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Amplitude and Latency of P300 Component from Auditory Stimulus in Different Types of Personality: An Event Related Potential Study

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***Abstract*—**The P300 from Event related potential (ERP) explains the psycho-physiological phenomenon in human body. The present study aims to identify the differences of amplitude and latency of P300 component from auditory stimuli, between ambiversion and extraversion types of personality. Ambivert (N=20) and extravert (N=20) undergoing ERP recording at the Hospital Universiti Sains Malaysia (HUSM) laboratory. Electroencephalogram data was recorded with oddball paradigm, counting auditory standard and target tones, from nine electrode sites (Fz, Cz, Pz, T3, T4, T5, T6, P3 and P4) by using the 128 HydroCel Geodesic Sensor Net. The P300 latency of the target tones at all electrodes were insignificant. Similarly, the P300 latency of the standard tones were also insignificant except at Fz and T3 electrode. Likewise, the P300 amplitude of the target and standard tone in all electrode sites were insignificant. Extravert and ambivert indicate similar characteristic in cognition processing from auditory task.

***Keywords*—**Amplitude, Event Related Potential, P300 Component, Latency

I. Introduction

PERSONALITY tells many things on characteristics of people and provides benefits in many ways especially for the therapist or counselor to get to know their patient better and planning for intervention. In addition, personality plays a role in determining a person's action or emotion when faced with everyday life event whether pleasant or stressful.

In [1], personality is said to be made up of three important parts: traits, characteristic adaptations and life stories. Meanwhile, it is also suggested that personality is developed through four main sectors – cognitive, conative, affective and somatic [2]. One quote even mentioned [3]:

> *"There is a growing consensus about the validity of human personality traits as important dispositions toward feelings and behaviors."*

A type of one's personality has been correlated to many other factors such as academics, health problems, employment, social life and even cognitive performance [4]-[6]. Formerly, personality is categorized into three parts which are emotional stability/instability (later known as neuroticism), extraversion/introversion and psychoticism (aggressiveness/ antisocial) [7]. Then, [8] proposed a new theory for personalities which are now commonly applied by researchers called the Big Five personalities trait. These are Openness to experience, Conscientiousness, Extraversion, Agreeableness and Neuroticism. These five personalities are discovered when researchers founded five recurrent factors in analyzing personality ratings in eight different samples from their study [9].

Contradict to introvert, extraversion refers to the tendency toward interpersonal interaction, activism, the need for happiness, and the capacity for joy [10]. Ambiverts are categorised as people who are neither introverts nor extraverts, but are in the middle between the two extremes [11]. It was shown that the risk of cognitive impairments was lower in the ambivert group compared to introvert group or those with high extraversion level [12].

Event related potential (ERP) is a method used in neuroscience to explain neural mechanism associated with human emotion and attention, as well as the neural process of decision making [13]. In ERP, the P300 is among an important component that able to describe or explain the psycho-physiological phenomenon in human body, and it is consistently related to attention, decision making and memory updating [14]. Thus, in this study, we hypothesize that there is some difference in cognitive processing between different type of personality (i.e. ambiversion versus extraversion), as indicated by the P300 component of ERP.

II. Methodology

A. Participants

Forty undergraduate medical students of Universiti Sains Malaysia were recruited as participants. The participants were grouped into two – ambivert (N=20) and extravert (N=20), based on the score obtained by using personality inventory [15]. A score of 17-32 was considered ambiversion and a score of 33 and above was regarded extraversion [15]. This study has been approved by the Human Ethical Committee of Universiti Sains Malaysia [USM/PPSP/2013/JKP-65[65.3(4)]. Written informed consent was signed up upon agreement to participate in the study. Subjects were excluded from the study if they had hearing impairment, neurosurgical operations history, history of stroke and Other major diseases.

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B. ERP Procedure

This study was conducted at Event Related Potential/ Magnetoencephalography (ERP/MEG) laboratory of Hospital Universiti Sains Malaysia (HUSM), a sound attenuated room in order to minimize noise. The 128 HydroCel Geodesic Sensor Net was applied, positioned symmetrically on the head (Fig. 1), following the guidelines of standard electrode positions by the 10–20 International system of electrode placement. Auditory stimulus was passed binaurally through a conventional audiometric earphone from the Net station. The electroencephalogram (EEG) data was recorded from nine electrode sites (Fz, Cz, Pz, T3, T4, T5, T6, P3 and P4) scalp sites with Ag/AgCl electrodes placed on the sites. Oddball paradigm was applied in which subjects counted target tones (60 dB sound pressure level with high pitch at 2000 Hz) and at the same time ignored the standard tones (60 dB sound pressure level with low pitch at 1000 Hz). Tone duration was set up at 100ms with rise/fall time of 10ms and amplifiers with band pass of 0.3 to 30 Hz. Pre-analysis (i.e. filtering, segmentation, artifact detection, bad channel replacement, averaging, montage operation and baseline correction) was done after experiment session. Estimated duration time for ERPs recording was approximately 15 minutes. After pre-analysis, the ERP data was transferred to the Statistical Package for the Social Science version 22 for further analysis. Descriptive statistic (mean and standard deviation) and Independent T-test was used to explain the difference between groups. Significance level was set at 0.05.

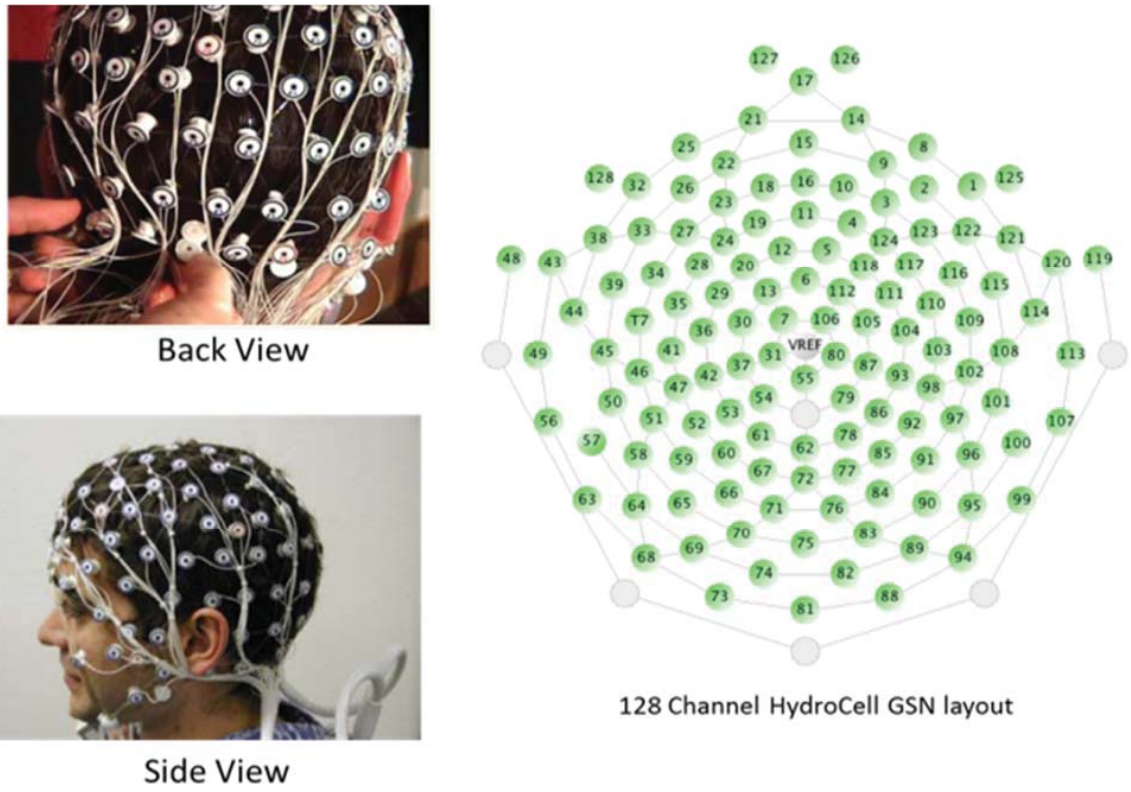

Fig. 1 128 HydroCel Geodesic Sensor Net

III. Result

A. Socio-Demographic Data

Out of forty respondents, ambivert comprised of twenty subjects, however, one respondent was excluded because the recording was too noisy (8 males and 11 females). Meanwhile, the extravert group comprised of twenty subjects (12 males and 8 females). The mean age and standard deviation of ambivert was 22.1±1.15 and extravert was 22.7±1.41. No significant of age difference was seen between the two groups (p=0.20). Mean and standard deviation of personality score in ambivert was 28.95±2.97 and in extravert was 38.45±3.87 (Table I)

TABLE I
Socio-Demographic Data

	Ambivert (n=19)	Extravert (n=20)
Sex (male/female)	8/11	12/8
Age (mean years±SD)	22.1±1.15	22.7±1.41
Personality (mean score±SD)	28.9±2.97	38.4±3.87
Handedness (right/left)	18/1	16/4
Race (Malay, Chinese, Indian)	8/8/3	9/9/2

B. P300 Latency

The mean latency of the target tone for the ambivert group was between 503.26 milisecond and 539.21 milisecond and for the standard tone was between 463 milisecond and 511 milisecond. For the extravert group, the mean latency for the

target tone was between 497.7 milisecond and 535.8 milisecond, and between 415.6 milisecond and 469.45 milisecond for the standard tone. The difference of P300 latency of target tone between extravert and ambivert was insignificant at all electrode sites - Fz (p=0.55), Cz (p=0.92), Pz (p=0.96), T3 (p=0.74), T4(p=0.55), T5 (p=0.36), T6 (p=0.53), P3 (p=0.56) and P4 (p=0.55) (Table II). For the standard tone, the difference of P300 latency between extravert and ambivert was significant at Fz (p=0.04) and T3 (p=0.05), however indicated insignificant result at Cz (p=0.14), Pz (p=0.11), T4 (p=0.21), T5 (p=0.36), T6 (p=0.32), P3 (p=0.06) and P4 (p=0.06) electrodes (Table III).

TABLE II
P300 LATENCY OF THE TARGET TONES

Electrode site	Ambivert (mean±SD)	Extravert (mean±SD)	*p*-value	Significance
Fz	539.2±76.7	515.6±139	0.55	NS
Cz	503.2±114	500.9±115	0.92	NS
Pz	513.7±123	520.6±124	0.96	NS
T3	537.0±90.3	525.1±110	0.74	NS
T4	513.2±73.7	497.7±136	0.55	NS
T5	508.2±93.5	535.8±112	0.36	NS
T6	509.6±90.7	533.9±134	0.53	NS
P3	506.8±105	531.8±98.4	0.56	NS
P4	513.1±111	533.6±123	0.55	NS

NS: Not significant; SD: Standard Deviation

TABLE III
P300 LATENCY OF THE STANDARD TONES

Electrode site	Ambivert (mean±SD)	Extravert (mean±SD)	*p*-value	Significance
Fz	511.0±67.0	468.7±109	0.04	S
Cz	463.0±109	415.6±119	0.14	NS
Pz	485.4±107	432.8±130	0.11	NS
T3	508.7±81.0	466.9±94.7	0.05	S
T4	496.1±81.9	462.7±99.8	0.21	NS
T5	492.2±102	469.1±116	0.36	NS
T6	493.2±77.7	469.4±104	0.32	NS
P3	504.4±97.4	465.5±111	0.06	NS
P4	506.5±80.6	462.1±120	0.06	NS

NS: Not significant; S: Significant; SD: Standard Deviation

C. P300 Amplitude

Mean amplitude for the target tone was between 3.08μV and 5.32μV in the ambivert group and 2.45μV to 5.9μV in the extravert group. For the standard tone, it was between 1.08μV to 3.30μV in the ambivert group and 0.88μV to 2.57μV in the extravert group. There was insignificant difference in the amplitude for the target tone between ambiverts group and extravert group at all electrodes Fz (P=0.46), Cz (P=0.64), Pz (P=0.24), T3 (P=0.30), T4 (P=0.38), T5 (P=0.38), T6 (P=0.36), P3 (P=0.35) and P4 (P=0.72) (Table IV). Similarly, there was an insignificant difference at all electrode sites for the standard tone between ambivert group and extravert group Fz (p=0.21), Cz (P=0.70), Pz (P=0.47), T3 (P=0.51), T4 (P=0.27), T5 (P=0.51), T6 (P=0.55), P3 (P=0.27), P4 (P=0.12) (Table V).

TABLE IV
P300 AMPLITUDE OF THE TARGET TONE

Electrode site	Ambivert (mean±SD)	Extravert (mean±SD)	*p*-value	Significance
Fz	5.32±2.53	5.97±3.41	0.46	NS
Cz	3.08±2.78	3.11±2.04	0.64	NS
Pz	4.87±2.60	5.87±2.60	0.24	NS
T3	3.32±2.76	3.63±1.75	0.30	NS
T4	3.26±3.03	2.45±1.92	0.38	NS
T5	4.42±2.94	4.46±1.66	0.38	NS
T6	4.05±2.23	3.55±2.56	0.36	NS
P3	3.64±2.00	4.37±2.01	0.35	NS
P4	3.46±1.73	3.71±1.97	0.72	NS

NS: Not significant; SD: Standard Deviation

TABLE V
P300 AMPLITUDE OF THE STANDARD TONE

Electrode Site	Ambivert (mean±SD)	Extravert (mean±SD)	*p*-value	Significance
Fz	3.30±1.57	2.57±1.49	0.21	NS
Cz	1.13±0.67	1.26±0.80	0.70	NS
Pz	1.71±1.35	1.91±1.15	0.47	NS
T3	2.01±1.10	1.76±1.14	0.51	NS
T4	2.28±1.27	1.69±1.03	0.27	NS
T5	2.10±1.61	1.78±1.14	0.51	NS
T6	2.38±1.43	2.01±1.08	0.55	NS
P3	1.08±0.62	0.88±0.58	0.27	NS
P4	1.80±0.77	1.42±0.77	0.12	NS

NS: Not significant; SD: Standard Deviation

IV. DISCUSSION

The present study aims to determine auditory cognitive function between extraversion and ambiversion types of personality by using auditory oddball paradigm of the event related potential. Findings of this study showed insignificantly larger P300 amplitude in the extravert group at Fz, Cz, Pz, T3, T5, P3 and P4, whereas ambivert group demonstrated larger amplitude at T4 and T6 for the target tone. Ambivert group showed insignificant larger amplitude for the standard tone at Fz, T3, T4, T5, T6, P3 and P4, while extravert group showed insignificant larger amplitude at Cz and Pz. Additionally, latency for the target tone appeared longer in ambivert group at electrodes Fz, Cz, T3 and T4, while extravert group showed longer latency at Pz, T5, T6, P3 and P4 electrodes. However, the difference was insignificant. For the standard tone, latency was longer in the ambiverts group at all electrode sites in comparison with extravert group, showing significance at Fz and T3 and insignificant at Cz, Pz, T4, T5, T6, P3 and P4 electrodes. It can be seen that the extravert group has larger amplitude, yet the difference is insignificant. In a related study to determine the relation between auditory P300 event related potential and major dimensions of personality, finding yielded a larger amplitude with a positive relation among extraversion, agreeableness, openness and conscientiousness trait, but the amplitude was negatively related to neuroticism. The study did not report statistically significant overall relationship between P300 latency and personality traits [16].

V. Conclusion

Extravert and ambivert indicate similar characteristic in cognition processing, as measured by the auditory task, presented in Event Related Potential. This finding might explains the nature of this type of personality. However, the weaknesess of the respondent selection should be taken into consideration. Future research is suggested to delve further the relation between neuro-cognition and personality, in different age group and population.

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