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Distinguishing Cognitive Tasks Using Statistical Analysis Techniques

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***Abtract**: EEG signals can be used to solve many real life problems. But it would only be possible if the EEG signals corresponding to different cognitive tasks could be distinguished from one another. Here, Statistical analysis techniques are used to distinguish these cognitive tasks recorded in the form of EEG signals. The results show that there lies significance difference among EEG signals corresponding to different cognitive tasks performed.*
***Keywords**: EEG, Intelligence, Psychometric Tests, Statistical Techniques, Kruskal-Wallis Test.*

I. Introduction

Measurement of human intelligence level has always been a difficult task for analysts. Different psychometric tests have been developed and are commonly used the testing human intelligence level. But performance in the theoretical tests is affected by various extraneous factors. This paper discusses a novel technique of measurement of intelligence level which can be used as a substitute for traditional methods. Brain activity related to different cognitive tasks can be recorded with the help of electroencephalogram and analyzed to simplify the task of judgment when measuring intelligence level of human beings.

II. Literature Review

2.1 PSYCHOMERTRIC TESTS: Psychometric tests are a standard and scientific method used to measure individuals' cognitive capabilities. Psychometric tests are designed to measure candidates' suitability for a role based on the required personality characteristics and aptitude. Different psychometric which are used to quotient human intelligence include personality tests, aptitude tests, verbal reasoning tests, numerical reasoning tests, abstract reasoning tests and mechanical reasoning tests etc [2].

2.2 ELECTROENCEPHALOGRAM: The recording of the brain's spontaneous electrical activity produced by the firing of neurons within the brain over a short period of time is called Electroencephalography (EEG). It is a spontaneous bioelectricity activity that is produced by the central nervous system. EEG amplitude is about 100 μV, when measured on the scalp, and about 1-2 mV when measured on the surface of the brain. The bandwidth of signal is from under 1 Hz to about 50 Hz [1][5][13]. There are five major brain waves distinguished by their different frequency ranges as shown in fig 1.. These frequency bands from low to high frequencies respectively are called delta (δ), theta (θ), alpha (α), beta (β), and gamma (γ). The range of delta wave is 0.5-4 Hz. These waves are primarily associated with deep sleep and may be present in the waking state. The range of theta wave are 3.5-7.5 Hz. Theta waves have been and are associated with access to unconscious material, deep meditation and creative. The range of alpha wave are 8-13 Hz and are been thought to indicate both a relaxed awareness without any attention or concentration. A beta wave (β) is the electrical activity of the brain varying within the range of 14-26 Hz and is associated with active thinking, active attention, focus on the outside world, or solving concrete problems. The frequencies above 30 Hz correspond to the gamma (γ) range and are also called the fast beta wave and are associated with solving typical problems requiring more attention as compared to beta waves[6].

The brain is divided into four different lobes that are frontal lobe, parietal lobe, occipital lobe, temporal lobe. Frontal lobe is involved in movement, decision-making, and problem solving and planning. There are three main divisions of the frontal lobes. They are the prefrontal cortex, the premotor area and the motor area. The prefrontal cortex is responsible for personality expression and the planning of complex cognitive behaviors[9]. The premotor and motor areas of the frontal lobes contain nerves that control the execution of voluntary muscle movement. The frontal lobes are involved in several functions of the body which include Motor Functions, higher order function, planning, reasoning, judgment, impulse control and memory[8].

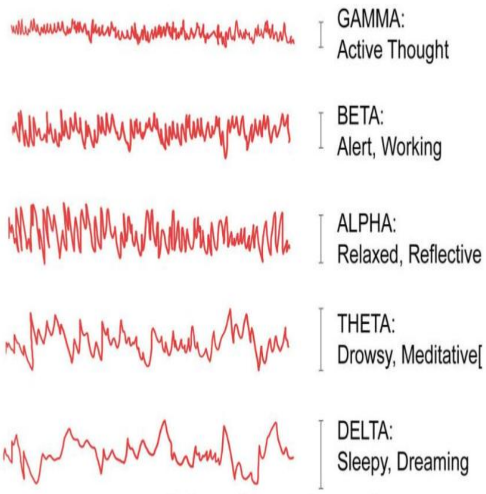

Fig1: EEG Spectrum (δ, θ, α, β, γ) [2].

2.3 STASTISTICAL TECHNIQUES: It is the study of the collection, organization, analysis, interpretation, and presentation of data. The data can be subjected to statistical analysis, serving two related purposes: description and inference.

2.3.1 Descriptive Statistics summarize the population data by describing what was observed in the sample numerically or graphically. Numerical descriptors incluludes mean and standard deviation for continos data types (like heights or weights), while frequency and percentage are more useful in terms of describing categorical data (like race) [10].

2.3.2 Inferential Statistics uses patterns in the sample data to draw inferences about the population represented, accounting for randomness. These inferences may take the form of answering yes/no questions about the data (hypothesis testing) estimating numerical characteristics of the data (estimation) describing association within the data (correlation) and modeling relationships within the data (for example, using regression analysis) Inference can extend to forecasting, prediction and estimation of unobserved values either in or associated with the population being studied; it can include extrapolation and interpolation of time series or spatial data, and can also include data mining[10].

2.4 KRUSKAL –WALLIS TEST: Kruskal–Wallis one-way analysis of variance is a non-paramertic method for testing whether samples originate from the same distribution. It is used for comparing more than two samples that are independent, or not related. The parametric equivalent of the Kruskal-Wallis test is the one-way analysis of variance (ANOVA). When the Kruskal-Wallis test leads to significant results, then at least one of the samples is different from the other samples. The test does not identify where the differences occur or how many differences actually occur. Since it is a non-parametric method, the test does assume an identically shaped and scaled distribution for each group, except for any difference in medians. It is also used when the examined groups are of unequal size [11][12].

III. Methodology:

A total of 3 students (1 male and 2 female) with a mean age of 23.1(SD 0.42) have been taken for the recording of EEG activity while solving tests papers on three subjects mathematics, physics and chemistry[9]. Recording were taken in accordance with the international 10-20 system as shown in fig 2. using RMS-32 polysomonographic machine and data has been analysed through Analysis & acquire software of SuperSpec software package. The signals from 8 channels have been considered for analyses which includes F8-F4,F4-FZ,FZ-F3,F3-F7,T4-C4,C4-CZ,CZ-C3, and C3-T3 of montage as shown in fig 3 [4][7]. The digitized values are obtained by applying FFT. Then the digitized data is analysed using non parametric statistical analysis technique named kruskalwallis test.

IV. Results And Discussions

The table1 shows the results of analysis EEG signals corresponding to different cognitive tasks[3]. The probability value comes out to be zero which shows that there is significant difference in the three cognitive

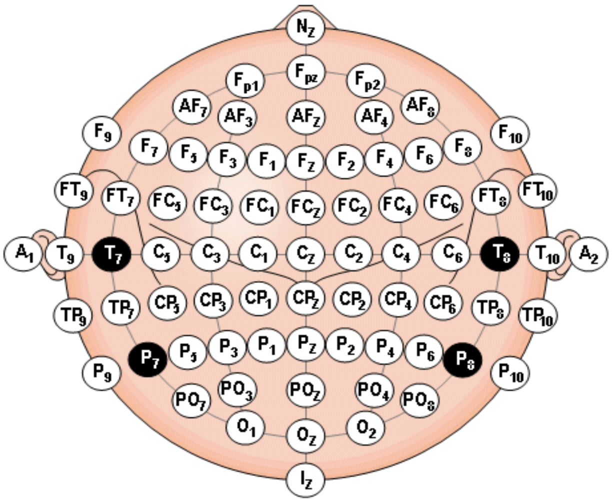

Fig 2 : International 10-20 Electrode Placement Systems[14]

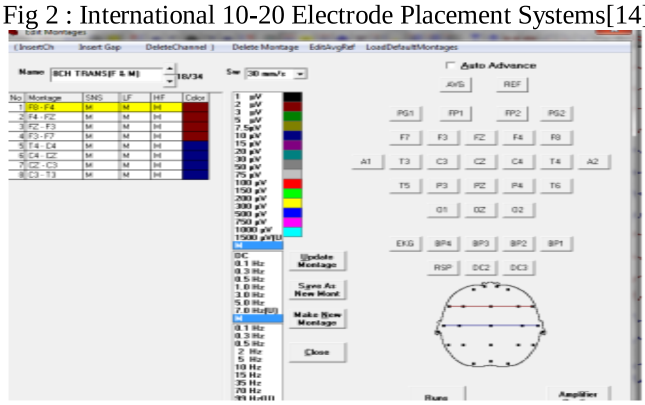

Fig 3: Montage used during data acquisition.

tasks performed. Fig 4 shows the Kruskalwallis Anova table and fig5 shows the box plot of the result.

Table1 : Kruskal-wallis Anova table

Kruskal-Wallis ANOVA Table

Source	SS	df	MS	Chi-sq	Prob>Chi-sq
Columns	1.08772e+009	2	543858814.3	1581.86	0
Error	9.08437e+008	2901	313146.3		
Total	1.99616e+009	2903			

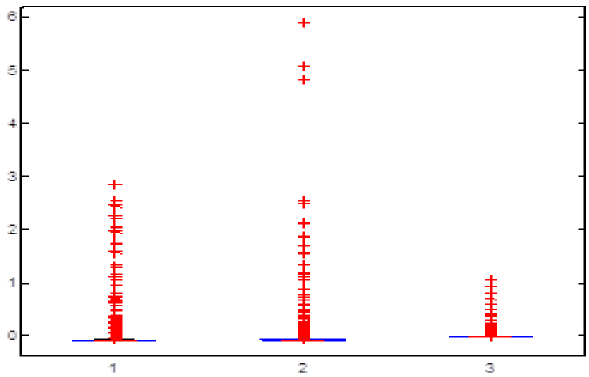

Fig 4: Box plot of Kruskalwallis analysis

.Refrences

[1] Aruna Tyagi,Manoj Duhan and Dinesh Bhatia, " Effect of mobile phone radition on brain activity gvm vs cdma" (IJSTM Vol. 2, Issue 1, April 2011

[2] M. Teplan "Fundamental of EEG measurement" Measurement science review, Volume 2, Section 2, 2002

[3] Wolfgang Klimesch "EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis" I Brain Research Review, 1999, 169–195.

[4] D posthuma, M.C.Neale, D.I. Boomsma, and E.J.C. Geus. "Are smarter Brains running faster? Heritability of Alpha Peak frequency IQ, and their correlation", Journal of Behavior Genetics, Nov 2001,Vol.31, No.6.

[5] Ricardo Vigário*, Jaakko Särelä, Veikko Jousmäki, Matti Hämäläinen, and Erkki Oja "Independent Component Approach to the Analysis of EEG and MEG Recordings" IEEE transaction on biomedical engineering , vol. 47, No. 5, May 2000 ,589

[6] Shah Aqueel Ahmed1, D. Elizabath Rani and Syed Abdul Sattar1,"Alpha Activity in EEG and Intelligence" (IJAIT) Vol. 2, No.1, February 2012

[7] Tien-Wen Lee ,Yu-Te Wu , Younger W.-Y. Yu , Hung-Chi Wu, Tai-Jui Chen" A smarter brain is associated with stronger neural interaction in healthy young females: A resting EEG coherence study", Intelligence, 40(2012),38-48.

[8] Xingyuan Wang, Juan Meng, Guilin Tan and Lixian Zou,"Research on the relation of EEG signal chaos characteristics with high-level intelligence activity of human brain", Nonlinear Biomedical Physics 2010, 4(2).

[9] Tongran Liu, Jiannong Shi, Daheng Zhao4, Jie Yang"The relationship between EEG band power, cognitive processing and intelligence in school-age children" ,Psychology Science Quarterly, 2008, 50(2), pp. 259-268.

[10] Zipora Libman "Integrating Real-Life Data Analysis in Teaching Descriptive Statistics: A Constructivist Approach" Journal of Statistics Education Volume 18, Number 1 (2010)

[11] Gibbons, J. D. Nonparametric Statistical Inference. New York: Marcel Dekker, 1985,

[12] Hollander, M., and D. A. Wolfe. Nonparametric Statistical Methods. Hoboken, NJ: John Wiley & Sons, Inc., 1999.

[13] Wikipedia.[online] available at: en.wikipedia.org/wiki/ Electroencephalogram [14].[Online]Available:mildpdf.com/result standard-international-10-20-electrode- placement-pdf.html