

Learners' Learning Style correlated to Agreeableness based on EEG

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Abstract. Students' Learning Style (LS) had been acknowledged as one of the prominent domain in the educational discipline. On the other hand, Agreeableness is an important personality trait which could reflect a learners' well-being. In this research, the participants' LS and Agreeableness were investigated using Kolb's Learning Style Inventory (KLSI) and Electroencephalogram (EEG) respectively. First, the participants' (N=41) LS were clustered using SPSS Cluster analysis approach which grouped them into the Diverger, Assimilator, Converger or Accommodator style of learning. Afterwards, their brainwaves were recorded whereby the Beta band is selected to find the significant correlation between LS and Agreeableness. The finding shows Assimilator is the LS that correlated to Agreeableness.

Keywords: Learning Style, EEG, Agreeableness, Clustering

1. Introduction

Learning Style (LS) is one of the important concepts which had brought a distinct perception into learning. LS refer to the general idea that individual diverse in regard to their customary approach to perceiving and processing information [1]. LS also linked to the process whereby a person acquiring knowledge or skills by interpreting and holding information [2]. Educational study had shown that learning quality could be raised when the instructional process accommodates the particular students' learning styles [3]. Furthermore, it has been confirmed that a learner inclination towards learning style will commit an impact to their academic performance. As such, the significant of LS had been broadly admitted in which a number of researches had been deployed resulted in diversity of definitions, theoretical positions, model, interpretations and measurement of the construct [4]. Beside LS, educational research also looked into Students' Personality Traits. This domain had given a relevant focus on the student well-being which ultimately influences their learning behaviour and academic achievement [5]. In order to probe the traits, The Big Five framework of personality traits (FFM) by Costa & McCrae [6] has emerged as a robust model for understanding the relationship between personality and various academic behaviours [7]. In FFM, the five personality traits were encompasses of extraversion, agreeableness, conscientiousness, neuroticism and openness to experience [8]. The trait, Agreeableness had been encountered to be correlated with LS [5] and also significantly affect student's academic performance [9]. Agreeableness refers to such traits as selflessness and sympathetic. Students with this trait learned most relevant in situations in which group projects, teamwork, and collaborative learning were applied [10]. The emergence of neuroscience method such as Electroencephalogram (EEG) had been instrumental in the advancement of "Personality Neuroscience" research which focusing to understand the biological basis of the personality traits such as Agreeableness [11]. It has been found that Agreeableness was moderately and negatively correlated with the EEG beta band [12].

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2. Methodologies

2.1. Learning Style classification using KLSI

The Kolb concept of LS chosen for this research is based on a model of experiential learning. Kolb proposed that learning consists of four interdependent constructs: (1) Concrete experience, (2) Reflective observation, (3) Abstract conceptualization and (4) Active experimentation. Kolb identifies 4 unique learning styles that emerged from the combination of the constructs which are: Diverger (CE and RO), Assimilator (RO and AC), Converger (AC and AE) and Accommodator (AE and CE) [1]. The KLSI had undergone extensive research since 1969 when the LSI was first created. It is a brief 12 item self-scoring instrument on which the result could tally to the four different learning styles mentioned above [13]. In this research Google Docs platform was used to deploy the Kolb's LSI. Consequently, the participants' response is processed and calculated using spreadsheet applications.

2.2. EEG Recordings

The process of EEG data acquisition was conducted by using EEG instrument (MindPeak's WaveRider). EEG was recorded with the following setting: 0.15 – 40 Hz band range and sampling frequency of 128 Hz. Ag/AgCl electrodes with impedance less than 5 k Ω were placed at two frontal locations (Fp1 and Fp2) according to the standard International 10-20 system. The left earlobe was used as reference. The recorded brain signals were filtered and processed using dedicated software (WaveWare version 2.5). The bands' Energy Spectrum Density (ESD) value was obtained off-lined using MATLAB ver. R2009. Each participant had been put through two sessions of 5 minutes (300 seconds) experiment where they were placed into resting condition of Open eyes [14]. In this research, the specific EEG Beta band was selected based on the Literature Review. Beta band will be analyzed for the determination of Agreeableness bound LS [12].

2.3. Statistical Analysis

A statistical program, 2Step Cluster Analysis of SPSS 17 was used to classify the LS towards the specific EEG Beta band dataset. In the test, LS was set as the categorical variables while the EEG bands ESD value was fixed as continuous variable [15]. The number of cluster index was automatically specified by the application. The Log-likelihood algorithm was used as the distance measure while the Schwarz's Bayesian (BIC) adopted as the Clustering criterion.

3. Results and Discussion

3.1. Learning Style classification using KLSI

Table I shows the participants' LS classification after answering the Kolb's LSI questionnaire. Each LS was almost equally represented where Assimilator was demonstrated as a dominant LS with 12 counts, followed by Diverger (11 counts), Accommodator (10 counts) and the least was Converger with 8 counts.

Table I Participants' Classification of LS using KLSI

LS	COUNT
Diverger	11
Assimilator	12
Converger	8
Accommodator	10

3.2. EEG analysis of Beta Band and LS clustering

The EEG analysis of Beta band had been carried based on the literature which correlated the band negatively with Agreeableness [12]. On top of that, The LS clustering was conducted to determine the corresponding LS.

3.2.1. Beta Left Open Eyes

Table II LS Clustering based on Beta Left in open eyes condition

Learning Style								
Cluster	Diverger		Assimilator		Converger		Accommodator	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	11	100.0%	0	.0%	0	.0%	0	.0%
2	0	.0%	0	.0%	8	100.0%	0	.0%
3	0	.0%	0	.0%	0	.0%	10	100.0%
4	0	.0%	12	100.0%	0	.0%	0	.0%
Combined	11	100.0%	12	100.0%	8	100.0%	10	100.0%

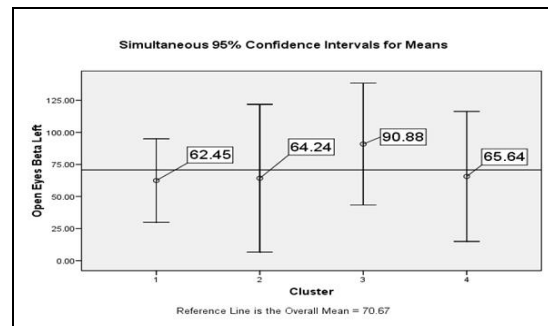


Fig. 1: Beta Left open eyes means comparison

Table II shows the clustering of LS for Beta band at left channel in open eyes condition. 100% clustering had been achieved which demonstrate Diverger grouped in Cluster 1, Assimilator in Cluster 4, Converger in Cluster 2 and Accommodator in Cluster 3. Fig. 1 shows the corresponding means value for each cluster and it had been ascertained that Cluster 1 had the lowest mean of 62.45. The result established that Diverger is related to Agreeableness.

3.2.2. Beta Right Open Eyes

Table III LS Clustering based on Beta Right in open eyes condition

Learning Style								
Cluster	Diverger		Assimilator		Converger		Accommodator	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	11	100.0%	0	.0%	0	.0%	0	.0%
2	0	.0%	0	.0%	0	.0%	10	100.0%
3	0	.0%	12	100.0%	0	.0%	0	.0%
4	0	.0%	0	.0%	8	100.0%	0	.0%
Combined	11	100.0%	12	100.0%	8	100.0%	10	100.0%

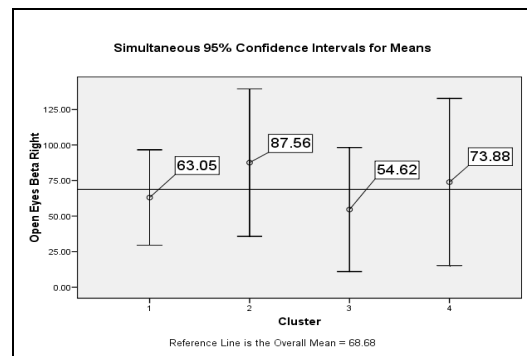


Fig. 2 : Beta Right open eyes means comparison

Table III shows the clustering of LS for Beta band at right channel in open eyes condition. 100% clustering had been achieved which demonstrate Diverger grouped in Cluster 1, Assimilator in Cluster 3, Converger in Cluster 4 and Accommodator in Cluster 2. Fig. 2 shows the corresponding means value for each cluster and it had been ascertained that Cluster 3 had the lowest mean of 54.62. Hence, the result established that Assimilator is related to Agreeableness.

3.2.3. Beta Left Closed Eyes

Table IV LS Clustering based on Beta Left in closed eyes condition

Learning Style								
Cluster	Diverger		Assimilator		Converger		Accommodator	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	0	.0%	0	.0%	0	.0%	10	100.0%
2	0	.0%	0	.0%	8	100.0%	0	.0%
3	11	100.0%	0	.0%	0	.0%	0	.0%
4	0	.0%	12	100.0%	0	.0%	0	.0%
Combined	11	100.0%	12	100.0%	8	100.0%	10	100.0%

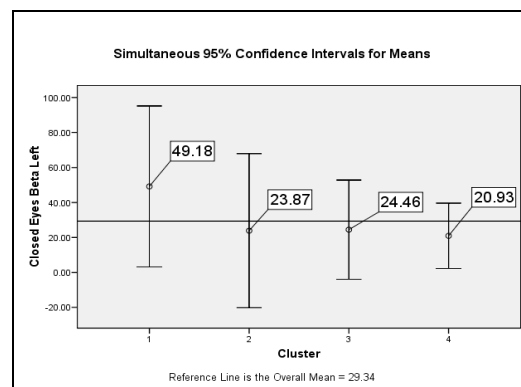


Fig. 3: Beta Left closed eyes means comparison

Table IV shows the clustering of LS for Beta band at left channel in closed eyes condition. 100% clustering had been achieved which demonstrate Diverger grouped in Cluster 3, Assimilator in Cluster 4, Converger in Cluster 2 and Accommodator in Cluster 1. Fig. 3 shows the corresponding means value for each cluster and it had been ascertained that Cluster 4 had the lowest mean of 20.93. The result established that Assimilator is related to Agreeableness.

3.2.4. Beta Right Closed Eyes

Table V LS Clustering based on Beta Right in closed eyes condition

		Learning Style							
		Diverger		Assimilator		Converger		Accommodator	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cluster	1	11	100.0%	0	.0%	0	.0%	0	.0%
	2	0	.0%	0	.0%	0	.0%	10	100.0%
	3	0	.0%	11	91.7%	0	.0%	0	.0%
	4	0	.0%	1	8.3%	8	100.0%	0	.0%
	Combined	11	100.0%	12	100.0%	8	100.0%	10	100.0%

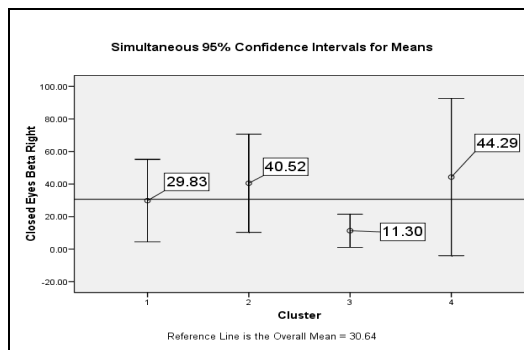


Fig. 4: Beta Right closed eyes means comparison

Table V shows the clustering of LS for Beta band at right channel in closed eyes condition. 100% clustering had been achieved except for LS Assimilator. In this clustering exercise Diverger is grouped in Cluster 1, Assimilator in Cluster 3(91.7%) and 4(8.3%), Converger in Cluster 4 and Accommodator in Cluster 2. Fig. 4 shows the corresponding means value for each cluster and it had been ascertained that Cluster 3 had the lowest mean of 11.30. The result established that Assimilator is related to Agreeableness.

4. Conclusions

In this research, the EEG Beta band was selected to relate the LS with personality traits of Agreeableness. Apart from that, the participants' learning style of Diverger, Assimilator, Converger and Accommodator had been clustered using the same EEG band mentioned. 100% classification had been achieved for all the clustering process except for one case of Beta right closed eyes. By comparing means of each cluster a particular LS which correlated to Agreeableness was determined. Table VI shows the summary of the result obtained from the research.

Table VI Results Summary

#	EEG bands	LS	Cluster %
1	Beta left open eyes	Diverger	100
2	Beta right open eyes	Assimilator	100
3	Beta left closed eyes	Assimilator	100
4	Beta right closed eyes	Assimilator	91.7

In conclusion, Assimilator is found to be correlated to Agreeableness in most cases. This finding will allow the educators to treat their learners who are related to both entities according to the best teaching strategies, either pedagogically or content-wise.

5. References

- [1] D.A. Kolb, *Experiential Learning*, Englewood Cliffs, Prentice Hall, N.J., 1984.
- [2] B. A. Adesunloye, O. Aladesanmi, M. Henriques-Forsythe, C. Ivonye. The Preferred Learning Style among Residents and Faculty Members of an Internal Medicine Residency Program. *Journal of The National Medical Association*, 2008, 100 : 172-175.
- [3] K. Buch and S. Bartley. Learning style and training delivery mode preference. *Journal of Workplace Learning*, 2002, 14 : 5-10.

- [4] S. Cassiday, S and P. Eachus. Learning style, academic belief systems, self report student proficiency and academic achievement in higher education. *Educational Psychology*, 2000, 20 : 307-322.
- [5] M. Komarraju, S. J. Karau, R. R. Schmeck and A. Avdic. The Big Five personality traits, learning styles, and academic achievement. *Personality and Individual Differences*, 2011, 51: 472-477.
- [6] R. R. McCrae and P. T. Costa Jr. Brief versions of the NEO-PI-3. *Journal of Individual Differences*, 2007, 28 : 116.
- [7] A. E. Poropat. A meta-analysis of the five-factor model of personality and academic performance. *Psycho Bull*, 2009, 135 : 322.
- [8] R. R. McCrae and O. P. John. An introduction to the five factor model and its applications. *Journal of Personality*, 1992, 60 : 175-215.
- [9] N. Nguyen, L. C. Allen, and K. Fraccastoro. Personality predicts academic performance: Exploring the moderating role of gender. *Journal of Higher Education Policy and Management*, 2005, 27 : 105-117.
- [10] M. S. Chowdhury and M. N. Amin. Personality and students academic achievement: interactive effects of conscientiousness and agreeableness on students performance in principles of economics. *Social Behavior and Personality: an international journal*, 2006, 34 : 381-388.
- [11] C. G. DeYoung. Personality Neuroscience and the Biology of Traits. *Social and Personality Psychology Compass*, 2010, 4 : 1165-1180.
- [12] C. Stough, C. Donaldson, B. Scarlata, and J. Ciorciari. Psychophysiological correlates of the NEO PI-R Openness, Agreeableness and Conscientiousness: preliminary results. *International Journal of Psychophysiology*, 2001, 41 : 87-91.
- [13] A.Y. Kolb and D. A. Kolb, *The Kolb Style Inventory-Version 3.1 Technical Specification*, Hay Resources Direct, Boston, USA, 2005.
- [14] R. J. Barry, A.R. Clarke, S.J. Johnstone et. al. EEG differences between eyes-closed and eyes-open resting conditions. *Clinical Neurophysiology*, 2007, 118 : 2765–2773.
- [15] N. Abdul Rashid, M.N. Mohd. Taib, S. Lias, N. Sulaiman. Classification of Learning Style based on Kolb's Learning Style Inventory and EEG using Cluster Analysis approach. *2nd International Conference in Engineering Education, Kuala Lumpur, Malaysia*, 2010.