CHAPTER 4 AIM AND OBJECTIVES

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4.1. AIM

To assess the effect of MPEMF on brain hemodynamics, cognition and subtle energy levels of teenagers and to understand whether OM chanting offers any resistance to changes induced by MPEMF exposure on these variables.

4.2. OBJECTIVES

I. To assess the effect of MPEMF exposure on brain blood flow in teenagers during Stroop task using fNIRS compared to sham.

II. To assess the effect of MPEMF exposure on subtle energy levels in teenagers compared to sham.

III. To assess the influence of 5 minutes of OM chanting after 30 minutes of MPEMF exposure on brain hemodynamics during Stroop task compared to SS chanting.

IV. To assess the influence of 5 minutes of OM chanting after 30 minutes of MPEMF exposure on subtle energy levels compared to SS chanting.

4.3. RESEARCH QUESTION

Does MPEMF exposure of 30 minutes produces any change in brain hemodynamics, cognition and subtle energy levels of Adolescents?

Does OM chanting of 5 minutes following MPEMF expsoure offers resistance to possible changes induced by MPEMFs?

4.4. HYPOTHESES AND NULL HYPOTHESES

4.4.1 HYPOTHESES

1. Mobile Phone Electro Magnetic Radiations will produce significant changes in brain hemodynamics, cognition and subtle energy levels of teenagers.

2. OM chanting practice will resist changes produced by Mobile Phone Electro Magnetic Radiations.

4.4.2 NULL HYPOTHESES

1. Mobile Phone Electro Magnetic Radiation will not produce significant changes in brain hemodynamics, cognition and subtle energy levels of teenagers.

2.OM chanting practice will not resist changes produced by Mobile Phone Electro Magnetic Radiations.

CHAPTER 5 METHODS

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5.1. SUBJECTS

Sample size n = 120

- Teenagers (both gender;13-19 years)

We enrolled one hundred and twenty right handed teenagers (60 males & 60 females) in the age range of 14.14 ± 0.83 years from various schools in Bangalore city of India. All subjects were healthy as assessed by general health questionnaire (GHQ-12), their mean GHQ score was 0.8±0.69 and average body mass index was 18.72 ± 3.0 kg/m^2. Subjects were students of class 9 and their last academic performance was with an aggregate of 76.61±18.87 %, suggesting absence of mental handicap or other significant psychological morbidity. Subjects were given a week long orientation in performing OM chanting or producing the sound 'sssss . . .' (SS) for same duration before the assessments.

5.1.1. INCLUSION CRITERIA

1. Subjects who were able to read and write in English language were selected.

2. Aged from 17 to 21 years.

3. Both genders

4. Physically and mentally healthy through GHQ

5.1.2. EXCLUSION CRITERIA

1. Subjects who had visual disturbances or colour blindness (screened using Ishihara Charts)

2. Those with a peak flow rate below 150 L/min were excluded;

3. Those who were regular meditators or who were regularly chanting OM (or other similar mantras) for the last 1 month or more. Similarly,

4. Female subjects were excluded during menstruation.

5. Those with mental handicap (as screened through Vineland Social Maturity Scale) or suffering from any psychological or chronic non-communicable disease or with congenital diseases were excluded.

6. Those on any kind of regular medications were excluded.

5.1.3. SOURCE

Subjects were selected from various schools in the city of Bangalore.

5.1.4. ETHICAL CONSIDERATIONS:

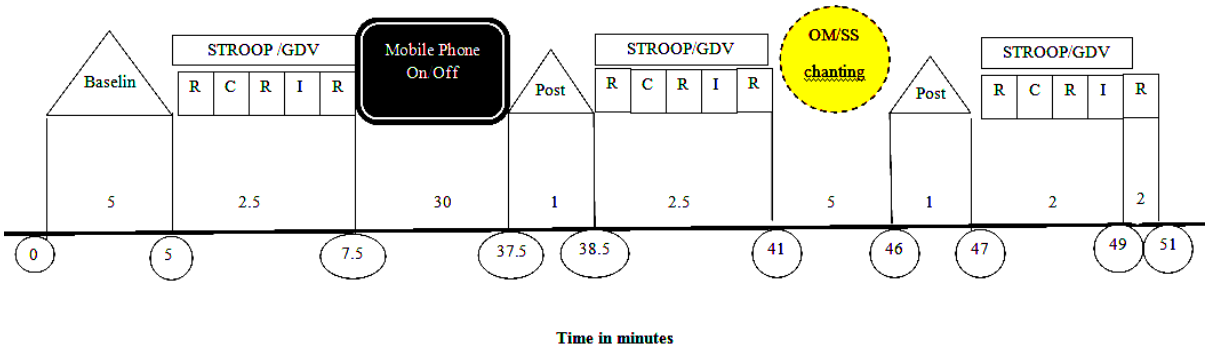
Informed Consent was obtained from the guardian/ parents of the subjects before starting the study. Institutional Ethical Committee clearance was taken before starting the study. Confidentiality: participants were assured that data collected from each individual, would only be used for study purposes.

5.2. DESIGN

A four group randomized controlled design was followed. Each subject was exposed to mobile phone on/ off for 30 min and then was asked to chant OM or SS for 5 min. Depending on the status of phone (on or off) and whether it is followed by chanting OM or SS, subjects were randomly divided into four groups with 15 males and 15 females in each group.

Randomization was performed using an online randomization program (www.randomizer.org). It was gender-stratified randomization to include equal number of males and females (two males and three females) in each group. Four groups were as follows: (1)MPONOM group: In this group, subjects were exposed to MPEMF through a mobile phone in 'ON' mode for 30 min and after this subjects chanted OM for 5 min; similarly, in (2) MPOFOM group: Subjects were exposed to mobile phone in 'OFF' mode and chanted OM; in (3) MPONSS group: Subjects were exposed to mobile phone in 'ON' mode followed by 'SS' chanting; and, lastly in (4) MPOFSS group: subjects were exposed to mobile phone in 'OFF' mode and chanted 'SS' afterwards. Assessments were done at three points of time in each group: (1) Baseline; (2) After mobile phone on/ off exposure; and (3) after OM/SS chanting. Table 4 provides demographic details of the subjects in each group. Demographic details did not differ significantly between the groups. A schematic representation of the study design is provided in Figure 10.

Figure 10: Schematic Representation of the Study Design



Abbreviations: R = Rest; C = Congruent task; I = Incongruent task

Table 4: Demographic details of the subjects

Variables/ Group	MPONOM (mean±SD)	MPOFOM (mean±SD)	MPONSS (mean±SD)	MPOFSS (mean±SD)
N	30	30	30	30
Age (years)	14.1±0.88	14.23±0.81	14.16±0.79	14.06±8.63
Gender (numbers)	Male (n = 15) Female (n = 15)	Male (n = 15) Female (n = 15)	Male (n = 15) Female (n = 15)	Male (n = 15) Female (n = 15)
Height (m)	1.58±0.06	1.58±0.10	1.56±0.06	1.58 ±0.07
Weight (kg)	47.8 ± 8.02	43.1 ± 7.8	45.53 ± 10.52	47.66 ± 8.53
BMI (kg/m^2)	19.11 ± 3.57	17.07 ± 1.88	18.45 ± 2.87	18.95 ± 2.64
Head circumference	52.81 ± 1.10	53.10 ± 1.32	53.00 ± 1.49	53.02 ± 0.94
Last academic performance	79.33 ± 7.73	75.55 ± 7.16	80.64 ± 9.68	83.4 ± 8.34
GHQ-12 scores	0.8±0.39	0.9±0.10	0.8±0.43	0.7±0.90
Social IQ Scores*	88.93±1.39	90.93±2.33	89.87±1.83	89.80±1.90
Average Mobile phone usage per day (minutes)	43.13±15.91	37.93±21.11	33.80±11.23	42.87±20.33

Abbreviations: MPONOM: mobile phone 'ON' followed by 'OM' chanting; MPOFOM: mobile phone 'OFF' followed by 'OM' chanting; MPONSS: mobile phone 'ON' followed by 'SS' chanting and MPOFSS (mobile phone 'OFF' followed by 'SS' chanting.

*as measured by Vineland Social Maturity Scale

5.3. EMF EXPOSURE SETTINGS

The source of EMF as a 2100MHz 3G mobile phone with a Universal Mobile Telecommunications System's (UMTS) network. It was an FCC approved device and had a head specific absorption ratio (SAR) of 0.4 W/Kg and body SAR of 0.54 W/Kg. Subjects sat on a comfortable chair with head resting on the chair and two identical mobile phones were kept at ~ 0.5 cm distance from the tragus, one on each side, using an adjustable wooden stand. On calling mode, the device emitted average EMF energy of $1.305 \pm 0.94 mW/m^2$ (with peak value of 2.34 mW/m^2) at 5 mm. Left side mobile was kept in off mode permanently with battery removed. Right side mobile status only was changed depending on the group to which the subject belongs.

Identical phones were kept on both sides at the same distance from the ear to rule out lateralization effects on brain haemodynamics. When subjects were needed to be exposed to MPEMF, i.e. in MPON groups, fully charged mobile was placed on the right side and a call was made for 30 min from another phone. Both the phones (caller and receiver) were kept mute throughout. During sham exposure, the right side mobile was kept off with battery removed. Subjects were unaware of the group status they were allocated to. A counterbalanced experiment with eight independent subjects, each with four trials, indicated that the subjects could not detect the EMF exposure condition any better than by guessing (response accuracy 50%). The cap of fNIRS was fixed on the head of the subject and recording was taken in a dark room with a computer screen displaying Stroop task. Figure 11 shows the settings of the study. During the 30- min period of mobile phone on/off exposure, subjects heard an audio describing geography of Karanataka state. To ensure that subjects remained awake during this period, subjects were asked to answer 10 simple multiple choice questions at the end, based on the audio. Those scoring more than 50% were only included in the study further.

Figure 11: Settings of the Study

5.4. fNIRS DEVICE

We used a 64 channel continuous wave fNIRS device Q4 (NIRx Medical Technologies, LLC, USA) with a sampling rate of 15.6 Hz. With eight light emitting sources and eight detector probes, 18 channels were measured quasi-simultaneously over both the pre-frontal cortices using two wavelengths of near-infrared light (760nm and 850 nm). Probes were fixed on the head based on 10–20 system using whole head standard sized caps (NIRS caps) for the age group assessed. Figure 12 provides the montage and Table 5 provides the channel distribution of fNIRS device followed in the study.

Figure 12: Montage of the study

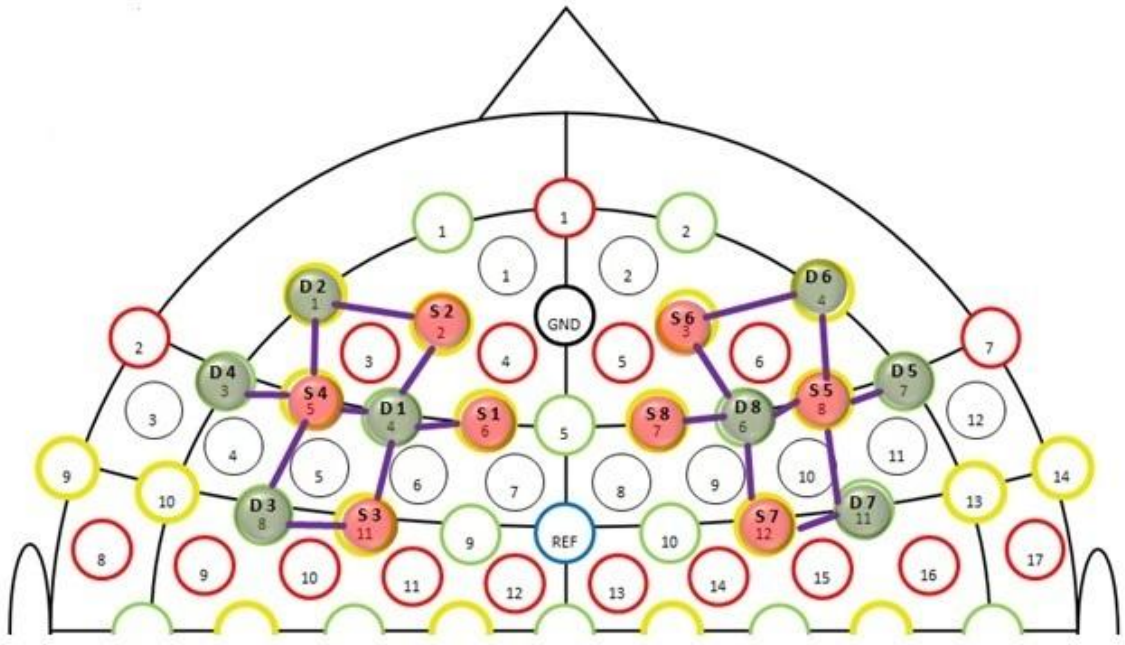


Table 5: Channel distributions followed in the study while using fNIRS device

Left Side	**S1-D1**	**S2-D1**	**S2-D2**	**S3-D1**	**S3-D3**	**S4-D1**	**S4-D2**	**S4-D3**	**S4-D4**
	Ch-1	2	3	4	5	6	7	8	9
Right Side	**S5-D5**	**S5-D6**	**S5-S7**	**S5-D8**	**S6-D6**	**S6-D8**	**S7-D7**	**S7-D8**	**S8-D8**
	10	11	12	13	14	15	16	17	18

Abbreviations: S1 to S8: Sources and D1 to D8: Detectors; Ch1 to 18: Channels

5.5. STROOP TASK AND PROCEDURE

Subjects were seated comfortably on a reclining chair in a Faraday cage, facing a 21-inch LCD monitor placed at a distance of 70 cm from their eyes. The cognitive paradigm used in the present study was Stroop task. The traditional 100 item paper and pencil version of Stroop was projected on a computer screen and verbal responses were recorded. The Stroop task was designed based on the paradigm followed in previous research (Taniguchi, Sumitani, Watanabe, Akiyama, & Ohmori, 2012). During the Stroop task, subjects were asked to read as many words as possible on a computer screen displaying 100 words. Subjects were randomly presented with words 'red', 'blue', 'yellow', and 'green' which were written in red, blue, yellow, and green ink. The task was presented in block design that consisted of rest periods and two test conditions: congruent and incongruent. In the congruent condition, the name of the word was congruent with the colour of the ink and subjects were asked to read them out. In incongruent conditions, the four words were written in incongruent colours. The time for Stroop task was fixed and it was given using automated software for a total duration of 2 min and 30 s in the following blocks: 30 s rest - 30 s task (congruent) - 30 s rest - 30 s task (incongruent) - 30 s rest. In the rest periods, clear instructions were shown to the subject for the next task condition, for e.g. before congruent condition the instruction was: 'Please read the words on the screen loudly and as quickly as possible' and before the incongruent condition the instruction was: 'Please read the colour of the words on the screen loudly and as quickly as possible'. Each subject was given orientation to the task one day prior to data collection. The responses (number of total, correct, and incorrect responses in 30 s of each condition) were recorded manually by two trained psychologists using an answer key for each condition. Both psychologists were blind to the group allocations of the subject. Data was considered valid only when the scores from both the psychologists were matching. The fNIRS measurement was performed during the whole task. Markers were applied for each

task condition (congruent and incongruent) during recording to segregate respective haemodynamic responses.

5.6. OM/SS CHANTING PROCEDURE

All the subjects were trained in 'OM' chanting by an experienced yoga teacher and an orientation training of one week was given to all the subjects before data collection. The subjects were trained to chant 'OM' loudly without distress and interruption—the vowel (O) part of the 'OM' for 5 s continuing into the consonant (M) part of the 'OM' for the next 10 s, maintaining a ratio of 1:2. The control condition was continuous production of 'sssss . . .' or 'SS' syllable for the same duration. This was chosen to control for the expiratory act of chanting 'OM', but without the vibratory sensation around the ears (Kalyani et al., 2011).

5.7. ELECTRON- PHOTO IMAGING (EPI) ASSESSMENTS

EPI is based on the well-known Kirlian effect (Korotkov, 2002). The measurement of Electro-pPhotonic imaging (EPI) is based on the electrical activity of the human organism. This activity is quite different in diseased condition of a human body as compared to the activity in a healthy body. The biophysical principles in the investigation of EPI technique are based on the ideas of quantum biophysics. This method draws stimulated electrons and photons from the surface of the skin under the influence of a pulsed electromagnetic field. This process is well studied through physical electronic methods and is known as "photoelectron emission"." EPI is being used as diagnostic and research tool in more than 63 countries. EPI consists of an electrode covered with dielectric (usually a glass plate), generator of electrical field of a high voltage 12KV, high frequency of 1000Hz, and low current and, applied for less that 1 millisecond. The resultant discharge pattern is photographed using a CCD video camera. (Korotkov, 1998) Electrons are pulled out of the finger pads of subjects by impressed voltage and this avalanche of electrons is captured by a

CCD camera. According to traditional Korean acupuncture practices, which are based on Chinese philosophy, different sectors of finger pads are connected to different organs of the body through meridians, and these meridians allow electrons from those organs to be drawn, providing the subtle energy status of the organ. From the information obtained from ten finger pads of the individual, electro-photonic mapping of the whole body can be done through a software program. Investigating these images of finger tips, which change dynamically with emotional and health status, one can identify areas of congestion or energy balance in the whole system (Korotkov, 2012).

5.7.1. EPI Parameters

Comprehensive assessments of EPI energy levels at all organs were performed before and after MPEMF and sham exposure respectively. Only right side mobile status was changed. Further, in our previous pilot study, we did not observe any significant changes on left sided EPI parameters. Forty two EPI parameters from right side of EPI images were assessed. These parameters provided subtle energy levels of almost all the major organs of the body. Outcome Variables were as follows:

Combination : Integral Area, Entropy, Overall Stress Levels

From Left Hand Fingers (25): Right Eye, Throat, Larynx, Trachea, Thyroid Gland, Left Ear, Left Side Of Jaw, Left Ear, Left Eye, Cerebral Zone, Descending Colon, Sigmoid Colon, Coccyx, Pelvis Minor Zone, Rectum, Sacrum, Lumbar, Thorax Zone, Liver, Abdominal Zone, Hypothalamus, Nervous System, Spleen, Pancreas, Thyroid Gland, Epiphysis, Left Kidney, Jejunum, Right Part Of Heart.

From Right Hand Fingers (28): Gall Bladder, Right Eye, Integral Area, Rms Of Integral Area, Integral Entropy, Right Ear, Nose, Maxillary Sinus, Jaw Teeth (Right Side), Throat,

Larynx, Trachea, Thyroid Gland, Left Eye, Cerebral Zone, Thorax Zone, Lumbar Zone, Coccyx, Pelvis Minor Zone, Blind Gut, Appendix, Ascending Colon, Immune System, Right Kidney, Cardiovascular System, Thyroid Gland, Pancreas, Spleen, Nervous System, Hypothalamus, Duodenum, Ileum, Mammary gland, Respiratory System, Right Kidney, Right Coronary Vessels.

5.7.2. EPI Procedure

For Electrophotonic imaging produced by "Kirlionics Technologies International", Saint-Petersburg, Russia, GDV camera Pro with analog video camera, model number: FTDI.13.6001.110310 was used to collect data. The measurements were carried out two times for each subject. The readings from all 10 fingers were taken. To maintain the reliability and reproducibility of data, the given guidelines for EPI measurements were followed (Alexandrova et al, 2002). The measurements were made three hours after food intake. The subjects were asked to remove all metallic objects from their body which were not used by them continuously for 24 hours prior to data collection. They were also asked to minimize and if possible completely avoid cell phone use in the previous 24 hours. Subjects stood on an electrically isolated surface during the measurements. Proper instructions were given to them to place the finger pads one after another on the dielectric glass. Calibration of the instrument was carried out before starting measurement. To clean the surface of glass, alcoholic solution was used between each subject. Hygrometer (Equinox, EQ 310CTH) was used during data collection to record variability in atmospheric temperature and humidity. During data recording at different time intervals, mean temperature was 26.63 and humidity 52.18 measured in degree Celsius and percent respectively to check for atmospheric effects and possible variability of electrophotonic emission from human subjects (Korotkov et al, 2011).

CHAPTER 6 DATA EXTRACTION AND ANALYSIS

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6.1.1. Brain Hemodynamics

NIRS optical intensity data was processed by NIR star acquisition software and extracted using accompanying topography software (nirsLAB; NIRx Medical Technologies, LLC). Data were corrected for the effects of vascular pulsation (Gratton & Fabiani, 2006). Pulse corrected data were filtered using a low-pass (zero phase shift) filter with a cut-off frequency at 0.01–0.2 Hz. For every subject, the channel measurements showing low signal-to-noise ratio were discarded. Linear trends of continuous oxyHb changes and fluctuations were also eliminated. For oxyhaemoglobin (oxyHb) concentration, changes for a 30 s baseline were taken for analysis. To obtain haemodynamic data, the modified Beer–Lambert Law was applied to artifact-free segments (Hoshy, Kobayashi, & Q6 Tamura, 1985). We focused on oxyHb concentration changes for further analysis because they provide the most robust signal-to-noise ratio and are the most sensitive parameters of cerebral blood flow (Hoshy et al., Q6 1985; Sato, Hirabayashi, Tsubokura, Kanai, Ashida, Konishi, et al., 2012). Values for changes in oxyHb were obtained during the contrast of interest (Incongruent minus Congruent Stroop), i.e. Stroop interference, for all 18 channels at three points of time: (1) Baseline, (2) Post mobile on/off, and (3) Post OM/SS for all the four groups (MPONOM, MPOFOM, MPONSS, MPOFSS). Similarly, Stroop task performance was assessed at these three points of time for the four groups.

Analysis of variance-repeated measures (RMANOVA) was used for data analysis using SPSS version 10. For analysis of Stroop performance, Stroop task condition (correct, incorrect, and total scores for each condition: congruent and incongruent) was the dependent variable with

‘group’ as between-subjects and ‘time point’ as within-subject factor. For haemodynamics data, one multivariate RM-ANOVA analysis was performed for all the 18 fNIRS channels. Channels 1–18 were the dependent variables (level), with ‘group’ as between-subjects and ‘time point’ as within-subject factor. Post-hoc comparisons between individual groups/time points were made through Bonferroni’s correction after checking for significance of main effects or interactions.

6.1.2. EPI Imaging

Raw data from each EPI diagram software was extracted on to an excel sheet for the analysis. Analysis of variance-repeated measures (RMANOVA) was used for data analysis using SPSS version 10. For EPI data, one multivariate RM-ANOVA analysis was performed for all the 42 variables. Variables were the dependent variable (level), with ‘group’ as between-subjects and ‘time point’ as within-subject factor. Post-hoc comparisons between individual groups/time points were made through Bonferroni’s correction after checking for significance of main effects or interactions.