yoga (meditation), Bhakti Yoga (devotion), Gyana Yoga (knowledge) and Hatha Yoga (purification). It is organised into 8 levels, with classes comprising asana, pranayama and meditation. Meditation is taught as part of yoga classes throughout Australia. See appendix 8 for details of meditation practices for level 1-2.

CHAPTER 7 – STUDY 1 – QUALITATIVE

“Meditation makes me calmer, less focused on myself”. “A more fulfilling life”

Qualitative study participants

7.1 Introduction

The purpose of this study was to obtain contemporary subjective accounts of the ‘lived experience’ of Australian Yoga meditators. The Satyananda Yoga community has been the subject of a few previous dissertations: a qualitative study of Satyananda and Rajneesh *sannyasins* (Aveling 1991); a phenomenological study of embodied ‘sense of being’ (Persson 2000) and an ethnographic enquiry charting a personal journey through Satyananda Yoga training (Pankhania 2008).

The length of time that Satyananda Yoga had been operating in Australia provided the opportunity to study Australian Yoga meditators comprising three ‘cohorts’, covering 40 years. Their experience was compared to a more recently introduced Yoga tradition, Yoga in Daily Life, with practitioners commencing their training in the 1990s.

Questions of interest were:

- “How did these Australians come to take up Yoga and meditation?”
- “What meditation training did they receive?”
- “What experiences did they have during the meditation practice?”
- “What effect does meditation practice have on daily life?”

The main focus of the study was to explore the domains of ‘place’, ‘person’, ‘practice’, and ‘phenomenology’ with particular attention to:

- Proficiency level
- Type of practice
- Changes in ‘sense of self’

7.2 Method

7.2.1 Participants

The study protocol was approved by the RMIT University Science Engineering & Technology Portfolio Human Research Ethics Sub-Committee as a Level 2 proposal (participants considered not to be exposed to physical, psychological or social risk above the everyday norm, but may contain slight risk).

36 Yoga practitioners from the Satyananda Yoga (SY) tradition and 23 from the Yoga in Daily Life (YDL) tradition were interviewed for the study. The former were recruited by word of mouth and direct approach at the Satyananda Yoga Academy ashrams at Mangrove Creek, NSW and Rocklyn, Victoria and at various locations in NSW. Participants from Yoga in Daily Life were recruited from a talk I gave at their weekly *satsang* at the Annandale centre in Sydney and direct approach from YDL staff to potential participants.

Participants were given the Plain Language Statement (Appendix 4) and when satisfied, signed the Consent Form (Appendix 5a)

The demographics of the participants are shown in Table 9.

Table 9 – Study 1 - Demographics of participants

	Male	Female	Age Range (Years)	Mean Age (Years)	Range of Meditation Experience (Years)	Mean Meditation Experience (Years)
SYT	11	14	39-67	55	18 – 39	28
SYS	5	6	29-51	38	2-14	5
YDLT	8	7	31-63	45	4-17	11
YDLS	0	8	24-62	43	1-8	4

The Satyananda Yoga teachers (SYT) were the oldest group, with the longest meditation experience (mean 28 years). The Satyananda Yoga students (SYS) were the youngest group, with comparable meditation experience to the Yoga in Daily Life students (YDLS) (4-5 years). The Yoga in Daily Life teachers (YDLT) had mean experience of 11 years.

7.2.2 Interviews

Face to face interviews (and three telephone interviews) were conducted and recorded on a portable voice recorder. Interviews lasted approximately half an hour to an hour. The researcher conducted all interviews, consistent with the constructivist grounded theory approach (Charmaz 2006).

The personal involvement of the researcher in the subject matter is acknowledged and attended to in this approach. Biasing effects of the researcher are addressed by the following: identifying the researcher’s background and conscious intention to set aside personal views while collecting data; recognizing that all bias cannot be removed and so interpreting the results with appropriate caution. On the positive side, the researcher’s familiarity with the context and practices greatly assists a shared understanding.

I came to this study as a fellow staff member and teacher in the Yoga teacher training course offered at Satyananda Yoga Academy. I have been a *karma sannyasin* disciple of Swami

Satyananda since 1983 and have practiced the meditations taught in this tradition for most of those years. I and my wife lived at Mangrove ashram from 2002 to 2010.

The interview questions followed a semi-structured format (see Appendix 6)

The research questions guiding the data collection included:

- Childhood experiences that led to an interest in meditation
- What led to meditation training being undertaken
- Tradition(s) studied
- Philosophical underpinning of meditation practice
- How meditation training and practice have developed over time
- What changes has meditation practice made to your life
- Place of meditation in life now
- Relation to other spiritual practices
- Description of current meditation practices
- Frequency, duration, type of practice
- Experiences during meditation state
- Effect of meditation on everyday life

The questions were designed to be open-ended, allowing participants to express their individual response to the stimulus. Occasionally participants expressed a reluctance to explore certain areas and these were not pursued. None of the participants expressed any distress following the interviews, with many reporting they enjoyed the experience.

All transcriptions of the audio files were done by the experimenter, with the files identified only by number. The experimenter had the only file linking identifying information with file numbers, which was kept in a separate, secure location.

7.2.3 Data analysis

7.2.3.1 Grounded theory

Grounded theory, developed by Glaser and Strauss (1967) and developed as a constructivist approach by Charmaz (2006) was used for data analysis. In place of hypothesis testing, grounded theory attempts to find the emergent themes, discovered through a process of coding and memo-writing. Originally developed for the study of social phenomena, grounded theory has been applied in the study of individual psychological experience (Corcoran 2007).

As outlined by (Charmaz 2006), grounded theory *constructs* theories “through our past and present involvements and interactions with people, perspectives and research practices” (p10). The “research participants’ implicit meanings, experiential views – and researchers’ finished grounded theories – are constructions of reality” (p10).

The procedure uses the interview transcriptions as the raw data, from which, meaningful units of data are coded. Coding leads to ‘memo-writing’ to draw together related ideas. “Memos provide ways to compare data, to explore ideas about the codes and to direct further data-gathering” (p32) (Charmaz 2006).

7.2.3.2 Software

A software program (MAX.QDA) (Version 2007) was used to conduct the coding, memo writing and analysis procedure.

7.2.3.3 Coding

Initial Coding

In grounded theory, “coding generates the bones of your analysis” (Charmaz 2006) (p45). As the initial coding should follow the data closely, the first step is “careful, word-by-word, line-by-line, incident-by incident coding”. This process complies with two criteria for grounded theory analysis – fit and relevance. Initial codes should be “short, simple, active and analytic” (Charmaz 2006) (p50).

Initial coding methods included:

- ‘in vivo codes’ – participants’ use of special terms or phrases that can reflect underlying assumptions, actions and imperatives, and
- ‘open coding’ – assigning descriptive labels to interview segments.

Initial coding was done at a fine grain level, yielding 959 codes from 59 transcripts totaling 81,706 words. The software program MAX.QDA was used to read through the transcripts, and to add codes to selected segments.

Memo writing

(Charmaz 2006) describes memo-writing as “the pivotal intermediate step between data collection and writing drafts of papers” (p72). Memos provide the mechanism for sorting ideas, codes and data to allow the emergence of clusters of categories and themes.

Focused coding

The codes were reviewed for frequency of use and significance, leading to the choice of a smaller number of 'focused codes'. When combined with memo-writing, these analyses led to the identification of 'themes'. Potential themes were cross-checked with the text of interview data to confirm they were adequately represented. Suitable quotations, illustrating the themes, were selected for inclusion in the results.

These themes fitted naturally into clusters grouped into categories of 'Practice', 'Person' and 'Phenomenology'.

- 'Person' included personal history and life experiences leading to meditation, as well as responses to meditation training received (11 themes)
- 'Practice' included formal training in various practices, as well as individual practice (11 themes)
- 'Phenomenology' included personal internal experiences in meditation and their effects in everyday life (11 themes)

The identified themes are presented in tables 10 to 14, with the number of teachers and students from each tradition who contributed.

7.3 Results

7.3.1 – 'Place'

7.3.1.1 Satyananda Yoga Teachers (SYT):

The first participant in my study to make contact with Satyananda Yoga arrived in Munger, India in 1969, for a *kriya* meditation course and stayed in India until 1984. The first *sannyasa* training course was conducted at Munger in 1970. Five of the other Satyananda teachers in my sample went to India in the 1970s, being initiated into *poorna sannyasa* and becoming members of the first cohort of Australian Satyananda Yogis.

The second cohort of Australian Satyananda Yoga disciples were initiated into *poorna* and *karma sannyasa* by Swami Satyananda in Australia between 1980 and 1984 and included the majority (fifteen) of the Satyananda teachers in my sample. Their experience of ashram life was mostly in Australian Satyananda centres. The remaining group of Satyananda teachers in my study (four), the third cohort, was initiated by Swami Niranjanananda during the years 1988 to 2006.

7.3.1.2 Satyananda Yoga Students (SYS):

All of the Satyananda students were undertaking Yogic Studies modules at Satyananda Yoga Academy. Five of the group had been initiated into *karma sannyasa* by Swami Niranjanananda in the years 2005 to 2007 and were living at the Mangrove ashram. One had also spent two years in the Satyananda ashram at Rikhia in India. Three had received a personal or 'guru mantra' at the *mantra diksha* level of initiation. A description of an initiation ceremony for performed by Swami Niranjanananda at Mangrove in 1996 is given by Asha Persson (Persson 2000)

7.3.1.3 Yoga in Daily Life Teachers (YDLT):

Yoga in Daily Life (YDL) was introduced to Australia in 1990. All of the YDL teachers began their involvement with the organisation in Australia during the 1990s and received their training in Australia. Only a minority (six) had been to the YDL centres in India and Europe, and only for relatively short stays. All except two of the teachers had received a spiritual name from Swami Maheshwarananda and all except one had been initiated into *mantra diksha* (giving of personal or 'guru mantra'). Eleven of the fifteen teachers had received a personal *kriya* practice from Swami Maheshwarananda.

7.3.1.4 Yoga in Daily Life Students (YDLS):

Three of the eight YDL students had received *mantra diksha* initiation, and two had been given a spiritual name. All but one began their meditation training with the YDL 'System' in Australia in the 2000s. None had spent time in the centres in India or Europe.

7.3.2 Results – 'Person'

Table 10 – Study 1 - Themes in domain of 'Person'

Cluster	Theme	No. SYT	No. SYS	No. YDLT	No. YDLS
Experiences leading to interest in Yoga	Childhood religious training	20	7	9	5
	Search for meaning	16	2	7	3
	Contact with nature	9	2	2	1
	Contact with spiritual people	8	4	4	3
	Drug experiences	10	3	3	1
How they came to Yoga meditation	Through physical Yoga	7	1	6	5
	Through significant life changes	4	4	7	1
	Through connection to guru	12	2	4	1
Consistency of meditation training	Changes in tradition followed	9	4	6	2
	Regularity of practice	20	8	15	8
	Duration of practice	19	5	15	8
No. of participants		25	11	15	8

7.3.2.1 Cluster: Experiences leading to an interest in Yoga

Theme: Childhood religious training

SYT:

The majority (eighteen of twenty-five) of Satyananda Yoga teachers (SYT) had Christian upbringing, (eight Catholic, seven Anglican, three Presbyterian). Two had Jewish backgrounds and five had no particular childhood religious training. In contrast, the majority (seven of ten) of Satyananda Yoga students (SYS) had secular backgrounds, with only two having Catholic and one (unspecified) Christian upbringing.

For a number of the Satyananda Yoga teachers, religion was an important part of their childhood until they reached an age of thinking independently, when it lost its meaning as a guide for life. A male, brought up in a country town said: *“I went to a Catholic school – religion was important until I started to think for myself – then I asked ‘why am I doing this?’ – then at about 12-13, I told my family ‘I’m not going to Mass anymore’. After a few years, everyone stopped going”*. A female daughter of immigrant parents, who attended a Catholic school, said: *“My family was quite strongly Catholic – I went to church regularly till about 15 – then it was time to make my own decision – then I didn’t go so regularly. I began to question the notion ‘what is God’ – ‘is there any difference between me and God?’ ”*.

For others in the SY teacher group, religion in childhood was less significant. A female SY teacher, educated at a Catholic convent school, said: *“I got an abundance of religious training at the boarding school, but it wasn’t heavy duty”*. A male, brought up in Africa, said: *“My mother used to take us to Church – Anglican – she herself wasn’t a follower, but she thought it was good for us. I remember it, but I don’t remember it being anything of importance”*

Neither of the two Jewish SY teachers had religious training. They were both in the first cohort, spending long periods of time in India. One reported *“I had no religious training - I went to a public school, where I used to sit in on some of the Christian lessons at school, just to hear what they had to say”*. The other said: *“My parents were non-practising Jews, more socially rather than religious. I went to public schools”*

Only two of the SY teachers had exposure to Eastern religions or Yoga during childhood. A female teacher said: *“My father was a big influence – he introduced me to Buddhism when I was 10, my mother directed me to attend the Anglican church till I was 16, but I went to a Quakers school”*. A male teacher said: *“Both my parents participated in Yoga, from when I was about 7 years old”*.

SYS:

Although the majority of Satyananda Yoga students' upbringing was secular, those who received religious training reflected a range of responses. A female student, brought up in Canada, said: *"I did attend church (Protestant) until high school, but it wasn't necessarily enforced – it was left open if I wanted to continue"*. Another female student said: *"My mother was an atheist, but we went to Sunday school – though there were a few things I wasn't comfortable with"*.

YDLT:

Similar to the Satyananda Yoga teachers, the majority (nine of fifteen) of YDL teachers had Christian upbringing (five Catholic, two Anglican, two - other Christian). Five had secular backgrounds and one was Jewish. However, for most of those who received religious training, it was not a major influence in their lives. A female YDL teacher remembers: *"Religion was part of my childhood – I was confirmed (Anglican) – I didn't really have a choice, but it was not pushed down our throats"*. A male YDL teacher said: *"We were Catholics – went to church on Sunday – religion was part of the program – I grew up not thinking so much for myself – I just went along with it"*.

For a few, religion was important. A female YDL teacher said: *"I have always felt compelled to the spiritual – I was reared Catholic – and stayed Catholic into my 20s – I'd go to drug parties and still go to Mass – I always felt a strong connection to God"*.

Some expressed dissatisfaction with religious training. A male YDL teacher remembers: *"My family was ceremonial Jewish, but my father was a declared atheist – his father's family was all killed in the holocaust – I thought Judaism was all just hypocrisy"*.

YDLS:

Similarly, the majority (five of eight) YDL students came from Christian backgrounds (three Catholic, two Anglican) with two secular and one born in India with a Yogic upbringing. A YDL student said: *"I was baptized a Catholic – did all the sacraments – went to church but stopped five years ago"*.

A female YDL student reported: *"I was brought up Anglican, but I've always been on the search for something spiritual"*. Another female student said: *"I didn't go to religion classes at school – I was happy about that – even in YDL I still have trouble with the word 'God', but I've always been spiritual – experiencing it through nature – simple pleasures"*.

Only one YDL participant had contact with Yoga as a child, growing up in India: *“I grew up in India and so was exposed to Yoga, but not meditation – my brothers learned japa meditation – but I (as a female) missed out”*

This theme of disillusion with or irrelevance of organised religion may have led to the search for meaning in life in other places.

Theme: Search for meaning

A search for meaning in life outside of established religion was a common theme.

SYT:

A female Satyananda Yoga teacher reported this experience: *“When I was about 14 – I just had this awareness – I remember sitting on the end of my bed thinking ‘what am I doing in this family?’ – so I had some sort of deeper understanding of things”*. A male teacher in the first Satyananda Yoga cohort said: *“I was always looking for something more – the mystical – I felt a strong resonance – very deep, something familiar – I pursued it quite actively”*.

Many participants reported experiences in childhood that orientated them to a “deeper” level of existence. Some reported “strange experiences” in childhood that they connected to a later interest in meditation.

A male SY teacher reported: *“I was aware of my spirituality without knowing it – I could see images at a young age – I didn’t know they were different – they weren’t human – I could see things that weren’t the normal run – I would look out the window and I could see this image coming towards me”*. Another male SY teacher said: *“I can remember when I was about five, I found a flyblown dead hedgehog under a hedge and had an intense awareness of death and transience, because I had seen the hedgehog alive just before”*.

SYS:

The Satyananda students also reported a number of “spiritual” experiences in childhood, which led to an interest in Yoga. A female SY student said: *“I had an out of body experience when I was 21 – so then I explored psychic things – it just progressed – the next thing – yoga”*. Another female SY student reported: *“As a teenager, I started getting interested in astral travel and experimented with my sister”*.

YDLT:

A Yoga in Daily Life teacher reported: *“When I was about 3, I remember sitting in the front garden, looking up at the sky I was always fascinated by clouds – and having a really profound thought of ‘what am I doing here?’”*.

Theme: Contact with nature

A number of participants reported that contact with nature provided meaningful, spiritual experiences.

SYT:

A senior female Satyananda Yoga teacher said: *"I had so much awe for nature – sunrise and sunset"*. Another female SY teacher expressed: *"I felt very much in tune with nature – it was a welcoming feeling with nature"* *"I had a really intense experience at sunset walking alone at the sheep station"*.

Similar experiences with nature were reported by Satyananda Yoga students and Yoga in Daily Life participants.

SYS:

An SY student reported: *"I was given a lot of freedom as a child to be as creative or expressive as I wished – we are part of nature – so go and explore"*.

YDLT:

Two YDL teachers expressed: *"I played in the bush a lot – I had a few experiences as a kid – I'd run back and tell Mum – but she would just shoo me away"*, *"I could spend a day just looking up at the clouds – I still feel I want to – I just adore sparkles on water – seeing a beautiful flower – I find them very moving"*

Theme: Contact with spiritual people

The influence of a significant person in early life who was seen as "spiritual" was reported by many participants.

SYT:

One of the Satyananda Yoga teachers recalled: *"My mother was always running off to lectures by visiting swamis like Krishnamurti – you'd call her a spiritual seeker"* and another SY teacher: *"My grandmother really impressed me – she was a very strong religious person in the community – a spiritual kind of person – the quiet strength of the whole family"*

SYS:

A female Satyananda Yoga student commented: *"I was close to my friend's mother who was a bit alternative – I used to tell her about the out of body experiences I had"* and a male student: *"My grandfather was very spiritual – he was a Sanskrit scholar – from a young age I had profound experiences"*

YDLT:

A senior female YDL teacher described her introduction to Yoga: *"I had neighbours when I was about 40 – they were vegetarians and took me to Yoga – my life just opened up in that way – after the first time I didn't look back"*.

YDLS:

A young female YDL student said: *"My brother took me to a retreat about 8 years ago – that's where I first saw Swamiji – then I moved away from it – then my father passed away 6 years ago and I came to Yoga to help with that – it gave me a new perspective on things"*

Theme: Drug experiences:

Drug experiences often provided a taste of another reality – that was then later pursued through meditation.

SYT:

Nine of the Satyananda Yoga teachers had tried marijuana, a popular expression of the counter-culture of the 1960s and 1970s. A male SY teacher recalls: *"I used to take marijuana – I was quite comfortable being stoned as it would take you to an alternative place – you could function quite normally in that space"*. A female SY teacher reported: *"Someone had put hash in a cake – it was strong enough to trigger strong experiences – I was going in and out of my body – I felt I was going to die – my awareness shifted – I had already started doing Yoga"*

Five tried LSD (acid), often with quite profound effects. A male SY teacher recalls: *"The cannabis gave me a sense of merging – losing a sense of 'I-ness' – that was the thing I was most addicted to. Acid gave me access to an absolutely altered state of mind and being – an altered reality – which seemed as authentic as you and I sitting here now"*. Another male SY teacher reported: *"LSD definitely encouraged me in a spiritual direction – it changes your perspective – combined with a lot of experience with nature – I spent a lot of time in the bush, a lot of time on boats"*. Another male SY teacher said: *"With LSD there was a going up and coming down and a semi-euphoria – I didn't get too many hallucinations or things like that – I was trying to use the drug as a springboard or a lever to meditation – so I was riding it"*

SYS:

Although they come from a later generation, two of the Satyananda Yoga students also tried LSD. A female student, in her early 30s, said: *"I dabbled in taking acid twice – the experience was quite profound – not necessarily enjoyable – but quite intense – it triggered a desire to become more sensitive to nature"*. A male student, in his late 20s, recalls: *"I tried acid pretty young – going into high school – it was such a strong experience – I had some pretty bad flashbacks for quite a while. It's only now that things feel so clean that the drug question (is this coming from me or the drug?) doesn't come into it at all"*

YDLT:

In contrast, only two of the Yoga in Daily Life teachers, and none of the YDL students mentioned drug usage as precipitating their involvement with Yoga. A male teacher said: *“My relationship with my wife was falling apart- taking drugs – we were high functioning drug-takers – still working – but looking for something to do together – walked into a Yoga centre – it was YIDL”*. Another male YDL teacher expressed the connection as: *“I was using marijuana and alcohol to manage stress in my business – became way too much – I had a major shut-down – put on medication – the doctor said – you need to learn to meditate”*

Summary

For all groups, organised Western religion did not satisfy their search for meaning in life, leading to a search for ‘something deeper’. Experiences with nature and the influence of spiritual people were often part of the journey leading to a predisposition to explore Yoga. For some of the Satyananda Yoga group, experimenting with drugs gave an introduction to altered states of consciousness experienced in meditation.

7.3.2.2 Cluster: How participants came to Yoga meditation

Theme: Through physical Yoga

A number of participants were attracted to Yoga for its benefits of physical well-being, or for assistance with a physical ailment. Involvement with Yoga then led to an interest in meditation.

SYT:

A male SY teacher reported: *“I became involved for the physical side of Yoga - I was involved in sport and found it really good for flexibility and relaxation”*. A female SY teacher said: *“I was very sick – felt like Yoga kept me alive for a couple of years. To work on a number of things that were wrong with me – I did a strong routine of sadhana (spiritual practice) and that got me into meditation”*.

SYS:

A male SY student recalls: *“I started doing Iyengar - I came to Mangrove – thought it was a beautiful place – then I hurt my shoulder and couldn’t do physical yoga, so I thought I’d come here and learn about meditation”*

Similar experiences were reported by the Yoga in Daily Life participants.

YDLT:

A male YDL teacher remembers: *“In the mid-90s I had a severe sciatica attack – took a few months before I could walk – I went to Yoga for my back – the Yoga was brilliant”*.

YDLS:

Reports from YDL students included the following accounts: a female in her 50s: *"I started with physical Yoga when I was pregnant with my second child – I always had an interest in Yoga. I didn't really start meditation until I came to YDL about 5 years ago"*; a female, aged 38: *"It was the exercise of Yoga (asana) that led me into meditation – I hadn't come across it until I started Yoga"*; and a female, aged 30: *"I didn't know much about meditation when I started – I just wanted the physical side of Yoga"*

Theme: Through significant life changes

A number of participants came to Yoga to deal with significant changes in life.

SYT:

A male Satyananda Yoga teacher in his late 30s said: *"I came to an awkward period in my life – I was diagnosed with a life-threatening condition – needed something more – I stumbled into (Satyananda Yoga) and stayed for five years"*.

SYS:

A female SY student in her late 30s remembers: *"As an early teenager, I started getting interested in astral travel and experimenting with my sister – I found a book in the library and was leading my sister through her experiences. I was fascinated by the possibility of it but I didn't have any experiences"*. An older SY student, in her late 40s, recalls: *"I had been doing massage and reflexology for about 12 years, then a friend said 'do you want to go to an ashram?' – I just went 'Oh' and started to cry"*

YDLT:

Two of the YDL teachers echoed these experiences. A female YDL teacher, aged 40, said: *"As a teenager, I went away from religion – went and saw bands – knocked about – got to a point where I thought I might go crazy if I didn't do something – then went and joined Yoga"*. Another female YDL teacher in her 40s, said: *"There were a lot of changes in my life – my dad died, my job finished, my relationship ended, I had to move out of my house – I moved in with some YIDL people – started taking on the lifestyle – started to meditate – then I went to India and Europe"*

Theme: Through connection to guru

A resonance with the person and teachings of the particular Yoga tradition often emerged through personal contact with the gurus – Swamis Satyananda and Niranjanananda and YDL's Swami Maheshwarananda.

SYT:

A male SY teacher in the second cohort described the experience: *"I heard these two girls talking in a restaurant about this guru who was coming to Australia and I thought 'that's him'"*

– so I went to see him – liked him (Swami Satyananda) a lot – by the end of the year I had sold all my assets and went to India, ready to take sannyasa”. A male SY teacher, now in his 40s, said: “I had been looking for something for a long time – I was looking at various systems but they just weren’t hitting the spot – then I went to a (Satyananda) meditation class and came out grinning like a Cheshire cat”

YDLT:

A male YDL teacher remembers: “The first time I met Swamiji (YDL) I was hooked”. A female teacher recalls: “I felt I needed a teacher who would be able to direct me personally – I saw a picture of Swamiji (Maheshwarananda) in the hairdresser’s and I knew I needed to meet him”

Summary

For many, the step to begin yoga driven by a desire for physical benefits, while for some a life crisis precipitated their involvement. An instant connection with ‘guru’ began a deep relationship for a few.

7.3.2.3 Cluster: Nature of meditation training

Theme: Changes in traditions/schools

The majority of participants in each group (16 of 25 SY teachers, 7 of 11 SY students, 9 of 15 YDL teachers and 6 of 8 YDL students) had received their Yoga/meditation training solely in the one tradition – Satyananda Yoga or Yoga in Daily Life.

Others reported a variety of other meditation training before coming to one of the above traditions.

SYT:

A male Satyananda Yoga teacher in the first cohort said: “I did TM (Transcendental Meditation) for a year before coming to Satyananda Yoga, then later I explored a lot of Buddhist practices while I was doing psychotherapy”. A female SY teacher in her fifties said: “I’ve tried various things – I thought I’d have a go at Raja Yoga in the form of Vipassana – just going inwards – and I thought it was a beautiful technique – but for me it was too dry – I’m a bhakti and I love mantra – mantra is my form of meditation”.

SYS:

Some of the SY students also explored other traditions. A female SY student recalled: “I couldn’t find yoga in Japan so did Tai Chi for 2 and a half years – then studied shiatsu – then I came to Mangrove and started Yogic Studies”. Another female SY student said: “I did a Vipassana retreat before going to India” (to study at Munger).

YDLT:

A number of the Yoga in Daily Life teachers had explored Buddhist teachings and practices, before coming to Yoga. A senior female YDL teacher reported: *"I did a few Vipassana retreats at Blackheath (NSW) – sitting for about 10-14 days"*. A male YDL teacher said: *"I learned TM when I was 21 – I did it every day for about a year then I stopped for a few years. Then I did a 10 day Vipassana retreat in Thailand – breath meditation and walking. After that I went to Hong Kong and while there learned Qigong which I enjoyed and used to practise more regularly – every morning. Then I came to Yoga"*.

A senior female YDL teacher summed up the theme of exploring other traditions: *"I believe it was very useful for me to have the variety of training – mantra and others – to have the experience of the range and knowing what works for me"*

YDLS:

In contrast, most of the YDL students have only studied in that tradition. Reports included:

"The YDL Self-Inquiry Method is the only meditation I have done – I'm at Level 1".

"I have only started meditating since starting YDL teacher training – the Self-inquiry method".

Theme: Regularity of meditation practice

For the majority of participants, meditation was a regular practice, maintained over years.

SYT:

A male SY teacher, in his 50s expressed a common response: *"Regular practice - mantra, still mantra – I don't do anything other than mantra really"*. Two female SY teachers in their 50s also reported regularity of practice: *"I meditated absolutely regularly for 20min since 1972 – there was no career that interested me – this was a path"* and *"For a long time I used my personal mantra, every night, every day and I went quite a way with that"*.

SYS:

A male SY student, in his 30s, said: *"I do mantra meditation every evening before going to bed"*

Other participants reported fluctuations in the regularity of their practice over time, but often experienced a mental or emotional pull to resume their practice.

SYT:

A male SY teacher, in his 50s, said: *"It has ups and downs, since leaving the ashram it has become a bit more spasmodic"*. A female SY teacher, in her 60s, reported: *"I've never stopped since that time (initiation into karma sannyasa), but it goes up and down. I just wish I was a more regular person, but if it goes a fortnight and I haven't done that particular sadhana, then I just have to get back to it, even if I go a week, I have to get back to it"*.

SYS:

A female SY student, in her 40s, said: *“My practice is a bit disjointed – I’m so busy at work – by the time I am finished I’m physically exhausted”*. Another, younger SY student, in her 30s, said: *“My practice is a bit all over the place – I’m learning many different practices over a short time”*

The Yoga in Daily Life participants showed a similar range of responses.

YDLT:

A female teacher, in her 40s, said: *“I used to just do meditation when I went to class, but now I meditate every day, in the evening”*. Another female teacher, in her 40s, reported: *“Since 1990, I have been practising yoga and meditation – pretty much every day – a few breaks for travel and other commitments”*.

YDLS:

A YDL female student, in her 50s, said: *“I’d just developed a need for meditation in my life – that inner focusing – I began to practise more regularly – read more about it – go to more classes”*

Theme: Duration and time of meditation practice

Variation was reported in the duration and time of day of meditation practice. Table 11 records the range and duration of daily meditation practice, and preferred time of day.

Table 11 – Study 1 - Duration and time of day of meditation practice

	Duration (minutes)		Time of day		
	Range	Mean	Morning	Evening	Both
SYT (N=25)	15- 60	26	16	6	3
SYS (N=11)	15-30	19	4	4	2
YDLT (N=15)	25-90	51	11	1	3
YDLS (N=8)	20-45	29	6	2	0

The results indicate that the mean duration of meditation for the Yoga in Daily teachers was twice as long as the Satyananda Yoga teachers. The mean duration of meditation for the YDL students was a third longer than the SY students. For the YDL participants, meditation (usually their personal *kriya* and guru mantra) was the major Yoga practice they performed on a daily basis. For the SY participants, meditation (usually guru mantra) often was part of a longer Yoga practice including asana, pranayama, chanting.

Some of the difficulties of fitting regular meditation into a busy lifestyle are illustrated by the following quotations: - a female SY teacher: *“Now (after the birth of a child) I do about half an hour whenever I can – some days one and a half hours – but not much sitting practice”*. A

female YDL teacher, in her 50s, said: *“The duration depends on the time available – on weekends I do a good hour and a half sit”*.

Comments on the preferred time included: a female YDL teacher, in her 30s, said: *“I have always practised meditation in the morning – in the first year I remember it being physically difficult – then it became part of who I am now – it’s like cleaning my teeth. I do an hour and a half”*. A female YDL student, in her 20s, said: *“I do 45minutes – I had a period of doing it morning and night – then I started work – so now it is morning – I do asana for half an hour then meditate for half an hour”*

Summary

The path to involvement in Satyananda Yoga or Yoga in Daily Life for a significant minority included exploration of other traditions, particularly TM and Vipassana retreats. Once established, most participants reported regular daily practice, usually in the morning. SY students had a mean duration of 20 minutes, YDL students and SY teachers 30 minutes and YDL teachers 50 minutes.

7.3.3 Results – “Practice”

Table 12 – Study 1 - Themes in domain of “Practice” – Satyananda Yoga

Cluster	Theme	No. SYT	No. SYS
Practices	Yoga Nidra	6	3
	Chanting and kirtan	14	2
	Kaya stairyam	4	0
	Mantra (Japa and ajapa)	25	9
	Antar Mouna	11	6
	Kundalini kriyas	18	1
No. of participants		25	11

7.3.3.1 Cluster: Satyananda Yoga practices

Theme: Preliminary practice: Yoga Nidra

The introduction to meditation in the Satyananda tradition is through the practice of Yoga Nidra – a relaxation/guided meditation, practiced lying down, delivered in person or by recording. This practice begins the process of *pratyahara* and as a group meditation is a feature of all Satyananda Yoga programs. It is a popular event in the daily ashram programme. For details of the practice, see Appendix 7b.

A number of SY participants commented on its significance. A senior male SY teacher, in his 60s: said: *“Yoga nidra is the most important practice of all”*. Another male SY teacher, in his 50s, reported: *“Yoga nidra definitely brings calm and peace – stillness”*. A male SY student, aged 47, living at Mangrove ashram, said: *“I do chanting in the morning and if I am lucky I will do some meditation during the day, but I always do yoga nidra – sometimes two a day”*.

Theme: Chanting and Kirtan

Apart from the daily Yoga Nidra, meditation conducted as part of the Australian and Indian ashram daily program primarily consists of the chanting of mantras. Evening programs usually include *kirtan*, the chanting of mantras to musical accompaniment. Morning chanting sessions consisted of group chanting of mantras. In earlier times, this consisted mainly the chanting of 'aum', but recently a number of other *bhajans* or mantras for specific purposes have been included.

A female SY teacher, who spent many years at Mangrove ashram in the 1980s, recalls: *"At Mangrove I used to do 'aum' chanting out loud, an hour in the morning and an hour at night"*

Another female SY teacher said: *"I started to practise 'aum' every day – chanting 'aum' – looking at a candle flame – out loud – with a mala – I thought it was crazy, but I did it because I believed that what I had been given – that if God had put me on this path, I was to keep going on it"*

Another female SY teacher said: *"My main practice is still 'aum' chanting – it's a steadying thing – it doesn't stir up too much – it heals and keeps my nervous system right – when I'm absolutely distressed – I can't meditate"*

A female SY student reported: *"To be honest, I don't feel I have gone very deep into meditation – I have had deep experiences with kirtan – it is only now that I feel I am getting into meditation"*

Theme: Kaya Stairyam meditation

Kaya stairyam is taught as an introductory practice in the formal training in Yogic Studies courses at Satyananda Yoga Academies. It involves awareness of body steadiness (for details, see Appendix 7c). This practice was learned by all the Satyananda Yoga students, but was not a formal part of the earlier training received by the Satyananda Yoga teacher group. However, this group was familiar with the practice from teaching it to the student group.

Theme: Mantra meditation

The primary meditation practice for most of the Satyananda Yoga group has been mantra meditation. This practice comes in two forms – *japa* and *ajapa japa*. *Japa* is the repetition of a mantra, usually that imparted by the guru in *mantra diksha* or *karma sannyasa* initiation, and termed the 'guru mantra' or 'personal mantra'. Those without a guru mantra use alternative mantras, often the 'universal' mantra 'aum'. Movement of a string of 108 beads,

the *mala*, through the fingers, is used to mark each mantra repetition and to help keep the practitioner 'grounded'.

The second form, *ajapa japa*, uses the mantra associated with the natural breath, 'so-ham'. It is termed 'ajapa' when it becomes a spontaneous repetition without conscious effort. It is designed to bring the hidden *samskaras* (mental impressions from the past) and *vasanas* (mental conflicts) to the surface where they can be witnessed and released (Saraswati 1983). The practice combines breath awareness with visualisation of its movement through 'psychic passages' based on the *chakras*. Those with a guru mantra may use this mantra instead of 'so-ham', coordinating repetition of the mantra with the breath and visualisation of movement through various Tantric psychic passages. For details of mantra practices, see Appendix 7d and 7e.

A male SY teacher, 50s, in the first cohort, described the central place of mantra meditation in the tradition: *"My regular practice is mantra, I don't do anything other than mantra really – it has changed a lot over the years, but the basic practice has remained the same – but the application, the way I understand it, has changed"*. Other comments included: a female SY teacher, 60s, 2nd cohort: *"I do other practices, such as trataka, but I keep coming back to my old faithful – my mantra"*; a female SY teacher, 30s, 3rd cohort: *"Mantra meditation has been regular since I was initiated in 2003 – daily practice – but not some of the other practices – I sometimes do trataka or antar mouna – when it feels right"*

Modification to the personal mantra sometimes occurred when participants became *sannyasins*. Some were instructed to use 'aum' as the mantra for *sannyasins*, instead of their personal mantra. While some participants followed this instruction, others continued to use their guru mantra.

A female SY teacher, 50s, in the 2nd cohort, who spent most of the 1980s in Australian ashrams, remembers: *"Swami said when you are initiated use 'aum' – so I only used my personal mantra for a short while – then in the last 8 years, when I came back I reverted to my personal mantra"*. Another senior female SY teacher, 60s, from the 1st cohort, said: *"I combined my guru mantra with 'aum'. Many of the swamis were told to drop their mantra and chant 'aum', but I never did"*.

Theme: Antar Mouna

The next most commonly practiced Satyananda Yoga meditation is *antar mouna* (inner silence), watching and dissolving thoughts as they arise. This practice is closer to a

'mindfulness' practice and is often practised outside of sitting meditation sessions, as an ongoing practice during the day's activities. It blends well the daily program of *karma yoga*. It is described as "one of the few permanent *sadhanas* which can be practised spontaneously all the twenty-four hours of the day by anyone who is really determined to know oneself" (Saraswati 1983) (p211)

It has been taught as a standard practice in both India and Australia, and is a fundamental practice in the Yogic Studies courses. For details see Appendix 7f.

Satyananda Yoga teachers reported: "*Antar mouna is always there in the background and that goes on quite a lot of the time – witnessing the thoughts and everything – consciousness and what is actually happening and the psychic stuff*" (female SY teacher, 60s, 2nd cohort); "*Before long I realized antar mouna was not just about doing it sitting down – that this actually had implications out there - I started to apply it*" (female SY teacher, 60s, 3rd cohort). A male SY teacher in the 2nd cohort described his practice as: "*I do the more contemplative, mindfulness forms of antar mouna – I do a lot of listening meditation – walking meditation and also karma yoga – whenever I'm doing anything – it's always mindfulness – mindfulness of what I'm doing – how I'm doing it – and why I am doing it*"

Differences between mantra and *antar mouna*

Some of the Satyananda Yoga students commented on the differences between their experiences in mantra and *antar mouna* meditations. A female SY student, 30s: "*I found in mantra meditation, I got a lot of really strong imagery – like another person has inhabited my space – in antar mouna – the thoughts were coming in a slow and steady way – sort of connected – not just random*". Another female SY student, 30s: "*In mantra meditation, my awareness was mostly with the mantra – the sound of it – the visualisation just blurred – just an up and down movement – in antar mouna - I wasn't really able to connect with the witnessing aspect – I was more involved in the thought – every now and again I was able to get a glimpse of it and just observe*".

Theme: Advanced practice: '*Kundalini kriyas*'

Many of the first and second cohort participants' early experience of meditation included the *kriyas*. These are advanced and powerful practices involving posture, *mudras*, *bandhas*, and visualisation of movement of the breath in psychic passages all going on simultaneously. They are advised to be taken up only under the guidance of a guru (Saraswati 1983). Although traditionally there are 76 practices, only twenty practices were usually taught in

Satyananda Yoga centres, in two groups of ten. The first ten are designed to induce *pratyahara*, the next nine *dharana*, and the last a state of *dhyana* (Saraswati 1983).

A common experience of the first cohort of their time at the Munger ashram was the intensity of meditation training in the *kriya* practices. The first of the sample to arrive (a man, then 28) said the effect of these practices was *“Amazing psychic visions, brilliant reds and blues, something you would only see in computer-generated images”*. Another male described his experiences as *“Visions of things, sensations of unity, very disruptive to normal daily life. You get these enormous highs and then be completely flat by the afternoon.”*

Perhaps because of the intensity of effects of the *kriya* meditations, there were strict restrictions placed on meditation practice in the Munger ashram. A male participant (20 years at the time) said: *“As I started to perfect the practice, I started to get quite major experiences. When I told Swami Satyananda, he said ‘OK, now stop’, you are in a different stage, don’t practise anymore”*

Some of second cohort had similarly powerful reactions. A male SY teacher who attended the first *kriya* course in Australia in 1980, remembered: *“They were incredibly powerful – strange experiences – I wasn’t practising them according to the directions – I was practising them cumulatively - I had misunderstood – I was doing a lot more than I should”*. Another male SY teacher recalled: *“I did practise the kriyas for 6-12 months and I nearly went “troppo”, then I gave it a miss for a while, then took it up again – went a different type of “troppo” the second time”*.

Some took them more gradually. A male SY teacher reported: *“I learned a few of the kriyas – it took me a lot of years to assimilate – it was the best way – let it all soak in – it took me a long way”*. A female SY teacher said: *“I found the kriyas to be a very subtle experience – I felt they opened up something inside – not kundalini – but definitely some subtle awareness was developing – I felt that it was something very beautiful”*

At the time the third cohort of Satyananda teachers and students were training (1990s to 2000s), the *kriyas* were no longer being taught in Australia, but courses were still being conducted in India. Only three of this cohort received this training and the experiences seemed more controlled. A female SY teacher reported: *“I continued the kriyas for a year, but only the first two – they were enough”*. Another female SY teacher said: *“I’ve dabbled with the kriyas on and off – little bouts here and there – usually don’t get past number 5”*. In

contrast, a female SY student said: *“I did the whole 20 kriyas in India – no profound experiences, except one time an experience of intense heat”*.

Summary

For most Satyananda Yoga participants, the guided relaxation meditation practice, Yoga Nidra, remains a popular and often daily practice, as does chanting of mantra. Daily personal meditation practice usually consists of 15-60 minutes of mantra meditation, with their ‘guru mantra’, either in the form of *japa* (independent of breath) or combined with breath and visualisation. *Antar mouna* is often practised as a ‘mindfulness’ technique outside the meditation session. The *kriya* meditations tend to be practiced for limited duration.

7.3.3.2 Cluster: Yoga in Daily Life practices

Table 13 – Study 1 - Themes in Domain of “Practice” - Yoga in Daily Life

Cluster	Theme	No. YDLT	No. YDLS
Practices	YDL System	3	6
	Guru Mantra	13	4
	Kriya	11	0
No. of participants		15	8

Theme: Yoga in Daily Life Self-Inquiry System

The meditation practices in the Yoga in Daily Life tradition were formalised into the ‘Self Inquiry’ system of eight levels in 2000s (Maheshwarananda 2005). For details, see Appendix 8 for meditation practices for Levels 1 and 2.

Only two of the YDL students had received other meditation training prior to commencing with Yoga in Daily Life and all YDL student participants were progressing through these levels. Comments included: YDL student, 50s: *“all I have done is meditation from the YDL ‘system’ – I’m at Level 1 – thinking about where I am – internalizing my thoughts – visualizing the energy and flow of the breath”*. Another YDL student, 30s, said: *“I’m doing Level 2 – just focusing on my mantra – I find it quite easy to stop my mind. I don’t have a personal mantra so I use so ham”*

Theme: Guru mantra

For all except four of the YDL practitioners, mantra meditation was their major daily practice, with similarities to that practiced in the Satyananda Yoga tradition. Most used a guru mantra, with repetition synchronised with the breath, but usually without visualisation of movement in psychic passages.

Although the training of most of the YDL teachers predated the formulation of the ‘System’, all but one had received a personal mantra in *mantra diksha* initiation. Comments included: a

female YDL teacher, 40s: *“In the early days (1990s) we didn’t work so systematically, didn’t have the ‘Self-inquiry System’ – the main practice was mantra japa – just sitting focusing on the mantra”*; male YDL teacher, 40s: *“I received a mantra from Swamiji the night I met him – so I practised mantra meditation from then on – it’s my favourite – it’s what I do”*.

Four of the YDL students had also received a guru mantra. Their comments included: YDL student, 30s: *“I do guru mantra, using a mala, but not synchronised with the breath”*; YDL student, 40s: *“I took mantra diksha in 2006, getting a “guru” mantra was the final seal – I practise before getting out of bed, with a mala”*.

Theme: Kriya meditation

When Swami Maheshwarananda considered a disciple showed sufficient dedication, he would instruct them in a personalised *kriya* practice, involving asana, pranayama and visualisation, to be incorporated into daily practice. The recipient made a commitment to daily practice. Eleven of the YDL teachers had received a *kriya*, but none of the YDL students had.

Comments of the *kriya* practice included: Female YDL teacher, 50s: *“I do my kriya – which is compulsory – in the morning – as well I do mantra meditation – sometimes with Swamiji’s guided meditation through one of the levels of self-inquiry”*; female YDL teacher, 50s: *“My kriya has guided me enormously – my practice has deepened a lot – I actually stay more aware – before I felt I just didn’t get out of kindergarten”*.

Summary

All except three of the YDL participants practised guru mantra as their regular daily practice, with the addition of a *kriya* practice for those showing sufficient dedication. Current students follow the sequential levels of the ‘Self-inquiry system’.

7.3.4 Results – ‘Phenomenology’

Table 14 – Study 1 - Themes in domain of ‘Phenomenology’

Cluster	Theme	No. SYT	No. SYS	No. YDLT	No. YDLS
Pratyahara	Awareness of outside world	6	2	3	2
	Awareness of body	12	5	2	1
	Awareness of breath	15	6	10	3
	Awareness of thoughts	9	6	4	1
	Awareness of emotion	9	3	4	2
	Moving into <i>pratyahara</i>	5	4	3	1
	State of <i>pratyahara</i> – “sense of self”	10	4	5	1
Beyond <i>pratyahara</i>	<i>Dharana</i>	7	1	4	2
	<i>Dhyana</i> - absorption	3	1	2	1
	Connection with guru	4	2	3	1
Effect of meditation in everyday life	Meaning of life	6	3	6	4
	Coping	6	5	7	5
No. of participants		25	11	15	8

7.3.4.1 Cluster: Stages of *pratyahara*

When asked about their experiences during meditation practice, participants described the process of withdrawal of awareness from the outside world, and a turning inwards towards internal phenomena. Both teachers and students tended to use the language of the Yoga stage of *pratyahara*, described in Chapter 2. The following descriptions were given.

Theme: Awareness of outside world

The first step in the process of *pratyahara* is decreased awareness of the external environment, outside the body.

SYT:

A female SY teacher, 50s, 2nd cohort, reported: *“When I am doing guru mantra, with mala, awareness of breath up and down the spine, I’m not aware of the environment – just the inner space”*. Another female SY teacher, 50s, 2nd cohort, described it as: *“In meditation (guru mantra), I’m aware of the outside – but can’t move – don’t want to move – but it’s more that I can’t move”*.

YDLT:

A female YDL teacher, 56, said: *“In deep meditation, I lose awareness of the outside world”*

Theme: Awareness of body

The next stage is the reduced awareness of bodily sensations.

SYT:

A female SY teacher, 60s, 2nd cohort, described this as: *“As I get into meditation, my awareness of the body seems to disintegrate – and all I am aware of is what’s happening inside”*.

This experience was reported most commonly in mantra meditation. For example, a female SY teacher, 50s, 2nd cohort, said: *“During (guru mantra) meditation, I lose all sense of body – if I go deep. If not, I just do it as a routine thing, but even then, it keeps you centered”*. A male SY teacher, 50s, 2nd cohort reported: *“The initial process in mantra meditation that I feel is absence of body – the second is like a pure energy that is very pleasant – almost euphoric”*.

YDLT:

A male YDL teacher, 50s, said: *“In deep mantra meditation, I lose awareness of my body – my head is very much an open space – filled with this umbrella – not a thought – just heightened awareness”*.

Loss of awareness of the body was also reported in other meditation practices: a female SY teacher, 60s, 1st cohort, said: *“During ‘aum’ chanting, I completely lost body consciousness”*

Theme: Awareness of breath

When the mantra is synchronised with the breath, awareness of the breath remains, but participants reported changes in the nature of the breath.

SYT:

A female SY teacher, 60s, 2nd cohort, reported: *“As soon as I start, the breath changes – it quietens and becomes slower”*.

SYS:

A male SY student, 30s, said: *“I synchronise the mantra with the breath, so awareness of breath is there but the speed of the mantra depends on what the mind is doing”*.

YDLT:

A male YDL teacher, 30s, said: *“My mantra is quite long so a mala takes me about 15-20 minutes with one breath per mantra – but I usually speed it up and do two mantras per breath”*, and a female YDL teacher, 56, said: *“My mantra is a long one, so it’s half on the inhalation, half on the exhalation”*

Sometimes awareness of the breath is lost.

SYT:

A female SY teacher, 50s, 2nd cohort, said: *“The breath is very quiet when I use my personal mantra – I can go into it very quickly – and all of a sudden – whoosh – it expands out and I’m not aware of breathing – and I will sit in that space”*. A female SY teacher, 60s, 1st cohort, reported: *“The breath (during guru mantra) is just automatic – there is that pause at the top and bottom – which becomes longer and longer – and you gasp as you begin to breathe again”*.

YDLT:

A female YDL teacher, 40s, said: *“About halfway around the mala, I feel I am getting into the space – like everything stops and I don’t have any pain in the body – the breathing is really slow – it feels naturally very deep”*

When the mantra is practised independently of the breath, changes in the breath were still noticed.

YDLT:

A male YDL teacher, 50s: *“I used to connect the mantra with the breath, now I just focus on the mantra – using the breath allows too much space”*.

YDLS:

A female YDL student, 30, reported: *“I do guru mantra, but independent of the breath – the breath slows down – becomes very subtle”*. A female YDL student, 24, said: *“In Europe, we did the so ham mantra with the breath – then our teacher taught us to disconnect the breath from the mantra – sometimes I do my (guru) mantra without breath awareness, but sometimes I notice I am doing it with the breath”*

Theme: Awareness of thoughts

With the awareness turned inwards, participants became more aware of their thought processes.

SYT:

A female SY teacher, 50s, 2nd cohort, reported: *“You go through stages – sometimes you get a lot of thought intrusion – sometimes thoughts just come and go – a lot of my awareness is watching images”*.

YDLT:

A male YDL teacher, 50s, said: *“In the first few minutes, I have lots of voices competing with the mantra- distractions – sometimes thoughts – sometimes pictures”*. A female YDL teacher, 40, said: *“I have my moments where my thoughts keep coming in and getting in the road – other times when I feel I am quite disciplined”*.

As the meditation deepens, thoughts are reduced in intensity or, if present, are not as intrusive.

SYT:

A male SY teacher, 50s, 2nd cohort, described this process: *“Deep in the practice of japa, thoughts would appear as random, non-significant, based on memories from my life. I would say that language disappears as I move deeper into the practice – and memory is much more visual. So I can be there, aware of being immersed in the practice, then the visual experience of past events in my life comes through”*. Another male YDL teacher, 50s, expressed it as: *“Where the mantra sounds really deep – more like one big thought – rather than repetition – blends into one big thought – no break between it”*

YDLT:

A female YDL teacher, 31, reported: *“In meditation I’m conscious of thinking about who I believe God is – my image of God – if I have thoughts – I recognise them as thoughts”*. A female YDL teacher, 44, said: *“My meditation is very inquiry-based – my mind is very active – it slows down or goes to a more steady place – a good meditation is where I feel I get deeper self-awareness – a whole sense of that relationship between my perception of myself and the world”*.

Theme: Awareness of emotion

Some participants described their emotional state during meditation in terms of calm peacefulness without strong emotions. Other participants reported more heightened and blissful emotional states.

SYT:

A female SY teacher, 1st cohort, described the state as: *“I feel very balanced, really – calm”*.

A male SY teacher, 50s, 2nd cohort, said: *“The emotional state is generalised from your current emotional state – to some degree. As you go deeper into the practice, there is typically witnessing of the emotional state and if anything – detachment from the emotional state. I have rarely had the experience of the high end – of blissfulness – or profound spaciousness and pure light”*.

YDLT:

A female YDL teacher, 31, said: *“I just feel empty – not excited – not depressed – it just is – it’s a space and a freedom – that everything is OK as it is”*

A female SY teacher, 50s, 2nd cohort, said: *“My emotional state is fairly even - I can feel very, very happy - and I would put it down to that - happy with no external cause - you practise meditation because of what it does for you – it’s a very even conscious state – it’s like an inner smile, an inner contentment”*.

YDLS:

A female YDL student, 31, said: *“There are heaps of experiences– tears coming on – I have to keep swallowing – I go through a stage where I can hear clicking sound inside – I think just relaxing – I also notice my mind is wandering – my forehead is tense”*.

Theme: Transition to *pratyahara*

The process of moving into the state of *pratyahara* was described by two senior male Satyananda Yoga teachers, from the second “cohort”. The first said:

*“Well the first thing is to get beyond pain - because often you are aware of pain - from bad posture during the day - so if you can get beyond pain you are doing well - so you've managed to sit - in fact I find the first five minutes is spent simply in getting rid of excess stress in the spine and the spine gradually sitting up and settling - so most of the time that's as far as I get - if you can get beyond pain, *pratyahara* is not far beyond that – when I actually achieve some *pratyahara*, then it’s a state of getting re-energised and re-aligned within yourself – it’s not immediately a great and transcendental experience - you simply experience flipping out for a moment - but the overall effect of it in your life is very significant and what I’ve found is that my life has completely changed over these 30 years”*

The second described the process as:

“When everything is going right – there seems to be initially an externalized approach to the practice – where you are mechanically performing it – and then a point comes sooner or later, when there is almost a binary change in the experience – to a state of internalization. During that state, there is no separation between mind and body – the mind is perfectly focused on the task in hand and the body is totally immersed in performing the practice – a very clear awareness of movement of the point of awareness around the channel – actively feeling the movement of that point of awareness – going up the frontal passage – around – and back down the spine”

Participants from Yoga in Daily Life described the process in similar terms. A female YDL teacher, 45, said: *“I don’t use a mala – I use my breath and I remain connected with my breath – it’s through that – then I find longer and longer periods of nothing in particular – that I know I am being drawn to a place of deep peace and feel very centred”*. A female YDL teacher, 40, said: *“At the moment it takes nearly halfway around the mala before I feel I am getting into the meditation space – it just feels as though everything stops and I don’t have any pain in the body – the breathing is really slow and I’m not focusing on much – the breath feels naturally very deep”*.

Theme: State of *pratyahara* – change in sense of self

While in the state of *pratyahara*, the experience of one’s ‘sense of self’ is altered, being no longer defined by the connection to the outside world, body sensations or thoughts.

Satyananda Yoga teachers provided the following descriptions:

A female SY teacher, 50s, from the 2nd cohort, described it as: *“I’m aware of the outside but can’t move – all my senses are withdrawn inside me – nothing concerns me – I’m in bliss”*.

A male SY teacher, 50s, from the 2nd cohort, gave a longer description:

*“The awareness of ego diminishes, there’s an awareness of self at another level”. “An evolution to a second state – a sense of spaciousness would be how I would describe it – a deeper state of *pratyahara* – you’re aware of inner fluctuations of light – your body is no longer measured in meters – the body seems to have a vast inner space – and all of this is interspersed with fluctuations of the mind – thoughts that intrude”*.

Other descriptions were: female SY teacher, 50s, 2nd cohort: *“The experience that has been important to me has been the feeling of stillness”*; male SY teacher, 50s, 2nd cohort: *“A loss of a sense of space and time – but still a level of awareness”*

The sense of identity changes. A male SY teacher, 50s, 1st cohort, described this as:

“I’m more conscious of my inner state, more conscious of who I am. The sense of myself is different, but very hard to articulate – it feels like a separation from the world, like a withdrawal, a diminishing of sensory perception, a dissolution of my persona – a disengagement from the world”.

Another male SY teacher, 60s, from the 2nd cohort, said:

“I don’t see “duckies” and “horsies” – I’m not really a great visualiser of things – but often I have a deeply refreshing experience – where you are gone for a split second but an eternity – totally withdrawn from the world”. A female SY teacher, 3rd cohort, said: *“I describe the state of meditation as - suspension – diffusion – suspension of reality – time, space – the outside – light-headedness – stillness – it’s putting yourself into that conduit”.* Another female SY teacher, 50s, 2nd cohort, said: *“a clarity - just aware of inner space – it’s like an inner smile, an inner contentment”*

Yoga in Daily Life teachers reported similar experiences.

A male YDL teacher, 30s, said:

“It’s like standing on a precipice – about to disappear – the recognition that it is about to happen pulls me back”.

A female YDL teacher, 45, said:

“At good times – as soon as I sit down to meditate there is an inner change – it feels really still – and unattached from your body – quite soon – an expansiveness – very peaceful in the heart – that’s the bit I enjoy most – the peacefulness - words like centered – undisturbed – peaceful – but sometimes not even peaceful – just nothing – like an emptiness – a void – doesn’t necessarily last a long time – sometimes momentary – for me that’s what nurtures me”.

Summary

Many of the phenomenal accounts of meditation described the process of moving from externalised awareness to a peaceful calm state of *pratyahara*, undisturbed by body sensations, and thoughts, with diminished awareness of breath and sometimes an experience of bliss. In this state, one’s sense of self becomes more diffuse, with a sense of expansion of internal space and a slowing of time.

7.3.4.2 Cluster: Beyond *pratyahara*

Theme: *Dharana* – concentration

In distinction to the descriptions of *pratyahara*, only the teachers from both traditions provided accounts of deeper meditation states of *dharana* and *dhyana*.

In the Yogic stage of *dharana*, the awareness becomes focused and concentrated on the meditation object.

A male YDL teacher, 56, said:

“I can describe what I see - it’s a kind of a bit of movement – like a light spot then it travels away – then gets still – if I concentrate on it – it continues to vanish – sometimes a bit of colour – more a blue light – comes from the periphery – then moves to a point”.

A female YDL teacher, 40, said:

“I have moments when I feel I am in a lot of light – but it doesn’t happen all the time – happens for a couple of months, then it disappears”.

Theme: *Dhyana* – absorption

Dharana becomes *dhyana* when the absorption in the meditation object becomes continuous. Descriptions from Satyananda Yoga teachers include:

A female SY teacher, 60s, from the 2nd cohort, described her awareness of the mantra:

“I’m just aware – it’s just there – it’s not in my head – it’s everywhere – it vibrates – in every particle – I’m aware there is stuff going on – but it is outside the psychic aura”.

The focus is sometimes the visualisation of a psychic symbol, given by the guru at the time of initiation.

A male SY teacher, 50s, from the 2nd cohort, said:

“Often at the end of meditation, there can be a clarity of visualization – when I bring in the symbol – it can be quite clear – in the actual meditation, there is the experience of absorption in the mantra and awareness of the psychic passage”.

A male SY teacher, 50s, from the 2nd cohort, described the resultant alteration in the sense of self:

“(Meditation is) a state of self- of being – with no attributes – where everything in the world has gone – whatever your thoughts have been during the day – whatever your impressions – for this period of time – which can go from one minute to ten minutes – there’s no thought. I don’t know whether it is dhyana or samadhi, but there is no effort – no concentration - no dharana - everything goes away completely – no impressions

stick to you – even if you were in a depressed or angry state going into meditation, you come out basically joyful”

Theme: Connection with guru

In this state of absorption, the connection with the guru can become a focus of awareness.

A senior female SY teacher, from the 1st cohort, described this experience:

“My awareness of myself totally changed – you become like the cells in the body – just energy – nothing but energy – the mantra goes on all the time – once the mantra becomes one-pointed – then immediately I see Swamiji (Swami Satyananda)”

A number of Yoga in Daily Life teachers reported similar experiences.

A male YDL teacher, 41, said: *“Part of the shift is that I feel closer to Swamiji (Swami Maheshwarananda) – sometimes memories will come up of moments with him – sometimes his facial features – meditation for me is almost guiding me towards Swamiji – so the process is to get rid of the noise that keeps me separate”*.

A female YDL teacher, 63, said: *“In deep mantra meditation, there is a connection to Swamiji – that’s increased a lot lately – that’s where my awareness is – I realise that my step now is the heart opening – compassion all the time”*

The sense of self then moves beyond its individual expression. A Male YDL teacher, 50s, expressed this:

“Now in meditation I get a sense of connection to something much bigger than me – I have had to let go of my egoistic attachment to “me” being the highest form of me – I had a lot of trouble accepting that there was another level that I couldn’t comprehend – meeting Swamiji (Swami Maheshwarananda) was the bit that got me through that – it’s still happening – I’m still grappling with it really – but recognizing that – when I do meditate – and get through all the pictures and sounds – it’s going into something bigger than me”

Summary

In experiences of *dharana* described by SY and YDL teachers, the awareness becomes concentrated and focused on the object of meditation. In *dhyana*, the awareness of self becomes absorbed into the meditation object. The connection with the guru in this state can expand the sense of self beyond its individual expression, giving a sense of a higher reality.

7.3.4.3 Cluster: 'Trait' effects of meditation in everyday life

Theme: meaning of life

Many participants reported that their experiences during meditation provided them with the fulfillment of the search for meaning in life that led to explore meditation.

SYT:

A male SY teacher, in the 2nd cohort, 59, said:

"I think meditation is joy and love and happiness and wisdom – I think this is who we really are – I think meditation is simply, basically becoming who we really are – which is love essentially. By stopping the mind – when you touch your essence – you become that – you emulate that – and your life manifests that – everything happens as it should – so very little can disturb you".

A female SY teacher, from the 2nd cohort, 50, said: (meditation is)

"An ability to tap into that inner resource of stillness and calmness when required and hopefully that can become more a part of one's life"

Theme: Coping with life

This awareness provides a perspective from which to view life experiences.

SYT:

A male SY teacher, from the 2nd cohort, 60, described the effect of meditation: *"It is the most important thing to me – the effect on my daily life – that's how I measure it – whether I see "duckies" and "horsies" doesn't matter – but if it has a positive effect on my day then I think it is going well".* A female SY teacher, 2nd cohort, 56, said: *"it helps get me through the day – it allows me to be the witness – just watching – observing yourself and others"*

SYS:

Satyananda Yoga students also reported positive on their ability to cope with everyday life. A female SY student, 32, reported:

"Two effects on life really – the first is to add balance – creates that space to step back – the second part is just the creative aspect – opening to what can happen or what is going on – becoming lucid to other areas of subtlety – like energetic healing".

A male SY student, 38, said:

"It gives me clarity of thought – enables me and heightens my ability to witness – the stability to rationalize what's happening rather than just getting lost in the thoughts and emotional reaction – I tend to have high emotional reactions – it does give great stability. I notice a difference if I don't practise my mantra before sleep – with the mantra I get more restful sleep and the dreams aren't as erratic – just brings them down".

YDLT:

Similar comments were made by the Yoga in Daily Life participants. A female YDL teacher, 40, said: *“I’m only just starting to feel like it is helping – I’ve been teaching for a long time – and burning out a lot – but starting to feel like I am coping much better – I feel it is the meditation, it gives me a balance”*.

Another female YDL teacher, 56, said:

“A complete transformation of myself- I don’t have any headaches anymore – I have the ability to share with others what I know – that gives me a stillness. A more fulfilling life – destructive habits fall away – conscience is very clear – paths seem to open up for you when you start this change – it’s like you just need to walk the steps”.

YDLS:

YDL students also reported benefits. A female YDL student, 62, said: *“It has had a dramatic effect on my life – in awareness. I couldn’t imagine life without it”*. Another female YDL student, 42, said: *“I have developed a lot of tolerance – I used to fly off the handle very quickly – that level of emotional response has dampened – softened. Meditation gives a sense of connectedness and a sense of wonder”*. A third female YDL student, 24: *“I feel meditation provides clarity even after the meditation practice – in my whole life – a better understanding of myself- everything is more clear”*

Summary

The experiences in deeper meditation states provided participants satisfied a need for meaning in life. Meditation provided the basis for balance and clarity from which to manage the stress of everyday life.

7.4 Discussion

7.4.1 ‘Person’

The study of Australian Satyananda Yoga *sannyasins* conducted in the late 1980s (Aveling 1991) found most mainstream religious denominations were represented in their background, with a slight dominance of Catholicism. This data aligns with the profile found in the present study for Satyananda Yoga teachers and Yoga in Daily Life teachers and students. A web-based national survey of Yoga practitioners in Australia (Penman 2008) found a lower frequency of mainstream denominations, with 36% identified themselves as “spiritual but not religious”, and 19% as “secular”. Only 29% were Christian, and 2% Jewish. This profile is similar to Satyananda Yoga students in my study.

Participants did not find their search for a ‘deeper’ meaning in life was satisfied by established religions, instead finding meaning in contact with nature, the use of ‘mind-altering’ drugs, and the influence of ‘spiritual’ people. The increasing availability of Yoga in

Australia provided an alternative path. The two reasons given for beginning Yoga in Aveling's study – "a search for a meaning in life" (mainly men) and "the desire to be healthy" (mainly women) (Aveling 1991) (p224) remained relevant for my study. The recent survey of Australian Yoga (Penman 2008) (p151) found the primary reasons for students to begin Yoga were "increase health and fitness" (72%) and "increase flexibility" (70%). While Penman found these remained as the two main reasons for students to continue Yoga practice, the category "spiritual path" increased from 19% as a reason to begin Yoga to 43% as a reason to continue Yoga.

This transition is illustrated by a personal quotation by Asha Perrson:

"Like many people who take up Yoga, I was looking for a gentle form of exercise, and something to help me relax and cope with life. I also wanted to satisfy other needs, a kind of nebulous yearning for something 'other' or something 'deeper', which I loosely labeled 'spiritual'" (Persson 2000).

Although the majority of participants received their Yoga/meditation in only one tradition, a substantial number explored other meditation traditions prior to settling with one Yoga school. For these, experimenting with different approaches allowed the opportunity to find the tradition in which they felt most comfortable. Another factor may be the transition of Yoga from an 'alternative' lifestyle in the 1970s to the status of accredited national training in the 2000s, becoming more accessible and acceptable to mainstream Australian society.

Once established at the Yoga school, participants' meditation practice (primarily mantra) became regular, with some fluctuation with life events. From the information provided by the participants, their total hours of practice can be estimated. This provides a more accurate measure than the number of years of practice.

7.4.2 'Practice'

Despite receiving training in a number of meditation techniques, for most participants, mantra meditation became their daily practice, most often with their guru mantra. The majority repeated the mantra in synchrony with the breath, with the aid of a *mala*. This finding coincides with the Yoga survey results that the two most popular meditation techniques were "breath" (any form) (95%), and "mantra" (64%) (multiple responses possible) (Penman 2008).

Differences between the traditions were that while Satyananda Yoga participants tended to practise a number of *kriyas* for limited periods, the individual *kriya* practice given to advanced Yoga in Daily Life participants became a strict daily routine. SY participants continued to

practice frequent Yoga Nidra and the 'mindfulness' awareness of *antar mouna* in their everyday life.

7.4.3 'Phenomenology'

The phenomenological descriptions given by participants of experience during meditation tended to follow the sequence and use the language of Patanjali's stages of *pratyahara*, *dharana* and *dhyana*.

Both teachers and students described their experiences of *pratyahara* in similar terms. It involved a sequence of – diminished awareness of outside world – diminished awareness of body sensation – varying awareness of breath, depending on type of practice – varying awareness of thoughts, depending on the practice, but usually become more peripheral in awareness, less intrusive – neutral or positive emotional state – leading to a place of stillness and spaciousness, accompanied by a less 'ego-bound' sense of self.

In distinction, only teachers gave descriptions of experiences in deeper states. In *dharana* there is diminished awareness of self and an experience of absorption in the object of meditation, becoming continuous in *dhyana*. In this state, there is often an intensified awareness or sense of presence of the guru.

Reported effects lasting beyond the meditation session included: a clarity of perception, a 'witnessing' sense of self, accompanied by an emotional detachment allowing a more compassionate and less reactive response to challenging situations.

A 'transcending' of the usual 'sense of self' was found to be an "invariant" component of the phenomenology of 'deep' meditation in an Australian study of meditators from a number of traditions (Gifford-May & Thompson 1994). Descriptions included a "dissolution of self", "loss of awareness of the body's boundary", "a merging with the breath, the focus of meditation", "a lack of awareness of the self as an individual".

7.5 Implications for this project

This qualitative study provided information on the cultural background of practitioners of Satyananda Yoga and Yoga in Daily Life in Australia, the domain of 'Place'. Within this context, the personal history and 'lived experience' of practitioners was described, detailing their adoption of Yoga as a spiritual disciple ('Person') and their development of regular meditation practice as part of their daily Yoga routine ('Practice').

Their descriptions of their experiences in the meditation state and changes in 'sense of self' ('Phenomenology') were expressed in the language of Patangali's stages.

The results of the qualitative study provided detailed information of the independent variables of proficiency and type of practice for the following quantitative studies.

CHAPTER 8 – SELF-REPORT MEASURES

This chapter describes the Self-report Questionnaire used in the following quantitative studies. This questionnaire was administered following the EEG recording sessions. See Appendix 9 for details.

8.1 Phenomenological mapping of meditation states

In keeping with the requirements for neural correlates of consciousness, some researchers see a goal of meditation research as linking a particular (subjectively experienced) meditation state to an isomorphic neurophysiological state (Fell, Axmacher & Haupt 2010). The phenomenological mapping of meditation states provides the framework for establishing the first requirement – a unique specification of the subjective state. The second requirement is the specification of a discrete altered brain state, described as “*a discrete change in the dynamics which regulate the spatial and temporal flux of physiological brain states*” (Jamieson & Hasegawa 2007) (p142).

To assist research into the “*plenitude of disparate and seemingly irreducible phenomena*”, Vaitl and colleagues reviewed lists of basic dimensions of characteristics of altered states of consciousness (ASCs), from which they proposed “a four-dimensional descriptive system”, into which most ASCs described in their review (Chapter 3) could be embedded.

The dimensions were:

- “*Activation*” represented subjectively by a continuum from high arousal (excitement, agitation) to low arousal (relaxation, inertia).
- “*Awareness span*” can vary from narrow, focused attention to broad extended awareness.
- “*Self-awareness*” can vary from “forgetting oneself” in absorption to an intensified feeling of one’s unique being.
- “*Sensory dynamics*” refers to the sensory and perceptual aspects of the experience, with variation from reduced sensation to heightened richness and vividness.

Specific ASCs are considered to occupy a particular region of this four-dimensional ‘state space’. Each dimension covers a continuum within which a particular ASC can be located.

Table 15 illustrates the range of dimensions for psychologically induced ASC.

Table 15 – Phenomenological mapping of ASC

Induction method	Activation (+ aroused - relaxed)	Awareness span (+ wide - narrow)	Self-awareness (+ present (- absent)	Sensory dynamics (+ increased (- decreased)
Sensory deprivation	-	+	+/-	-
Rhythm induced trance	+	+	-	-
Relaxation	-	-	+	-
Meditation	+/-	+/-	+/-	+/-
Hypnosis	+/-	+/-	+/-	+/-

(Extract from Vaitl et al, 2005) (p115)

For example, different meditation practices may be at different points along each dimension, enabling a ‘phenomenological’ classification system. Most passive meditation practices, while using low physical activation, require a balance of mental excitation and inertia.

8.2 Mapping of meditation practices

Using this four-dimensional system, the Satyananda Yoga practices used in this project can be located in different ‘state-spaces’, as shown in Table 16.

Table 16 – Phenomenological dimensions of Satyananda Yoga meditation practices

Meditation practice	Activation Aroused + Relaxed -	Attention Span Wide + Narrow -	Self-awareness Enhanced + Reduced -	Sensory dynamics Increased + Decreased -
Kaya stairyam	-	+	+	+
Mantra	-	-	-	-
Antar Mouna Stage 2 (Watching thoughts)	-	+	+	-
Antar Mouna Stage 4 (Dissolving thoughts)	-	-	-	-

From this classification, the dimension of ‘Attention span’ was included in the Self-report Questionnaire, as a bipolar scale, with rating from -9 to +9. See Appendix 9 for details. This dimension corresponds to the classification of practices into ‘Focused attention’ (FA) and ‘Open monitoring’ (OM) proposed by Lutz et al (2008).

According to this classification, *Kaya stairyam* and *Antar mouna* stage 2 could be considered as OM practices, with a ‘wide’ attention span, in contrast to Mantra (japa) and *Antar mouna* stage 4 as FA practices (Vivekananda 2005).

8.3 Mapping of *pratyahara* dimensions

The specific phenomenological dimensions of Patanjali’s stage of *pratyahara* have been detailed and mapped against a number of Satyananda Yoga practices by Swami Niranjanananda (private correspondence 2009). This relationship is shown in Table 17.

The column “*Pratyahara* stage” describes the sequence of progressive shift in awareness from external to internal stimuli. The greyed areas in the “Stage of practice” columns list the

stages of Satyananda Yoga practices corresponding to these *pratyahara* stages. The purple coloured cells are the particular practices used in the following quantitative studies.

Table 17 – Pratyahara stages and Satyananda Yoga meditation practices

Pratyahara Stage	Description	Stage of Practice			
		Kaya Stairyam (Body steadiness)	Yoga Nidra	Antar Mouna	Mantra with breath
1. Body awareness	Awareness of posture, body parts, sensations	Stage 2: Awareness of posture Stage 3: visualisation of body	Stage 1: Preparation	Preparation	Preparation
2. Breath awareness	Awareness of breath, breath counting	Stage 10: Breath awareness	Stage 4: Breath awareness	Preparation	Preparation
3. Sensory awareness	Awareness of superficial, deeper, particular sensation	Stage 5: Awareness of body sensations Stage 6: Awareness of body parts	Preparation	Stage 1: Awareness of external sensations	Preparation
4. Withdrawal of awareness into mind	Awareness to front of closed eyes – watching mind Mantra-japa at eyebrow centre or breath at nostrils	Stage 10: Breath awareness	Stage 3: Rotation of awareness	Stage 1: Awareness of external sensations	Practice
5. Sensory awareness from immediate past	Spontaneous sensory impressions of immediate past		Stage 4: Breath awareness Stage 5: Opposites of sensations	Stage 2: Awareness of spontaneous thoughts	Practice
6. Thought awareness from immediate past	Spontaneous awareness of thoughts from immediate past		Stage 6: Visualisations	Stage 2: Awareness of spontaneous thoughts	Practice
7. Thoughts triggered by memories	Among thoughts of immediate past – an unrelated thought from memory – observe it		Stage 6: Visualisations	Stage 2: Awareness of spontaneous thoughts	Practice
8. Awareness of thought pattern	Thoughts that are linked				Practice
9. Awareness of type of thought	Past, present, future; family, work, friends, pleasure etc				Practice
10. Awareness of present feeling	Just the feeling, without any thought		Stage 5: Opposites of feelings		Practice
11. Awareness of feeling component of thought	Feeling linked with present thought – rajas, tamas, sattwa		Stage 5: Opposites of feelings		Practice
12. Awareness of habitual pattern of thoughts and feelings	As per stages 9 and 11				Practice
13. Creation of thoughts and feelings opposite to pattern	Bringing up opposite linkage				Practice
14. Awareness of chosen thought	Developing thought in chosen direction			Stage 3: Creation and disposal of thoughts at will	
15. Awareness of any spontaneous thought	Developing spontaneous thought in chosen direction			Stage 4: Awareness and disposal of spontaneous thoughts	
16. Just simple awareness	Of thought or thoughtlessness			Stage 5: Awareness of inner space	

Swami Niranjanananda, private correspondence (2009)

8.4 Self-report questionnaire

The Self-report Questionnaire used for the following EEG studies incorporated some of the rating scales for *pratyahara* dimensions from Table 15.

Using a ten-point scale, the dimensions used were:

- Perception of the outside world (awareness of outside sound, external environment)
- Awareness of body (awareness of posture, body parts, sensations)
- Awareness of breath (awareness of movement of breath from nostrils to lungs)
- Awareness of feeling (awareness of feeling state, from negative to positive emotions)
- Awareness of thought (awareness of the presence of thoughts, regardless of content)

8.5 ‘Meditation depth’

As noted in the literature review, there has been little use of subjective scales for recording the phenomenological experience of meditation. The most frequently used dimension was an undefined ‘meditation depth’, recorded on a 10 point scale (Cahn, Delorme & Polich 2010; Berkovich-Ohana, Glicksohn & Goldstein 2012).

The dimensions of ‘meditation depth’ were explored in a questionnaire developed by Ulrich Ott, derived from interviews with TM, Yoga and Buddhist meditators (Ott 2001). A factor analysis of 300 responses produced three major factors:

- ‘mystical experience’ – (25% of variance) - included items of positive feelings of love, joy and happiness, connection with a higher being, unity with inner self and others
- ‘nirvana’ - (16% of variance) – included items describing total vanishing of thoughts, feelings, sensations, ego, resulting in state of pure awareness and deep absorption
- ‘mental and bodily relaxation’ – (16% of variance) – related to reduction of stress, slowing of breath, reduction of muscle tension

Ott (2001) concluded that ‘meditation depth’ is not a “one-dimensional construct”. His questionnaire provides the means to assess a number of dimensions of meditation depth in a particular session and associated changes in subjective experience.

The descriptions of the phenomenal experiences during meditation can be linked with the factors identified by Ott (2001). His factor of ‘nirvana’ (described as “total vanishing of thoughts, feelings sensations and even ego” seems to correspond to the experiences of *pratyahara*. The factor of ‘mystical experience’ (described as “feelings of love, contact with a

higher force, feeling united with others and inner self, experiences of energy and light”) can be linked to *dharana* and *dhyana*.

8.6 Graphical scale for subjective reporting of ‘meditation depth’

Based on Ott’s work, the following graphical scale (Figure 6) was used in the following EEG studies for subjective reporting of ‘meditation depth’.

Figure 6 – ‘Meditation depth’ scale

Please describe the depth of your meditation by drawing a continuous line from the starting point to the end point (drawing down to indicate greater depth or absorption in meditation) (Adapted from Ott, 2001)

Start	Outside sounds	Meditation 1	Meditation 2	Meditation 3	Meditation 4	End
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

8.7 Measurement of ‘Absorption’

As described in Chapter 2, ‘absorption’ is considered to represent a personality trait determining ease of entering altered states of consciousness (such as meditation) and to have inherent correlates in phenomenal experiences in those states. A study of Yoga meditators found the trait ‘absorption’ had a higher influence on ‘meditation depth’ than did the amount of meditation practice (Holzel & Ott 2006).

The original questionnaire developed to measure ‘absorption’, the Tellegen Absorption Scale (TAS), was modified following a factor analysis of its structure into a form using a 5 point scale instead of ‘true/false’. This scale was called MODTAS (Modified TAS) (Jamieson 2005). Factor analysis of this modified scale identified five primary factors.

These were named:

“Synesthesia” defined by “items in which experience in one sensory modality is associated with experiences in another modality”.

“Altered States of Consciousness” comprised of “items which involve profound alterations in one’s sense of self or reality”.

Aesthetic Involvement in Nature” defined by “items such as “I am deeply moved by a sunset” and are predominantly visual in modality”.

“Imaginative Involvement” defined by “items which tap deep involvement in vivid imaginative experiences”

“Extra Sensory Perception” items having “the theme of at least apparent, ESP experiences (Jamieson 2005). For details of the MODTAS scale see Jamieson (2005).

The MODTAS scale was used in the following EEG studies as a measure of ‘trait’ absorption.

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CHAPTER 9 - STUDY 2 – COMPARISON OF TRADITION

9.1 Introduction

This study compares Australian Yoga practitioners from two different but similar traditions – Satyananda Yoga (SY) and Yoga in Daily Life (YDL). Participants were volunteers from those who participated in the qualitative study (Study 1). The study was limited to a comparison of the two teacher groups, as technical problems were experienced with the EEG recordings of the YDL student group.

From the results of the qualitative study, the following similarities between the two groups of Yoga teachers were considered to include:

- All had similar background in Christian upbringing but some disillusion with established religion in their search for ‘meaning in life’, leading to an interest in Yoga.
- All received their Yoga training primarily within the one tradition.
- All were Yoga teachers, teaching and practising an ‘integral’ style of Yoga, comprising *asana*, *pranayama* and meditation.
- All practised meditation within a spiritual context, under the guidance of the teachings of a guru.
- All practised mantra meditation, using their ‘guru mantra’ with the aid of a mala, synchronised with breath rotation, as their main daily meditation practice. This practice could be classified as ‘Focused attention’ (FA)
- All practised other forms of meditation, including group chanting of mantras.

Differences between the two groups were considered to include:

- Five of the six SY teachers had been initiated into *poorna sannyas*, spent some time in India, and were residing and teaching in *ashrams* in Australia. The other SY teacher was a *karma sannyasin* living and teaching Yoga in the community.
- All of the YDL teachers were living in the community.
- The Satyananda Yoga meditation training received by the SY teachers tended to be more varied and less systematic than the Yoga in Daily Life Training.
- Although both traditions include intense *kriya* practices, the SY teachers had practised these in blocks of practice in the past and they were not part of current practice.
- In distinction, the YDL teachers currently practised one *kriya* daily on a regular basis, leading to a more intense meditation state experience.

- SY teachers had been practising meditation for longer (mean 30 years) compared to YDL teachers mean of 14 years.
- Although both groups spent similar times in daily Yoga practice, the YDL teachers spent more time in silent 'mantra' practice than the SY teachers.

From these similarities and differences, the following hypotheses were formulated:

- 1) The YDL teachers will show higher scores on subjective ratings of 'meditation depth' and greater activity in neural networks associated with greater meditation 'depth' in mantra meditation due to their more intensive daily practice. Based on previous correlation of 'depth' in Yoga mantra (FA) meditation (Aftanas & Golosheikin 2003), the YDL teachers are predicted to show an increase in power in the theta band in midline frontal regions, associated with increased activity in the anterior cingulate cortex (ACC)
- 2) The SY teachers will show higher scores on the 'trait' absorption scale (MODTAS) and greater activity in neural networks associated with 'trait' effects of meditation due their greater immersion in ashram Yogic lifestyle. Based on the findings of Tei et al (2009), whose Qigong meditators practised both FA and OM meditations, the SY teachers are predicted to show more higher activity in the delta band in the prefrontal cortex and ACC than the YDL teachers in a non-meditation condition, indicative of a neuroplasticity effect of greater trait 'detachment' or 'witnessing' attitude persisting beyond meditation practice.

EEG (and brain imaging) meditation studies have usually compared the meditation practice to "eyes-closed rest" (ECR), leading to a recent trend to interpret meditation effects as a modulation of the operation of the "default mode network" (DMN) (Berkovich-Ohana, Glicksohn & Goldstein 2012), which is predominant in this condition. To clearly separate the effects of meditation from the operation of the DMN, the present study used a mental calculation non-meditation condition, similar to that of Ott (2001).

9.2 Method

9.2.1 Participants

The study protocol was approved by the RMIT University Science Engineering & Technology Portfolio Human Research Ethics Sub-Committee as a Level 2 proposal (participants considered not to be exposed to physical, psychological or social risk above the everyday norm, but may contain slight risk). Six 'Satyananda Yoga' (SYT) teachers and six 'Yoga in Daily Life' (YDLT) teachers were recruited for the study. All the SY teachers had received initiation as *sannyasin* disciples of Swami Satyananda of Munger, India and had received a personal mantra from him which they used in the 'Mantra' practice. All the YDL teachers had

received *mantra diksha* initiation from Swami Maheshwarananda, with a personal mantra which they used in the 'mantra' practice. All were free from medical, psychiatric or drug usage issues that might alter their brain functioning.

The SYT group consisted of three males and three females, age range from 44-63 years (mean 54 years, SD 6.5 years). All were right-handed. The group had a mean of 30 years regular practice (range: 24-37 years). From the information on duration of daily practice provided in the qualitative study, this equated to a mean of 10,600 hours (SD = 3200hours) of meditation. The YDLT group consisted of three males and three females, age range 40-63 years (mean age 51 years). All but one was right-handed. The YDLT group had a mean of 14 years regular practice (range: 10-17 years). From the information on duration of daily practice provided in the qualitative study, this equated to a mean of 6,000 hours (SD = 2200 hours).

9.2.2 Setting

The study was conducted in a non-laboratory setting to provide an 'ecologically valid' situation conducive to the attainment of deep meditation states. Small meditation rooms at Satyananda Yoga Academy (Mangrove Creek, NSW) and the Yoga in Daily Life Annandale (NSW) centre were used. After being fitted with the Compumedics 32 channel EEG 'Quik Cap', participants sat in their usual cross-legged meditation position on the floor, supported by cushions, with the room dimly lit by a candle on a meditation table. The battery-operated Compumedics 'Siesta 802' recording unit attached to the 'Quik Cap' was the only electronic device in the meditation room. This unit transmitted signals by radio to a laptop computer in an adjacent room.

9.2.3 Procedure

Participants were given the Plain Language Statement (Appendix 4) and when satisfied, signed the Consent Form (Appendix 5b)

The experimental conditions were:

- Non-meditation condition – 'Calculation' - mentally counting backwards from 200 by 4 – (5minutes)
- Meditation – 'Mantra' - mental repetition of personal mantra, using mala (beads) – (SY practice *japa*, YDL practice 2.2) – (10minutes)

All conditions were performed in the meditators' usual cross-legged meditation posture, with eyes closed.

9.2.4 Subjective measures

Following the EEG recording, participants completed the 'Self-report Questionnaire' form devised specifically for this study. This consisted of a graphical representation of 'meditation depth' on a 10 point scale and ratings on a 9 point scale of 'attention span', perception of outside world', awareness of body', 'awareness of breath', 'feeling', 'thought content', 'thought intrusion', and 'imagery'. See Appendix 9 for details. A short interview was conducted to record participants' experiences.

9.2.5 Measurement of trait 'absorption'

Following the session, the participants completed the Modified Tellegen Absorption Scale (MODTAS) (Jamieson 2005).

9.2.6 EEG Data collection

EEG signals were obtained using a Compumedics "Quik Cap" from 25 scalp electrodes, based on the International 10/20 system, referenced to left mastoid. Electrodes were placed at FP1, FP2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6, Fz, Cz, Pz, Oz, TP7, TP8, CP3, CP4, FC3. Four additional channels were allocated to eye movement detection, with electrodes positioned on the outer canthi of each eye and above and below the left eye. The sampling rate was 256Hz. Data was acquired via radio signal to a laptop computer running Compumedics Profusion EEG software.

9.2.7 EEG Data pre-processing

Following the recording session, the data was exported from the Profusion EEG in EDF format for input into the EEGLab (Delorme & Makeig 2004) program running in Matlab. Data was processed through the FASTER algorithm (Nolan, Whelan & Reilly 2010) to clean the signal from sources of artifact including eye movement and blink artifacts, electrode pop-offs and drift, shifting electrodes and residual white noise. FASTER interpolated missing or bad channels, re-referenced to the common average and applied a bandpass filter of 1 to 45 Hz. FASTER employed independent components analysis for detection and removal of signal artifacts. Z-score thresholds for rejecting artifactual components were set at 3.0 (except for eye movement, which was set at a threshold of 1.8). EEGLAB version 9 (Delorme and Makeig, 2004) was employed for criterion-based artifact rejection of epochs with values greater than ± 75 mV.

Ten sample epochs, each of five seconds duration, were extracted for the first 5 minutes of each condition for each participant from the cleaned datasets, commencing 100 seconds from the start of the practice and then at 20 second intervals. If a selected epoch showed

residual artifacts on visual inspection, the subsequent 5 second epoch was selected. The epochs were analysed using a user defined frequency allocation into bands of: delta (1-4Hz), theta (4-7.5Hz), alpha1 (8-10Hz), alpha2 (10-12Hz), beta (12.5-25Hz), and gamma (25-42Hz).

Precautions were taken to ensure the gamma band analysis was not confounded by electromyographic (EMG) muscle activity or eye-saccades artifacts. All conditions were conducted with the eyes closed. Each epoch was visually inspected for artifacts and the cut-off frequency for gamma was set well below the EMG frequency range, which peaks at 70-80Hz (Lutz et al, 2004).

9.2.8 EEG Source analysis

Based on the scalp-recorded electric potential distribution, the exact low resolution brain electromagnetic tomography (eLORETA) software (publicly available free academic software at <http://www.uzh.ch/keyinst/loreta.htm>) was used to compute the cortical three-dimensional distribution of current source density (CSD). The eLORETA method is a discrete, three-dimensional (3D) distributed, linear, weighted minimum norm inverse solution. The particular weights used in eLORETA endow the tomography with the property of exact localization to test point sources, yielding images of current density with exact localization but low spatial resolution (neighboring neuronal sources will be highly correlated). The description of the method together with the proof of its exact zero-error localization property, are described in two papers by Pascual-Marqui (Pascual-Marqui 2007; Pascual-Marqui 2009). It is important to note that eLORETA has no localization bias even in the presence of structured noise which constitutes an improvement over the previous tomographies of LORETA (Pascual-Marqui, Michel & Lehmann 1994) and the standardized version sLORETA (Pascual-Marqui 2002). Correct localisation of deep structures is important in the assessment of differences between the participant groups (Zumsteg et al. 2006; Pizzagalli et al. 2001).

Current eLORETA computations were made in a realistic head model (Fuchs et al. 2002), using the MNI152 template (Mazziotta et al. 2001), with the three-dimensional solution space restricted to cortical gray matter, as determined by the probabilistic Talairach atlas (Lancaster et al. 2000). Standard electrode positions on the MNI152 scalp were taken from Oostenveld and Praamstra (2001). The intracerebral volume is partitioned in 6239 voxels at 5 mm spatial resolution. These eLORETA images represent the electric activity at each voxel in Montreal Neurological Institute (MNI) space as the exact magnitude of the estimated current density. Anatomical labels as Brodmann areas are reported using MNI space, with correction to Talairach space (Brett, Johnsrude & Owen 2002).

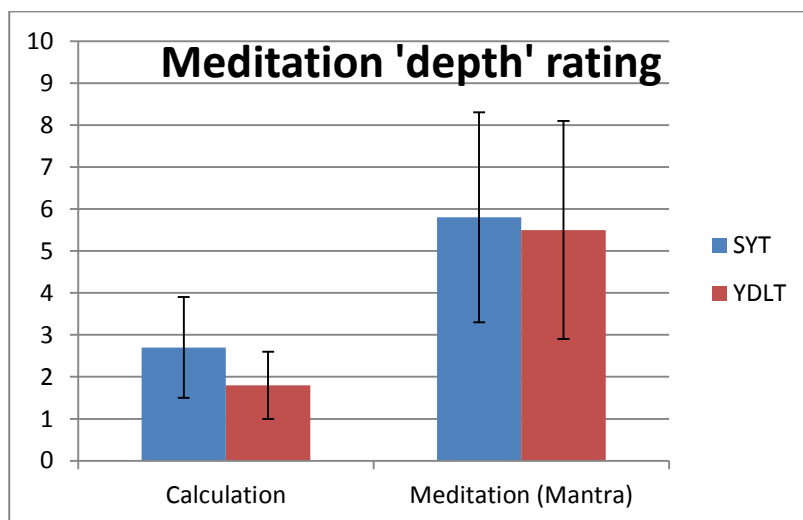
The eLORETA software package was used to perform these statistical analyses. The methodology used is non-parametric. It is based on estimating, via randomization, the empirical probability distribution for the max-statistic (the maximum F statistic), under the null hypothesis. This methodology corrects for multiple testing (i.e. for the collection of tests performed for all voxels, and for all discrete frequencies). Due to the non-parametric nature of the method, its validity need not rely on any assumption of Gaussianity. The reader is referred to Nichols and Holmes (2002) for a detailed overview of this methodology.

9.3 Results

9.3.1 Meditation self-report measures

The subjective ratings of ‘meditation depth’ are shown in Figure 7. This was a graphical representation of ‘depth’ of meditation in the two conditions. For details see Chapter 8.4 to 8.6. Figure 7 shows the mean ratings for the greatest depth in each condition for each participant group.

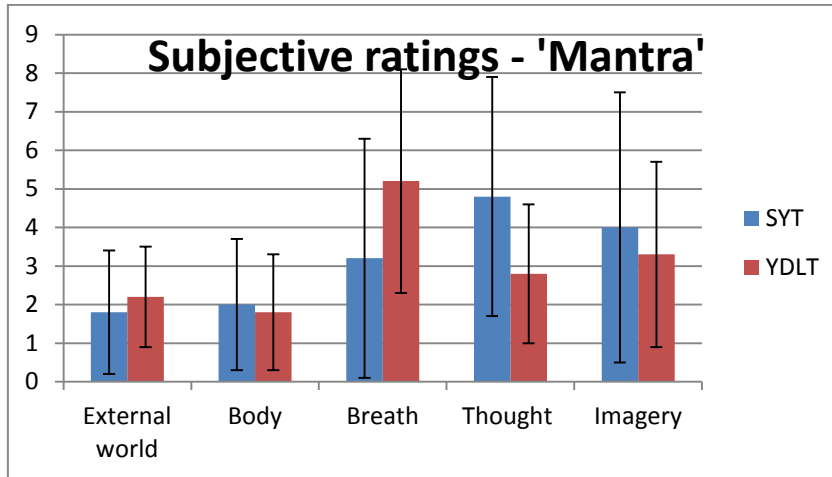
Figure 7 – Study 2 – ‘Meditation depth’ ratings



The ratings by both groups on ‘meditation depth’ were similar, with a moderate level of ‘depth’ in the meditation condition. A low level of ‘meditation depth’ was reported even in the non-meditation condition (Calculation).

The subjective ratings on ‘Meditation dimensions’ are shown in Figure 8.

Figure 8 – Study 2 – ‘Meditation dimensions’ ratings – ‘Mantra’

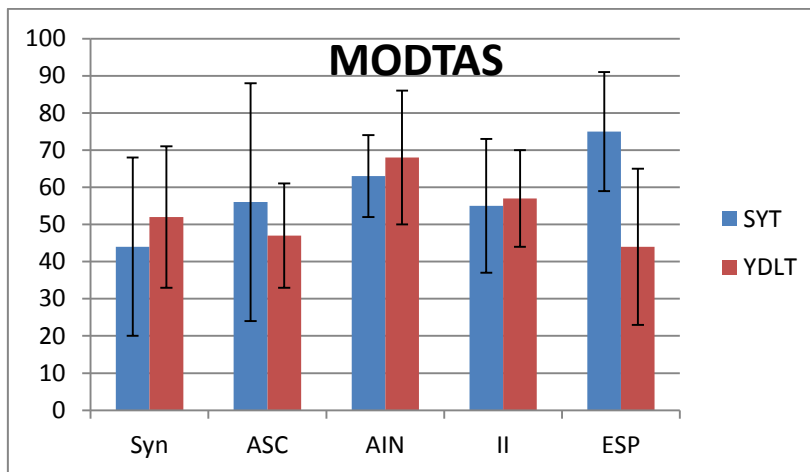


The ratings on ‘meditation dimensions’ confirmed that for both groups, their awareness of the ‘external world’ and ‘body sensations’ were at a low level during the ‘Mantra’ meditation, with higher awareness of more internalised phenomena – ‘breath’, ‘thoughts’ and ‘imagery’. This result is interpreted to indicate that both groups experienced *pratyahara*, withdrawal of awareness from the outside world. While the two groups had similar ratings for ‘imagery’, the YDLT group tended to rate ‘breath awareness’ more highly and the SYT ‘thought awareness’ more highly.

9.3.2 Trait ‘absorption’ results

The results on the modified Tellegen Absorption Scale (MODTAS) are shown in Figure 9.

Figure 9 – Study 2 - MODTAS scores (Absorption Scale)



LEGEND: Syn = Synesthesia
 ASC = Altered states of consciousness
 AIN = Aesthetic involvement in nature
 II = Imaginative involvement
 ESP = Extra sensory perception

See Chapter 8.7 for details

The scores of the two groups were similar, with a trend for the Satyananda Yoga teachers to score more highly on the factor ‘ESP’, relating to experiences of extra sensory perception.

9.3.3 EEG Source comparisons for meditation condition

Table 18 shows for each frequency band the region, Brodmann area, Tailairach coordinates and the (absolute) maximum voxel *F* statistic or statistical difference between SYT and YDLT groups and total number of significant voxels (two tailed threshold) for the meditation condition (Mantra). Positive *F* values indicate greater CSD in SYT and negative values indicate greater values in YDLT participants.

Table 18 – Study 2 - SYT > YDLT - ‘Mantra’

Band	Max/min region	Lobe	Max/min BA	Talairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Cuneus	Occipital	C18	0, -85, 15	1.72**	2902
Theta	Cuneus	Occipital	L18	-15, -80, 15	1.41**	550
Alpha	Cuneus	Occipital	L19	-25, -90, 30	1.31*	56
Alpha2	Sup occipital gyrus	Occipital	L19	-30, -85, 25	2.24**	3044
Beta	Precuneus	Occipital	L31	-25, -75, 20	1.48**	740
	Anterior cingulate gyrus	Limbic	L32	-10, 45, 5	-1.43**	455
Gamma	Med frontal gyrus	Frontal	L10	-10, 45, 15	-1.39**	414
	Sup temp gyrus	Temporal	R41	40, -30, 5	1.11*	35

* Signif at 0.05, ** Signif at 0.01

In the meditation condition (Mantra), the SYT group had voxels with maximally significant higher CSD predominantly in the delta and alpha2 bands, located in central cuneus (BA18) and left superior occipital gyrus (BA19) respectively. See figures 10 and 11.

Figure 10 – Study 2 - Differences in CSD in Mantra - Delta band

Increased delta activity (yellow) in SYT compared to YDLT in ‘Mantra’ - maxima in central BA18 (cuneus)

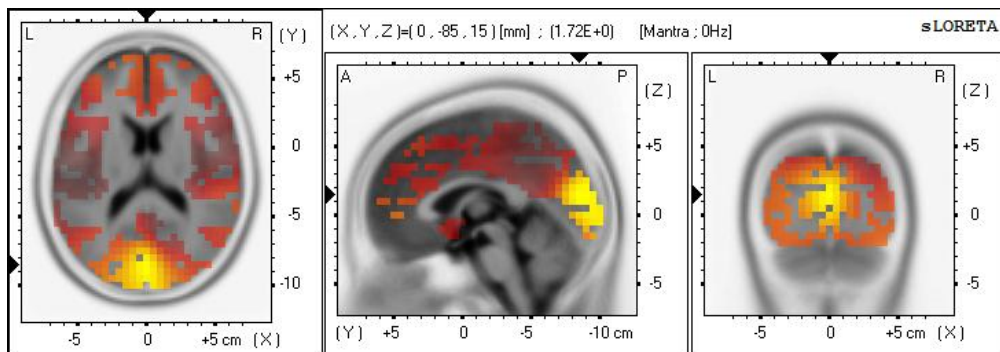
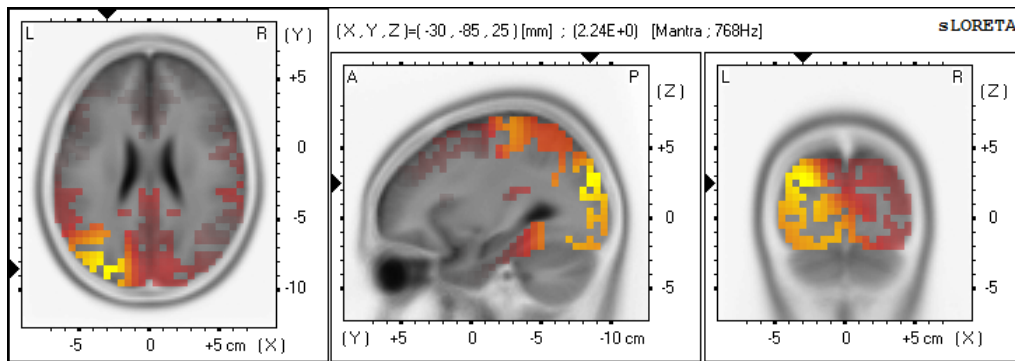


Figure 11 – Study 2 - Differences in CSD in Mantra – Alpha2 band

Increased alpha2 activity (yellow) in SYT compared to YDLT in 'Mantra' - maxima in left BA19 (superior occipital gyrus)



The other frequency bands had fewer voxels with significance at $p < 0.05$. The theta and alpha1 bands showed a similar pattern to the delta band, with the SYT group showing significantly higher CSD voxels than the YDLT group with maxima in the left cuneus (BA18, 19).

In the higher frequency bands, a mixed result was found. The SYT group had voxels with maximally significant CSD in the left precuneus (BA31) in beta, and in right superior temporal gyrus (BA41) in gamma. The YDLT group had voxels with maximally significant higher CSD in the left anterior cingulate gyrus (BA32) in beta, in the left medial frontal gyrus (BA10) in gamma. See figures 12 and 13.

Figure 12 – Study 2 - Differences in CSD in Mantra - Beta band

Increased beta activity in SYT (yellow) compared to YDLT in 'Mantra' - maxima in left precuneus (BA31)
Increased beta activity in YDLT (blue) compared to SYT in 'Mantra' – maxima in left anterior cingulate gyrus (BA32)

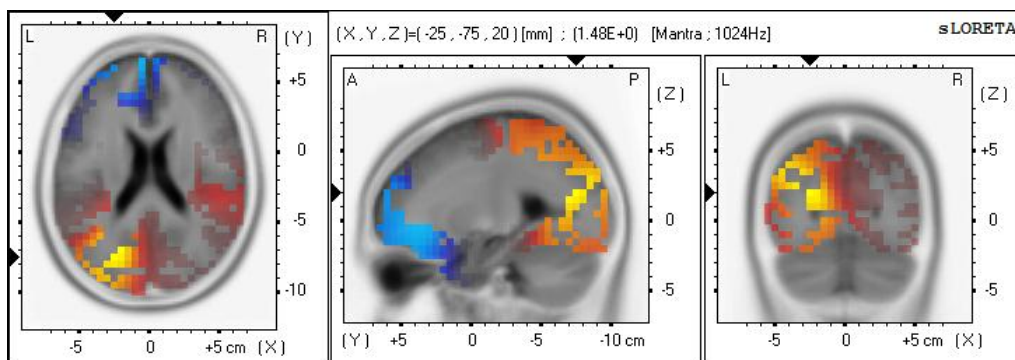
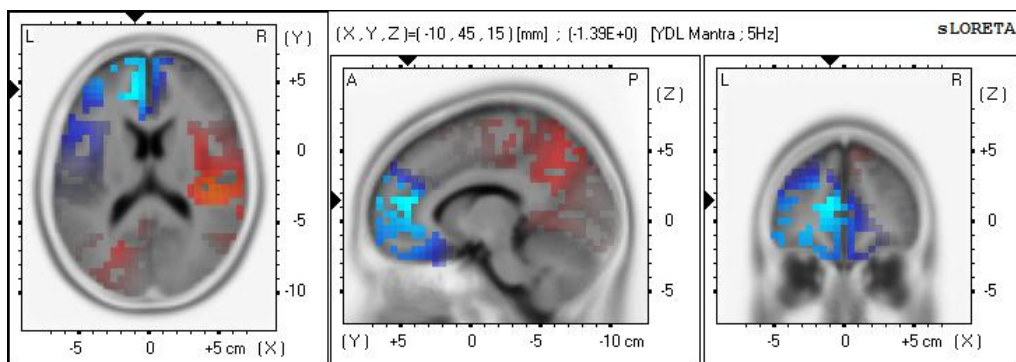


Figure 13 – Study 2 - Differences in CSD in Mantra - Gamma band

Increased gamma activity in SYT (yellow) compared to YDLT in in ‘Mantra’ - maxima in right superior temporal gyrus (BA41)
 Increased gamma activity in YDLT (blue) compared to SYT in in ‘Mantra’ – maxima in left medial frontal gyrus (BA10)



9.3.3 EEG Source comparisons for non-meditation condition

Table 19 shows for each frequency band the region, Brodmann area, Tailairach coordinates and the (absolute) maximum voxel *F* statistic or statistical difference between SYT and YDLT groups and total number of significant voxels (two tailed threshold) for the non-meditation condition (Calculation). Positive *F* values indicate greater CSD in SYT and negative values indicate greater values in YDLT participants.

Table 19 – Study 2 - SYT > YDLT - ‘Calculation’

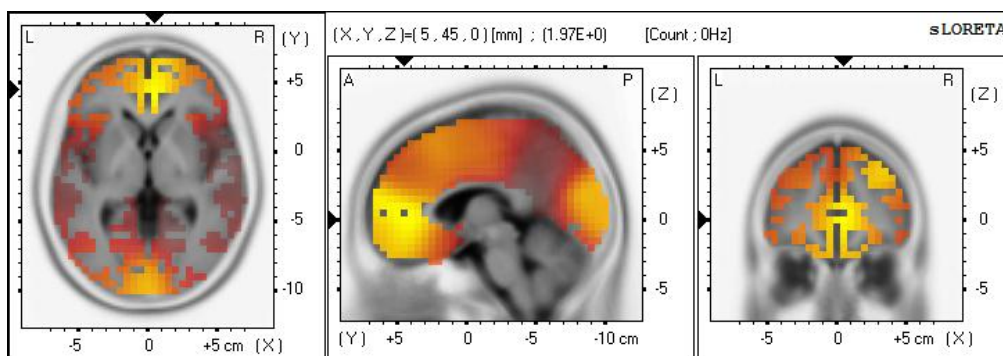
Band	Max/min region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Ant cingulate	Limbic	R32	5, 45, 0	1.97**	4734
Theta	Cuneus	Occipital	L18	-10, -85, 15	1.41**	2037
Alpha1	Cuneus	Occipital	L19	-25, -90, 30	1.05 ns	
Alpha2	Cuneus	Occipital	L19	-30, -90, 25	1.63**	1056
Beta	Ant cingulate	Limbic	L32	-5, 45, 0	-1.47**	462
	Sup temp gyrus	Temporal	R22	55, -25, 0	1.29**	879
Gamma	Sup temp gyrus	Temporal	R41	50, -25, 5	1.79**	756
	Ant cingulate	Limbic	L32	-5, 40, 0	-1.61**	627

* Signif at 0.05, ** Signif at 0.01

Significant differences in the ‘Calculation’ condition were found for voxels across all frequency bands, except alpha1. The major difference was in the delta band, with SYT showing significantly higher CSD voxels than the YDLT group with maxima in right anterior cingulate gyrus (BA32). See figure 14.

Figure 14 – Study 2 - Differences in CSD in ‘Calculation’ - Delta band

Increased delta activity (yellow) in SYT compared to YDLT in ‘Calculation’ - maxima in right BA32 (anterior cingulate)



9.4 Discussion

9.4.1 Hypotheses 1- meditation ‘depth’

Contrary to hypothesis 1, the groups had similar subjective ratings on ‘meditation depth’ and ‘meditation dimensions’, with only a trend for the YDLT group to have more awareness of ‘breath’ and the SYT group to be more aware of ‘thought’ in the ‘Mantra’ meditation.

In distinction, clear differences were found in the eLORETA results. However, the major differences were in the delta band, rather than the predicted theta band and in posterior regions rather than frontal. The SYT group showed more inhibition of cortical processing in the secondary visual areas (BA18, 19) than the YDLT group (indicated by higher CSD in lower frequencies, particularly in the delta band)

A possible explanation is the greater emphasis given to visualisation in the YDL style of meditation in both level 1 and 2 practices (see Appendix 8). It may also reflect the lower level of proficiency in the YDLT group compared to the SYT group. Lou et al (1999) found activation of the occipital lobe in the visual mental imagery stage of Yoga Nidra in Yoga teachers with more than five years’ experience. It may also be evidence of a greater ‘trait’ effect in the more experienced SYT group. A study of experienced (mean 11years) Qigong meditators who meditated for about an hour a day showed a ‘trait’ effect of more activation (in lower delta) in the visual regions BA18, 19 compared to non-meditator controls during non-meditation conditions of both eyes open and eyes closed rest (Tei, Faber & Lehmann 2009).

The difference predicted in hypothesis 1 did occur in the higher frequency bands, although with fewer voxels with maximally significant CSD. The YDLT group had higher CSD than the SYT group in beta in the left ACC (BA32) and in gamma in the left medial frontal gyrus (BA10). The relationship of ACC activity to meditation proficiency has yet to be fully

determined, but Brefczynski-Lewis et al (2007) suggest 'intermediate' level meditators have the most activity in these regions. These results may suggest that the SYT group are at a more advanced level than the YDLT group.

9.4.2 Hypothesis 2 - Trait effects

Contrary to hypothesis 2, the scores on the sub-scales of the MODTAS were similar, except for 'Extra-sensory perception' (ESP). However, as this sub-scale is based on only a few items, its significance is not yet clear (Jamieson 2005), but may indicate a greater incidence of occurrences in which a person believes in non-sensory derived but "perceptual-like" experiences, without implying their veridicality (or otherwise) (Graham Jamieson, personal communication, 2009).

However, the subjective ratings of a low level of 'meditation depth' in the 'Calculation' condition may indicate that participants experienced a 'meditative state' to some degree during that condition. Although engaged in a cognitively demanding task, the posture and setting were associated with meditation. This may reflect a 'trait' (implying neural network changes) of meditative awareness active in non-meditation situations.

Hypothesis 2 was strongly supported in the eLORETA results, with the SYT group showing more activity in networks in the anterior cingulate gyrus (ACC) (BA32) in the delta band. This finding complements that of Tei et al (2009) who found similar LORETA source activity in long-term (mean 11years) Qigong practitioners compared to non-meditators in resting conditions. The authors interpreted the stronger activation in the delta band found in meditators as indicative of inhibition of activity in the prefrontal cortex and ACC, areas related to "appraisal systems". Inhibition in these networks is "in line with a detachment from experience, defined by an attenuation of analysis, judgment and expectation, implying a lesser degree of processing of ongoing experience" (Tei, Faber & Lehmann 2009) (p162). Their findings were taken as evidence of "neuroplasticity" 'trait' changes of "detachment" in long-term meditators which carries over into non-meditation states. The authors did note, however, that for long-term meditators, the distinction between meditation and non-meditation states becomes increasingly blurred.

9.4.3 Choice of non-meditation condition

The challenge in selecting an appropriate non-meditation or baseline condition in which to study trait like (as distinct from meditation state) changes due to meditation practice is that task requirements should not intrinsically engage similar neural networks to the actual meditation practices in question. Although ECR has the advantage of similarity to "everyday

thinking” (Cahn, Delorme & Polich 2010), its difficulties in blurring with meditation in experienced practitioners have been discussed above. A further disadvantage is the issue of drowsiness, which may be proficiency-related. Cahn et al (2010) reported differential effects on drowsiness from length of meditation experience and intensity of current practice. Our baseline task while performed in the meditation posture required active and intentional manipulation of representations in verbal working memory. The relationship of the ‘Calculation’ condition and ECR will be investigated in Study 5.

9.4.4 Strengths and limitations of this study

A strength of this study is the advanced level of meditation experience in a sample of Western Yoga practitioners following a spiritual tradition. Both groups were Yoga teachers, involved in teaching formal training courses for trainee Yoga teachers. While their hours of practice was at the low end of the range of long-term Tibetan Buddhist monks in the study of Lutz et al (2004) (10,000 to 50,000 hours), their experience was comparable to or exceeded that of other ‘advanced’ Western meditators (Cahn, Delorme & Polich 2010).

A further strength was the attention given to preserving the ecological validity of the meditation states attained, the study being conducted in a meditation setting conducive to the participants’ usual practice. The intrusion of equipment into this setting was minimized, with the EEG cap and small radio transmitter being the only items in the meditation room. A number of authors have commented on the intrusive effect on the meditation state of measuring equipment (Lazar 2000; Newberg et al. 2001; Wang et al. 2011).

A limitation of the study is the small sample size and the lack of a comparison of student groups from the two traditions, caused by technical problems with the EEG recordings. Although their usual daily meditation practice was similar for the two groups, the large number of differences between the groups in cultural context, personal history and ashram experience results in numerous potential confounding variables.

9.5 Conclusion

A recent study compared groups of Tibetan Buddhist, Qigong, Sahaja Yoga, Ananda Marga Yoga and Zen meditators (with mean years of meditation experience ranging from 6 to 12 years), performing the practice leading to that tradition’s ‘most desirable’ meditative state (Lehmann et al. 2012). Although posture and eye positions differed, they found overall functional connectivity was lower during meditation states compared to rest for all traditions. While this suggests there are basic similarities in the meditation states attained by practices

in different traditions, the present study found similarities in subjective reports but significant differences in brain activation sources between two similar Yoga traditions.

The differences found in the mantra meditation state may be attributable to differences in style of practice or level of proficiency or to other factors. However, there was evidence of a 'trait' difference between the groups, suggesting a neuroplasticity change resulting in a more 'witnessing' or 'detached' 'sense of self' in the more experienced and 'ashram-based' Satyananda Yoga group, extending beyond the meditation situation. Overall, the results indicate there may be subtle differences between practitioners and practices from different traditions, requiring further careful analysis.

CHAPTER 10 – STUDY 3 – COMPARISON OF PROFICIENCY

10.1 Introduction

This study compares two groups from the same tradition (Satyananda Yoga) more clearly distinguished by differences in meditation proficiency. The first group is the same group of Satyananda Yoga teachers (SYT) used in the previous study. The second group was drawn from Satyananda Yoga students (SYS) who participated in the qualitative study.

From the results of the previous qualitative study, similarities between the two groups were considered to include:

- All practise meditation within a spiritual context, under the guidance of the teachings of a guru.
- All practise meditation within an 'integral' style of Yoga, comprising *asana*, *pranayama*, chanting, *karma yoga* and meditation.
- All practise mantra meditation, using their 'guru mantra' with the aid of a mala, synchronised with breath rotation, as their main daily meditation practice.
- All received their Yoga training primarily within the Satyananda Yoga tradition

Differences between the two groups were considered to include:

- The SYS group was younger than the SYT group (see below)
- The SYT group included five with a Christian upbringing, but in the SYS group, four had a secular childhood.
- Five of the six SY teachers had been initiated into *poorna sannyas*, spent some time in India, and were residing and teaching in *ashrams* in Australia. The other SY teacher was a *karma sannyasin* living and teaching Yoga in the community.
- Three of the SYS group were *karma sannyasins* and were living in Satyananda ashrams. The others had received a personal mantra in *mantra diksha* initiation and were living in the community.
- The meditation training received by the SYT group tended to be more varied and less systemised than that for the SYS group, whose meditation training was part of their formal training to become Satyananda Yoga teachers. Only one of the SYS group had received prior meditation training in another tradition (Vipassana).
- Four of the SY teachers had practised *kriya* meditations previously, but none of the SY students had learned these practices.

Two meditation practices were used for the study, '*kaya sthairyam*' ('*Body steadiness*') and '*japa*' ('*Mantra*').

It was hypothesised that while the student meditators might be expected to be engaged mostly in achieving sense withdrawal (*pratyahara*), the advanced practitioners might progress to the absorption stage (*dhyana*) when engaged in these practices.

In keeping both with results from moderately experienced Western meditators and the demands of sensory inhibition, it was hypothesized:

- 1) That the Satyananda students (with a lower level of meditation practice) will show more source activity in the lower frequency bands (theta, alpha1 and alpha 2). It is expected that this activity will be higher in the SYS group than in the SYT group as the latter group has developed beyond this stage of practice.
- 2) It is expected that the SYT group will show greater source activity in the higher frequency bands (beta and gamma) compared to the SYS in both meditation conditions.
- 3) Extended practice (spanning years) in both student and teacher groups is expected to result in enhanced neural connectivity and thus trait activation in networks habitually activated in each group during meditation outside the context of meditation itself. Thus those regions most differentiated in low and high frequency bands between the groups during meditation are expected to show similar (but reduced) differences in the non-meditation (counting backwards) condition.
- 4) To the extent that yoga meditation practices engage similar psychological and neurophysiological processes to traditional Buddhist/ mindfulness practices, it is expected that the cortical foci of these length of practice differences will lie in the anterior and posterior midline hubs of the DMN.

10.2. Method

10.2.1 Participants

The study protocol and consent forms were approved by RMIT University Ethics Committee. The Satyananda Yoga teachers (SYT) group comprised three male and three female, age range from 44-63 years (mean 54 years, SD 6.5 years) and the Satyananda Yoga students (SYS), three male and three female trainee Yoga teachers, age range 30-51 years (mean 42 years, SD 8.0 years). The teacher group was significantly older ($t(11) = 2.90$, one-tailed, $p <$

.05). The SYT group had a mean of 30 years regular practice (range: 24-37 years) and the SYS group a mean of 4 years (range: 3-5 years). From the information on duration of daily practice provided in the qualitative study, this equated to a mean of 10,700 hours (SD = 3,200hrs) for the SYT group and 2,000 hours (SD = 600hrs) for the SYS group.

10.2.2 Setting

The study was conducted in a small meditation room at the Satyananda Yoga Academy to provide an 'ecologically valid' situation conducive to the attainment of deep meditation states. After being fitted with the Compumedics 32 channel EEG 'Quik Cap', participants sat in their usual cross-legged meditation position on the floor, supported by cushions, with the room dimly lit by a candle on a meditation table. The battery-operated Compumedics 'Siesta 802' recording unit attached to the 'Quik Cap' was the only electronic device in the meditation room. This unit transmitted signals by radio to a laptop computer in an adjacent room.

10.2.3 Procedure

To obtain as authentic meditation experience as possible, the sequence of conditions was selected to resemble the practitioners' usual meditation practices. It was considered that a design incorporating counterbalanced order of conditions would introduce a conflict with traditional practice, as *kaya stairyam* would usually precede but not follow *japa* (Saraswati 1981). Following the mental calculation condition, the participants performed the two meditation practices in the same order.

The experimental conditions were:

- Mental Calculation condition – 'Calculation' - mentally counting backwards from 200 by 4 – (5 minutes)
- Meditation 1 – 'Body steadiness' - Satyananda Yoga practice "*kaya stairyam*" – awareness focussed on body steadiness and awareness of flow of the natural breath – (5 minutes)
- Meditation 2 – 'Mantra' - Satyananda Yoga practice "*japa*" – mental repetition of personal mantra, using mala (beads) – (10 minutes) (Saraswati 1981)
- Two additional practices (reported in Study 4)

All conditions were performed, sitting in cross-legged meditation posture, with eyes closed.

10.2.4 Subjective measures

Following the EEG recording, participants completed the 'Self-report Questionnaire' form. This consisted of a graphical representation of 'meditation depth' on a 10 point scale and ratings on a 9 point scale of 'attention span', perception of outside world', awareness of body', 'awareness of breath', 'feeling', 'thought content', 'thought intrusion', and 'imagery'.

See Appendix 9 for details. A short interview was conducted to record participants' experiences.

10.2.5 Measurement of trait 'absorption'

Following the session, the participants completed the Modified Tellegen Absorption Scale (MODTAS) (Jamieson 2005).

10.2.6 EEG Data collection and analysis

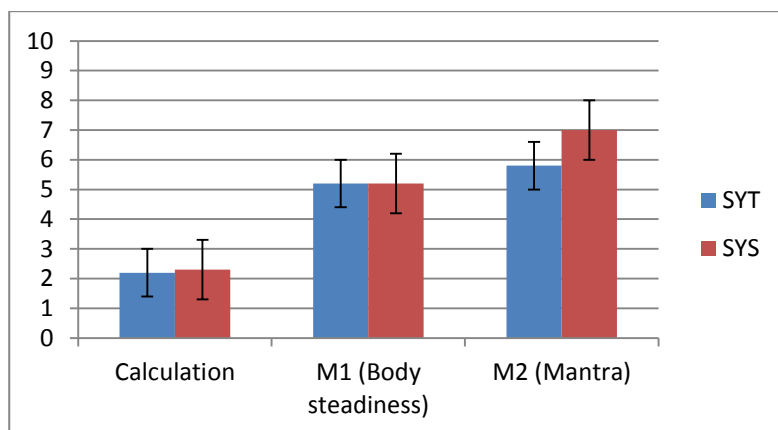
As for previous study.

10.3 Results

10.3.1 Meditation state subjective ratings

The subjective ratings of 'meditation depth' are shown in Figure 15.

Figure 15 – Study 3 - 'Meditation depth' ratings

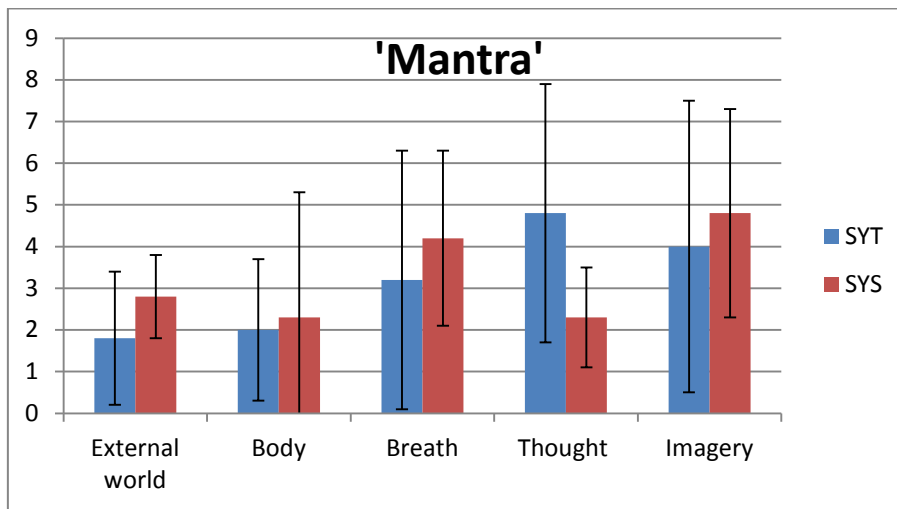


A low level of 'meditation depth' was reported in the non-meditation (Calculation) condition, but a higher level for the meditation conditions. The reported levels of ratings were similar between the groups.

The subjective ratings on 'Meditation dimensions' for 'Mantra' meditation are shown in Figure 16.

Figure 16 – Study 3 - ‘Meditation dimensions’ ratings

a) ‘Mantra’

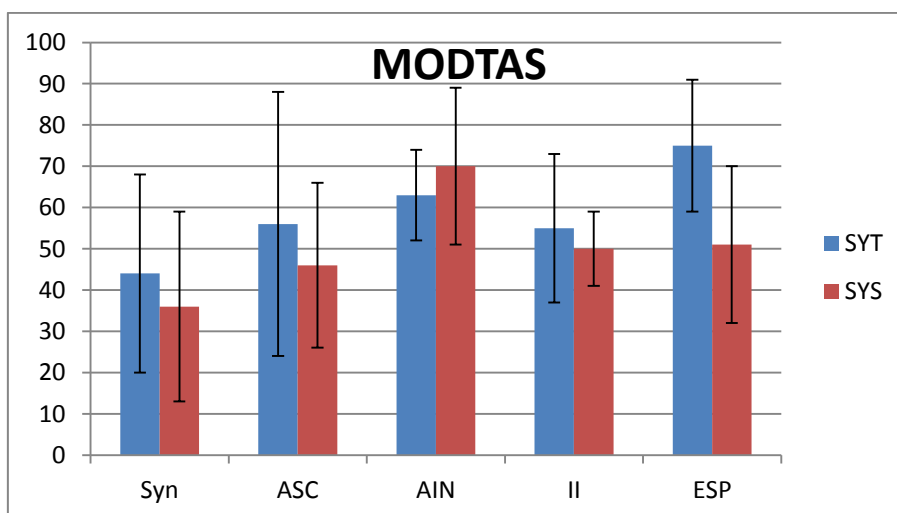


The ratings on ‘meditation dimensions’ for the ‘Mantra’ meditation confirmed that for both groups, their awareness of the ‘external world’ and ‘body sensations’ were at a lower levels than awareness of the ‘internal’ dimensions – ‘thought’ and ‘imagery’. This result is interpreted to indicate that both groups experienced *pratyahara* in the meditation states.

10.3.2 Trait ‘absorption’ results

The results on the modified Tellegen Absorption Scale (MODTAS) are shown in Figure 17.

Figure 17 – Study 3 – MODTAS scores



The scores of the two groups were similar, although with a trend for the Satyananda teachers to score more highly on the factor ‘ESP’.

10.3.3 EEG source comparison of proficiency groups

Tables 20 to 22 show for each frequency band the region, Brodmann area, Tailairach coordinates and the (absolute) maximum voxel *F* statistic or statistical difference between SYT and SYS groups and total number of significant voxels (two tailed threshold) for the control condition (Calculation), Meditation 1 (Body steadiness) and Meditation 2 (Mantra).

Table 20 – Study 3 - SYT > SYS - ‘Calculation’

Band	Max/min region	Lobe	Max/min BA	Tailairach Coordinates	Max/min F value	No. of voxels p< 0.05
Delta	Sup temp gyrus	Temporal	R41	55, -25, 5	-1.72**	390
Theta	Sup temp gyrus	Temporal	R22	65, -20, 0	-1.07 ns	
Alpha1	Precentral gyrus	Frontal	R6	45, -10, 40	-1.96**	856
Alpha2	Inf parietal lobule	Parietal	R40	50, -50, 55	-1.43*	123
Beta	Sub-gyral	Temporal	L20	-45, -10, -25	1.07 ns	
Gamma	Fusiform gyrus	Temporal	R20	40, -15, -30	1.52*	85

* p< 0.05, ** p< 0.01

Table 21 – Study 3 - SYT > SYS – ‘Body steadiness’

Band	Max/min region	Lobe	Max/min BA	Tailairach Coordinates	Max/min F value	No. of voxels p< 0.05
Delta	Inf parietal lobule	Parietal	R40	40, -40, 60	-0.729 ns	
Theta	Inf parietal lobule	Parietal	R40	45, -45, 60	-1.32 **	490
Alpha1	Precentral gyrus	Frontal	R4	55, -10, 45	-2.01 **	1827
Alpha2	Inf parietal lobule	Parietal	R1	45, -30, 65	-1.08*	30
Beta	Sub-gyral	Temporal	R20	40, -10, -25	1.03 *	33
Gamma	Fusiform gyrus	Temporal	R20	40, -15, -30	1.65 **	1631

* p< 0.05, ** p< 0.01

Table 22 – Study 3 - SYT > SYS – ‘Mantra’

Band	Max/min region	Lobe	Max/min BA	Tailairach Coordinates	Max/min F value	No. of voxels p< 0.05
Delta	Ant cingulate	Limbic	L32	-10, 35, -5	0.822 ns	
Theta	Inf parietal lobule	Parietal	R40	50, -50, 55	-1.52 **	613
Alpha1	Precentral gyrus	Frontal	R4	50, -10, 50	-1.97 **	1676
Alpha2	Sup temp gyrus	Temporal	R22	45, -20, 0	1.10 ns	
Beta	Rectal gyrus	Frontal	L11	-10, 40, -25	1.30 *	917
Gamma	Insula	Sub-lobar	R13	30, 20, 15	1.92 **	2092

* p< 0.05, ** p< 0.01

Note: Positive value for *F* indicates SYT shows higher CSD than STS, negative value for *F* indicates SYS has higher CSD than SYT

10.3.3.1 Differences on source activation in meditation conditions

The two meditation conditions showed a similar pattern, the SYS (intermediate group) having voxels with significantly higher CSD in the lower frequencies (theta, alpha1) and the SYT

(advanced group) having voxels with significantly higher CSD in the higher frequencies (beta, gamma).

The alpha2 band showed differences between the meditation conditions, with the SYS group having voxels with significantly higher CSD in 'Body steadiness', but the SYT group having a non-significant difference in 'Mantra'. No significant differences were found in the delta band for the meditation conditions.

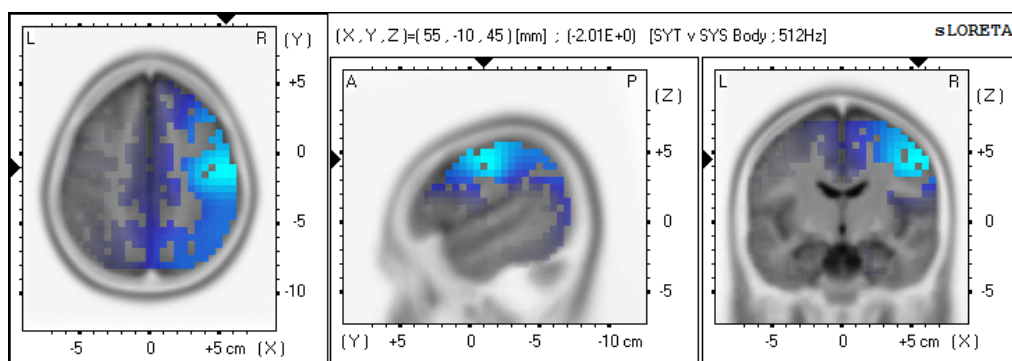
The location of the maximum difference of the SYS group compared to the SYT group was predominantly in the right hemisphere and occurred in the alpha1 band. For both meditation practices, those voxels with maximum alpha1 *F* values were located in right BA4 (precentral gyrus).

Figure 18 illustrates the location of maximum differences in the alpha1 band.

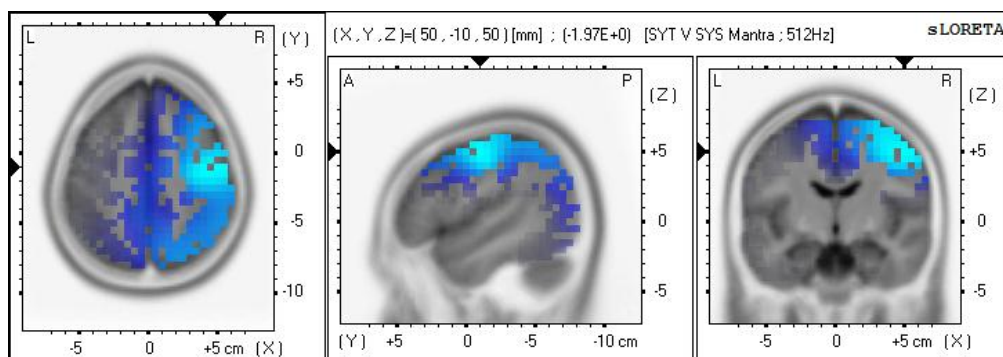
Figure 18 – Study 3 - Differences in CSD - Alpha1 band - meditation

Increased alpha1 activity (blue) in SYS compared to SYT in
a in 'Body steadiness' - maxima in right BA4 (precentral gyrus),
b in 'Mantra' – maxima in right BA4 (precentral gyrus),

a) Meditation 1 (Body steadiness)



b) Meditation 2 (Mantra)



The location of the maximum difference of the SYT group compared to the SYS group was also predominantly in the right hemisphere, occurring in the gamma band. Those voxels with

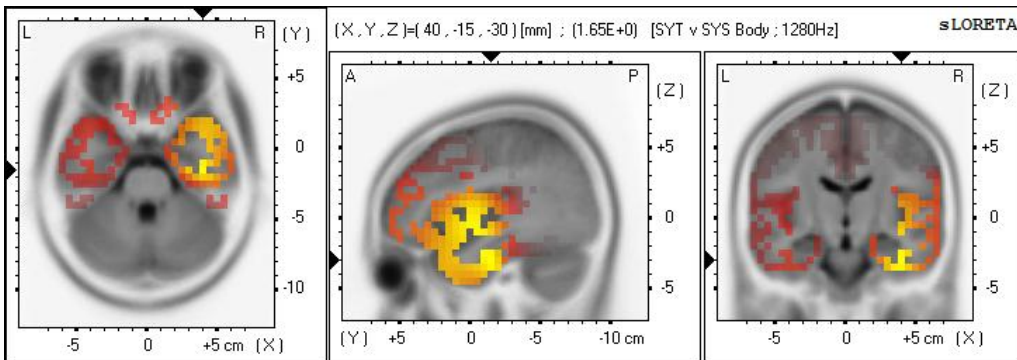
maximum gamma F values were located in right BA20 (fusiform gyrus) ('Body steadiness') and right BA13, 45 (insula) ('Mantra').

Figure 19 illustrates the location of maximum differences in the gamma band.

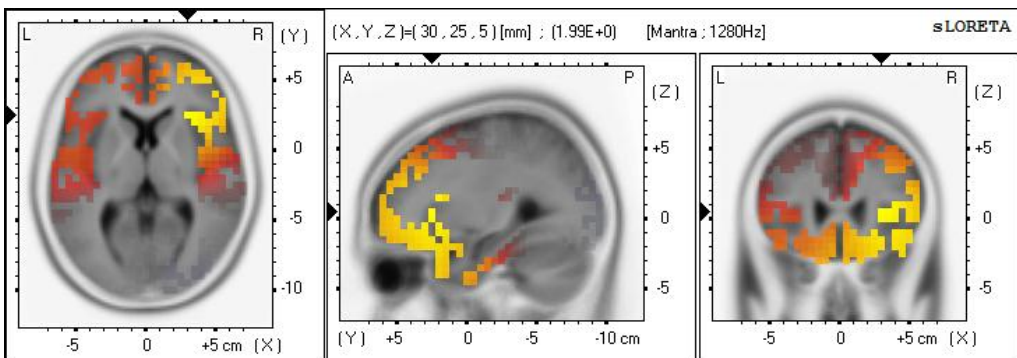
Figure 19 – Study 3 - Differences in CSD - Gamma band - meditation

Increased gamma activity (yellow) in SYT compared to SYS in
a in 'Body steadiness' – maxima in right BA20 (fusiform gyrus),
b in 'Mantra' – maxima in right BA13 (insula),

a) Meditation 1 (Body steadiness)



b) Meditation 2 (Mantra)



10.3.3.2 Differences between groups on source activation frequency and location in the non-meditation condition

The non-meditation condition (Calculation) showed a similar pattern to the meditation conditions, with the SYS (student group) having voxels with significantly higher CSD in the lower frequencies (delta, alpha1, alpha2) and the SYT (advanced group) having voxels with significantly higher CSD in the higher frequencies (beta, gamma).

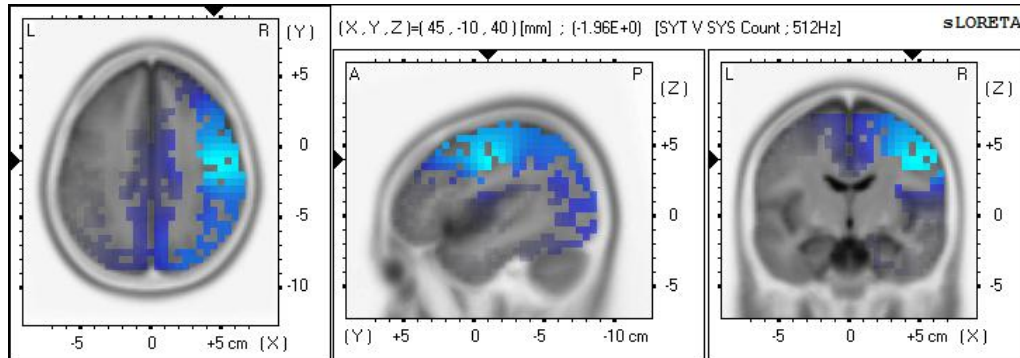
The location of the maximum difference of the SYS group compared to the SYT group was entirely in the right hemisphere. Voxels with maximum F values were located in right BA41 (superior temporal gyrus) in delta, right BA6 (precentral gyrus) in alpha1 and right BA40 (inferior parietal lobule) in alpha2.

Figure 20 illustrates the location of maximum differences in the alpha1 band.

Figure 20 – Study 3 - Differences in CSD - Alpha1 band – non-meditation

Increased alpha1 activity (blue) in SYS compared to SYT in 'Calculation' – maxima in right BA6 (precentral gyrus)

Non-meditation (Calculation)



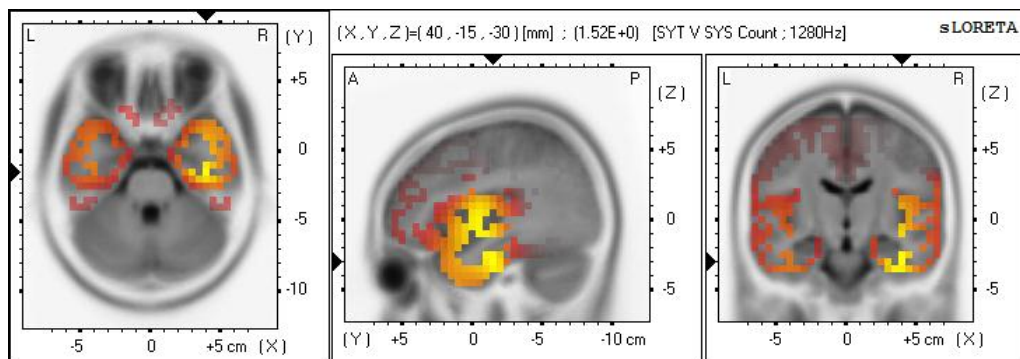
The location of the maximum difference of the SYT group compared to the SYS group was also entirely in the right hemisphere, occurring in the gamma band. Those voxels with maximum gamma *F* values were located in right BA20 (fusiform gyrus).

Figure 21 illustrates the location of maximum differences in the gamma band.

Figure 21 – Study 3 - Differences in CSD - Gamma band – non-meditation

Increased gamma activity (yellow) in SYT compared to SYS in 'Calculation' – maxima in right BA20 (fusiform gyrus)

Non-meditation (Calculation)



10.3.4 Cortical sources of differences between groups

Across all conditions the number of significant differences was consistently greatest in the gamma band for the high frequencies and the alpha1 band for the low frequencies (highlighted in tables 20-22 above). In order to examine the specific regional pattern of these high and low frequency group differences, the number of significant voxels in each (right and left) Brodmann Area are presented for each experimental condition in the alpha1 band and

gamma bands in tables 23, 24. These additional results for the delta, theta, alpha2 and beta frequency bands are in Appendix 10.

Table 23 – Study 3 – No. of significant voxels - Alpha1 band

Alpha1 band (8-10Hz) SYS > SYT

No. signif voxels

BA	Calculation		Body		Mantra	
	L	R	L	R	L	R
1		9		9		9
2		47		49	2	53
3		59	12	72	17	70
4		54	12	63	13	61
5		12	27	50	32	50
6		170	38	265	84	267
7		130	92	208	113	208
8		33		64	1	76
9		55		84		69
10						
11						
13				5		
17		8		40		13
18		25		158		48
19		64	6	145	2	98
20						
21						
22				4		
23		3		6		2
24		1		34	14	44
25						
28						
30		1		18		6
31		12	12	90	27	69
32		1		12	2	20
33						
34						
35						
36						
37				14		3
38						
39		28		58		55
40		143		163	3	149
41						
42						
43				3		
44				3		
45		1		6		1
46				4		
47						

Total 0 856 199 1627 310 1371

Note: Blue highlight = Brodmann area of maximum significant difference for that band

The regions containing the most significant voxels occur in clusters predominantly in right-sided Brodmann areas 1 to 9, 17 to 19, 23 to 24, 30 to 32, and 39 to 40.

Table 24 – Study 3 – No. of significant voxels - Gamma band

Gamma band (25-42Hz) SYT > SYS

No. signif voxels

BA	Calculation		Body		Mantra	
	L	R	L	R	L	R
1						
2						
3				2		
4			2	7	4	5
5						
6		1	7	46	9	55
7						
8					4	85
9				22	16	135
10			14	109	133	135
11			101	122	115	122
13		28	51	143	83	79
17						
18						
19						
20		22	56	86	69	50
21		7	40	108	71	45
22		10	34	75	48	27
23						
24			2	3	5	14
25			15	22	16	27
28			10	18	17	18
30						
31						
32			10	24	30	59
33						1
34		1	8	16	17	16
35			2	5	3	6
36		1	6	11	9	8
37						
38		9	76	88	76	88
39						
40				6	1	
41				20	10	
42				17		
43			5	12		
44		5	6	28	43	28
45				34	16	34
46				25	13	25
47			97	113	107	113

Total 0 84 542 1162 915 1175

Note: Blue highlight = Brodmann area of maximum significant difference for that band

The regions containing the most significant voxels occur in clusters predominantly in right-sided Brodmann areas 9 to 13, 20 to 22, 38, 44 to 47.

10.4 Discussion

10.4.1 Hypotheses 1 and 2

The first prediction that during Yoga meditation student meditators would show greater CSD in the low frequency bands was supported in the theta, alpha1 and alpha 2 bands for 'Body steadiness'; and in theta and alpha1 for 'Mantra'. In both meditations the number of significant voxels at the lower frequencies was overwhelmingly greatest in the alpha1 band (see tables 21 and 22).

The second prediction that advanced practitioners would show greater CSD in the high frequency bands was supported for beta and gamma frequency bands for all meditation conditions. For the higher frequencies the number of significant voxels was overwhelmingly greatest in the gamma band (see tables 21 and 22).

More broadly the F values for SYT versus SYS were negative for all low frequencies (delta to alpha2) in all experimental conditions (except 'Mantra' for alpha2) and positive for all higher frequency bands (beta and gamma) (see tables 20 to 22). It appears then that patterns of increased EEG activity in Yoga meditation students are consistent with the tradition based expectations of *pratyahara*, (somatosensory withdrawal, evidenced by low frequency inhibition of corresponding cortical processing). By contrast, patterns of increased EEG activity in advanced yoga teachers most likely correspond to activity in brain regions recruited in the conscious states of concentration and absorption (*dharana* and *dhyana*) which emerge in advanced practitioners.

10.4.2 Hypotheses 3 and 4

Tables 23 and 24 show that for the alpha1 and gamma bands respectively only right hemisphere Brodmann Areas show significant differences between SYT and SYS in the non-meditation (counting backwards by four) condition. Looking across the rows of these tables these same regions are also found to have the greatest number of significant voxels in the meditation conditions (typically with a greatly increased number of significant voxels). This pattern is interpreted as support for the third prediction of trait differences in baseline neural activity brought about by long term meditation practice. These findings are further interpreted as evidence for a core right sided (rather than midline) network that is progressively modulated over the course of Yoga meditation practice. The strongly right lateralised location of the maximal F statistic voxel can be observed for both alpha1 and gamma in each of the experimental conditions in Figures 18 to 21.

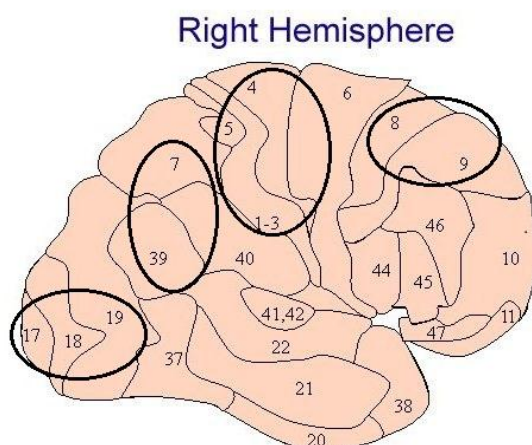
Hypothesis four was not supported. The results of this study suggest that in Yoga meditation practice (as distinct from recent studies of mindfulness/Buddhist meditation practices) the midline nodes of the DMN, although included in regions of significant voxel differences, do not appear to be a principal locus of practice related changes in cortical activity. This study also differs from the CSD changes in midline DMN structures found in “concentrative” (breath-focused) meditation with “intermediate level” (mean 4 years) practitioners of unspecified tradition compared to controls (Lavalley, Hunter & Persinger 2011).

10.4.3 Regional differences related to Yoga meditation proficiency

10.4.3.1 Alpha1 band

In the alpha1 band, significant voxel differences always showed greater activity in the student than the teacher meditators. In all conditions maximal voxel *F* values were always located in the right somatosensory (BA 1, 2, 3, 5), motor (BA 4) and premotor cortex (BA 6). In the baseline (mental calculation) condition a core network of right sided regions can be identified comprised, in addition to those regions identified immediately above, of right occipital (BA 17, 18, 19), right parietal (BA 7, 39, 40) and right superior frontal gyrus (BA 8, 9). It should be noted that right anterior (BA 24, 32) and posterior (BA23, 30, 31) DMN regions are represented here but not strongly. These same regions remain the core of proficiency related differences in all meditation conditions. The key changes are an increase in the number of significant voxels recruited in each region and a spread of significant voxels to the homologous left sided Brodmann Areas while always retaining a strong imbalance toward right sided voxels (see table 23 and figure 22).

Figure 22 – Major regions of difference – SYS > SYT – Alpha band



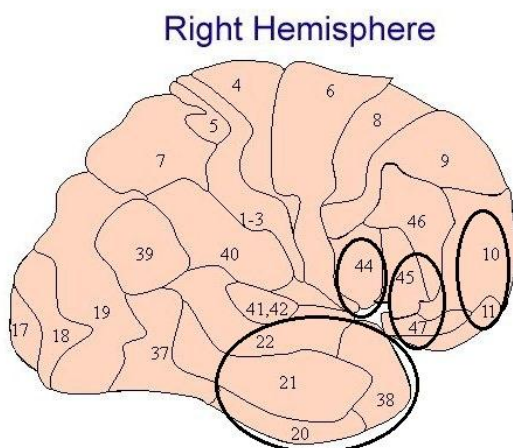
Numbers = Brodmann areas

10.4.3.2 Gamma band

In the gamma band, significant voxel differences always showed greater activity in the teacher than the student meditators. In the non-meditation condition, all significant voxel differences were found in the right temporal lobe (principally BA 20, 21, 22, 38) and right ventral prefrontal cortex (principally BA13 and BA44). All these regions showed a great expansion of significant voxel counts in the meditation conditions.

In the 'Body steadiness' meditation, 1631 out of a possible 6239 cortical voxels showed significant proficiency differences. In the 'Mantra' meditation this rose to 2090 significant voxel differences. A right-sided bias continued to be observed for both meditations but was much less extreme than in the alpha1 band. Additional regions showing significantly greater CSD in gamma for the long-term meditators in all meditations were principally in BA 10, 11, 45 and 47 (see table 24 and figure 23).

Figure 23 – Major regions of difference – SYT > SYS – Gamma band



Numbers = Brodmann areas

This result adds to the converging lines of enquiry regarding the role of meditation-specific increases in gamma band activity in “advanced” practitioners, adding evidence from Western meditators practising in an integral Yoga spiritual tradition. The teacher group in this study (mean experience 30 years) displayed striking increases in gamma band activity similar to studies of “advanced” Tibetan Buddhist meditators (Lutz et al, 2004) and Western Buddhist Vipassana meditators with mean experience 20 years (Cahn et al, 2010). Although those studies did not estimate cortical sources, the high level of gamma activity during meditation in advanced practitioners requires widespread synchronisation throughout extensive cortico-cortico and cortico-thalamic neural networks (Lutz et al. 2004).

In the 'Body steadiness' meditation, the most significant voxel differences were located in the right mid temporal gyrus (BA21) and the insula (BA13). This result aligns with that of an advanced Tibetan Buddhist meditator showing increased gamma activity in right mid temporal gyrus (BA21) in the comparisons of sensory-focused "visualisation" meditation versus the verbal-focussed "mantra" meditation and also in a "self-reconstruction" versus "self-dissolution" meditation (Lehmann et al. 2001). In the other meditations, the most significant sources were located in the right insula and right superior frontal gyrus (BA9, 10).

The right insula has been linked with a more detached and objective awareness of interoceptive sensory events (Farb et al. 2007) involved in the shift from "narrative" to "experiential" self-awareness. Deen et al (Deen, Pitskel & Pelphrey 2011) identify three distinct clusters of functional networks in posterior, mid and anterior insula respectively, suggesting a further parcelation of anatomical and functional subregions within the insula will be required to fully understand the role (or roles) it is playing in Yoga and Buddhist tradition meditative states.

10.4.4 Strengths and limitations of this study

As for previous study

10.5 Conclusion

To my knowledge, this study is the first to report enhanced gamma band activation in advanced Western meditators practising in the Yoga tradition, compared to less experienced practitioners. The finding supports the frequency band hypothesis proposed by Fell et al (2010) of distinct low and high frequency band effects for intermediate and advanced levels of experience in meditation training. It adds a finding of increased gamma band activity in advanced western Yoga meditators to those found with advanced Buddhist meditators.

CHAPTER 11 – STUDY 4 – EFFECT OF PRACTICE

11.1 Introduction

Although only a few studies have directly compared brain activity patterns with different meditation practices, some distinct differences have been found, in both Buddhist (Lehmann et al. 2001) and Yoga meditators (Lou et al. 1999).

This present study examines subjective ratings and brain activity differences between Yogic practices, using the distinction between ‘Focused attention’ (FA) practices and ‘Open monitoring’ (OM) (Antoine Lutz et al. 2008). Of the practices previously described, ‘Mantra’, and ‘Dissolving thoughts’ can be classified as FA, the first requiring attention to mental repetition of a mantra, the second requiring attention to the emergence of spontaneous thoughts and a “quick act of will” to release the thought. The practices ‘Body steadiness’ and ‘Watching thoughts’ can be classified as OM, the first requiring non-selective attention to body sensations and natural breath, the second requiring non-selective, non-judgmental observation of spontaneous thoughts. See Appendix 7 for details of the practices.

Within the Yoga tradition, mantra meditation (FA) has been associated with increased alpha (Corby et al. 1978; Kamei 2000); midline frontal theta power (Baijal & Srinivasan 2010); and increased activity in the ACC (Lazar 2000). Prior to the time of the experimental work for the present study (2010), the only study involving an OM-type meditation in the Yoga tradition (scanning body sensations in Yoga Nidra) suggested OM was associated with lateralised right (inferior frontal) and left (superior parietal) activity (Lou et al. 1999).

In the Buddhist tradition, ‘mindfulness’ (OM) practices have been associated with deactivation of the anterior (medial frontal cortex) node of the DMN (Ott, Walter & Gebhardt 2010) and lateralised prefrontal activity in both hemispheres (Manna et al. 2010). In the LORETA study of an advanced Buddhist Lama, the comparison of ‘Self-dissolution’ meditation versus ‘Self-reconstruction had voxels with maximum difference in the gamma band located in the right superior frontal gyrus (BA6) and for the reverse comparison in the right middle temporal gyrus (BA21). This result might have some relevance to the changes invoked in the ‘sense of self’ by the comparison of ‘Dissolving thoughts’ to ‘Watching thoughts’

Based on these studies, the following hypotheses were formulated:

- 1) ‘Mantra’ compared to ‘Body steadiness’ will show higher theta activity in midline frontal regions and the anterior cingulate cortex.
- 2) ‘Body steadiness’ compared to ‘Mantra’ will show more lateralised frontal activity

- 3) 'Dissolving thoughts' compared to 'Watching thoughts' will show more right lateralised frontal lobe activity in the gamma band.
- 4) 'Watching thoughts' compared to 'Dissolving thoughts' will show more right lateralised temporal lobe activity in the gamma band.

11.2 Method

The study protocol and consent forms were approved by RMIT University Ethics Committee.

11.2.1 Participants

These hypotheses were tested for the groups: SYT, SYS and YDLT. The composition of these groups was as for the previous studies.

An additional analysis was conducted with repeated performance of the same practices by a single SY teacher over six days. The Satyananda Yoga teacher used for this study was one of the participants in the previous studies. He is a *poorna sannyasin* disciple of Swami Satyananda, resident at Satyananda Yoga Academy at Mangrove Creek and a senior teacher.

At the time of the study, he was 55 years old and had been meditating in the Satyananda Yoga tradition for 33 years. He is in the "second" cohort of Satyananda Yoga practitioners, having taken *sannyasa* and received most of his Yoga training in Australia. He spent most of the last 30 years living and teaching in Satyananda centres throughout Australia. His regular meditation practice is *japa* mantra meditation, performed with his guru mantra. Based on an average of one hour regular practice a day, this would equate to a mean of 11,000 hours of meditation practice.

11.2.2 Setting

As for previous study

11.2.3 Procedure

Comparisons of 'Mantra' and 'Body steadiness' were made for the SYT, SYS and YDLT groups, and for repeated measures with the single SYT. The comparisons of 'Watching thoughts' and 'Dissolving thoughts' were conducted for the SYT and SYS groups.

The single SYT performed the following practices, in the same sequence at the same time of day (9am) on six days over a two week period. All conditions were conducted in a cross-legged seated meditation pose, supported by cushions.

- Eyes closed (2 minutes)

- Control condition 1 – Count1 - mentally counting backwards from 200 by 4 (5 minutes)
- Mental Calculation condition – ‘Calculation’ - mentally counting backwards from 200 by 4 – (5 minutes)
- ‘Body steadiness’ - Satyananda Yoga practice “*kaya stairyam*” – awareness focussed on body steadiness and awareness of flow of the natural breath – (5 minutes)
- ‘Mantra’ - Satyananda Yoga practice “*japa*” – mental repetition of personal mantra, using mala (beads) – (10 minutes) (Saraswati 1981)
- Control condition - Count 2 - mentally counting backwards from 200 by 4 (5 minutes)

This study reports comparisons between the meditation conditions. Comparisons between the control conditions are reported in Study 5.

11.2.4 Data collection and analysis

As for previous study

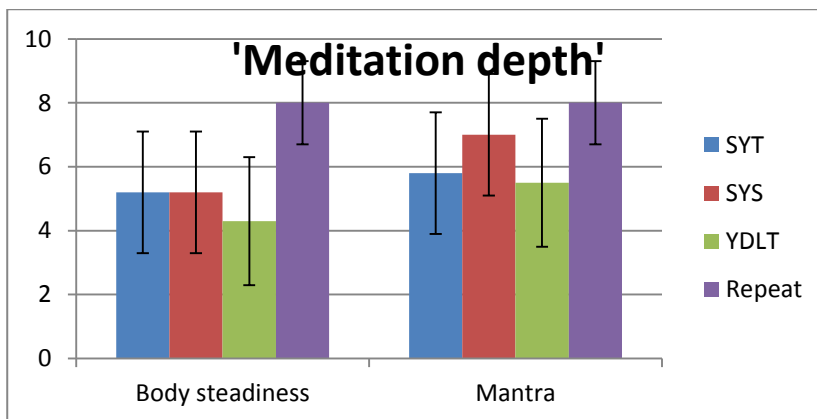
11.3 Results

11.3.1 Comparison of ‘Mantra’ and ‘Body steadiness’

11.3.1.1 Subjective ratings

The subjective ratings of “meditation depth” are shown in Figure 24.

Figure 24 – Study 4 - ‘Meditation depth’ ratings – ‘Mantra’ and ‘Body steadiness’



LEGEND: SYT = Satyananda Yoga Teachers
 SYS = Satyananda Yoga Students
 YDLT = Yoga in Daily Life Teachers
 Repeat = Repeated measures – single participant

‘Meditation depth’ ratings were similar for the three groups, with a tendency for greater depth ratings in ‘Mantra’. However, as ‘Mantra’ followed ‘Body steadiness’, this may be partly an effect of increasing depth with duration of practice. Repeated measures of the single SYT

over six sessions rated both meditations at the same ‘depth’, but at a higher level than the group means.

Subjective ratings for ‘meditation dimensions’ were not obtained for all these groups for comparison.

11.3.1.2 EEG Source comparisons across conditions

Tables 25 to 28 and figures 25 to 27 show for each frequency band the region, Brodmann area, Tailairach coordinates and the (absolute) maximum voxel *F* statistic or statistical difference and the number of significant voxels between ‘Mantra’ and ‘Body steadiness’ condition for the SYT, YDLT and SYS groups and for repeated measures with the single SYT case study.

Satyananda Yoga teachers (SYT):

Table 25 – Study 4 - ‘Mantra’ > ‘Body steadiness’ – SYT group

Band	Max/min region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Paracentral lobule	Frontal	R5	5, -45, 55	-0.567ns	
Theta	Paracentral lobule	Frontal	C5	0, -45, 65	-0.386ns	
Alpha1	Cingulate gyrus	Limbic	L24	-10, 10, 50	-0.403ns	
Alpha2	Post cingulate	Limbic	R30	5, -65, 10	0.441ns	
Beta	Sup temp gyrus	Temporal	R22	65, -15, 5	-0.376ns	
Gamma	Mid frontal gyrus	Frontal	R9	35, 25, 35	0.621ns	

* Signif at 0.05, ** Signif at 0.01

No significant differences were found for ‘Mantra’ vs ‘Body steadiness’ in the SYT group.

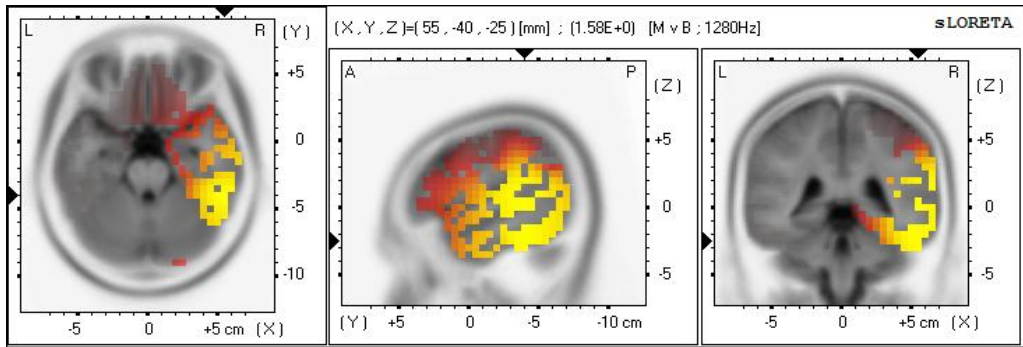
Table 26 – Study 4 - ‘Mantra’ > ‘Body steadiness’ – SYT case study

Band	Region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Precentral gyrus	Frontal	L6	-35, -10, 35	-0.528 ns	
Theta	Mid frontal gyrus	Frontal	R10	35, 60, -5	-0.347 ns	
Alpha1	Precuneus	Occipital	C23	0, -65, 20	0.357 ns	
Alpha2	Postcentral gyrus	Parietal	R40	65, -30, 20	0.274 ns	
Beta	Inf temp gyrus	Temporal	R20	60, -40, -20	1.32**	980
Gamma	Inf temp gyrus	Temporal	R37	55, -40, -25	1.58**	1708

* Signif at 0.05, ** Signif at 0.01

Figure 25 – Study 4 - ‘Mantra’ > ‘Body steadiness’ – case study – Gamma

Increased gamma activity (yellow) in ‘Mantra’ compared to ‘Body steadiness’
 – maxima in right BA37 (inferior temporal gyrus)



The repeated measures on the single SYT participant (case study) showed ‘Mantra’ had voxels with significantly higher CSD than ‘Body steadiness’ in the beta and gamma bands, with maximum significant difference located in the right inferior temporal gyrus (BA20, 37).

Yoga in Daily Life teachers (YDLT):

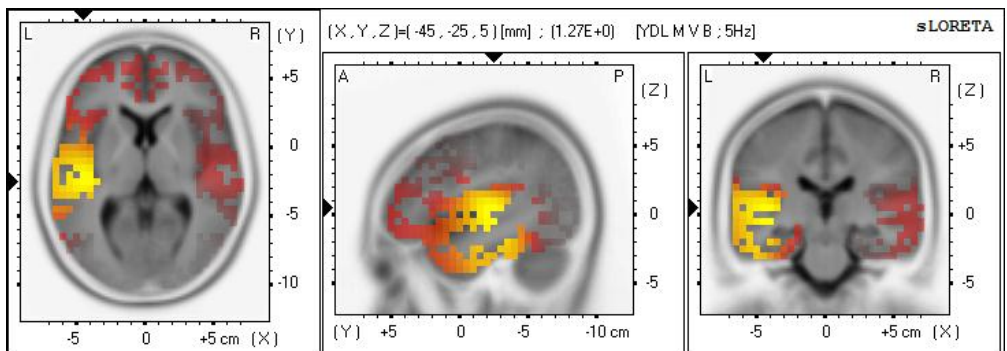
Table 27 – Study 4 - ‘Mantra’ > ‘Body steadiness’ - YDLT

Band	Max/min region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Paracentral lobule	Frontal	L31	-5, -15, 50	-0.60ns	
Theta	Post cingulate	Limbic	L30	-25, -70, 10	-0.383ns	
Alpha1	Med frontal gyrus	Frontal	L10	-5, 65, 10	0.284ns	
Alpha2	Sup frontal gyrus	Frontal	R6	10, 20, 65	-0.321ns	
Beta	Sup temp gyrus	Temporal	L38	-50, 20, -20	0.711ns	
Gamma	Sup temp gyrus	Temporal	L41	-45, -25, 5	1.27**	583

* Signif at 0.05, ** Signif at 0.01

Figure 26 – Study 4 - ‘Mantra’ > ‘Body steadiness’ – YDLT – Gamma

Increased gamma activity (yellow) in ‘Mantra’ compared to ‘Body steadiness’
 – maxima in left BA41 (superior temporal gyrus)



Only the gamma band a showed a significant difference in the YDLT group, with ‘Mantra’ having voxels with significantly higher CSD than ‘Body steadiness’, with maximum significant difference located in the left superior temporal gyrus (BA41).

Satyananda Yoga students (SYS):

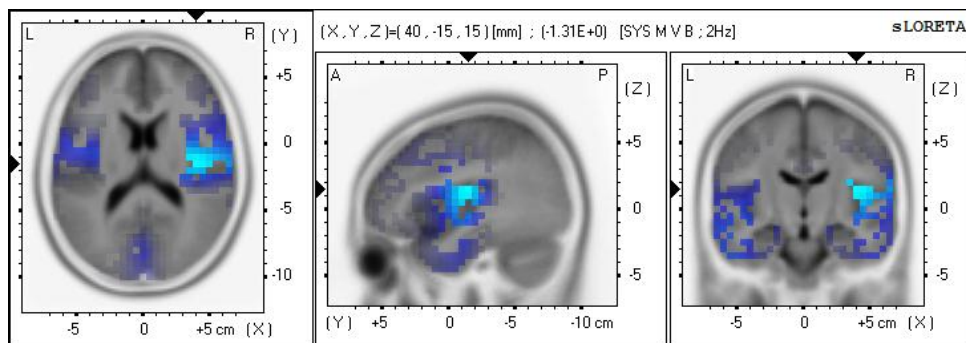
Table 28 – Study 4 - ‘Mantra’ > ‘Body steadiness’ - SYS

Band	Max/min region	Lobe	Max/min BA	Talairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Precentral gyrus	Frontal	L6	-35, -10, 35	-0.588ns	
Theta	Precuneus	Occipital	L31	-20, -70, 20	0.397ns	
Alpha1	Insula	Sub-lobar	R13	40, -15, 15	-1.31**	473
Alpha2	Cingulate gyrus	Limbic	L31	-5, -60, 30	0.598ns	
Beta	Sup temp gyrus	Temporal	L39	-35, -60, 30	0.585ns	
Gamma	Sub-gyral	Temporal	L39	-30, -60, 30	0.727ns	

* Signif at 0.05, ** Signif at 0.01

Figure 27 – Study 4 – ‘Mantra’ > ‘Body steadiness’ - SYS – Alpha1

Increased alpha1 activity (blue) in ‘Body steadiness’ compared to ‘Mantra’ – maxima in right BA13 (insula)



In contrast, the SYS group showed differences in the alpha1 band, with ‘Body steadiness’ having voxels with significantly higher CSD than ‘Mantra’, with maximum significant difference located in the right insula (BA13).

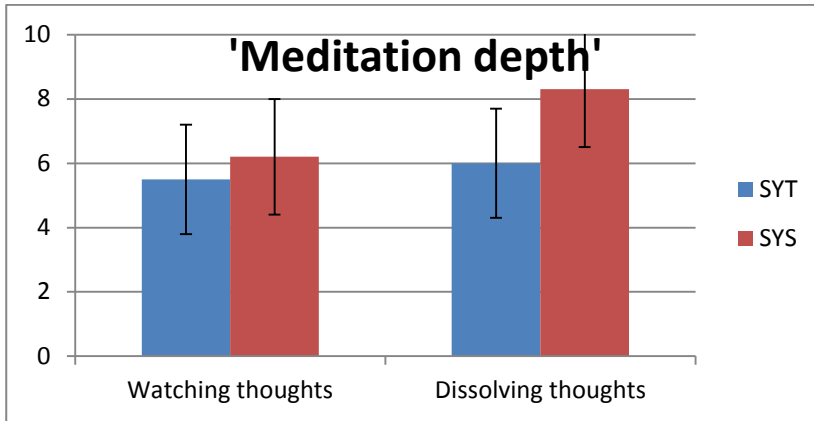
11.3.2 Comparison of ‘Dissolving thoughts’ and ‘Watching thoughts’

The comparison of ‘Dissolving thoughts’ and ‘Watching thoughts’ was only obtained for the SYT and SYS groups.

11.3.2.1 Meditation depth ratings

The subjective ratings of “meditation depth” are shown in Figure 28.

Figure 28 - Study 4 - 'Meditation depth' ratings



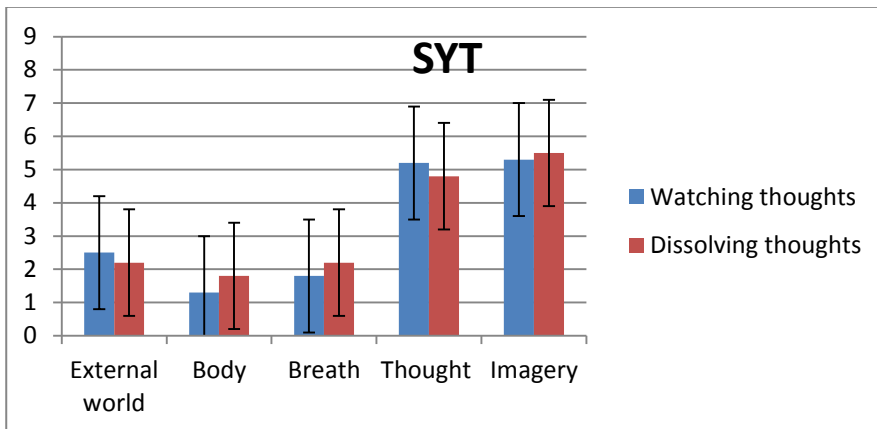
The 'meditation depth' ratings were similar for 'Watching thoughts' and 'Dissolving thoughts', with the SYS tending to a slightly higher ratings on 'Dissolving thoughts'.

11.3.2.2 Subjective ratings

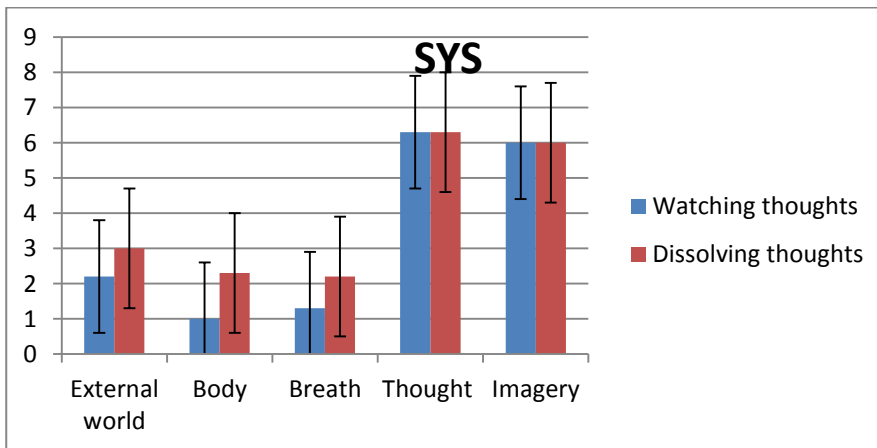
The subjective ratings on 'Meditation dimensions' are shown in Figure 29.

Figure 29 - Study 4 – 'Meditation dimensions' ratings – 'Watching thoughts' and 'Dissolving thoughts'

a) SYT



b) SYS



Both groups had similar ratings on ‘meditation dimensions’ for both meditations, with ‘internal’ dimensions of ‘thought’ and ‘imagery’ higher than ‘external’ dimensions of ‘external world’, ‘body’ and ‘breath’.

11.3.2.3 EEG Source comparisons across conditions

Tables 29 to 30 show for each frequency band the region, Brodmann area, Tailairach coordinates and the (absolute) maximum voxel *F* statistic or statistical difference and the number of significant voxels between ‘Watching thoughts’ and ‘Dissolving thoughts’ conditions for the SYT and SYS groups.

Table 29 – Study 4 - ‘Watching thoughts’ > ‘Dissolving thoughts’ - SYT

Band	Region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Cingulate gyrus	Limbic	C24	-5, -10, 50	-0.279ns	
Theta	Postcentral gyrus	Parietal	L3	-10, -40, 70	0.176ns	
Alpha1	Insula	Sub-lobar	L13	-35, 15, 0	-0.154ns	
Alpha2	Precuneus	Parietal	L19	-35, -80, 35	0.447ns	
Beta	Mid frontal gyrus	Frontal	R9	35, 25, 35	0.404ns	
Gamma	Mid frontal gyrus	Frontal	R9	35, 20, 35	0.573ns	

* Signif at 0.05, ** Signif at 0.01

No significant differences were found for ‘Watching thoughts’ vs ‘Dissolving thoughts’ in the SYT group.

Table 30 – Study 4 - ‘Watching thoughts’ > ‘Dissolving thoughts’ - SYS

Band	Region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Cuneus	Occipital	C18	-5, -90, 20	-0.751ns	
Theta	Sup temp gyrus	Temporal	L41	-40, -35, 5	0.421ns	
Alpha1	Precentral gyrus	Frontal	R6	20, -20, 70	0.397ns	
Alpha2	Postcentral gyrus	Parietal	R5	10, -45, 70	0.407ns	
Beta	Paracentral lobule	Frontal	L5	-15, -45, 60	0.219ns	
Gamma	Mid temp gyrus	Temporal	R22	55, -35, 5	-0.314ns	

* Signif at 0.05, ** Signif at 0.01

No significant differences were found in the comparison of ‘Watching thoughts’ vs ‘Dissolving thoughts’ in in the SYS group.

11.4 Discussion

11.4.1 Hypothesis 1 and 2 - ‘Mantra’ and ‘Body steadiness’

The subjective ratings of ‘meditation depth’ did not differentiate between ‘Mantra’ and ‘Body steadiness’ for the groups or the single SYT.

The first prediction that 'Mantra' compared to 'Body steadiness' would show greater CSD activity in the theta band in midline frontal regions and the anterior cingulate cortex was not supported for any of the groups or for the single SYT. No significant differences were found in the theta band.

Rather than in the theta band, significant differences found were in the gamma band, with greater CSD in 'Mantra' compared to 'Body steadiness' in the right inferior temporal gyrus (BA37) in the single SYT and in the left superior temporal gyrus (BA41) in the YDLT group. While the result in the YDLT does not have a ready explanation, the finding in the single SYT is consistent with the 'trait' activation in the right temporal gyrus found in the SYT group in Study 3 (although the SYT group itself does not show the difference here).

The second hypothesis that 'Body steadiness' compared to 'Mantra' will show more lateralised frontal activity received support only for the SYS group, in the alpha1 band, with 'Body steadiness' having more CSD than 'Mantra' in the right insula (BA13). The right insula was found to have greater grey matter concentration in 'mindfulness' meditators (mean 6,000hours practice) (Lazar et al. 2005) and to be involved in interoception and visceral awareness, related to training in awareness of body sensations (Farb, Segal & Anderson 2012). The finding of increased alpha1 activity in 'Body steadiness' (indicative of reduced information processing compared to 'Mantra') in the right insula in the SYS group in the present study may suggest a stage in the student group's development of *pratyahara*, of reducing awareness of body sensations. The more experienced teacher groups did not show a difference between 'Body steadiness' and 'Mantra'.

11.4.2 Hypotheses 3 and 4 - 'Watching thoughts' and 'Dissolving thoughts'

The subjective ratings on 'meditation depth' and 'meditation dimensions' did not differentiate the 'Watching thoughts' and 'Dissolving thoughts' stages of *antar mouna* meditation.

The eLORETA results did not show significant CSD differences between the meditations for either the SYT or SYS group. Contrary to the third prediction, 'Dissolving thoughts' compared to 'Watching thoughts' did not show more right lateralised frontal lobe activity in the gamma band for either group.

However, for prediction four, 'Watching thoughts' compared to 'Dissolving thoughts' did show more right lateralised mid temporal lobe activity (BA22) in the gamma band for the SYS, although it did not reach significance.

11.5 Conclusion

This study failed to find the predicted differences between meditations characterised as FA or OM, but found some evidence consistent with 'trait' related effects in the right temporal lobe in the results of the single advanced practitioner and the involvement of right insula modulation by the student group in the 'Body awareness' meditation. The large number of significant differences found between different proficiency levels in Study 3 compared to this study may indicate that proficiency is a much stronger factor in generating differences in brain activation in Yoga meditation states than is the type of practice.

CHAPTER 12 – STUDY 5 – ‘TRAIT’ EFFECTS AND DMN

12.1 Introduction

This study explored the relationship between ‘trait’ effects of long-term meditation practice, control conditions and the default mode network (DMN) in more detail, by means of repeated measures with a single advanced Satyananda Yoga teacher (used in Study 4). This single case study provided the opportunity for examination of ‘trait’ effects without the inter-individual variability found in group comparisons.

For this study, in addition to the ‘non-meditation’ condition of mental calculation as the first condition, a mental calculation condition followed the meditation condition. Prior to these conditions, EEG was also measured in a condition of ‘eyes closed rest’ (ECR) (non-meditating state).

The conclusions from the previous studies that there are ‘trait’ neural networks evidenced in gamma band activation centered on the right temporal gyrus, present in non-meditation (but cognitively active) conditions and strongly enhanced in meditation, led to the following hypotheses:

- 1) The ‘Mantra’ meditation condition will show more activity in the gamma band in right temporal networks than the initial ‘Calculation’ (1) condition.
- 2) The ‘Mantra’ meditation condition will show more activity in the gamma band in right temporal networks than the final ‘Calculation’ (2) condition, but with a smaller difference than for ‘Calculation1’, due to a ‘carryover’ effect following meditation.
- 3) Study 3 found evidence that the ‘trait’ effect of long-term meditation is reflected in right-sided brain activity in non-meditation situations rather than in midline regions associated with the DMN. Although the ECR condition is conducive to DMN (midline) activity, it is predicted that ECR will show more activity in the gamma band in right temporal networks than the initial ‘Calculation’ (1) condition, due to this practice-related or ‘trait’-like change in resting state brain activity (in the absence of a cognitive task).
- 4) The ECR condition will show more activity in the gamma band in right temporal networks than the final ‘Calculation’ (2) condition, but with a smaller difference than for ‘Calculation1’, due to a ‘carryover’ effect following meditation.

12.2 Method

12.2.1 Participant

This study used the single participant from the previous study.

12.2.2 Setting

As for previous study.

12.2.3 Procedure

As described in the previous study, the single participant performed the following practices, in the same sequence at the same time of day (9am) on six days over a two week period. All conditions were conducted in a cross-legged seated meditation pose, supported by cushions.

- Eyes closed rest (ECR) (2 minutes) – with instructions not to meditate
- Calculation1 - mentally counting backwards from 200 by 4 (5 minutes)
- 'Body steadiness' – Satyananda Yoga practice - "*kaya stairyam*" – (10 minutes) (not reported in this study)
- 'Mantra' – Satyananda Yoga practice – "*japa*" – (30 minutes)
- Calculation2 - mentally counting backwards from 200 by 4 (5 minutes)

12.2.4 Data collection and analysis

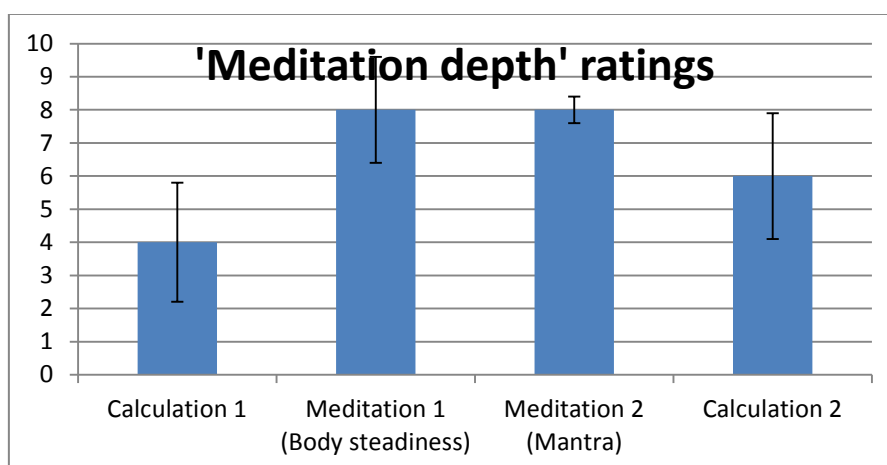
As for previous study

12.3 Results

12.3.1 Subjective ratings

The subjective ratings of "meditation depth" are shown in Figure 30.

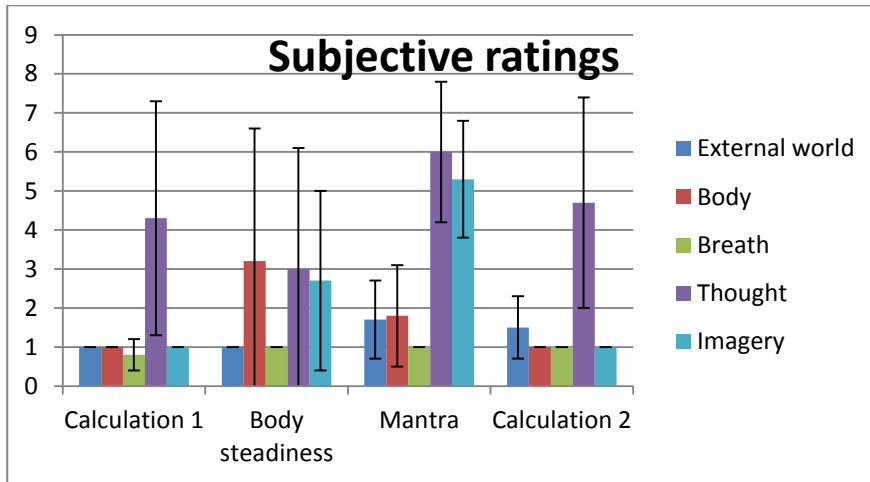
Figure 30 – Study 5 – 'Meditation depth' ratings



The first 'Calculation' condition was rated with some 'meditation depth' and the second 'Calculation' higher, but lower than the meditation conditions.

The subjective ratings on 'Meditation dimensions' are shown in Figure 31.

Figure 31 – Study 5 – 'Meditation dimension' ratings



The two 'Calculation' conditions had low ratings on all dimensions, except 'Thought awareness', as expected in this cognitive task. 'Awareness of body' was elevated in 'Body steadiness' meditation, as expected. 'Awareness of thought', but also 'awareness of imagery' was heightened in 'Mantra'.

12.3.2 Comparison between meditation and control conditions

Tables 31 to 33 show for each frequency band the region, Brodmann area, Tailairach coordinates and the (absolute) maximum voxel *F* statistic or statistical difference for the comparisons between the 'Mantra' meditation and control conditions and total number of significant voxels (two tailed threshold) for these comparisons. Figures 32 to 34 illustrate the brain regions involved in these comparisons.

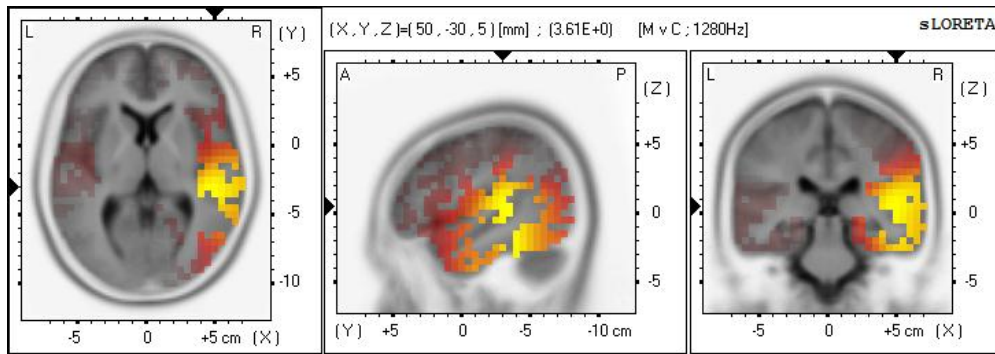
Table 31 – Study 5 – 'Mantra' > 'Calculation 1'

Band	Region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Transverse temp gyrus	Temporal	L41	-35, -35, 10	-1.43*	8
Theta	Insula	Sub-lobar	L13	-35, 20, 10	-0.789 ns	
Alpha 1	Inf frontal gyrus	Frontal	L45	-40, 20, 15	-0.753 ns	
Alpha 2	Sup temp gyrus	Temporal	R42	65, -30, 5	0.426 ns	
Beta	Mid temp gyrus	Temporal	R21	60, -30, -5	2.30**	744
Gamma	Sup temp gyrus	Temporal	R22	50, -30, 5	3.61**	1776

* Signif at 0.05, ** Signif at 0.01

Figure 32 – Study 5 – ‘Mantra’ > ‘Calculation 1’ – Gamma band

Increased gamma activity (yellow) in ‘Mantra’ compared to ‘Calculation 1’
 – maxima in right BA22 (superior temporal gyrus)



‘Mantra’ had significantly greater CSD than ‘Calculation1’ in the beta and gamma bands, with location of greatest significant difference in right middle and right superior temporal gyrus (BA21, 22) respectively.

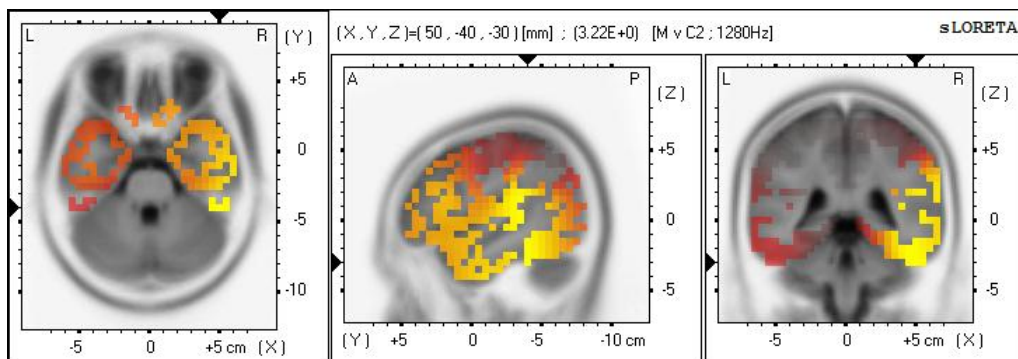
Table 32 – Study 5 - ‘Mantra’ > ‘Calculation 2’

Band	Region	Lobe	Max/min BA	Talairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Postcentral gyrus	Parietal	R3	55, -15, 50	0.873 ns	
Theta	Subcallosal gyrus	Frontal	L34	-10, 5, -15	-0.551 ns	
Alpha 1	Insula	Sub-lobar	L13	-30, 15, 15	-0.584 ns	
Alpha 2	Mid frontal gyrus	Frontal	R10	30, 45, 25	0.743 ns	
Beta	Mid temp gyrus	Temporal	R21	70, -20, -10	2.34**	3343
Gamma	Fusiform gyrus	Temporal	R20	50, -40, -30	3.22**	4731

* Signif at 0.05, ** Signif at 0.01

Figure 33 – Study 5 – ‘Mantra > ‘Calculation 2’ – Gamma band

Increased gamma activity (yellow) in ‘Mantra’ compared to ‘Calculation 2’
 – maxima in right BA20 (fusiform gyrus)



Similarly, ‘Mantra’ had significantly greater CSD than ‘Calculation2’ in the beta and gamma bands, with the location of voxels of greatest significant difference shifted downwards to the right middle temporal and right fusiform gyrus (BA21, 20). However, the number of significant

voxels in these bands was approximately three times as numerous as in the comparison with ‘Calculation1’.

12.3.3 Comparison of non-meditation conditions

Tables 33 to 34 show for each frequency band the region, Brodmann area, Tailairach coordinates and the (absolute) maximum voxel *F* statistic or statistical difference for the comparisons between the conditions and total number of significant voxels (two tailed threshold) for the comparison of ‘Eyes closed rest’ and ‘Calculation1’ and ‘Eyes closed rest’ and ‘Calculation2’. Figures 34 to 36 illustrate the brain regions involved in these comparisons.

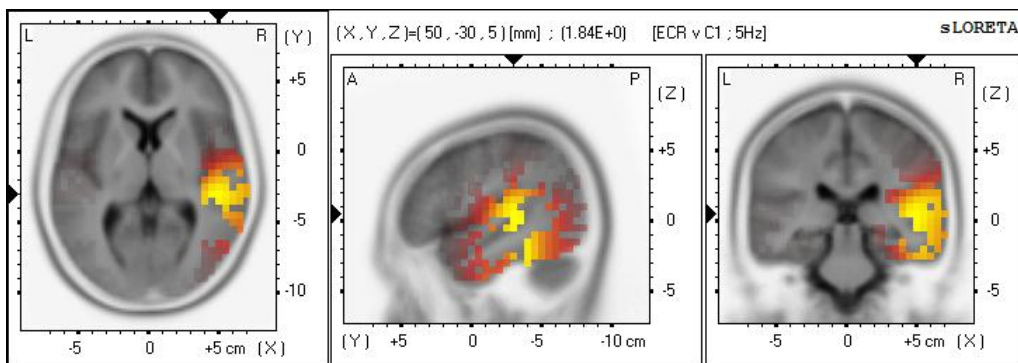
Table 33 – Study 5 - ‘ECR’ > ‘Calculation 1’

Band	Region	Lobe	Max/min BA	Tailairach coords	Max/min F value	No. of voxels $p < 0.05$
Delta	Insula	Sub-lobar	L13	-35, -35, 20	-0.819ns	
Theta	Postcentral gyrus	Parietal	R3	55, -25, 40	0.474ns	
Alpha 1	Cingulate gyrus	Limbic	R31	20, -45, 25	0.622ns	
Alpha 2	Inf parietal lobule	Parietal	R40	45, -45, 60	0.529ns	
Beta	Mid temporal gyrus	Temporal	R21	60, -30, -5	0.876ns	
Gamma	Sup temporal gyrus	Temporal	R21	50, -30, 5	1.84**	507

* Signif at 0.05, ** Signif at 0.01

Figure 34 – Study 5 - ‘ECR’ > Calculation 1’ – Gamma band

Increased gamma activity (yellow) in ‘ECR’ compared to ‘Calculation 1’
– maxima in right BA21 (superior temporal gyrus)



The condition ‘Eyes closed rest’ had significantly greater CSD than ‘Calculation1’ in the gamma band, with location of voxels with greatest significant difference in the right superior temporal gyrus (BA21). This comparison suggests the existence of a ‘trait’ network, with a hub in the right temporal gyrus, resulting from long-term meditation practice, spontaneously activate in a non-task situation, which reduces with the commencement of a specific cognitive task.

Table 34 – Study 5 - ‘ECR’ > ‘Calculation 2’

Band	Region	Lobe	Max/min BA	Talairach coords	Max/min F value	No. of voxels p< 0.05
Delta	Precentral gyrus	Frontal	R4	60, -15, 45	1.59**	5032
Theta	Precentral gyrus	Frontal	R6	50, -5, 55	1.24**	2584
Alpha 1	Mid frontal gyrus	Frontal	R10	45, 55, -5	0.896*	152
Alpha 2	Sup frontal gyrus	Frontal	L10	-25, 65, -5	1.07**	1265
Beta	Inf frontal gyrus	Frontal	L47	-50, 45, -10	1.29**	2467
Gamma	Med frontal gyrus	Frontal	L9	-20, 35, 25	1.73**	4614

Figure 35 – Study 5 - ‘ECR’ > Calculation 2’ – Delta band

Increased delta activity (yellow) in ‘ECR’ compared to ‘Calculation 2’
 – maxima in right BA4 (precentral gyrus)

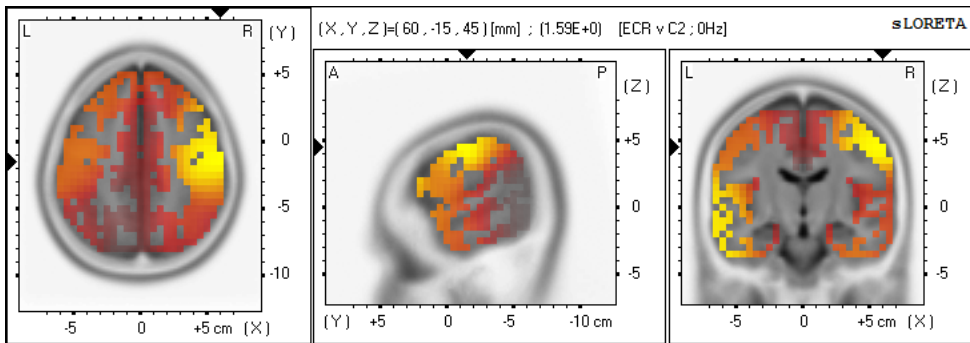
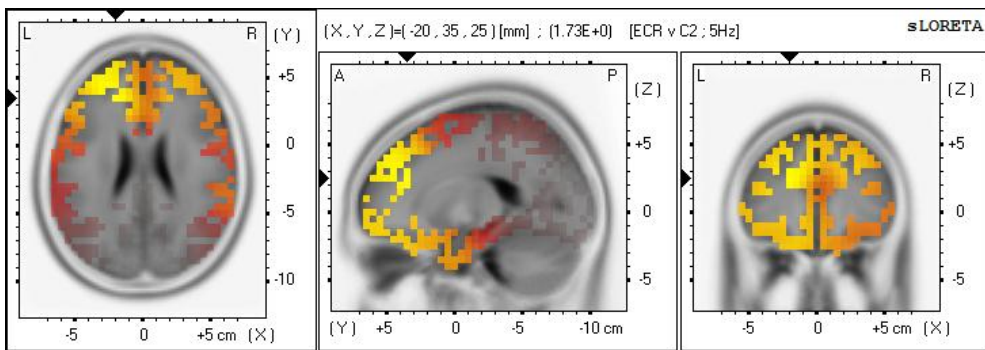


Figure 36 – Study 5 - ‘ECR’ > Calculation 2’ – Gamma band

Increased gamma activity (yellow) in ‘ECR’ compared to ‘Calculation 2’
 – maxima in left BA9 (medial frontal gyrus)



The condition ‘Eyes closed rest’ had significantly greater CSD than ‘Calculation2’ across all frequency bands, with the greatest number of voxels with significant difference in the delta and gamma bands. The voxels with greatest significant difference were located in the frontal lobe, right precentral gyrus (BA4) in delta and left medial frontal gyrus (BA9) in gamma. This result indicates that the ‘Calculation’ task following meditation practice has vastly reduced activity across all frequency bands in frontal regions compared to ECR prior to the meditation practice.

12.3.4 Differences between conditions on source activation

In order to examine the specific regional pattern of these differences, the number of significant voxels in each (right and left) Brodmann Area is presented for each comparison in the gamma band in table 35.

Table 35 – Study 5 – No. of significant voxels - Gamma band

BA	M v C1		M v C2		ECR v C1		ECR v C2	
	L	R	L	R	L	R	L	R
1		3	1	8			9	9
2		27	13	49			44	49
3		13	15	72		1	67	65
4	4	11	21	65		2	63	61
5				26			18	15
6	7	39	259	276		3	60	264
7				63			51	
8			82	93			79	93
9		34	131	138			129	139
10		5	139	136			137	135
11		27	115	122			115	122
13	48	117	125	117		45	123	117
17				15				
18		31	1	73				3
19		104	37	145		14	22	53
20	75	112	100	112		79	109	112
21	70	126	105	124		94	105	125
22	44	93	95	93		73	86	93
23								
24			62	68			57	53
25	7	16	20	24			18	25
27	1	9	7	9			4	5
28	11	20	21	21			21	20
30		11	7	26			1	1
31			3	23			2	
32		1	74	80			75	81
33			3	4			3	4
34	1	16	17	16			17	16
35	6	13	13	13			13	13
36	11	26	30	26		8	30	26
37		88	96	92		74	91	92
38	8	88	76	89			76	88
39		54	26	65		8	37	41
40	4	100	83	182		48	189	141
41	13	27	28	28		28	26	28
42	13	20	20	21		20	19	20
43	13	12	14	12		10	14	12
44	5	28	27	28			27	28
45		33	29	34			29	34
46		18	20	25			20	25
47		102	107	112			107	113
Total	341	1424	2022	2725	0	507	2093	2321

LEGEND: BA = Brodmann area; C1 = 'Calculation1'; C2 = 'Calculation2';
M = 'Mantra'; ECR = 'Eyes closed rest'
Blue highlight = Brodmann area of maximum significance difference for that band

The comparison of 'Mantra' with the preceding 'Calculation' condition was strongly right hemisphere dominant, with activity located in the temporal gyrus (BA20, 21, 22). In contrast, the comparison of 'Mantra' with the subsequent 'Calculation 2' condition was bilateral, with activity not only in the temporal gyrus, but also in the adjoining parietal (BA40) and frontal (BA6, 9, 10, 11) lobes and the insula (BA13).

The comparison of condition 'ECR' with the 'Calculation 1' condition was entirely located in the right hemisphere, with activity focused in the mid (BA21), superior (BA20) and inferior (BA37) temporal gyrus. The comparison of 'ECR' with the mental calculation condition conducted after an extensive mantra meditation session 'Calculation 2' showed a pattern of activation similar to the comparison of 'Mantra' with 'Calculation 2', with bilateral activity, in frontal, temporal and parietal regions, as well as the insula (BA13).

12. 4 Discussion

12.4.1 Hypotheses 1 and 2

Hypothesis 1 was supported, with the significant difference between meditation and calculation conditions being located in networks with hubs in the right temporal lobe.

However, the transition from meditation conditions to a subsequent calculation condition was much more marked, contrary to hypothesis 2. Also contrary to this hypothesis, the differences were bilateral and extended to the frontal locations and the insula. An interpretation of this result is that the 'trait' network located in the right temporal gyrus becomes more strongly activated, and extends bilaterally into temporal and frontal regions in meditation states, particularly the precentral gyrus (BA6). On returning to the cognitive task of mental calculation following meditation, these regions show a corresponding drop in activation below initial levels.

12.4.2 Hypotheses 3 and 4

Hypothesis 3 was supported, with the ECR versus the initial 'Calculation' condition showing significantly more activity in the gamma band, primarily in right temporal networks (BA20, 21, 22). This finding adds further evidence of a right temporal focus for 'trait'-like network changes in an advanced Satyananda meditator and evidence for a 'neuroplasticity' effect of meditation.

Contrary to hypothesis 4, the comparison ECR with the final 'Calculation' condition showed

a similar pattern to the comparison 'Mantra' versus 'Calculation 2'. The differences were bilateral and extended to the frontal locations and the insula.

This result aligns with those of two recently published articles. Wang et al (2011) found neural activity persisted in the left anterior insula and precentral gyrus following two Kundalini Yoga meditations. They suggest the persistent involvement of the insula with the left frontal regions after meditation may induce a lasting positive emotional state. Lehmann et al (2012) found in a study of a number of different meditation traditions that "coming out" of meditation is associated with different changes of coherence topography compared to "going into", and is not simply a reversal of the induction process.

12.5 Conclusion

This study found further evidence for a beta-gamma 'trait' network located in the right temporal gyrus in an advanced Satyananda Yoga meditator present in a cognitive task situation which becomes amplified and more extensive in the mantra meditation state. Return to a cognitive task shows an 'after-effect' of reduced activation below initial levels.

Although the comparison of ECR with mental calculation might be expected to elicit midline DMN activity, gamma band right temporal network activity was found. This finding suggests this right temporal 'trait' network may permanently modulate the activity in the DMN in advanced meditators.

CHAPTER 13 – DISCUSSION AND CONCLUSIONS

Despite the large number of research studies conducted into meditation ‘states’ and ‘traits’ to date, there are still many unanswered questions. This thesis examined the practice of Yoga meditation within a sample of Australian practitioners. The key research questions addressed were:

- Can the meditation ‘states’ experienced by Australian Yoga meditators be differentiated by level of proficiency or type of practice, using ‘subjective’ experience and ‘brain activity’ measures?
- Are there ongoing ‘trait’ alterations in the ‘sense of self’ reported by advanced Yoga meditators and observable by ‘brain activity’ measures in non-meditation conditions?
- Can these results be related to the conceptual framework of traditional Yoga literature?

These questions were explored by:

- An examination of the underlying philosophical concepts
- The methodology of scientific study of meditation
- A qualitative exploration of the lived experience of Yoga practitioners
- A number of EEG studies using LORETA tomography to test hypotheses about proficiency and type of practice.

13.1 Underlying philosophical concepts

The differing paradigms underlying traditional Yogic philosophical concepts and those of Western science pose a challenge for meditation research. The classical Yoga framework (attributed to Patanjali) views meditation as the path towards ‘self-realisation’, seen as a reunification with ‘one’s true self’ and attainment of ‘higher’ states of consciousness. The stages of *pratyahara*, *dharana*, *dhyana* and *samadhi* describe the ‘internal’ (mental) processes of this path.

The results of the qualitative study conducted for this project showed that Australian meditators from two Yoga traditions found these concepts meaningful and useful for describing their experiences in meditation. The translation of these concepts into Western terms such as “absorption” provided the theoretical framework for this project.

Western conceptions of meditation have focused on the neural processes involved, viewing meditation as an ‘altered state of consciousness’, characterised by internalised attention and reduced mental activity. The discovery of the ‘default mode network’ (DMN), a neural

network active in passive, internally-focused mental states, has provided a recent point of reference for meditation research. The association of a 'narrative' sense of self with the DMN, and its distinction from an 'experiential' sense of self provided the background for the investigation of neural networks in this investigation. The EEG studies in this project explored these distinctions.

13.2 Methodological issues

Although there has been a recent trend (Fell, Axmacher & Haupt 2010; Lehmann et al. 2012) to emphasise similarities rather than differences between meditation traditions and practices, this project has argued for the need to examine the context in which meditation practices are performed.

The large number of potential confounding variables identified in the literature led to the methodological framework proposed in this investigation. This provides a classification of relevant independent variables into domains of cultural context (Place), personal history of the meditator (Person) and the details of the practice (Practice). It was argued that the outcome variables should include both subjective (Phenomenology) and objective (Psychophysiology) measures.

Within this framework, the major independent variables of proficiency and type of practice were investigated for their impact on meditation 'states' and 'traits'.

13.3 Meditator proficiency

The major finding of my investigation was that levels of proficiency within a Yoga tradition clearly differentiated participants on qualitative reports and brain activity measures.

The concept of meditator proficiency, especially for Western meditators with varied meditation training and practice, requires a more detailed specification than mere 'years of practice'. My qualitative study of Australian Yoga meditators showed there were clear demarcations between different 'cohorts' of practitioners on a number of dimensions, including: the cultural context of the time, length of time spent in India, the intensity and type of meditation training received and experiences in Australian ashrams.

The introduction of Yoga into Australia in the 1960s and 1970s provided an 'alternative' expression of spirituality for those disenchanted with established religion. Satyananda Yoga offered an 'integrated' style of Yoga and the opportunity to commit to a Yogic 'lifestyle', either

while still living 'in the world' as *karma sannyasins* or fully committing to a renunciate life as a *poorna sannyasin*.

Although all groups tended to look to Yoga in a search for 'meaning in life' not found in Western religion, there were many differences. For those in the first cohort, in the 1960s and 1970s, lifelong commitment to a spiritual Indian discipline in the form of *poorna sannyasa* was a radical step, requiring a rejection of mainstream Australian values. In contrast, those in the third cohort, who received their training in the 2000s, were usually attending a recognised vocational training course. Significant experiences with nature, the influence of 'spiritual' people and some experimenting with mind-altering drugs were often contributing factors for commencing Yoga. While some discovered Yoga through its physical benefits, or significant life changes, the connection to the 'guru' cemented their commitment.

The commitment to 'guru' became a central aspect of their meditation practice, with the mantra given by the guru being the most frequent daily practice. Although regularity of practice sometimes varied with life stages and events, all were practising regularly at the time of the study. However, the duration and nature of daily practice varied between the groups.

The path to involvement in Satyananda Yoga or Yoga in Daily Life for a significant minority included exploration of other traditions, particularly TM and Vipassana retreats. Once established, most participants reported regular daily practice, usually in the morning. SY students had a mean duration of 20 minutes, YDL students and SY teachers 30 minutes and YDL teachers 50 minutes. Satyananda Yoga personal meditation practice usually consisted of 15-60 minutes of mantra meditation, with their 'guru mantra', either in the form of *japa* (independent of breath) or combined with breath and visualisation. *Antar mouna* was often practised as a 'mindfulness' technique outside the meditation session. Most YDL participants practised guru mantra as their regular daily practice, with the addition of a guru-given *kriya* practice for some.

All of which makes the classification of proficiency levels for Australian meditators a complex task. While the relationship between student and teacher may involve instruction in technique and feedback on experiences, it does not usually involve formal assessment of proficiency in accordance with standardised levels. In the absence of any 'objective' measure of proficiency, an estimate of total hours of practice with a particular practice currently provides the best measure. As noted in the literature review, this measure is tending to replace the previously used 'years of practice' (Lutz et al. 2004; Brefczynski-Lewis et al. 2007).

My qualitative study found differences in the reports given of phenomenological experiences during meditation. All participants described the process of moving from awareness of the outside world to an internalised awareness of peaceful calm, a state of *pratyahara*, undisturbed by body sensations, and thoughts, with diminished awareness of breath and sometimes an experience of bliss. In this state, they reported their one's sense of self became more diffuse, with a sense of expansion of internal space and a slowing of time.

Only the teacher groups reported experiences of *dharana*, in which the awareness becomes concentrated and focused on the object of meditation and *dhyana*, in which the awareness of self becomes absorbed into the meditation object. They frequently described a connection with the guru in this state which expanded their sense of self beyond its individual expression.

However, on the self-report measures used in the EEG studies, participants from all groups produced similar ratings for 'meditation depth' and 'meditation dimensions', with no significant differences being found. These findings suggest that subjective ratings of meditation phenomenology tend to be similar whatever the participants' 'objective' level of proficiency. While the 'meditation dimension' scales showed the ability to discriminate aspects of the *pratyahara* process (awareness of external world, body, breath), they did not differentiate aspects of the *dharana/dhyana* stages. Further research is needed to address these issues.

The major finding was the significant difference in brain activity measured by EEG between Satyananda Yoga teachers and students. To my knowledge, this is the first study to report enhanced gamma band activation in advanced Western meditators practising in the Yoga tradition. It adds to the findings in the Buddhist tradition of sustained high amplitude gamma oscillations in EEG recordings of advanced Tibetan Buddhist monks (Lutz et al. 2004) and long-term Western Vipassana meditators (Cahn, Delorme & Polich 2010).

The finding lends support to the hypothesis proposed by Fell et al (2010) of distinct low and high frequency band effects for intermediate and advanced levels of experience in meditation training. The results are consistent with the traditional accounts of the stages of *pratyahara* (involving networks associated with sense withdrawal) in the student group and *dharana/dhyana* (involving networks associated with absorption) in the teacher group.

The results are interpreted as support for a *pratyahara* stage in 'intermediate' level meditators of sensory withdrawal and stripping away of the 'outer' onion-like layers of self as described in traditional Yoga literature. The networks involved are right lateralised, comprising visual, somatosensory and body-world self-representations.

A subsequent stage, attained by advanced meditators in *dharana/dhyana* states, involves both the disengagement from these self-representational systems and the development of widespread gamma synchronization throughout temporal and ventral prefrontal cortical regions extending from a right sided core network incorporating temporal lobe and insula.

The finding of distinct differences in neural activity in meditation 'states' between proficiency groups adds to the body of evidence contributing to an understanding of the neural basis of consciousness, as suggested by Fell et al (2010). The question of whether the distinctive characteristics of gamma band EEG activity shown by 'advanced' meditation practitioners is specific to such states, or is found in other 'altered states of consciousness', remains to be explored.

13.4 Type of practice

In contrast to the differences found for proficiency, the comparison of practices categorised as 'focused attention' (FA) or 'open monitoring' (OM) found few significant differences between a number of Satyananda Yoga practices. No differences were found between the stages of 'watching thoughts' and 'dissolving thoughts' of antar mouna meditation for either the teacher or student groups. The low resolution tomography method (LORETA) used in this study may have failed to detect the subtle differences between these practices.

Significant differences were found between the FA practice of 'mantra' and the OM practice of 'body steadiness' in higher frequency bands for the Satyananda Yoga teacher case study and for the Yoga in Daily Life teachers. The location of source activation differed, being in the left temporal lobe in the YDL teachers and in the right temporal lobe in the SY teacher. A difference in the alpha1 band was also found in the Satyananda Yoga student group, with more activity in the right insula in 'body steadiness'.

My results differ from neuroimaging studies of Yoga meditation. Lou et al (1999) found different stages of Yoga Nidra activated different brain regions, and Wang et al (2011) found a 'focused-based' Yoga meditation produced more activity in frontal regions than a 'breath-based' meditation. However, a recent study of five meditation traditions, using LORETA (Lehmann et al. 2012) found a similar reduction in functional connectivity across different

meditation practices. All were “experienced” meditators. These findings, together with the results from my study, suggest that proficiency at more ‘advanced’ levels of practice may have more effect on brain activity than the type of practice. As well, subtle differences between practices may only be found by fine-grained spatial techniques such as fMRI.

The classification of practices into ‘focused attention’ (FA) and ‘open monitoring’ (OM) is limited by its utilization of only one variable, that of direction of attention. As suggested by Fell et al (2010), a more complete specification of a practice would include a number of dimensions of ‘states of consciousness’. Although the self-report rating scale used in my study attempted this, further development is needed to achieve the required accuracy.

13.5 Trait effects

Evidence of proficiency-related ‘trait’ effects, associated with an alteration in the ‘sense of self’ were found in the EEG studies in this project. The Satyananda Yoga teachers showed more activity than Yoga in Daily Life teachers in the delta band in the anterior cingulate gyrus in a non-meditation (calculation) condition. This finding supported that of Tei et al (2009) with Qigong practitioners in ‘eyes-closed-rest’, which was interpreted as indicative of a trait of increased “detachment”, associated with “an attenuation of analysis, judgment and expectation, implying a lesser degree of processing of ongoing experience” (p162).

The comparison of Satyananda Yoga teachers and students provided evidence of a ‘trait’ effect in the teachers, associated with neural networks with hubs in the right temporal gyrus and insula, but distinct from the default mode network (DMN).

The results of the case study involving repeated performance of the same practices on six successive days by a single Satyananda Yoga teacher also found significant ‘trait’ effects. This study found further evidence for a beta-gamma ‘trait’ network located in the right temporal gyrus present in a non-meditation cognitive task. Activity in this network became amplified and more extensive following the transition to a mantra meditation state. Return to a cognitive task following meditation showed an ‘after-effect’ of reduced activation below initial levels. These results add to the findings of other studies of the ‘after-effect’ of meditation. Wang et al (2011) found neural activity persisting in the insula following Kundalini meditation. Lehmann et al (2012) in a study of a number of different meditation traditions found that “coming out” of meditation was associated with different topography compared to “going into”, and was not simply a reversal of the induction process.

My results support Fell et al's (2010) theory of neuroplasticity changes with advanced practice, evidenced by enhanced right lateralised enhanced gamma band activity. Repeated experience of deep meditation states is considered to gradually evolve into lasting traits, permanently altering one's 'sense of self'. This process may contribute to the therapeutic benefits attributed to meditation resulting from neuroplasticity (Berkovich-Ohana, Glicksohn & Goldstein 2012).

The involvement of brain regions associated with awareness of body space and interoceptive sensations is interpreted as responsible for alterations in the 'sense of self', experienced as an habitual 'observing' or 'witnessing' awareness of oneself, and a deactivation of the 'narrative', 'ego-centered' awareness associated with the default mode network. These findings support Farb et al's (2007) theory that long-term meditation training results in a "decoupling" of the 'narrative' mode from the 'experiential' mode of self-awareness.

My findings suggests that this right temporal 'trait' network may permanently modulate the activity in the DMN in advanced meditators. However, the discovery of a number of "resting state networks" in addition to the DMN (Jann et al. 2010) suggests that the effects of meditation training may involve more complex alterations of brain networks, both during meditation practice and effecting permanent changes in the 'sense of self'.

13.7 Strengths and weaknesses of the investigation

A major strength of this investigation was the access gained to teachers and students from the Satyananda Yoga tradition provided by my status as a fellow *sannyasin* and staff member at Satyananda Yoga Academy. The cooperation and support of senior staff enabled me to recruit participants from the major teaching centres and Satyananda teachers in the community. My status at Satyananda Yoga Academy also provided an introduction to the Yoga in Daily Life group and assisted in obtaining their enthusiastic support for the project. As a fellow meditator, I was able to converse easily using "Yoga" concepts to describe experiences in meditation. My position enabled me to undertake a detailed investigation of the meditation experience of the participants.

The major weakness of the investigation was in the subjective measures used in the EEG studies, which were intended to capture the phenomenological experiences in the form of rating scales. While they mapped the relevant dimensions of *pratyahara*, they were less effective in the reporting of the phenomenology of *dharana* and *dhyana*. Also, the scales measuring 'meditation depth' and 'absorption' did not discriminate participants at these levels of proficiency.

A further weakness was the lack of a counter-balanced design of conditions in the EEG studies. It was decided to sacrifice this requirement in the interests of preserving the 'ecological' validity of the meditation experience, keeping the order of practices to that usually followed by the practitioners. Conducting the experiments in non-laboratory settings conducive to meditation practice also enhanced the validity of the meditation states attained.

Other limitations were the small sample size for the EEG studies and the loss of the YDL student group EEG recordings. As with other cross-sectional studies, differences between groups may be due to pre-existing differences, rather than the independent variables under study.

13.8 Implications for future research

Although there are similarities in subjective experience and neural activity patterns between meditation traditions (Fell, Axmacher & Haupt 2010; Lehmann et al. 2012), I contend there is still much to be gained from detailed collaboration with a particular meditation tradition as suggested by Lutz et al (2007), and as in this investigation.

The results of the qualitative study in this project showed the importance of context for the study of meditation. The transposition of Yoga practices and philosophy to a Western society like Australia has produced a unique cultural environment for the practice of meditation, impacting on how the independent variables of 'proficiency' and 'type of practice' are measured. It is suggested that future research would be enhanced by incorporating an understanding of the cultural context of the meditation under study.

Future research would also benefit from more detailed collaboration with senior meditation teachers in each tradition to develop more extensive and relevant subjective measures to tap deeper aspects of meditation experience. Training in these measures would then be required to maximize their usefulness in matching phenomenal experience to brain activity measures.

Collaboration with spiritual disciplines needs to engage further on the issues of meditator proficiency and classification of practices. Only one study in the literature (Kasamatsu & Hirai 1966) used ratings of proficiency by the participants' meditator teacher. Extended consultation with each disciple may be needed to produce relevant and practical means of classifying proficiency and the dimensions of practice.

The choice of an appropriate non-meditation or baseline condition for meditation research remains a challenge. A requirement is that the task should not intrinsically engage similar

neural networks to the actual meditation practices in question. Although ECR has the advantage of similarity to “everyday thinking” (Cahn, Delorme & Polich 2010), its overlap with the ‘default mode network’ and some meditation states confounds the making of clear distinctions. Experimentation with a number of control conditions may be required to draw out the most important differences between specific meditation states and non-meditation states. The relationship of meditation states to other ‘resting state networks’ should prove a fruitful line of inquiry.

13.9 Conclusion

Addressing the key research questions for this thesis, the conclusions are:

- Meditation ‘states’ experienced by Australian Yoga meditators were clearly different on measures of brain activity according to level of proficiency, but less clearly distinguished by type of practice. The study adds the first finding of meditation-specific gamma band activity in advanced Western Yoga meditators to studies of advanced Buddhist meditators.
- ‘Trait’ alterations in the ‘sense of self’ were reported by advanced Yoga meditators and corroborated by observed brain activity measures in non-meditation conditions. A neural network with primary hubs in the right temporal gyrus and right insula, related to a ‘witnessing’ experience of ‘self’, seemed to be implicated in this process.
- Both ‘state’ and ‘trait’ results were consistent with descriptions of Patanjali’s stage of *pratyahara* in the less advanced student group and the stages of *dharana/dhyana* in the advanced teacher group.

In conclusion, long-term meditation has made a profound impact on the lives of the Australian Yoga practitioners studied in this investigation. Although none reported reaching the ultimate stage of ‘self-realisation’ or the state of *turiya*, their Yoga training has impacted positively on their ‘lived experience’ as shown in the qualitative study. Both ‘state’ and ‘trait’ effects were found in neural network activity, experienced subjectively as changes in their ‘sense of self’.

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APPENDICES

Appendix1 – Publications during the period of candidature

JOURNAL ARTICLES

Thomas, JW; Jamieson, G; Cohen, M. Brain activity localisation with differing levels of expertise. *Neuroimage*, under review, 2012

CONFERENCE PAPERS

Thomas, JW. Research into meditation states: a review. 11th International Holistic Health Conference, *Australian Integrative Medicine Association*, Sunshine Coast, Queensland, Australia, August 2005

Thomas, JW. Meditation state research. *Swan Research Institute Symposium*. Satyananda Yoga Academy, Mangrove Creek, NSW, April 2006

Thomas, JW. Meditation as a state of consciousness: a phenomenological, psychological and neuropsychological study. *School of Health Sciences Research Conference*, RMIT University, Melbourne, July 2007

Thomas, JW. Putting the meditation state in its context – results of a qualitative study of Australian meditators. *Meditate 09 Conference*, Melbourne, Australia, June 2009

CONFERENCE POSTER PRESENTATIONS

Thomas, JW. Meditation as a state of consciousness, *School of Health Sciences Research Conference*, RMIT University, Melbourne, Australia, July 2006

Thomas, JW. Meditation as a state of consciousness: a phenomenological, psychological and neuropsychological study. *Third International Congress on Complementary Medicine Research*. Sydney, Australia, March 2008

Appendix 2 – Patanjali's Yoga Sutras

The *Yoga Sutras* systemise the methods of Yoga using the philosophical framework of *Samkhya* (Y. Saraswati 1996).

Chapter 1, Sutra 2 gives the essence of this process –

“*Yogah cittavritti nirodhah*” - “To block the patterns of consciousness is Yoga” (Saraswati 1976) (p3).

In this context, the term *chitta* means individual consciousness, comprising the three states of consciousness, described in the previous section – waking, dream and deep sleep. According to Swami Satyananda, the expression “*nirodha*” (blocking) does not refer to blocking the “*fundamental stuff of awareness*”, but to the patterns (or disturbances) of awareness of individual consciousness (*chitta*), known as *vrittis* (Vivekananda 2005).

Sutra 3 gives the culmination of Yoga:

“*Tada drastuh swarupeavasthanam*” – “Then the seer is established (abides) in his own essential nature” (Saraswati 1976) (p10).

and Sutra 4 the “unrealised” state of being:

“*Vritti sarupyamitaratna*” – “Or there is identification with the modifications of *chitta*, the *vrittis*” (Saraswati 1976) (p11).

The *vrittis* are fivefold: *pramana* (right knowledge), *viparyaya* (wrong knowledge), *vikalpa* (imagination), *nidra* (sleep) and *smritayah* (memory) (Sutra 6). These can be either painful (*klistah*) or non-painful (*aklistah*).

The causes of pain (the *kleshas*) are listed as: ignorance (*avidya*), I-feeling (*asmita*), liking (*raga*), dislike (*dvesa*), and fear of death (*abhiniveshah*) (Chapter 2, Sutra 3). However the root cause is *avidya* (Chapter 2, Sutra 4). In the following sutra, *avidya* is defined as mistaking the non-eternal and impure for the eternal and pure. Swami Satyananda describes *avidya* as “the divine illusion, a kind of veil, a morphic dose, a defect of our psychic vision” (Saraswati 1976) (p97).

Yoga's eightfold path

To overcome *avidya* (ignorance), the *Yoga Sutras* (Chp 2, sutras 28 – Chp 3, sutra 8) offer an eightfold method. Although Feuerstein (1979) considers these sutras to be an insertion of uncertain origin, they contain the essentials of ‘classical yoga’. The first two stages, *yama*

(abstentions or 'external' disciplines) and *niyama* (observances or 'internal' disciplines) provide the ethical framework needed for the practice of Yoga. At a practical level, these stages help to reduce the distractions that would hinder progress. The next stage, *asana*, is frequently the entry point for many Western practitioners. It establishes the physical basis for meditation through the development of posture that is steady (*stira*) and comfortable (*sukha*).

Control of the movement of the breath (particularly its cessation) is the fourth stage (*pranayama*). The next stage, *pratyahara*, begins the activities usually referred to by the term 'meditation' and marks the transition from the first four 'external' (*bahiranga*) stages to the four 'internal' (*antaranga*) stages. *Pratyahara* involves the withdrawal of awareness from sensory input, to enable an internal focus to develop, sealing the *chitta* from the external realm. It involves the development of internalized attention, rather than just a physical activity of closing the eyes. It develops a sense of detachment from the physical realm, thus limiting the afflictions (*kleshas*) and beginning the inward journey towards self-realisation.

Then the awareness can be made more concentrated in the stage of *dharana* (fixing the consciousness at one point). This leads to true meditation, the seventh stage, *dhyana*, in which the meditator is absorbed in the steady flow of attention directed towards the meditation object. In the eighth stage, *samadhi*, there is clear perception of one's true self. Although *samadhi* is often translated as ecstasy, Eliade (1958) prefers the term 'enstasy' indicating an internally, rather than an externally- focused process. Jentoft (2004) reports Iyengar's description of *samadhi* as a level of meditation in which the meditator's sense of self-awareness is lost in absorption in the object of meditation. It is equivalent to the *turiya* state described in the *Mandukya Upanishad* (Y. Saraswati 1996).

Appendix 3 – Reporting of variables for ‘Place’, ‘Person’, ‘Practice’

a) EEG Studies reporting of “Place”, “Person”, “Practice”

Study	Place			Person			Practice		
	Context	Intent	Setting	Demographics	Proficiency	History	Tradition	Category	Description
Das & Gastaut (1957)	O	Sp	F	NR	Est	N	Y	NR	B
Wenger & Bagchi (1961)	O	Sp	F	NR	Est	N	Y	NR	B
Anand et al (1961)	O	Sp	F	NR	Est	N	Y	NR	B
Kasamatsu & Hirai (1966)	O	Sp	F	A/S	Yr	N	B	NR	A
Wallace (1971)	T	W	L	A/S	Yr	N	TM	NR	B
Banquet (1973)	T	W	L	A/S+	Yr	N	TM	NR	NR
Pagano et al (1976)	T	W	L	A/S	Yr	N	TM	NR	NR
Ghista et al (1976)	O	Sp	L	NR	Est	S	Y	NR	A
Hebert & Lehmann (1977)	T	W	L	A/S	Yr	N	TM	NR	NR
Morse et al (1977)	S	E	L	A/S+	Yr	N	TM	NR	B
Fenwick et al (1977)	T	W	L	A/S+	Est	N	TM	NR	NR
Elson et al (1977)	T	Sp	L	A/S+	Yr	N	Y	NR	A
Corby et al (1978)	T	Sp	L	A/S	Yr	S	Y	NR	A
Stigsby et al (1981)	T	W	L	A/S+	Yr	S	TM	NR	NR
Becker & Shapiro (1981)	T	Sp	L	A/S	Yr	N	B, Y, TM	NR	NR
Farrow & Hebert (1982)	T	W	L	A/S	Yr	S	TM	NR	A
Badawi et al (1984)	T	W	L	A/S	Yr	N	TM	NR	NR
Taneli & Krahn (1987)	T	W	L	A/S+	Yr	N	TM	NR	NR
Ikemi (1988)	S	W	L	A/S+	Yr	S	Other	NR	B
Zhang et al (1988)	O	W	L	A/S+	Yr	N	QG	NR	B
Gaylord et al (1989)	T	W	L	A/S+	Yr	S	TM	NR	B
Benson et al (1990)	O	Sp	F	A/S	Yr	N	B	NR	B
Pan et al (1994)	O	W	L	A/S	Yr	N	QG	C/NC	B
Travis & Wallace (1999)	T	W	L	A/S	Yr	N	TM	NR	B
Dunn et al (1999)	S	E	L	NR	Yr	S	Other	C/M	A
Khare & Nigam (2000)	O	Sp	L	A/S	NR	N	Y, TM	NR	NR
Arambula et al (2001)	O	Sp	L	A/S	Yr	S	Y	NR	NR
Travis (2001)	T	W	L	A/S	Yr	N	TM	NR	NR
Lehmann et al (2001)	O	Sp	L	A/S	NR	S	B	NR	B
Ott (2001)	T	W	L	A/S	Yr	N	TM, Y	NR	NR
Aftanas & Golosheikine (2001, 2002, 2003)	T	Sp	L	A/S	Yr	N	Y	NR	NR
Lo (2003)	O	Sp	L	A/S+	Yr	S	B	NR	A
Lutz et al (2004)	O	Sp	L	A/S	Hr	S	B	NR	B
Faber et al (2004)	O	Sp	L	NR	NR	N	B	NR	NR
Murata et al (2004)	O	Sp	L	A/S+	Nov	N	B	NR	A
Takahashi et al (2005)	O	Sp	L	A/S+	Nov	N	B	NR	A
Hebert et al (2005)	T	W	L	A/S+	Yr	S	TM	NR	NR
Huang & Lo (2009)	O	Sp	L	A/S	Yr	N	B	NR	B
Cahn (2010)	T	Sp	L	A/S	Yr	N	B	M	A
Baijal & Srinivasan (2010)	O	Sp	L	A/S+	Yr	N	Y	C	B
Travis et al (2010)	T	W	L	A/S	Yr	N	TM	NR	A
Berkovich-Ohana (2011)	T	W	L	A/S+	Hr	N	B	M	B
Yu et al (2011)	O	Sp	L	A/S+	Nov	S	B	FA/OM	A

b) Neuroimager Studies reporting of “Place”, “Person”, “Practice”

Study	Place			Person			Practice		
	Context	Intent	Setting	Demogr	Proficiency	History	Tradition	Category	Description
Herzog et al (1990)	T	Sp	L	A/S+	Yr	N	Y	NR	NR
Lou et al (1999)	T	Sp	L	A/S	Yr	S	Y	Rel	A
Kamei et al (2000)	T	W	L	S	NR	N	Y	NR	NR
Lasar et al (2000)	T	Sp	L	A/S	Yr	N	Y	NR	A
Barentsen et al (2001)	T	W	L	A/S+	Yr	N	NR	NR	NR
Newberg et al (2001)	O	Sp	L	A/S+	Yr	S	B	C	A
Litscher et al (2001)	T	Sp	L	A/S	Yr	N	QG	NR	NR
Kjaer et al (2002)	T	Sp	L	A/S+	Yr	S	Y	Rel	NR
Lazar et al (2005)	T	Sp	L	A/S+	Yr	S	B	M	B
Holzel et al (2007)	T	Sp	L	A/S	Yr	S	B	M	A
Brefczynski-Lewis et al (2007)	O	Sp	L	A/S	Hr	S	B	C	A
Lutz et al (2008a)	O	Sp	L	A/S	Hr	S	B	NC	A
Beauregard et al (2009)	S	E	L	A/S+	NR	N	NR	NR	B
Kilpatrick et al (2009)	S	W	L	A/S	Yr	N	B	M	NR
Luders et al (2009)	T	Sp	L	A/S+	Yr	N	B	NR	NR
Baerentsen et al (2010)	T	Sp	L	A/S+	Yr	S	Y, B	NC	B
Newberg et al (2010)	T	Sp	L	A/S+	Yr	N	B	NC	NR
Manna et al (2010)	O	Sp	L	A/S	Hr	S	B	FA/OM	A
Holzel et al (2010)	S	W	L	A/S+	Yr	N	B	M	A
Wang et al (2011)	T	Sp	L	A/S	Hr	N	Y	FB/BB	B
Jang et al (2011)	S	W	L	A/S+	Yr	N	Other	NC	NR
Luders et al (2011)	T	Sp	L	A/S+	Yr	N	B	NC	NR

“Place” codes: **Context:** “O” – Original spiritual context, “T” – Transposed spiritual context, “S” – Secular context

Intent: “Sp” – Spiritual, “W” – Wellbeing, “E” - Experimental

Setting: “F” – Field, “L” - Laboratory

“Person” codes: **Demographics:** “A/S” – Age sex; “A/S+” – Additional demographics

Proficiency: “Est” – Estimated, “Yr” – Years, “Hr” – Hours”, “Nov” - Novice

History: “S” – Some personal history recorded, “N” - None

“Practice” codes: **Tradition:** “Y” – Yoga, “B” – Buddhist, “TM” – Transcendental Meditation, “QG” – Qigong, “Other” - Other

Category: “C/NC” – Concentrative/Non-concentrative, “C/M” – Concentrative/Mindfulness, “FA/OM” – Focused attention/Open Monitoring, “M” - Mindfulness C” – Concentrative, “Rel” – Relaxation, “FB/BB” – Focused-based/Breath-based

Description: “A” – adequate, “B” - brief

“NR”: Not reported

Appendix 4 - Letter to participants

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

PROJECT INFORMATION STATEMENT

Project Title:

A neurophysiological study of meditation

Investigators:

- Mr John Thomas, M.A, M.Psych (Health Sciences PhD student, (02) 43771871)
- Dr Marc Cohen PhD (Project Supervisor: Professor of Complementary Medicine, School of Health Sciences, RMIT University, marc.cohen@rmit.edu.au, (03) 9925-7440)

Dear

You are invited to participate in a research project being conducted by RMIT University. This information sheet describes the project in straightforward language, or 'plain English'. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators.

Who is involved in this research project? Why is it being conducted?

This study is being conducted by John Thomas as part of his PhD degree. His supervisors are Dr Marc Cohen, Professor of Complementary Medicine, School of Health Sciences, RMIT, Melbourne and Dr Graham Jamieson, School of Psychology, University of New England, Armidale.

The project has been approved by the RMIT Human Research Ethics Committee. The purpose of the project is to further our understanding of the states of consciousness during meditation.

Why have you been approached?

You have been asked to participate in this study as a person with experience in the practice of meditation.

What is the project about? What are the questions being addressed?

We want to explore the relationship between the experience of consciousness in the meditation state and its physiological and psychological effects. Both novice and experienced meditators will be asked to participate in the study.

If I agree to participate, what will I be required to do?

The study is in two parts. You may participate in Part 1, without going on to Part 2.

Part 1:

This begins with a semi-structured interview with questions about your current meditation practice, your training in meditation and its place in your life, and the experiences you have in meditation. This interview will be recorded. You will then complete 3 personality assessments, 2 being questionnaires and one using inkblots.

An example of a questionnaire item is:

Circle the number which fits best for the following statement where

0 means “never”, 1 means “at least once”, 2 means “occasionally”, 3 means “often” and 4 means “very often”.

“When I listen to music, I get so caught up in it that I don’t notice anything else.” 0 1 2 3 4

It is expected that this entire session may take 1 ½ hours.

Part 2:

Following completion of Part 1, the researcher will discuss with you about proceeding to Part 2. This will depend on: you meeting the criteria for Part 2 and your willingness to proceed.

The second part of the study involves you doing some meditation practices while physiological data is recorded. This means wearing a close fitting cap incorporating EEG electrodes, and a chest electrode to measure heart rate. There may be some slight discomfort from wearing this instrumentation. You may try out wearing the equipment before deciding whether to participate in this part of the study. As the equipment is portable, it will be possible to conduct this session in your usual meditation situation, or a convenient location.

Following the meditation session, you will be interviewed about your experiences in the meditation session, and asked to complete 2 questionnaires about your meditation experience.

It is expected that the entire session may take 2 hours.

You may examine the complete set of questions before deciding whether you want to participate. You will have the opportunity to review the accuracy or add information.

What are the risks or disadvantages associated with participation?

This study does not involve any risk beyond your usual activities as you will be undertaking your normal meditation practices.

The researcher (John Thomas) is an experienced Clinical Psychologist who practises meditation regularly. If you have concerns as a result of the interviews, questionnaires or testing, he is able to talk with you about your experiences and provide immediate debriefing.

The physiological recording equipment has been approved for medical use and does not involve any electrical risk. The recording is passive only and does not involve any electrical stimulation and is not connected to the mains electrical supply.

What are the benefits associated with participation?

By participating in the study, you may gain a deeper appreciation of the psychological and physiological effects of your meditation practice. Your participation may advance the knowledge base on the immediate and long-term effects of meditation practice and our understanding of the mechanisms of consciousness.

What will happen to the information I provide?

The data collected for this study will be kept securely, with identifying data kept separately. The only persons having access to identifying information will be the two investigators (John Thomas and Dr Marc Cohen). All electronic data will be held on a password-protected computer and hard data in a

locked filing cabinet. The research data will be kept securely at RMIT University for a period of five years and then will be destroyed.

You can have access to the information you have provided. Any information that you provide can be disclosed to others only if (1) it is to protect you or others from harm, (2) a court order is produced, or (3) you provide the researchers with written permission.

The results of the study will form part of a PhD dissertation and may be used for preparation of research articles or conference presentations. Participants will not be identified in these publications. If individual results need to be presented, they will be identified only by broad classifications, eg meditation tradition, length of experience, unless you have given written permission for more identifying information to be used.

What are my rights as a participant?

You have the right to

- withdraw from participation in the study at any time, without needing to give any reason.
- have any unprocessed data withdrawn and destroyed, to amend or have destroyed any personal information you have provided that you do not want retained as research data.
- have any questions answered at any time.

Whom should I contact if I have any questions?

You may ring John Thomas on (02) 4377-1871, both day and evening or
Dr Marc Cohen on (03) 9925-7440

What other issues should I be aware of before deciding whether to participate?

It is important that you are comfortable with the nature of any personal information you disclose and that you are clear about how much identifying information you may wish to give written permission for use in any publication.

Yours Sincerely

John Thomas

M.A., M.Psych, M.A.P.S

Dr Marc Cohen

PhD, MB BS, B Med Sci

<p>Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745. Details of the complaints procedure are available from the above address.</p>
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Appendix 5a - Consent form – Qualitative Study

Prescribed Consent Form for Persons Participating In Research Projects Involving Interviews, Questionnaires or Disclosure of Personal Information

Portfolio **Science, Engineering and Technology**
School of **Health Sciences**
Name of participant: _____
Project Title: **A neurophysiological study of meditation**
Name(s) of investigators: **John Thomas** Phone: **(02) 3771871**
Dr Marc Cohen Phone: **(03) 9257440**

1. I have received a statement explaining the interview/questionnaire involved in this project.
2. I consent to participate in the above project, the particulars of which - including details of the interviews or questionnaires - have been explained to me.
3. I authorise the investigator or his or her assistant to interview me or administer a questionnaire.
4. I acknowledge that:
 - (a) Having read Plain Language Statement, I agree to the general purpose, methods and demands of the study.
 - (b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.
 - (c) The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.
 - (d) The privacy of the personal information I provide will be safeguarded and only disclosed where I have consented to the disclosure or as required by law.
 - (e) The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to RMIT University. Any information which will identify me will not be used without my written consent.

Participant's Consent

Participant: _____ Date: _____
(Signature)

Witness: _____ Date: _____
(Signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251.
Details of the complaints procedure are available from the above address.

Appendix 5b – Consent form – EEG studies

Prescribed Consent Form for Persons Participating In Research Projects Involving Tests and/or Medical Procedures

Portfolio Science, Engineering and Technology
School of Health Sciences, RMIT University
Name of participant: _____
Project Title: A neurophysiological study of meditation

Name(s) of investigators: (1) John Thomas Phone: (02) 43771871
(2) Dr Marc Cohen Phone: (03) 99257440

I have received a statement explaining the tests/procedures involved in this project.

I consent to participate in the above project, the particulars of which - including details of tests or procedures - have been explained to me.

I authorise the investigator or his or her assistant to use with me the tests or procedures referred to in 1 above.

I acknowledge that:

The possible effects of the tests or procedures have been explained to me to my satisfaction.

I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied (unless follow-up is needed for safety).

The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.

(d) The privacy of the personal information I provide will be safeguarded and only disclosed where I have consented to the disclosure or as required by law.

(e) The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to RMIT University. Any information which will identify me will not be used without my written consent.

Participant's Consent

Participant: _____ **Date:** _____
(Signature)

Witness: _____ **Date:** _____
(Signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251. Details of the complaints procedure are available from the above address.

Appendix 6 - Semi-structured interview

SEMI-STRUCTURED INTERVIEW GUIDE for MEDITATION STUDY

General areas to be covered:

- Brief life history – where born, family structure
- Childhood experiences that led to an interest in meditation
- Significant events leading to commencement of Yoga/meditation
- Yoga/other tradition(s) studied – meditation practices learned
- Philosophical underpinning of personal meditation practice
- How meditation training and practice have developed over time
- What changes has meditation practice made to your life
- Place of meditation in life now
- Relation to other spiritual practices, Yoga practices
- Description of current meditation practices
- Frequency, duration, type of practices, place
- Experiences in meditation states
- Effect of meditation on life
- Any other comments

Appendix 7 - Satyananda Yoga Practices

a) General principles for meditation

Precautions

Meditation practices can induce powerful experiences, and should be introduced gradually. It is also advisable to seek the guidance of a qualified teacher when learning meditation. Some practices are contraindicated for people who are excessively introverted, prone to depression or have other symptoms of mental imbalance. These people should seek the guidance of a qualified teacher before commencing any meditation practice.

The stages of Meditation

Internalisation

Pratyahara

Dharana

Dhyana

Samadhi

Externalisation

The 8 limbs of Raja Yoga

The last 4 of the 8 limbs (*pratyahara*, *dharana*, *dhyana* and *samadhi*) in particular focus on the development of meditation. *Pratyahara*, *dharana* (concentration), and *dhyana* (the state of meditation) represent vital steps on the journey towards the meditative state, and *samadhi* (self-realisation), the ultimate goal. They are stages that are aimed for, and achievable through the practices of meditation.

Internalisation

Internalisation represents the first step in any meditation practice. At this stage preparation of the physical body is essential. If the body is not made sufficiently comfortable, aches, pain and general discomfort are more than likely to cause distraction. The initial stages of *Kaya sthairyam* are particularly useful for developing this aspect. Plenty of time should be spent feeling in to the posture, fine tuning and adjusting it for utmost comfort.

Pratyahara

As part of the internalization process, the mind is then turned to achieving a state of *pratyahara*. *Pratyahara* is the state of disconnecting the mind from the senses. Normally in the waking state, the mind is externalised and following the senses i.e. what we see, hear, smell, taste and experience physically. This first stage of meditation practice involves witnessing and harmonising the mind's involvement with the senses, and ultimately withdrawing the awareness from the sensory inputs, and allowing the awareness to witness the inner world of the mind. We might observe the flow of thoughts, memories, visual or auditory impressions, emotions, fantasies etc. Through this process the senses can be trained to follow the mind.

Pratyahara is the foundation of meditation. Many of the practices, such as *Antar Mouna* and *Yoga Nidra*, focus on the *pratyahara* component.

Although *pratyahara* is an important transitional phase in the eight limbs, there are also ***pratyahara practices*** which, in themselves, bring great benefits. The ability to dissociate from the body and mind from the senses brings rest to both and cultivates inner peace and quietness.

The Process of *Pratyahara*

Awareness

By drawing attention to the information being taken in by the senses and the continuous flow of the thoughts, we begin to notice things, often for the first time. This awareness enables us to more fully understand our situation and to manage our responses to it.

Witnessing

Sometimes the appropriate response when we become aware of something – whether it be a noise or a distracting thought – is simply to observe it. The capacity to witness allows us to remain steadfast and slightly removed from whatever experience occurs. Developing the capacity to witness allows us to cultivate a meditative state and not be swayed by distracting impressions that may arise.

Extension: Extension refers to the stage of a *pratyahara* practice where the attention is taken consciously to the surroundings (such as awareness of sounds in the environment). This allows us to go directly to anything that may be distracting and saturate the mind with the distraction until the mind becomes naturally disinterested.

Detachment: Going through the above process, the mind is then ready to switch off from external and extraneous stimuli. Events may still be occurring but we no longer notice them. The awareness has become internalized.

Withdrawal: As *pratyahara* is mastered the mind becomes quiet. Generally in life we are always externally oriented. The process of withdrawal in *pratyahara* has been referred to as being like a tortoise withdrawing into its shell. When this is done we create an internal space in which deep meditative experiences are able to take place.

Dharana

Dharana is defined as the 'holding or binding of the mind to one point' (*Dharana Darshan*, pg. 432). It is commonly referred to as concentration or one-pointedness. Its perfection leads to *Dhyana* or true meditation.

Dharana is a way of channelling the energy of the mind which is usually highly dissipated amongst the various sense impressions and the continual stream of thoughts. Through concentration, perception is heightened allowing us to see more of the underlying truth behind phenomena.

Concentration may be practiced on almost any object. Once an object has been chosen however, the important thing is to remain with it. Concentration should also be carried out in a relaxed manner. Strain and effort are only likely to cause tension and a negative attitude towards practice.

Developing concentration involves training the mind. This takes time and regular practice to achieve. Its development can be enhanced by practicing increased awareness outside of formal meditation practice. Meditation is best approached without expectation.

Externalisation

Externalisation is the process of moving internalized awareness back out in to the external environment. It is a process of reconnecting with the senses, the physical body and the world around us. It is an essential part of any meditation and yoga nidra practice.

If externalisation is omitted various negative effects may ensue. These include experiencing headaches, feelings of not 'having it together', vagueness, difficulty following conversations, inability to safely operate machinery and so on. Therefore it is essential that externalization takes place at the end of a practice.

In the event of experiencing any of these or related symptoms, externalization and grounding may be achieved through physically rubbing the body, eating and drinking, taking a shower, walking barefoot on grass – any activities which encourage an increase physical awareness.

Externalisation usually follows a sequence as outlined below. It is similar to a reversal of the internalization sequence carried out at the beginning of a practice, but should move fairly quickly so that internalization does not reoccur.

In internalization, awareness shifts from the more gross to the more subtle.

In Externalisation this is reversed, shifting the awareness from the more subtle to the more gross. About 3 to 5 minutes should be spent on externalising, depending on the depth reached in the practice.

b) Yoga Nidra

'Yoga nidra' means "psychic sleep". It is a core Satyananda Yoga practice, included in the daily timetable at every Satyananda Yoga centre. Yoga Nidra can be a relaxation practice, a *pratyahara* practice or a meditation practice, depending on the aim of each technique

The practice generally lasts for twenty to forty minutes. There are separate techniques for people suffering from hypertension and other problems, and for those who want to go deep into the spiritual side of yoga.

Yoga nidra is actually a very simple practice, and once learnt, can be done from a tape or record. Before starting, choose a quiet room and close the windows and doors. Turn off the television or radio, loosen your clothing, and switch on the tape recorder. Then lie down in *shavasana* and listen to the instructions. Go on following the instructions mentally. Do not concentrate, do not control your breath, just listen to the instructions and follow them mentally. The most important thing in yoga nidra is to refrain from sleep. If you fall asleep you lose the awareness which you are aiming for in the practice.

Preparation for the practice

Yoga nidra is generally performed in *shavasana*, which minimises touch sensations by eliminating contact between the limbs of the body. Fingertips, which are extremely sensitive organs of touch, are kept away from the floor by turning the palms of the hands upwards. Light, loose clothing should be worn. The room should be neither hot nor cold, and there should be no breezes or drafts directed toward the body. Sight stimuli are eliminated by simply closing the eyes.

Stage 1- Settling – Internalisation

Body Preparation – this starts to focus the mind and instructions for *shavasana* or alternative posture, are given for comfort and alignment.

Body release – letting go of tensions by consciously relaxing body parts

Body sensations – awareness of physical body through sense of touch.

Outside sounds - if all sensory impressions were forcibly excluded, then the mind would become restless and disturbed. Therefore, the mind is directed to external sounds, and to move from sound to sound with the attitude of a witness. After some time the mind loses interest in the external world and automatically becomes quiet. It prepares the consciousness for practising yoga nidra.

Sound of breath – listen to subtle sound of own breath

This is the start of the process of *pratyahara*

Stage 2 - Sankalpa - Resolve

In Yoga Nidra the mind assumes a very receptive phase. The subconscious mind is a very obedient disciple, and immediately carries out orders that you put to it. You can train your subconscious mind and then the ordinary mind and intellect will follow suit.

The *sankalpa* is one of the most effective means of training the mind. It is an important stage of yoga nidra and a powerful method of reshaping your personality and direction in life, along positive lines. The *sankalpa* takes the form of a short mental statement which is impressed on the subconscious mind when it is receptive, sensitive, calm and quiet.

At the beginning and at the end of the practice, there is a short period dedicated to *sankalpa*. The *sankalpa* you make at the beginning of the practice is like sowing a seed, and the *sankalpa* at the end is like watering it.

Stage 3 - Rotation of consciousness

Rotation of consciousness through the different parts of the body is not a practice of concentration, and it does not involve any physical movement. During the practice there are only three requirements to be fulfilled: (i) remain aware (ii) listen to the voice, and (iii) move the mind very rapidly according to the instructions. When the instructor says 'right hand thumb', repeat it mentally, think of the right hand thumb and move on. It is not necessary to be able to visualise the different body parts. You have only to become accustomed to following the same sequence, mentally repeating the names of the different body parts in the same way that the child learns to repeat the letters of the alphabet. You don't have to remember what part comes next. The whole process takes place in the subconscious mind.

The sequence of body parts has to be automatic, spontaneous and thorough. The rotation of consciousness in yoga nidra proceeds in a definite sequence, beginning with the right thumb and ending with the little toe of the right foot; then the circuit from the left thumb to the little toe of the left foot. Subsequent circuits proceed from the heels to the back of the head, and from the head and individual facial features to the legs.

Stage 4 - Awareness of the breath

After these rotations of consciousness have been completed, physical relaxation is then continued and completed by drawing attention to the breath. In this practice one simply maintains awareness of the breath; there should be no attempt to force or change it. One may watch the breath in the nostrils, in the chest, or in the passage between the navel and the throat. Usually, greater relaxation is attained by simultaneously counting the breaths mentally. Awareness of the breath not only promotes relaxation and concentration, but also awakens higher energies and directs them to every cell of the body

Stage 5 - Feelings and sensations

Next comes relaxation on the plane of feelings and emotions. Feelings that are intensely physical or emotional are recalled or awakened, experienced fully, then removed. Usually this is practised with pairs of opposite feelings, such as heat and cold, heaviness and lightness, pain and pleasure, joy and sorrow, love and hate. The pairing of feelings in yoga nidra harmonises the opposite hemispheres of the brain and helps in balancing our basic drives and controlling functions that are normally unconscious. This practice also develops willpower on the emotional plane and brings about emotional relaxation by means of catharsis, as memories of profound feelings are relived.

Stage 6 - Visualization

The last stage of yoga nidra induces mental relaxation. In this part of the practice, the student visualises the images named or described by the instructor. Since the images that are used often have universal significance and powerful associations, they bring the hidden contents of the deep unconscious into the conscious mind. They may include landscapes, oceans, mountains, temples, saints and flowers, stories, and descriptions of powerful psychic symbols such as the chakras, the lingam, the cross, or the golden egg.

The practice of visualisation develops self-awareness and relaxes the mind, by purging it of disturbing or painful material. It leads the mind to concentration or *dharana*. In advanced stages, visualisation develops into *dhyana* or pure meditation. Then there is the conscious

experience of the visualised object in the unconscious, the distinction between conscious and unconscious dissolves and distracting images cease to arise. The visualisation practice is usually finished with an image that evokes profound feelings of peace and calmness

Stage 7 - Sankalpa is repeated.

The unconscious mind is very receptive to positive thoughts and suggestions. Therefore, the practice of yoga nidra ends with a resolve. This direct order from the conscious mind to the unconscious is the seed enabling one to radically change one's attitude, behaviour and destiny. It is very important that the resolve be stated clearly and positively and in same wording as at beginning of yoga nidra. This will give the mind strength and a positive outlook. One should have sincere faith that the resolve will be effective. This faith strengthens the effect of the resolve on the unconscious mind, so that the resolve will become a reality in one's life.

Stage 8 - Externalisation

The practice of yoga nidra is concluded by gradually bringing the mind from the condition of psychic sleep to the waking state. Allowing minimum of 5 minutes for slow externalisation.

c) Kaya sthairyam

Kaya sthairyam is both a *pratyahara* and *dharana* practice. It is a basic practice of concentration on the steadiness of the body. In Sanskrit the word *kaya* means 'body' and *sthairyam* means 'steadiness'. It is taught as the first formal meditation practice in Yogic Studies at Satyananda Yoga Academy.

Because of the interrelation between the body and the mind, when the body becomes steady and still, the mind follows suit. As a *pratyahara* practice the sensations of the body are 'cut off from the mind' through repeatedly extending the focus towards them. As in all other *pratyahara* practices, the mind eventually becomes bored and turns naturally in. Each of the *dharana* practices therefore, should begin with five to ten minutes of *kaya sthairyam*. Only when the body is absolutely steady and immobile should the actual *dharana* practice begin.

It is also important to note that the mind remains one-pointed only while the body is still. As soon as any part of the body moves, the mind also moves. Thus the concentration is broken and once broken it cannot be attained again in the same sitting. During *pratyahara* practices you can move the body, you can shift your position, you can even get up and then come back to the practice. In *dharana*, however, you cannot move a finger, you cannot bat an eyelid, you cannot even swallow, without breaking the concentration.

Before attempting the practices of *dharana*, *kaya sthairyam* must first be mastered. You should be able to sit without moving any part of the body for at least half an hour, then you will be ready to begin the practices of *dharana*. In the initial stage of *kaya sthairyam* the body should be comfortable and relaxed in the meditation posture. Later on, as immobility develops, the physical awareness will gradually subside as awareness of stillness increases. At this time the concentration is shifted from the body to the natural breath, so that the mind still has a focus. Ultimately the awareness of the breath will also subside, so that there is only awareness. At that time you are ready to begin *dharana*.

With that awareness which is steady and still, and which is unhampered by the body, you must begin to concentrate on the object of meditation. If *dharana* is attempted with an unsteady body and a fluctuating mind, no benefits will result from the practice, even if you perform it for 100 years. The only results will be tensions, frustration and a broken mind. Therefore, give your attention to the preparatory practices in the beginning. Master *kaya sthairyam*, then you will be able to proceed with the practices of *dharana* without any obstacle.

Stage 1: Preparation

Sit in a comfortable meditation posture. Make sure your spine is erect. Place your hands on your knees in chin or jnana mudra. Close your eyes. Become aware of slow deep breathing and count five breaths mentally.

Stage 2: Body posture

Switch your awareness to the body. Concentrate on your meditation posture. Feel your spine rising straight up from the floor, supporting the head. Be aware of the synchronised and balanced position of the arms and legs. Total awareness of the body.

Stage 3: Visualisation of the body

Visualise the body externally as if in a mirror. See your body in the meditation posture from the front, back, right side, left side, from the top. See your body from all sides at the one time.

Stage 4: Body tree

Be aware of your whole body. Feel that you are rooted to the floor. Imagine that your body is growing up from the floor like a tree. Your torso is the trunk, your arms and head are the branches, and your legs are the roots. Your body is rooted to the floor and it will not move.

Stage 5: Sensations in the body

Be aware of any physical sensations: cold, heat, wind, itching, pain, uneasiness, tension, stiffness. Direct your awareness to these feelings. Let them be a focus for your mind. If your mind starts to wander, bring it back to the sensations in the body.

Stage 6: Body parts

Direct your awareness to the head. Be aware of the head and nothing else. Feel any sensation in the head. Visualise the head. Shift the awareness to the neck. Feel any sensations in the neck. Continue to be aware. Following the same process, move your awareness to the shoulders, right arm, left arm, whole of back, the chest, the abdomen, the right leg, the left leg, and finally the whole body. Be aware of the whole body. Intensify the awareness of the body. Do another round maintaining full awareness.

Stage 7: Immobility in the body

Make a resolve that "I will not move my body throughout the whole practice. My body will not move or shake. I will remain steady and motionless like a statue." Even if you feel an impulse to move a finger or toe, to adjust your clothing, or to scratch, try to overcome this urge. When you feel the urge to move, you must say to yourself "No, I will not move any part of my body until the end of the practice".

Stage 8: Steadiness and Stillness

Be aware of your physical body, of your meditation posture and of nothing else. There should be total uninterrupted awareness of the whole body. The body is perfectly steady and motionless. Develop the feeling of steadiness. Be aware of your body and steadiness. Be aware of your body and stillness. Be aware of your physical body. There is no movement, no discomfort, only steadiness and stillness.

Stage 9: Stillness from body into psyche

Feel the steadiness and stillness of the body. Gradually your body will become rigid and stiff like a statue, as though all the muscles have frozen. The body should become so stiff that you are unable to move any part, even if you try. Total awareness of the body, of immobility, of psychic rigidity. Feel the locked position of the body. Be aware of the body and stillness.

Stage 10: Awareness of subtle breath

As the body becomes stiff and rigid, you will begin to lose physical awareness. At this time shift your attention to the breath. Become aware of the natural breath, without altering or modifying it in any way. Simply watch the breath as it moves in and out of the body. The

breath moves in and out in a rhythmic flow. Follow each movement of the breath with your awareness.

At the same time become aware of the body. Let the awareness alternate from breath to body, then from body to breath. As the body becomes stiffer and stiffer, the awareness will automatically shift more and more to the breath. No effort is required. When the body is absolutely still and motionless, the breath will become more and more subtle, until it seems that you are hardly breathing at all.

Stage 11: State of concentration

As the breath becomes more and more imperceptible, you will begin to experience the pure awareness which functions through the unfluctuating mind. The breathing is responsible for the movements of the mind and body. When the breath becomes very subtle, the mind becomes one-pointed and still. This is the state in which *dharana* must be practiced.

Stage 12 – Ending the practice

Externalise the awareness gradually, moving from subtle back to gross, through breath, sound and body.

(Saraswati 1999)

d) Japa

Of all the systems of yoga used to induce *pratyahara* and then to *dharana* and to lead eventually to *samadhi*, *japa* is the easiest and safest. The word *japa* means 'to rotate'. *Japa yoga* means union of the self with the highest existence through the rotation of consciousness.

The first requirement is a mantra, a grouping of sound vibrations, usually given to the aspirant by their *guru*. The next requirement is a *mala*, a string of beads, usually 108 in number, with an extra bead, the *sumeru*, which marks the beginning and end of one round (or rotation).

In *japa*, there is a continued rotation of consciousness centred on the mantra and the mind becomes concentrated and relaxed. No forced concentration is required, the mind being an unconcerned observer of this spontaneous process. When other thoughts arise, they should be allowed to go, and the attention brought back to the mantra.

Japa may be practised in audible form, at a whispering level, or more usually with mental repetition of the mantra. *Japa* repetition is said to bring about mental purification, in which past impressions (*samskaras*) and future desires (*vasanas*) are naturally eliminated.

Any mantra can be used during the practice of *japa*, it is only a technique, but it is important to try and remain with one. The mind gets bored easily and may suggest Gayatri one day, Aum the next and Mahamrityunjaya on another day. But this is like digging lots of little holes only a metre deep in an search for water. Remaining with one mantra allows you to dig deep. The mantra becomes a vehicle in to the depths of the mind. A life raft in uncharted territory.

Great results have been achieved using Guru mantra and Gayatri (one half with inhalation, one half with exhalation). Aum is another widely used universal mantra. Whichever mantra is chosen, its subtle vibrations will gradually begin to permeate one's being down to a cellular level.

There are three components of *japa*: Breath awareness; steady movement of the mala and mantra repetition. Each of these components is co-ordinated with the others.

Breath

Awareness of breath flowing in and out, being totally attentive to every incoming and outgoing breath; feeling in to the rhythm of the flow. Respiration rhythmic and relaxed.

Mantra & Mala

Once the practitioner is steady and centred, the mala can be turned and the mantra is added. (For more detail refer to the practice outline, below)

Developing *Pratyahara*

Together the different components of chanting Mantra with a Mala have the effect of occupying the body/ mind. The natural outcome of this is that the mind becomes still. External sense impressions fade & *pratyahara* develops. This brings mental peace, one pointedness, & leads to meditation.

Purification

There is no need to suppress the fluctuations and distractions of the mind, but simultaneously maintain awareness of the breath and mantra. Let the mind roam, all you have to do is be aware.

As the mind becomes focussed, distractions and deeper mental impressions begin to emerge. It is here that the witnessing skills learnt in *Antar mouna* become useful. Through continued focus on the practice, distractions are able to surface in the background, be faced, and then fade away. The practice brings about a process of purification, particularly on mental and psychic levels.

Regularity

For many, mantra chanting is a practice that accompanies them daily for at least one lifetime. Regular practice is essential for success. With daily practice the positive effects of mantra repetition accumulate and a natural state of spontaneous and continuous repetition occurs. The practice gives the benefits of all other meditative practices. The benefits that you reap will depend entirely on your effort, regularity of practice, and the degree to which your mind is now harmonized.

e) Ajapa japa

Japa is the constant repetition of a mantra. *Japa* becomes *ajapa japa* (spontaneous) when the mantra automatically repeats itself without conscious effort.

f) Antar Mouna

This practice translates from Sanskrit as 'inner' (*antar*) 'silence' (*mouna*). It is designed to direct the attention to the internal workings of the mind – thoughts, emotional reactions and can be practised spontaneously outside of formal meditation sessions.

As a formal practice, it consists of a number of stages, performed with closed eyes and a steady posture.

Stage 1: Awareness of external stimuli

Awareness is directed to outside sounds and occurrences going on outside of the self. Without creating mental conflict, attention is paid to objects of perception and the sensations arising from their perception. This stage initiates the process of *pratyahara*, withdrawal of the mind from the senses.

Stage 2: Awareness of spontaneous thought processes

In this stage, the awareness is withdrawn from outside stimuli and directed only to the workings of the mind – what it is thinking, how it is reacting and what images are coming from the subconscious. Thoughts are allowed to come and go spontaneously, without conscious direction. A witnessing attitude is maintained. When you become aware of a

particular thought, you mentally say "I am thinking about this and that". It is important to remain vigilant and aware of each thought as it comes and goes.

Stage 3: Creation and disposal of thoughts at will

This stage involves the conscious creation of thoughts. A particular thought is brought to mind by an act of will, a spontaneous thought. The thought is entertained and followed for a short time and then mentally, suddenly disposed of. No spontaneous thoughts are allowed to arise, only those chosen by will. After a short time of attention, each chosen is mentally dashed off.

Stage 4: Awareness and disposal of spontaneous thoughts

In this stage, spontaneously arising thoughts are entertained. Again, after a short period of following the thought, it is mentally disposed of, with a quick motion of the mind. Although the thought arises spontaneously, it is disposed of by an act of will.

Stage 5: Awareness of the inner space

In this stage, awareness is directed to the inner space, the mental space before the closed eyes. If any thought comes, it is immediately dashed off, disposed of. This stage leads to the experience of thoughtlessness. In the place of thoughts, forms and visions may arise and you will need to dissolve their forms into formlessness. This is the state of inner silence.

Outside of meditation sessions, *antar mouna* can be practised at any time by simply reflecting on the question "What am I thinking? What is occurring now in my mental space?" When practised regularly, the witnessing process becomes automatic.
(Saraswati 1983)

Appendix 8 – Yoga in Daily Life Practices

Level 1 – basic level

1.1 Awareness of the space around you

Space you are in and your physical, mental and spiritual existence

1.2 Physical awareness and stillness

Awareness of body tension – relaxing tension
Stillness in the body

1.3 Awareness of the unity of body and breath

Awareness of normal breath
Unity of body and breath – expansion and contraction
Flow of breath in the whole body

1.4 Concentration on inner purification

Visualise toxins flowing out with relaxation
Visualise negative thoughts leaving with exhalation
Feel inner purification

1.5 Concentration on reception of prana

Visualise cosmic energy entering on inhalation
Feel energy flowing throughout body
Visualise mind becoming clearer with each inhalation
Awareness of feeling quieter, balanced and refreshed with each breath

1.6 Concentration on *ahahata* chakra

Awareness of gentle flow of breath in centre of chest
Feel calm and even beat of heart
Immerse consciousness in heart centre
Visualise a stream of light in heart space

Level 2 – Concentration exercises

2.1 Concentration on breath with ‘so ham’

Awareness of gentle flow of breath at centre of centre (10min)
Listen to inner sound of breath as SO – inhalation, HAM – exhalation (10min)

2.2 Deepening concentration on breath with ‘so ham’

Awareness of gentle flow of breath at centre of centre (5min)
Think of mantra ‘so ham’ with each breath (15min)
Inhale with SO with consciousness from navel to throat
Exhale with HAM with consciousness from throat to navel
Focus on mantra, letting other thoughts go
Return to simple breath awareness (5min)

2.3 Concentration on chidakasha

Look at inner space behind forehead, simple awareness (15min)
See yourself in inner space (15min)

2.4 Observation of thoughts

Observe coming and going of thoughts without evaluation, just observing (15min)
Observe thoughts and relationship to them – how evaluated (15min)

2.5 Expansion of consciousness into past

Take consciousness into past – progressively from yesterday (10min)
Return in reverse order to present (10min)
Relax mind and observe thoughts (5min)

2.6 Meditation on Gayatri mantra

Chant Gayatri mantra 5 times

Appendix 9 – Self-report Questionnaire

Please describe the depth of your meditation by drawing a continuous line from the starting point to the end point (drawing down to indicate greater depth or absorption in meditation) (Adapted from Ott, 2001)

Start	Outside sounds	Meditation 1	Meditation 2	Meditation 3	Meditation 4	End
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Please rate your level of awareness of the following dimensions in the stages of meditation practice, by putting the symbols: e.g. **M1**: Meditation 1 **M2**: Meditation 2, on the appropriate point on the line

Attention span	-9	-7	-5	-3	-1	0	1	3	5	7	9	
	very focused						very open					

Perception of outside world	0	1	3	5	7	9			
	not aware			very aware					

Awareness of Body	0	1	3	5	7	9			
	not aware			very aware					

Awareness of Breath	0	1	3	5	7	9			
	not aware			very aware					

Feeling	-9	-7	-5	-3	-1	0	1	3	5	7	9	
	strong negative						strong positive					

Thought content	0	1	3	5	7	9			
	none			very present					

Imagery	0	1	3	5	7	9			
	none			strong images					

Describe the practices and any significant experiences:

Appendix 10 – No. of significant voxels in SYT v SYS

Delta band (1-4Hz)

SYS>SYT

No. signif voxels

BA	Count		Body		Mantra	
	L	R	L	R	L	R
1						
2						
3						
4						
5						
6		2				
7						
8						
9						
13		22				
17						
18						
19		3				
20		65				
21		92				
22		70				
23						
24						
30						
31						
32						
36		4				
37		50				
39		6				
40		21				
41		27				
42		20				
43		8				
44						
45						
46						
Total	0	390	0	0	0	0

Theta band (4-7.5Hz)

SYS > SYT

No. signif voxels

Count		Body		Mantra	
L	R	L	R	L	R
			8		8
			40		42
			49		53
			41		49
			9		14
			17		48
			81		142
					1
			9		8
			39		45
			2		3
			16		17
			40		44
			138		139
0	0	0	489	0	613

