Brain Waves and Emotional Competency: Mediating Role of Creativity

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Abstract

A general opinion is coming out among researches that brain waves are associated with cognition and emotion. Brain waves are tiny pulses of the electrical activity which are detected using sensor placed on the scalp. Our brain waves change according to what we are doing and feelings. The present study attempts to explore the possible role of creativity in explaining the relationship between brain waves and emotional competency. Thirty participants (18 graduate and 12 post graduate) were assessed on measures of EEG recording, creativity and emotional competency. Analysis revealed that alpha, beta and theta waves are positively correlated with all dimensions of emotional competency and creativity. The findings of stepwise multiple regression analysis revealed that alpha waves emerged as the best predictor of creative fluency, creative flexibility and originality followed by theta waves. To examine the meditational role of creativity in alpha – emotional competency relationship a meditational analysis was carried out. Finding revealed that the creativity significantly mediated this relationship. In the total sample, alpha waves predicted emotional competency in an initial regression model (beta = 0.64, $p < 0.001$). When creativity was added to the model, however, alpha waves – emotional competency relationship was attenuated less and insignificant (beta = 0.27, NS). A Sobel test of significance confirmed a mediated effect ($p<0.01$).The results have been discussed in the light of available empirical researches.

Key words: *Brain waves, creativity, emotional competency*

Introduction

Brain networks have small-world attributes, and studying complex brain networks has become an important direction for brain waves research. Brain waves are generated by the building blocks of brain, the individual cells called neurons. Neurons communicate with each other by electrical changes. We can actually see these electrical changes in the form of brain waves as shown in an electroencephalogram (EEG). Brain waves are measured in cycles per second measured in Hertz (Hz). The Alpha wave (about 8-10Hz) occurs when brain activity slows just below the normal waking state of Beta (11-25 Hz). In Alpha, the mind and body are relaxed but a level of focus is easily maintained. In this deeper brainwave state, information can be processed consciously without as much "mental activity" to interfere with it. There is also a greater link between the conscious and subconscious mind in Alpha, meaning that while one is consciously learning, their brain is also unconsciously processing what one is learning. Alpha waves have a positive relationship with cognitive performance [1,2,3]. Alpha is 'the power of now', being here, in the present. Alpha is the resting state for the brain. Alpha waves aid overall mental coordination, calmness, alertness, mind/body integration and learning. The beta brain waves frequency ranges from 13 Hz to 30 Hz and has been correlated with attention, high level of concentration, and solving of complex mental problems. It has been observed that an increase in beta power is related to increased tasks difficulty [4,5]. Beta brainwaves dominate our normal waking state of consciousness

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when attention is directed towards cognitive tasks and the outside world. Beta is a 'fast' activity, present when we are alert, attentive, engaged in problem solving, judgment, decision making, or focused mental activity. Theta brainwaves occur most often in sleep but are also dominant in deep meditation. Theta is our gateway to learning, memory, and intuition. In theta, our senses are withdrawn from the external world and focused on signals originating from within. It is that twilight state which we normally only experience fleetingly as we wake or drift off to sleep. In theta we are in a dream; vivid imagery, intuition and information beyond our normal conscious awareness. It's where we hold our 'stuff", our fears, troubled history, and nightmares [6, 7].

Creativity is defined as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others. The psychometric approach to creativity reveals that it also involves the ability to produce more. A focus on the nature of the creative person considers more general intellectual habits, such as openness, levels of ideation, autonomy, expertise, exploratory behavior, and so on. Guildford (1967) suggested that creative processes involve divergent thinking which allows an individual to break free from previous and the most obvious type of ideas [5]. This is then followed by convergent thinking which involves the process of narrowing down and choosing the best idea [8, 9]. Creativity, the ability to produce novel and useful work, is one of the most extraordinary capabilities of the human mind [10]. In particular, creative idea generation was associated with increased oscillation power in the alpha band in prefrontal and parietal cortical areas [11, 12]. Several research sources state the positive effects of a brainwave entrainment program. D. S. Foster (1990) defines Alpha brainwave entrainment as a consciousness management technique, implying a self-adjustment component [13]. Some researchers reported considerable decrease in anxiety levels and a raised level in the participants' life quality and overall wellbeing, following a brainwave entrainment program [14, 15].

Human emotion is very difficult to determine just by looking at the face and also the behavior of a person. Although we all experience emotions, we markedly differ in the way we process them. Some of us are able to identify our emotions, express them in a socially acceptable manner, and regulate them when they are inappropriate, others have a hard time interpreting their emotions and seem most of the time overwhelmed by them. Emotional Competency refers to individual differences in identifying, expressing, understanding, regulating, and using emotions [16, 17]. Brain rhythms act as a gate for information entering and leaving the mind. One of the most scientifically studied and proven benefits of brainwave entrainment is its ability to improve academic performance, increase IQ, and improve cognition, but which brainwave is best for studying? It hasn't cleared yet. Creativity, the ability to produce innovative ideas, is a key higher-order cognitive function that is poorly understood. Yet, the neural basis of creativity remains poorly understood.

It is evident from the review that the cognitive performances are related to the different brain waves [18, 19]. Particularly alpha brain wave is associated with enhanced creativity and emotional competency. It is very important to understand how brain waves contribute to the state of mind. This observation lends indirect support to our speculation that the beneficial effect of alpha brain waves may be mediated by creativity. There is shortage of literature in this area and most of the early studies on brain waves explain their dominant roles on cognition. So the present study will be modest attempt to examine the brain waves- emotional competency relationship in general population using physiological measures of brain waves through EEG and explore the relative significance of various brain waves in predicting creativity. It will also explore the potential mediating role of creativity in Alpha wave-emotional competency relationship.

Method

Sample: The present study was conducted on a sample of 30 subjects belonging to middle class from Noida and Delhi NCR with the help of randomized sample technique (age range18- 45 years, Mean age 32.4 yrs.). With the help of EEG, 4 waves were taken for the study. No one had reported any history of chronic illness (hearing ability, mental state, and health conditions of the test subjects were normal). Furthermore, the test subjects had not undergone any EEG-related training. This study was designed in a controlled environment.

Tools

1. The electroencephalogram (EEG): It is a widely used non-invasive method for monitoring the brain. It is based upon placing metal electrodes on the scalp which measure the small electrical potentials that arise outside of the head due to neuronal action within the brain. The EEG signal that arises on the scalp is measured as a voltage in the time domain, with a wide number of potential signal morphologies present. Software Version 4.48, hardware version 3.2 was used in this study. It is a 24 Channel EEG, USB powered. Copyright c Clarity Medical Private Limited, C-84, Industrial Area, Phase-7, Mohali, Punjab (INDIA) – 160055.This EEG is characterized by diving it into frequency bands, each given the name of a Greek letter: • Delta: Activity at less than 4 Hz • Theta: Activity between 4 and 8 Hz • Alpha: Activity between 8 and 13 Hz • Beta: Activity between 13 and 30 Hz

2. Verbal test of Creative thinking [20]**:** It is a verbal test of creativity which evaluates the level of creativity on the basis of three domains. **(a) Fluency**: which represents the number of responses that are appropriate and not repeated, **(b) Flexibility:** represents the ability to produce distinct responses which differ in the trend of thought. The ideas expressed are limited to one category of classification, and **(c) Originality:** which is represented by uniqueness of the responses given by less than five percent of the normalized group. The test-retest reliabilities of factor scores are as follows – 0.945 for fluency, 0.921 for flexibility, and 0.896 for originality.

3. Emotional Competence Scale [21]: measures emotional competence on five dimensions, namely, adequate depth of feeling (ADF), adequate expression and control of emotions (ACCE), ability to function with emotions (AFE), ability to cope with problem and enhancement of positive emotions

Procedure

The participants were made to sign the consent and the confidentiality sheet to ensure that they are willingly participating in the research study. All the subjects were told to wash their hair the day before the test as, an oily scalp is a contra-indication for an EEG recording. The participants were then administered verbal test of creativity and emotional Competence along with the proper instructions. Their responses were recorded in an answer booklet. The participants were asked to solve the problems at their own preferred pace, without interruption. Next, the participants were asked to commence with their electroencephalogram recording as and when they completed filling the response sheet. The EEG recording was carried out by experienced technicians so that the data being collected has minimal artifacts. The scores of the test were later assessed. The average of the relative power of the brain waves present in all the lobes was then calculated and later correlated with the scores in the test.

Results

To examine the relationship of brain waves with all dimensions of creativity bivariate correlations were computed and obtained results have been displayed in table-1

Table1: Bivariate Correlation among the relative frequency of brain waves and scores of creativity.

Waves/Creativity	Total Alpha waves	Total Beta waves	Total Theta waves	Total Delta Waves
Fluency	0.743**	0.371*	0.482**	-0.641**
Flexibility	0.571**	0.365*	0.470**	-0.605**
Originality	0.668**	0.367*	0.348	-0.613**
Total creativity	0.755**	0.412*	0.481**	-0.696**

*p<0.05,**p<0.01

Inspection of the table-1 indicates that the sub-domain of creativity – Fluency, flexibility and originality as well as the total scores of creativity significantly and positively correlated with alpha, beta, and theta waves and negatively correlated with delta waves. It suggests that a correlation between an increase of alpha brain waves—either through electrical stimulation or mindfulness and meditation—and the ability to reduce depressive symptoms and increase creative thinking. Our various states of consciousness are directly connected to the ever-changing electrical, chemical, and architectural environment of the brain. Daily habits of behavior and thought processes have the ability to alter the architecture of brain structure and connectivity, as well as the neurochemical and electrical neural oscillations of your mind. At the root of all our thoughts, emotions, and behaviors is communication between neurons. Brain waves are produced by synchronized electrical pulses from masses of neurons communicating with each other [22]. To determine the relationship of brain waves with all dimensions of emotional competency bivariate correlations were computed and obtained results have been displayed in table-2

Table2: Bivariate Correlation among the relative frequency of brain waves and scores of emotional competency.

Waves/EC	Adequate depth of feeling	Adequate expression and control	Ability to function with emotion	Ability to cope	Enhancement positive emotion	Total emotional competency
Alpha	0.41*	0.60**	0.61**	0.58**	0.47**	0.64**
Beta	0.39*	0.59**	0.51**	0.32	0.38*	0.52**
Theta	0.16	0.21	0.19	0.09	0.25	0.22
Delta	-0.42*	-0.60**	-0.58**	-0.52**	-0.44*	-0.61**

*p<0.05,**p<0.01

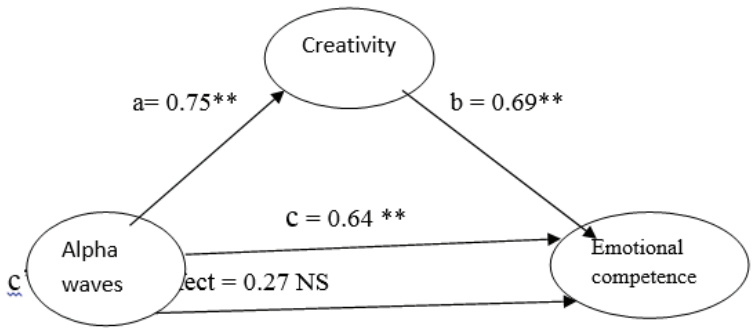
Inspection of table-2 indicates that alpha and beta waves are significantly positively related with all dimensions of emotional competency whereas delta wave significantly negatively related. Pattern of this correlation suggests that thoughts and other mental activity play an essential role in the formation of emotional competency. When a person is happy he or she is very existed and full of energy, enthusiastic. When they are happy and are relax and do not have any sort of stress or very low stress alpha waves are seen [23]. In addition, previous studies on brain wave reported that the participants who have high EQ (over 110), had their entropy of Beta band increased significantly. In contrast, the subjects with the entropy of Alpha band in high IQ (over 120), decreased significantly [24]. However, as relative significance of various brain waves in predicting creativity cannot be determined by simple bivariate correlation, a series of stepwise regression analyses was conducted using different brain waves as predictors and various dimensions of creativity as criterion variable. The result has been displayed in table 3.

Table: 3 Step wise multiple regression analysis using brain waves as predictors and dimensions of creativity as criterion

Predictors	R	R2	R2 change	F change	B	Beta	T
Criterion variable (Fluency)							
Alpha	0.74	0.55	0.55	34.45**	0.05	0.66	5.51**
Theta	0.79	0.64	0.08	6.50	0.01	0.31	2.55**
Criterion variable (Flexibility)							
Alpha	0.57	0.33	0.33	13.57**	0.01	0.48	3.20**
Theta	0.66	0.44	0.11	5.19*	0.01	0.34	2.28*
Criterion variable (originality)							
Alpha	0.67	0.45	0.45	22.55**	0.04	0.67	4.75**

The results revealed that Alpha waves emerged as the best predictor of all dimensions of creativity (fluency, flexibility and originality) contributing 55%, 33%and 45% followed by Theta wave contributing 8% of fluency and 11% of flexibility. Beta indicates the significantly positive direction with fluency, flexibility and originality. Overall, the findings suggest that Alpha is 'the power of now', being here, in the present. Alpha is the resting state for the brain. Alpha waves aid overall mental coordination, calmness, alertness, mind/body integration and learning [25, 26]. Several studies also indicate that EEG alpha activity is associated with cognitive performance [27, 28].

Present research study suggests that brain waves are associated with creativity as well as with emotional competence. Furthermore, it is also evident from the results of the present study that power of creativity is positively associated with emotional competency. This pattern of relationship between alpha waves, creativity and emotional competence support this possibility that the emotional competency is likely to be mediated by the creativity. However, present research tried to empirically examine this creativity as a mediator between alpha waves and emotional competency. The mediation analysis was computed by running an Andrew Heys (2009) macro for estimating direct and indirect effects in single mediator models [29]. For this analysis total scores on alpha waves was considered as predictor and the total scores of emotional competences was taken as criterion variable. The mediation relationship of alpha waves and emotional competence via creativity has been displayed in fig-1 along with path coefficient.



It is evident from fig-1 that the total effect of alpha waves on emotional competency (path C= 0.64) reduced substantiality after controlling the indirect effect of creativity resulting in a non-significant direct effect of alpha waves on emotional competency (path C' = 0.27 NS). It explains that alpha waves promote the emotional competence by increasing the creativity. Creative Behavior shows the power of emotional intelligence to make creativity happen. Alpha waves aid overall mental coordination, calmness, alertness, mind/body integration and learning. A series of studies explained the special role of alpha activity in creative cognition [30, 31, 32, 33, and 34].

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