CHAPTER – 6

DATA EXTRACTION

TABLES & FIGURES

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6.0 DATA EXTRACTION

Participants were assessed in two separate sessions pre and post intervention, in the EEG lab of DRDO (Defence Research and Development Organisation), Delhi where the study was conducted. The order of the recording and assessment was randomized as per the online random number generator log table. On both the recording day's pre and post for (CM) and (SH); participants were asked to avoid all other physical activity (e.g. walking, jogging, or other yoga practices). However they continued with the rest of their routine (e.g. listening to lectures in their usual schedule) since all of them were students at a local university wherein their routine was relatively comparable.

6.1 DATA ACQUISITION

Study conducted in phases, (i.e., sessions) involving EEG recording, which took place inside a sound proof lab and the floor was electrically shielded and grounded.[32]Creativity testing session involving paper and pencil tests of ATTA, in an adjoining room housing a desk and a chair. Participants began by filling out a questionnaire to collect demographic data as well as data regarding creativity (ATTA). (See Appendix 6.1 Participant Information Questionnaire).

In order to ensure good quality EEG signals, participants were asked to not to put oil for hair and wash their hair before attending the recording session and for non scalp electrodes, their skin was carefully cleaned using an alcohol solution. Then they moved to a separate room for EEG preparation.

The EEG preparation procedure was as follows:
(a) Participants were asked to sit in a comfortable chair;
(b) Participants were fitted with an elastic cap with sensors to record brain responses
(See Figure 6.1). Sensors on this cap were oriented according to the international 64 channels EEG system, which provided coverage across the entire scalp;
(c) Using a blunt-tipped syringe, electrolyte gel was inserted into holes in the cap/sensors; (see Figure 6.2)
(d) Additional sensors were also taped to the nose to act as reference, and on the cheeks and forehead (above and below the eyes) to monitor eye movements and blinking.

Figure 6.1 – EEG Machine Cap depicting 64 channel electrodes

Figure 6.1, depicts the 64 channel electrodes locations of the EEG cap.

Figure 6.2 – Electrodes Orientation and Procedure of Injecting before recording

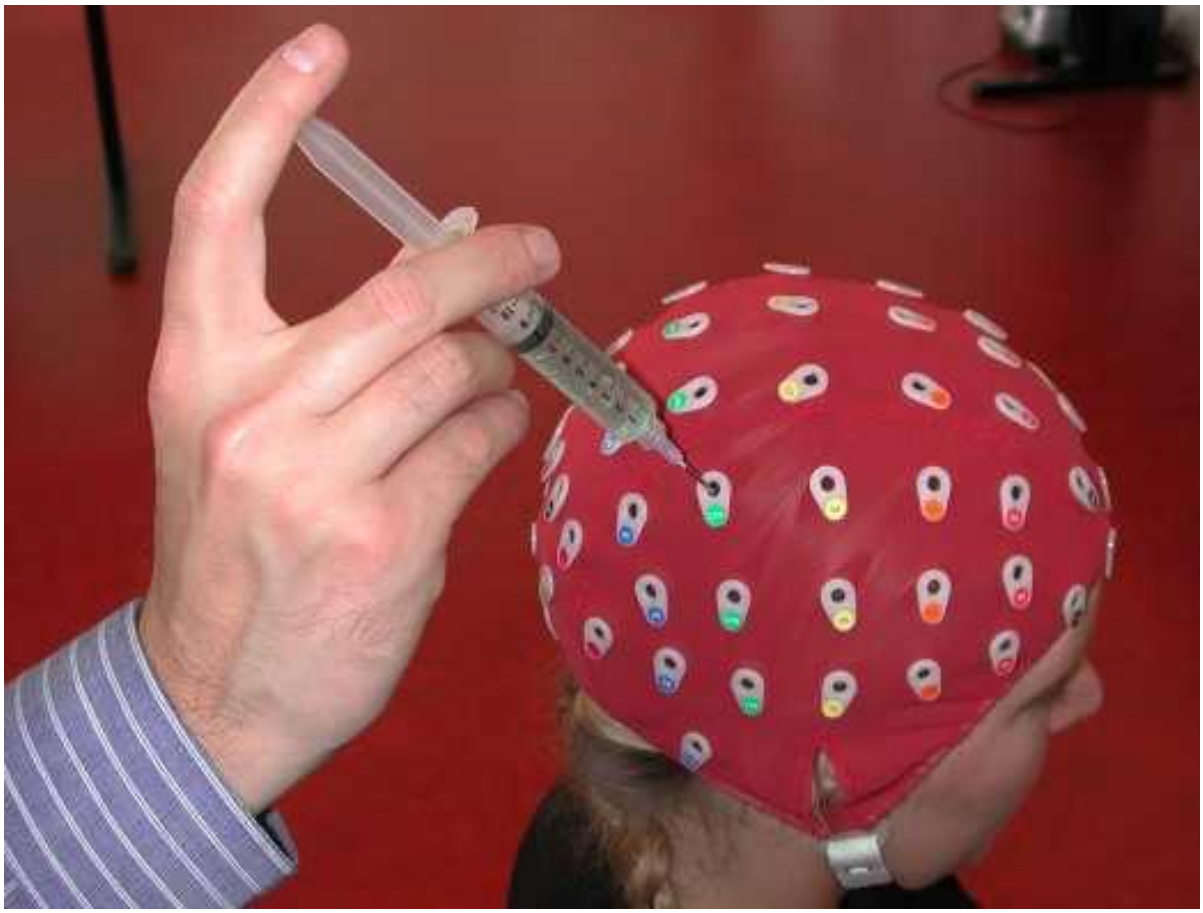

Figure 6.2, depicts orientation of 64 channels elastic cap of the EEG , with the placements of the electrodes using a blunt-tipped syringe, and insertion of the electrolyte gel holes in the cap/sensors;

Prior to attaching the sensors, the skin was cleansed using sterile alcohol wipe. Electrode impedances were kept below 5 Ω (ohms), which maximized conductance from scalp to electrode and minimized the electrodes' susceptibility to exogenous electromagnetic noise from the environment. The set up procedure took approximately 30 minutes. After setup, participants were seated in front of a computer screen and the ATTA, [341] procedures were explained to them. They were told that computer software would present pictures of four common household items, and that each item would be displayed for 3 minutes. (see Appendix 6.2).They were instructed to free associate or "come up with" as many alternatives for the questions in the section 1 and complete the remaining sections 2,3 & 4 e.g. incomplete picture and innovative use of the idea etc. For each idea, they were asked to press a button on the desk in front of them, and then verbalize their idea into a microphone

situated above the computer screen. Participants were asked to continue free-associating ideas and the alternatives for 3 minutes for each item. Fifteen seconds of pre-stimulus reference activity was recorded prior the ATTA test phase; during this pre-stimulus interval participants focused on a fixation cross that was presented in the centre of the computer screen in front of them. All electrodes were kept within 50 mV offset of the BIOSEMI system metric for measuring impedance. EEG data were recorded using a 64-channel Active Two Biosemi system (Biosemi, Amsterdam, Netherlands), in a continuous mode at a digitization rate of 512 Hz, with a bandpass of 0.01-100 Hz, and stored on disk for later analysis. (See Figure 6.1,6.2 & 6.3) Eye blinks and movements were monitored through electrodes placed on both temples (horizontal electrooculagram) and another one below the left eye (vertical electrooculogram [EOG]). Following steps were taken in data processing:

6.2 EEG PROCEDURES – DATA ACQUISITION

Data were amplified at a gain of 500 using a SynAmps amplifier to boost the electrical signals received at electrodes situated over the scalp, and filtered online using 60 Hz notch and .1-100 Hz bandpass filters to limit the frequency range being recorded and minimize the intrusion of exogenous electrical noise. The continuous EEG files were later separated by experimental condition (e.g., Pre Baseline, Creativity and Cyclic Meditation phases for experimental group and Shavasana for the control group) conditions into unique data files.

The following steps were taken for data processing;

(a) Filtering and removal of excess noise from data;

(b) ICA (Independent Component Analysis) for artifact removal;

(c) Segmentation of data into different brain wave frequencies and

(d) Calculation of energy and power for different frequency segments for all events and conditions, baseline-pre-post, creativity test, cyclic meditation.

Figure 6.3 – 64-Channel Active Two BIOSEMI EEG System

Figure 6.3- depicts the 64-channel Active Two BIOSEMI system (Biosemi, Amsterdam, Netherlands)

6.3 DATA PROCESSING AND ARTIFACT REJECTION

Data processing was carried out using the EEGLAB open source software version 12 running on Matlab R2009b (The Matworks Inc.) under a Linux operating system (Ubuntu 12.04).[33] EEG data were first referenced to the right mastoid and down-sampled from 1024 Hz to 256 Hz. A high-pass filter at 1 Hz using an infinite impulse response (IIR) filter with a transition bandwidth of 0.3 Hz and an order of 6 was applied.

We automatically removed portions of the signals presenting non-stereotyped artifacts using pop_rejcont function of the EEGLAB software.[33] The data were first segmented in 1-second epochs with 0.5 second overlap. Segments of 8 contiguous epochs in which the 0-10 Hz frequency band and the 35-128 Hz frequency band had amplitude higher than 17 and 14 decibels respectively were labeled as artifactual. We used this rejection procedure to ensure that artifact rejection was uniform for all subjects. Rejection of low-frequency segments helped remove signals related to subjects' head and body movements.

Rejection of high frequency activity helped reject data portions of muscular activity. Finally, we used Infomax Independent Component Analysis (Infomax ICA) on the pruned data to reject eye movement related and muscle artifacts.[34]

6.4 DATA SEGMENTATION

Following artifact rejection, data was separated into lengths of a pre-determined duration called epochs. For the purposes of this study, the continuous data was transformed into blinks-free epochs spanning 510 ms in duration. The number of sweeps varied by participant according to the amount of noise artifacts present in the EEGs. The average number of accepted epochs/sweeps per condition was 26.95 (SD=3.8) for Pre-stimulus, 276.41 (SD=72.4) for listen, 300.64 (SD=73.0) for CM 286.86 (SD =83.1). As mentioned earlier in the methods section, participants whose epoch files elicited less than 15 useable sweeps during pre-stimulus baseline trials were eliminated from further analysis (n=6).

6.5 OFF-LINE FILTERING AND BAD CHANNEL ELIMINATION

During this study, I chose to focus my investigation on the gamma band (25-60 Hz), which is sensitive to group-wise differences in gamma synchronization related to tasks of varying creativity demands.[42,43] Therefore, all frontal and parietal gamma wave synchronization data reported in this study pertain specifically to the upper gamma band.

After averaging the useable epochs by power, averaging seeps were filtered by frequency bands defined as overall gamma (25-60 Hz).Electrode channel signals were visually inspected, with exceedingly noisy ones eliminated further analysis. [301,310]

6.6 TASK-RELATED POWER CALCULATIONS AND ELECTRODE GROUPING

Finally, EEG data was calculated in terms of task related power values in each trial. These values represent the difference between cortical activity measured at an electrode site during a task activation interval and during a resting pre-stimulus reference interval. Electrodes were grouped for analysis as Front Left F3, P3 and Right F4, P4. (Refer Figure 6.4) These abbreviations refer to the position of EEG cap electrodes. Data from the Frontal & Parietal, Left and Front Right, electrode groups were used for further comparisons and analysis in this study.

Figure 6.4 (a) – ROI in Frontal and Parietal Brain Areas

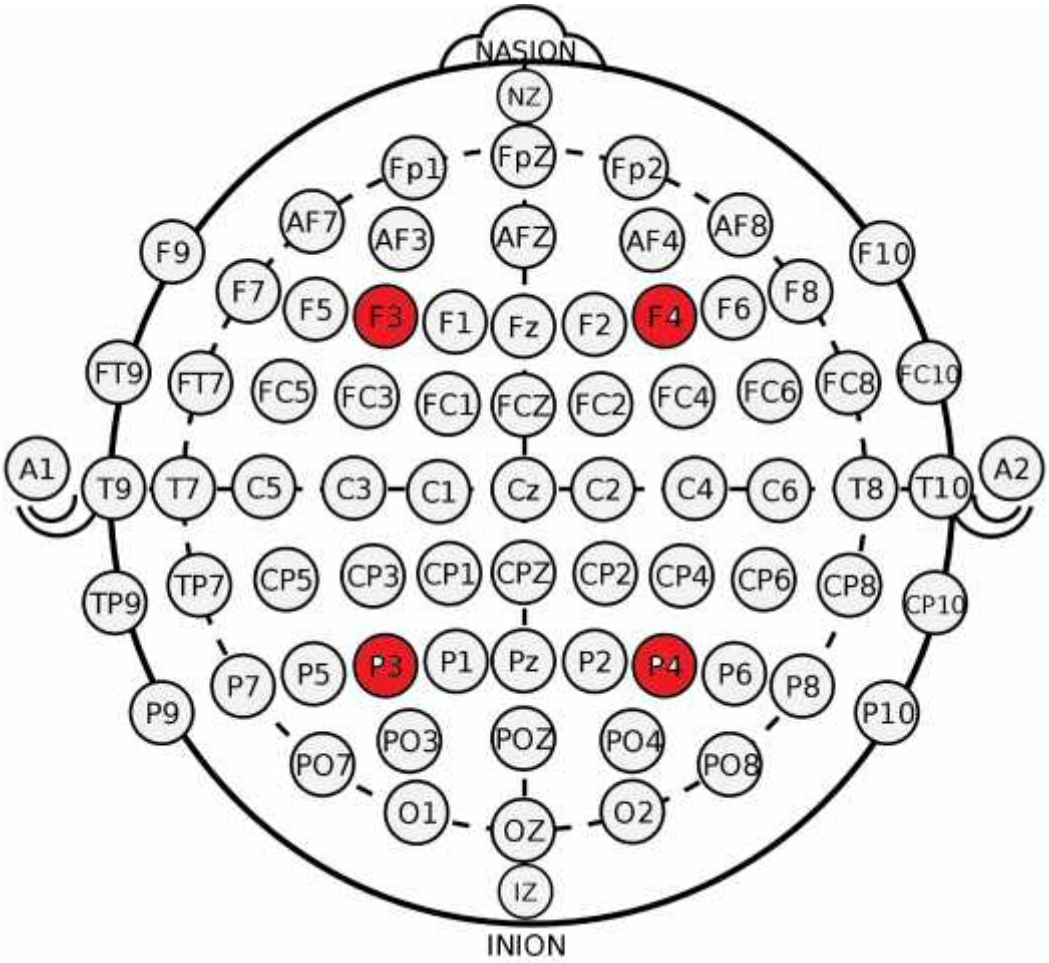

Figure 6.4 (a) depicts the ROI, circled in green frontal left F3 and right F4 and parietal left P3 and right P4, as per the Creativity and CM hypothesis.

Figure 6.4 (b) – ROI in Frontal and Parietal Brain Areas

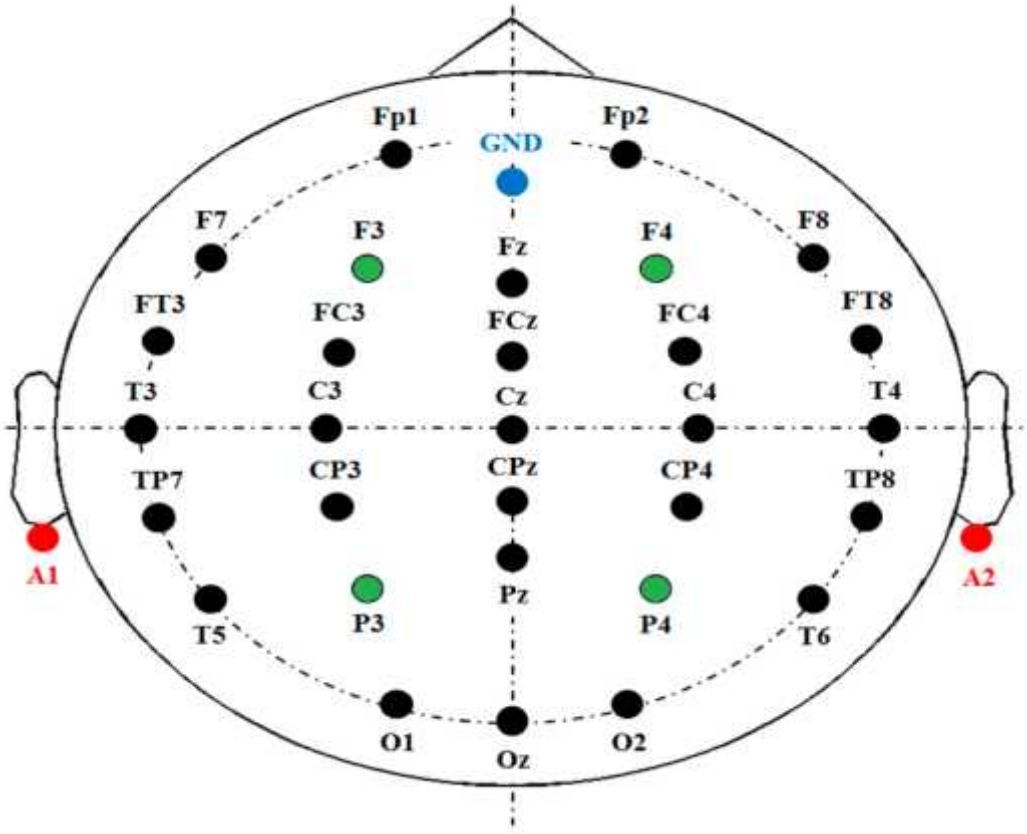

Figure 6.4 (b) depicts the ROI, circled in green frontal left F3 and right F4 and parietal left P3 and right P4, as per the Creativity and CM hypothesis.

6.7 STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was first used to assess significance of the EEG spectral power across groups and conditions using one-way Welch's ANOVA.[34,35] The final statistical analysis was using SPSS (Version 20.0). Between and within group comparison for creativity and EEG using Independent 't' test to determine whether scan protocol affected the creativity and EEG measurements on our ROI measurements and their scores. Descriptive statistics were used to identify outliers and normality of distribution for variables of interest. For significant relationships that were found between Creativity total scores and ROIs, correlations were determined posthoc between the areas of frontal brain regions i.e., F3, F4 and parietal P3, P4, following a significant relationship between the experimental and control groups, practicing Cyclic Meditation (CM) and Shavasana (SH) and the total scores of Creative Cognition within each dimensions and in each group.