

EXECUTIVE SUMMARY

EMPIRICAL EVIDENCE FOR INCREASED CREATIVE COGNITION AND EEG SYNCHRONY FOLLOWING EXPERIENCE OF SELF DURING LOW DEFAULT MODE NETWORK ACTIVITY IN YOUTH'

Background: Western science divides the creative process into four stages: preparation, incubation, illumination and verification. The scientific study of creativity now focuses on brain function studying how different brain regions are involved, suggesting that process depends on coordinated use of the frontal, parietal and temporal lobes of the brain. Brain studies indicate that EEG coherence is a bio-marker signature, suggesting that creativity involves increased integration between different brain regions. Traditional Indian approaches to understanding creativity are based on expanded states of mind described in Vedic literature. They suggest that 'expansion of mind' is the key step, achieved by practice of deep meditations. The disparity between the two approaches western and eastern, suggests that considering both together may bring deeper insights. Deep meditation is known to bring illumination, which is important. Brain mechanisms suggest themselves as illumination correlates with brain coherence and synchrony. Eastern wisdom may help resolve problems in the scientific approach.

Eastern Literature: Certain *Upaniṣat*, *Śikṣā*, *Yoga*, and *Alaṅkāra Śāstra* contain insights into the nature of creativity. The *Upaniṣat* have deep implications for workings of the mind. *Śikṣā* identifies four levels of speech: transcendental, ideas, linguistic thoughts, and speech. Ideas form the basis for cognition. *Yoga* brings access to the deepest level of consciousness *Samādhi*, the 'blank' state of mind held to be necessary for incubation; and *Ṛtambharā Prajñā*, the state where creativity arises. The works of *Vyasa*, *Kālidāsa*, and *Saint Jñāneśvara*, all experts in *Alaṅkāra Śāstra*, offer examples of profound processes of cognition and creativity. The *Upaniṣat* offer insights and patterns of thought that guide disciples of Masters to their own realization of illumination, and abilities to help solve humanity's problems.

Western Literature: Present western neuroscientific understanding of creativity is based on work of Andreasen, Austin, Craig, Damasio, Heilman, Raichle, and Ramachandran. Activation of various networks, like the executive-network and deactivation of the default mode network, are thought to be central. Studies of creativity, EEG, and brain connectivity after practice of focused attention, open-monitoring, and self-transcending meditations, the three basic types, yield important insights.

Integration of Western & Eastern Approaches: Programs to integrate the two approaches, started in the 1960s, have continued to the present. Some scientists have proposed using *Vedānta* to avoid limitations in the western approach. Blocks to creative thinking are caused by activation of the Default Mode Network, equated with the *Citta- vṛttayaḥ*. Preventing its activation by meditation enhances access to creative states of awareness.

Aim and Objectives: To study the effect of cyclic meditation, deep relaxation, on various scales of adult creativity. Performance on the ATTA test was hypothesized to improve.

Study Design: The two experiments used the Abbreviated Torrance Test for Adults (ATTA), the most widely used, neuro-scientifically researched creativity test. (1) 240 participants, 120 experimental and 120 controls pre- and post- 4 weeks daily CM practice at Bangalore (2) 15 experimental and 15 controls, at Ministry of Defence, New Delhi, pre- and post- 7 days practice, with additional EEG measures using a 64 channel EEG.

Materials & Methods: Participants: Experiment 1: 120 participants, in two groups of 60, were attending one-month yoga training courses in Bangalore that included daily CM training; controls consisted of two groups of 60 young adults from outside Bangalore not practicing Yoga or Meditation. Experiment 2: participants were from Delhi University & DRDO, with no prior Yoga practice. Of the 30 who started final data could only be obtained from 12 in each group.

Assessments: ATTA for students and adults was administered pre- and post- intervention. Its four subscales have 13 criteria-referenced measures. It was scored blind by the author.

Results: Both studies showed large increases in post-intervention creativity scores (Cohen's d , 0.62 & 0.79), For EEG: in Fluency, d was 0.93 (frontal) and 0.94 (parietal); in Elaboration, d was again 0.93 (frontal) and 0.94 (parietal); while in originality d was 0.78 (frontal) and 0.95 (parietal). Synchrony was observed between F3, F4 (frontal lobe) and P3, P4 (parietal lobe).

Discussion: Results showed that CM enhances creativity, with Cohen's d similar to other meditation studies, probably due to effects observed in the frontal (F3,F4) and parietal (P3,P4) lobes. Frontal lobe activation enables the parietal lobes, containing skills and domain knowledge for creative cognition. Next, the temporal lobes responsible for episodic memory are activated. Results suggest that future research should use similar techniques. Differences will shed light on roles of different brain areas. Choosing techniques affecting precise brain areas used in creative cognition will achieve this best. Brain imaging techniques may produce key breakthroughs in such research.

Conclusions: Our results demonstrate that Cyclic Meditation improves creativity compared to *Śavāsana*. Correlations between creativity test scores and EEG activity suggest the key to connectome between the frontal and parietal lobes in delta and gamma frequency bands; either singly or combined. We may conclude that research using EEG-based associations and connectivity patterns among brain regions may be fruitful, and yield new directions for research on creativity. That would point to ways to use Vedic Sciences to enhance the highest potential of the brain, and develop higher states of consciousness for creative cognition and innovation.

The future of this research area may depend on what can next be proven to be scientific, building on present understanding of the biophysics of meditation. Of particular importance will be first person accounts of meditation; its deepest states as per the wisdom of Yoga and the *Upaniṣat*; self-organised criticality, and its implications for cognition; the *Pañcakoṣāḥī* model and related concepts. Future research should study how different meditation systems enhance higher levels of cognition, especially creative cognition; how they stimulate the mid- brain and influence its development; and how they benefit mental health, and emotional and spiritual intelligence.