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Reading Pattern of Emotions Using LORETA

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Abstract

The basic motive of this study is to find the relationship between the activation of brain and the real time while the person observes the pictures shown to him or her. The study aims at studying the emotions of the person. We have observed four emotions here, namely, emotions of happiness, sadness, fear and disgust. We have used LORETA in order to study these emotions on various persons at a mean age of 24 years. Later, by the technique of TONOVA, we have found the difference between the pre and the post-data collected and recorded by EEG. Different subjects were asked to see some pictures and note down what they feel about it at that time of moment. They were asked to rank themselves. This study's aim is to investigate the response of the brain by using the software or method or technique named as LORETA by seeing emotional pictures. With other brain imaging studies like PET or fMRI we can say that our findings are in good agreement when we compare it to others, because of the advantage to investigate the evolution of emotional process which is actually temporary in the millisecond range. The results here showed that each emotion condition has different characteristics in a particular time sequence of activation.

Keywords: *Brain, LORETA, emotions, EEG, stimuli*

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INTRODUCTION

Talking about the psychology and neuroscience, the important issue is to identify the elements which are irreducible when we are concerned with emotions; in other words, to find the structure of emotions. In the last few decades, many technologies have been introduced to have the clear picture of the emotion's structure. Then results were obtained with methods like fMRI ERP, EEG etc.

However, apart from these technologies, until now, there is no clear and definitive response to the structure and elements of the emotions. When we see any picture, different areas or regions of the brain are activated; on behalf of which, we can see the reference point for various emotions.

It is in principle that it should be possible to discriminate different emotional states, but the pattern of waves found while watching any picture and reacting may depend on the time duration too. As quoted by Ekman (1984), emotions usually last only a few seconds and can have different timings depending upon their type.

fMRI

fMRI is nothing but the Functional Magnetic Resonance Imaging which actually measures the activity of the brain by just detecting the changes which are associated with the blood's flow. The fact of this technique is that neural activation and cerebral blood flow are actually coupled. It basically relies on it. The increase in the flow of blood in some areas, could be specific, is directly proportional to that of the brain actually in use.

ERP

Event Related Potential is nothing but the response of the brain's measure which is a direct result of motor event or specific sensory or we could say the cognitive. Stereotyped electrophysiological retort to a stimulus can be the better version to say.

EEG

It is actually the method named as the electrophysiological monitoring which records the brain's electrical activity. This method is non-persistent, with electrodes differently placed along the scalp. So here we have the different methods used to record and

investigate the different electrical signals of the brain activity on behalf of which we can decide how a person actually behaves and how do they react in different situations and conditions.

MATERIALS AND METHODS

Subject

Few males and females of mean age group of 24 years participated in the study. These subjects did not have any personal history of any kind of neurological or psychiatric illness or any drug or any alcoholic activity or abuse. Neitherhave they any medication.

Everyone was informed about the study's aim and design and asked for their consent in written.

Stimuli

A standardized IAPS which shows emotions like happy, sad, disgust, four emotions were pre-selected. We chose these emotions only because most of the theorists include these emotions only.

Procedure

All the activities were done and seen on 21 in screen. Each subject was asked to sit quietly at 1 m distance from the screen. They were asked to sit comfortably without demanding any cognitive task. Subjects sitting over there were directed to be relaxed and asked to look at the centre of the screen in order to reduce the prospect of artefacts like eye movement. Pictures were shown separately for 500 msec, with 1 sec of black screen after every picture.

The pattern was recorded as a stimulus for each emotional category and represented as block design. These blocks' order was randomized between the subjects. There was a gap of 5–6 min in order to bring the subject back to baseline level after relaxing. Block design was used to reduce the probability of confusion and enhance or increase the chance of pure result.

An EEG recording was done and the subjects were asked to assess the marks or points to themselves after viewing the pictures. The ranges were from 1–9 for different scales as given below:

- 1: Very Unpleasant; 9: Very Pleasant (HAPPINESS)
- 1:Not at All, Very Calm; 9: Very Exited (AROUSAL)
  Subjects were asked to indicate the intensity of the emotions, whichever the emotion they are getting or having.
- 1: Present not at All; 9: Felt very strongly.

EEG Measurement

EEG has been recorded. A ground electrode is used as cap for the scalp with number of channels in it was set on the forehead. A proper placement of the E-Motive from nasion was placed in 10/20 system (Figure 1).

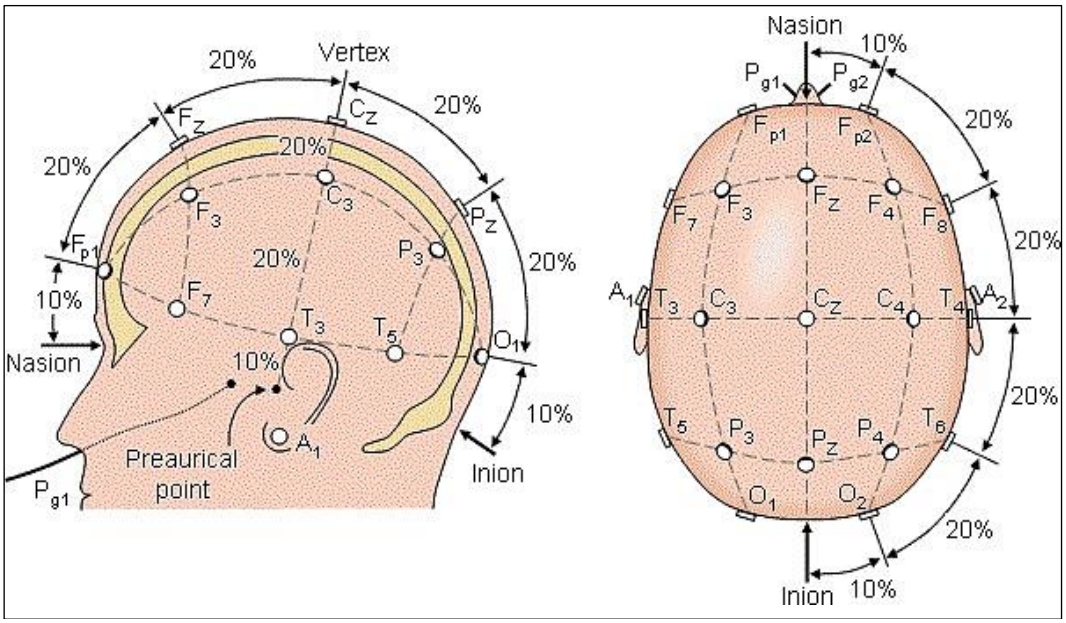

Fig. 1: *Placement of Electrodes.*

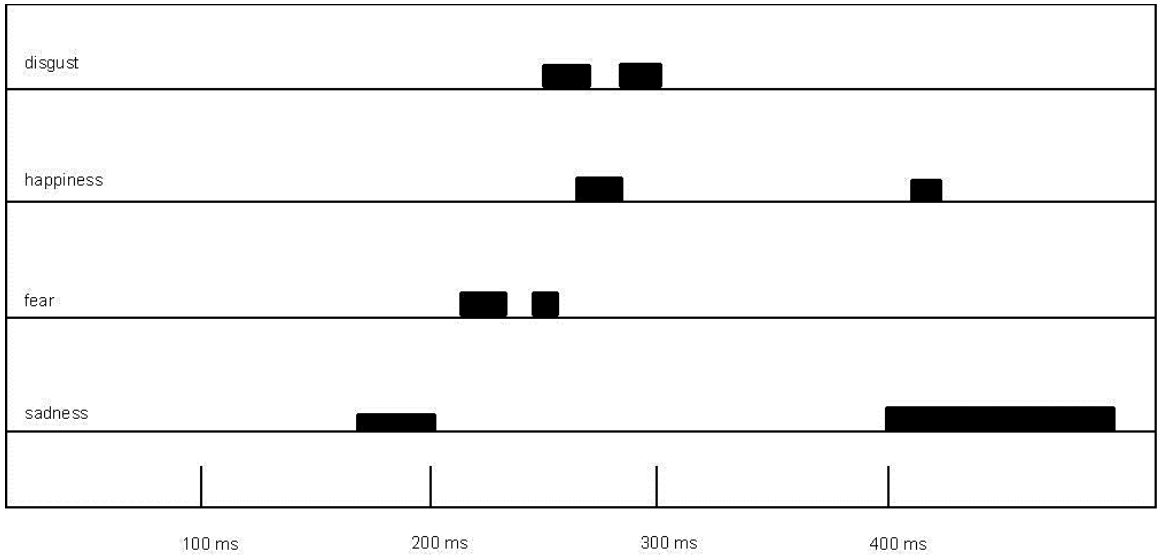

Fig. 2: *Time Segments of Significant Differences for Each Condition Compared to the Neutral Condition.*

The (EOG) i.e. Electro-oculogram was measured to have artefacts scoring and vanish them from EEG recordings.

Post-Processing

The post processing involves the rejection of the artefacts. Epoch with eye-movement, eye-blink, head movement etc. were rejected.

RESULTS AND ANALYSIS

To understand and investigate the difference between the various types of conditions we opted or chose a dissimilarity measure named as TANOVA (Topographic Analysis of Variance). To know and find the difference between the different conditions we used a dissimilarity measure named as TANOVA. This is a universal measure to find the difference between the two scalp potential maps.

The result of the study and the analysis of self analysis show that the emotional state they felt actually mapping the expected emotions. Targeted emotions were actually identified correctly with high co-ordnance between the result expected and the result seen after self reported.

This analysis showed that the four emotions and neutral observation of each emotional picture were levelled by a specific temporal dynamic which involves the difference in the significant segment's numbers with respect to their onset time and duration (Figure 2).

Negative stimuli of various emotions with respect to time span are as follows:

- Disgust: 2; onset time:250 msec
- Fear: 2; onset time:250 msec
- Happiness and sadness shared the latest onset time.
- Sadness took the longest time segment: 400 to 500 msec.

At first, the overall comparison between the emotional and neutral conditions was done in one go. That is with the whole time span of EEG response. Then every value in this was taken into account by averaging them according to the images acquired during presentation.

Later, we analysed the dynamics of activation while showing the pictures in a segment of time and then averaging them (Figures 3 and 4).

The frontal regions were largely activated by disgust compared to the neutral with an occurrence in the left side of the brain, particular with the frontal gyrus and the left middle gyrus at a lesser extent. In addition to it, the disgust activated the limbic structures. This was also related to the insular activation.

Talking about happiness, we can say that happiness activated the left and the right of the orbitofrontal cortex. This is more extended in comparison to the disgust emotions.Interestingly, we observed that happiness created a large activity in the

occipital structures which are helpful in forming associative visual systems.

Next is fear which was associated with particular increase of the limbic activation's right side, including most of the part of cingulated cortex. With respect to the time or in time reference, the fear was characterized by an activity in a condition of increase which specifically involved the right hemisphere, or more specifically over the pre-motor cortex.

The left frontal gyrus was occupied by the emotion sadness which showed a vast and specific activation in the given part. And taking the limbic level, the right posterior cingulated was the part which was the indicator of sad emotions. This particular emotion activated the premotor cortex's right side intensely and broadly with left insula.

If we consider the LORETA images which are in accordance to the time segments, then very precise information could be achieved as how the different tasks and various activities in different regions of brain changed over the specific time period to the emotional stimuli category.

Disgust was seen in the left ventral anterior cingulated where we saw an increase of activity after about 250 msec. When it comes to the emotion happiness, it showed an opposite pattern. There were two activation states: the early one and the late one. The early activation was in the right PFC and the late one in the left PFC and the temporal areas.The pattern of fear was almost similar to the pattern of disgust, even though there was not a clear frontal processing in the late segment just like the disgust.

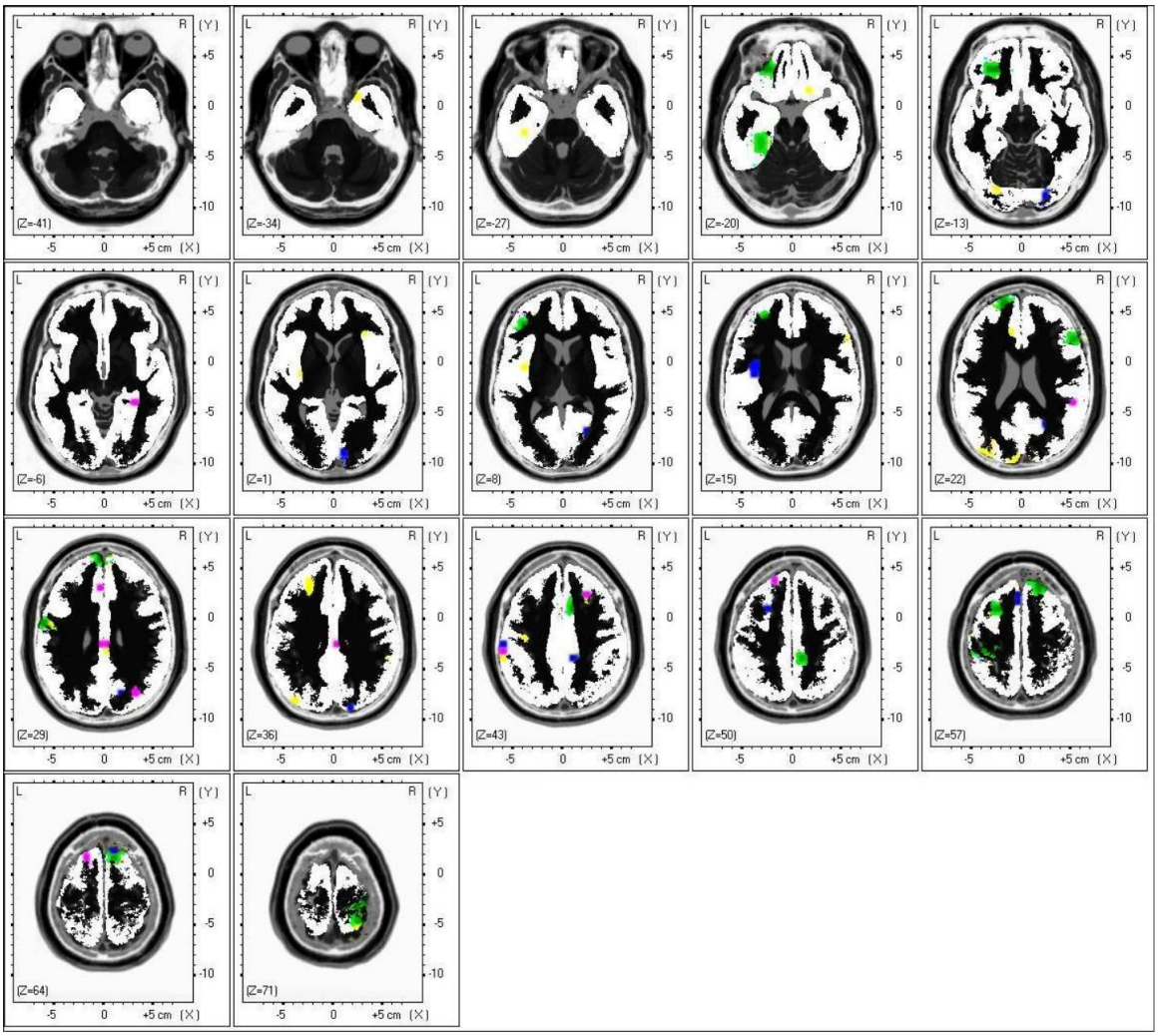

Fig. 3: *Slices of the Brain Area Activated in the Different Condition: Disgust(Green), Happiness(Yellow), Fear(Pink), Sadness(Blue).*

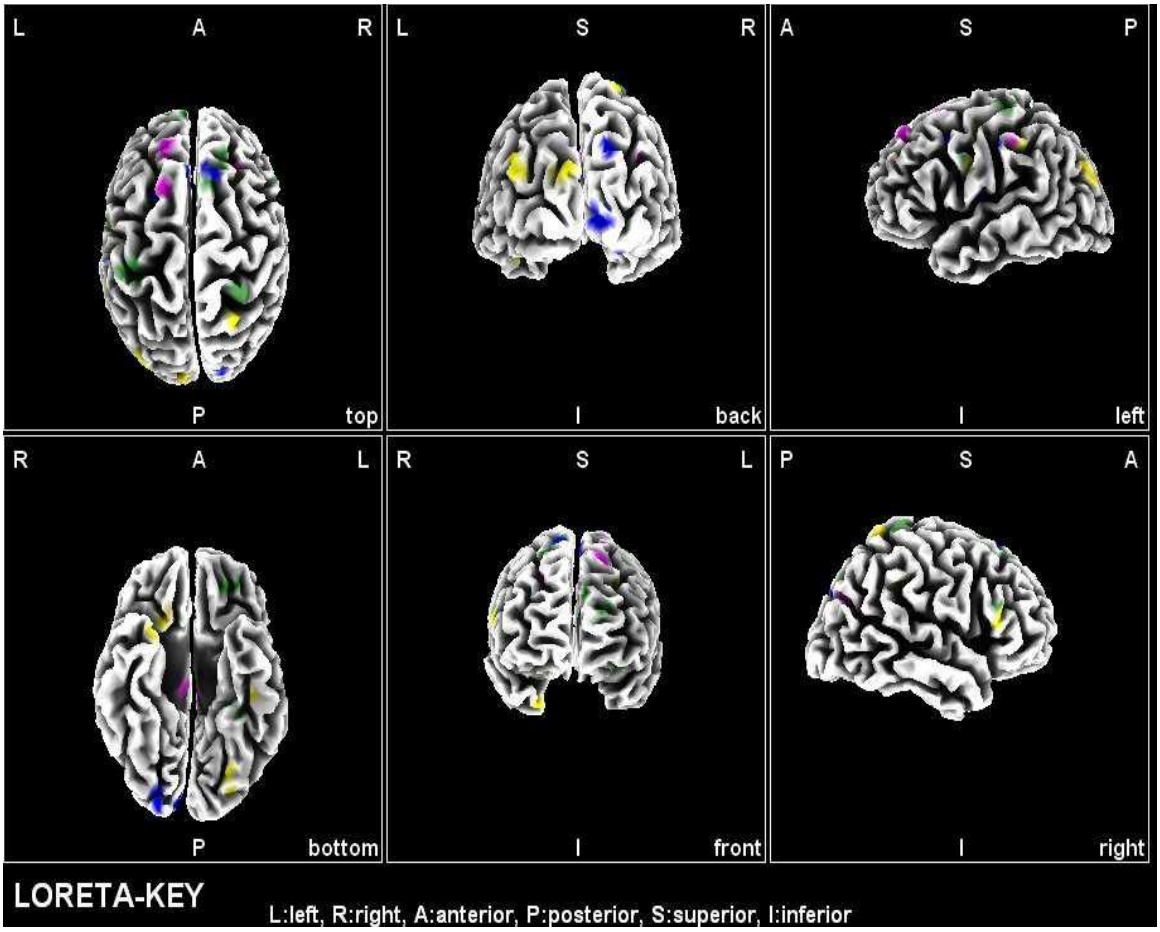

Fig. 4: *Ortoview of the Brain Area Activated in the Different Conditions: Disgust(Green), Happiness(Yellow), Fear(Pink), Sadness(Blue).*

CONCLUSION

Our investigation and findings validate the relationship and hypothesis of a distinct neural circuitry and time behaviour, at least for the different emotions we used. However, the results obtained must be considered as explorative because of the limited number of electrodes in the E-Motive which was not able to take reading as precisely as it could have done if the electrodes numbers were more for a potential source imprecision.

Esslen and colleagues did the findings on the same and our results are in conformity with them which actually legitimise the LORETA for low resolution localization. However, few differences were seen here. Well, if we consider the whole-time span for the response of the neural which were synchronised with the observation of the stimuli, we saw that some of the regions of the brain were in multiple shares. Every emotion was sharing some of the parts or areas of the brain. At present, the study reveals a large bilateral involvement of PFC for all emotions in accordance to the findings of Esslen *et al.* (2004).

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