CHAPTER – 9

APPRAISAL

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9.0 APPRAISAL

This chapter summarizes prior research on which this thesis was based, and the results obtained in the two experiments. Those decisively demonstrated that, compared to *Śavāsana*, Cyclic Meditation (CM) improves creativity. The chapter also assesses the strengths and weaknesses of the experiments, and considers the kind of research that may grow out of them in future. Observed correlations between Creativity test scores and EEG activity, suggest that the current experiments shows key connections of Creativity tested, are between frontal and parietal lobes in delta and gamma frequency bands either singly or combined.[3] We may conclude that further research using EEG-MEG-fMRI based associations and connectivity patterns among brain regions could be fruitful; offering new directions for creativity research and the unleashing the brain networks in the brain development of an individual over a period of time. It would point to ways to use Vedic Sciences to enhance the highest potential of the human brain, and develop higher abilities of Creative Cognition and Innovation, by building sensitivity and enhancing ones conscious awareness, by the techniques of yoga meditation.

9.1 SUMMARY OF FINDINGS

This 'thesis' started by reviewing the ideas presented by the Vedic Sciences on levels of mind;[100,104] and how Creativity takes place from deeper levels of mind close to *Samādhi*. The concepts of *Cittākāśaḥ*, *Cidākāśaḥ* and the *Mahākāśaḥ* [28, 76] were explained, and the first two were identified as spaces of ideas and cognition to occur. Those in the *Cittākāśaḥ*, arise from the *Chitta-vrittis* due to stress, while those in the *Cidākāśaḥ* arise from Cosmic Creative Cognition. The science of Yoga Meditation was discussed, showing how cognition and *Prajñā* were related; while the higher level of *Ṛtambharā Prajñā* is regarded as the source of creative cognition.[106] Many relevant verses from the *Upaniṣat*, *Yoga Sūtra* and *Bhagavadgītā* were quoted, as well as key verses from *Ādi Śaṅkarācāryaḥ's Ātmabodha* and *Tatvabodha*, explaining the basic structure of self as the unity of knower, process of knowing and known.[100,104] The Vedic analysis of subjectivity recognizes the four levels of mind *Manaḥ, Buddhiḥ, Ahaṅkāra*, and *Citta*, which may be connected to the different bodies or koshas, and the *Kuṇḍalinī Cakraḥ*, which connect to the various levels of pranic vibration, in the different *Ākāśāḥ* or spaces.[138, 159,10,

Chapter 3, reviewing the western scientific literature concerning Creativity and Neurophysiology, focused on large scale brain networks, and their relationship both to Creative processes given in the Vedas, and those understood by western science. The activity of the Pre-frontal lobes was related to the *Ajñā Cakra*, while that in the Parietal lobes was related to *the Sahasrāra Cakra*, since both these areas are involved in Creativity according to both Western Science [176,179] and the Vedic Sciences.[28,60,61] This correspondence enabled us to propose a relationship between the two systems. It also reviewed the understanding of meditation, reviewing the three kinds of meditation, Focused Attention, Open Monitoring and Self-Transcending, characterized respectively by EEG waves, beta 2 and gamma, mid-line theta, and alpha.[67] In light of that discussion, the observed dominance of gamma EEG waves during Cyclic Meditation, compared to the delta observed in *Śavāsana*, suggests that CM should be classified as a form of focused attention meditation, though this requires investigation in a larger future study.

Cyclic Meditation is a practice requiring practitioners to follow auditory instructions given to them to focus attention leading to awareness, via the deeper levels of sensitivity, in their body; so observing EEG characteristics of Focused Attention meditation is expected.[67, 275]

The result of these considerations is that pathways in the brain for creativity stages 1 and 2 i.e. Preparation and Incubation, may be equated with awareness, attention and arousal.[11, 162] The three A's of meditation can be co-related to *Dhāraṇā*, *Dhyāna* and *Samādhi*. [29, 57-59]

9.2 STRENGTHS OF THE STUDY

The present experiments were the first experiments on the effects of Cyclic Meditation (CM) on the ATTA creativity test, and are therefore completely original. Simplicity of the meditation used as an intervention is also a major strength of the study. As is a technique with combination of stimulation and relaxation aspects together; 'meditation' that is easily learned, culturally acceptable, and therefore widely applicable to all age ranges in the population, with significant results within the time spans of one month or one week yielding wonderful results, which can be applied as a great tool in the education sector.

9.3 WEAKNESSES OF THE STUDY

The weaknesses of the experiments were primarily the limited age range of participants in the experiments; though this range from age 20 to 40 is of primary interest for improving Creativity: It is also the age range suggested by advisers and external examiners, during the pre-synopsis and IEC presentations of this study. The experiments were performed for the most part on participants from professional positions with above average levels of academic exposure, education and work experience i.e. graduate and post graduate levels. This is reflected in the high levels of performance on the tests, which were a credit to the participants, particularly post-intervention. Therefore the levels of improvement in test performance observed on three of the four ATTA Creativity subscales may or may not extrapolate to other populations. Equally some populations might improve on the flexibility scale for which no improvement was seen. These questions from the present investigation can only be resolved by further long term experiments with different age groups and considering the development of brain at various levels and the evolving brain network in future.

9.4 LIMITATIONS OF THE STUDY

The limitations – related to the method and procedure that was used, the nature of brain waves and their interpretations; the size and nature of the sample, the kind of information the data analyses yielded and the final goal of the study. I employed data collection/analysis method as EEG, although EEG has temporal accuracy it is limited to its spatial accuracy and the ability to isolate specific areas over the scalp.[172] Also, EEG electrodes measure electrical current at the surface of the scalp after conductance through brain matter that vary in density.

The second measure employed was a test of Creativity and divergent thinking i.e. abbreviated Torrance test for adults (ATTA). Divergent thinking has been a cornerstone of the psychometric measurement of creativity for over a half century. As in the creativity dimensions of fluency, flexibility, elaboration and originality, was measured as the sum of responses to a prompt in the test, with higher quantities of responses signifying greater creativity; however, the question remains as to whether quantity of responses signifies Creativity, a separate cognitive ability (e.g. general intelligence), or a cognitive ability necessary for Creativity but not sufficient in itself (e.g. imagination). When considering the usefulness of ATTA for testing Creative ability, examining psychometric characteristics and specifically predictive validity of these measures is informative.

The reliability of divergent thinking tests, including ATTA is high [328] and the concurrent validity of divergent thinking tests are satisfactory, however there is variation in opinions on whether divergent thinking tests predict real-world Creative achievements.[206]

Researchers studying the predictive validity of divergent thinking tests have typically assessed associations between divergent thinking test scores and the quantity, but not quality of creative achievements and their accurate neural co-relates with brain mechanisms. Consequently, Runco had suggested the use and inclusion of 'creative attainment indicators' that measure quality and not only quantity (i.e. achievements).[328]

Adding such criticisms into the limitations and accuracy in testing creativity, their psychometric properties, divergent thinking tests (such as Torrance) ATTA the one used here, have also been criticized for being influenced by coaching and intervention effects.[357] In current study, I addressed this criticism by constantly providing only a minimal instruction to 'come up with as many ideas as you can' to participate during divergent thinking of the experimental phase.

9.5 APPLICATIONS

In this investigation, I interpreted increased task-related frontal and parietal gamma asymmetry and synchronization in the F3, F4 and P3, P4 regions of brain as evidence of a distinct mental state occurring during Creative Cognition; and characterized by internal focus of attention, suppression of external stimuli, and top-down processing. My interpretations were founded on previous research.[358,359] It is reasonable to infer that internal focus of attention is at least part of creative cognition. Therefore, future research should isolate different possible processes underlying such states during creative and non-creative cognition during ecologically valid creative tasks; and in the expert domain wherein the agreeableness on whether the processes underlying frontal gamma and synchrony are related to creativity or general can be investigated at a depth.

As discussed in the introduction, study of creative problem solving has distinguished between performance on insight and non-insight kind of tests, the former requiring original, out of the box, divergent thinking, and the latter logical convergent thinking. Future research should investigate the effects of relaxation and meditation techniques on different kinds of thinking, problem solving (insight / non-insight) , also kinds of Creativity, as measured by a variety of other Creativity tests available; and do this on a variety of different populations and age/gender groups.

On a more practical level, future experiments should identify which simple attention enhancing techniques increase creativity to maximum in different domains of Creativity; and which are easiest to apply and practice, for the purpose of Creativity training in the current education systems for shift from mere education to inspiration and innovation.

Accordingly, future research is needed to conduct similar studies on subjects of other types of creators (artists, writers, visual artists, dancers, musicians, singers) and other types of creative people (e.g., mathematicians, scientists, engineers, computer programmers), for character building in that particular domain and creating role models, creative leaders in the coming future generations, which was the vision of Swami Vivekananda, the youth icon of India.

In addition, the sample consisted of adults between the ages of 20 to 40, wherein the choice was made in order to minimize the effects of biological, neurological maturation, specifically the development of the prefrontal cortex that is amongst the last brain structures to reach adult development. Although the educational and developmental implications of the current study are potentially impactful, they may be generalizable only to adults, (with frontal lobe development). In future; researchers can address this limitation by conducting similar investigation on groups at different stages of development (e.g, early childhood, late childhood, early adolescence) and in particular the flowing trend in the default mode network (DMN) and central executive network (CEN).

Although challenging, such research would shed light on the development and illumination stage of creativity; on inspirational and spontaneous processes in cognition and pattern formation. If spontaneous processing ability improves with the progression of developmental stages, such research may also indirectly confirm the role of the prefrontal cortex in deliberate and spontaneous processing along with its modes of attention in the different stages of creativity and higher levels of cognition. This can lead to a broader field of study of different types and their classifications based on the recruitment of attention and their devises, which is at the heart of neuroscience and cognitive research and human behaviour.

9.6 RECOMMENDATIONS FOR FUTURE RESEARCH:

Further research should also investigate the neurophysiology and neuropsychology of improvements in creativity; such as relationships between activation of default mode (DMN), self-referential network (SRN), and executive attention control (EAN) networks etc. and even the reticular activating system (RAS); particularly due to the influence of deeper meditation techniques other than CM. Another dimension of such research would be to take directions from the Vedic sciences to link

the modern cognitive neuroscience disciplines of neurophysiology and neuropsychology more closely to traditional concepts such as Wisdom, *Buddhiḥ* and *Prājña*. That could precisely link levels of mind with activation of important brain networks, such as the EAN and SRN, and deactivation of the DMN, all part of the CMS and large scale brain networks.[109,360,361] Not only EEG can be used to investigate exact brain regions and brain networks, but also magneto-encephalography (MEG), possibly in combination with EEG and fMRI.

Future research should also focus on what can next be proven to be scientific building on present understanding and theoretical models of the biophysics of meditation. Of special importance are its applications for health benefits.[115] First person accounts, its implications to the self and overall quality by the applications of meditation.[23] Similarly, the deepest states as per the wisdom of Yoga and the *Upaniṣat*. Exploring the higher states of Self-organised criticality using meditation, [49] and its implications for cognition and creative innovation. [65] Testing the *Panchakosha* model in light of different levels of mind and creative cognition;[55] and extended concepts of yoga meditation for '*Young India'* for character building, emotional intelligence and spiritual sciences based on the vision of Swami Vivekananda.[50]

Future research should also study different meditation systems and the recruitment of attention and their mechanism. Their abilities to enhance deeper levels of attention turned inward, in different Vedic personality types and its potential excellence in cognition; thereby stimulating higher levels of Creativity and Cognition. Further deeper understanding of different varieties of Creativities such as 64 arts and 16 domains knowledge, as mentioned in the Vedanta. Also how they stimulate the mid-brain development and influence overall balanced and holistic development of an individual, in the process of Man-Making. Such applications of meditation and neuroscience should enliven the human frontiers left unleashed to consciousness-based approach to human life and benefit mental and physical health, and emotional and spiritual intelligence. By such means we may also learn how to tap into divine intelligence: its deeper understanding of attention may even show how to go beyond *Ṛtaṁbharā Prajñā* to understand Lord Gaṇeśaḥ as the authority of the 64 arts and 16*Vidyā*; as mentioned above and their expressions or to understand the science of goddess *Mahā-Sarasvatī* as expressed in the works of great scholars. Combining spiritual insights with brain science could lay all such considerations open to scientific investigation, by connecting and uniting the east and west and exploring the new perspectives of *Prajñā* within the frontiers of human brain and mind, to solve the mystery of human mind and conscious awareness itself.