Analysing Brain Responses to Affective Pictures from Electroencephalogram (EEG) (Two-page summary)

Background and Purpose of Research

This project investigates the relationship between emotion and scalp brain activity using electroencephalography (EEG). This is done by analysing brain signals when subjects view pictures which elicit varying degrees of valence (positive/approach or negative/withdrawal) and arousal (calm or excited). Emotionally evocative pictures from the International Affective Picture System (IAPS) database, a reliable elicitor of emotional experience were used for the study. Being able to use affective information enables applications to respond more aptly to the user e.g. offer help when user is experiencing stress. This would enable machines to better satisfy human needs. This research can also help in the marketing industry to improve the visual appeal of products by detecting viewer preference through processing of brain signals.

Two-dimensional Scale of Emotion

Emotions can be mapped in Lang's two-dimensional scale of emotion, according to their valence (positive/approach versus negative/withdrawal), and arousal (calm versus excited) For instance, fear is categorised under low valence and high arousal and contentment is classified under high valence and low arousal.

Emotions and the Brain

Much research has been done on vocal and facial expression. However, these expressions can be concealed, so an alternative source of affective information less reliant on overt expression is physiological responses such as cardiovascular response or electrodermal activity. One type of physiological response is neural activity. Since the brain is the central processor of stimuli, memories and thoughts, detecting emotions from the brain is a direct method of assessing emotion.

Electroencephalography (EEG)

Electroencephalography is a medical technique that reads electrical activity generated by brain structures. When neurons are activated, local current flows are produced. Electrical activity from the brain known as electroencephalogram (EEG) can be measured by placing metal electrodes on the scalp and then plotting voltage over time in different channels (regions of the brain).

Brain waves and bands

Brain waves are categorized into frequency bands – delta (0.5-4 Hz), theta (4-8 Hz), alpha (9-12 Hz), beta (12-35 Hz) and gamma bands (40-70 Hz). This study will focus only on analysis of theta, alpha and beta bands. Alpha waves are typical for an alert, but relaxed mental state. Beta activity is related to an active state of mind, prominent during intense focused mental activity. Theta is dominant during sleep and in deep meditation. Dominance of certain power bands or certain features at certain cortical regions can be observed during different states of valence and arousal.

Aim of experiment

This experiment aims to verify correlations between brain activity and states of valence and arousal found in other studies. This is done by computing the value of features such as frontal alpha asymmetry, midline theta power or beta-alpha ratio and then comparing it to the valence/arousal state of the subject.

Method

A program was designed and developed to display pictures to the subjects. The program also communicates with an EEG Amplifier and software to send commands e.g. when to start and stop recording EEG. One experiment was conducted in trials whereby subjects view and rate one picture per trial. After viewing, they are asked to rate their emotional state using the SAM pictorial assessment technique which evaluates valence and arousal.

Data Analysis

Pictures were categorised either based on ratings provided by subjects themselves or the official IAPS documentation. Signals were filtered based on frequencies (alpha or beta or theta). Features such as power of the signals, alpha asymmetry indices, and beta-alpha ratio were computed. Average values of these features were taken for each category and the trend is found by comparing these average values.

Conclusion

The results were similar to those found in neuroscience studies where it was observed that midline theta power increased with increasing valence, asymmetry indices increased with increasing valence and beta-alpha ratio increased with increasing arousal.