Association Between Personality Traits with Brain Waves of The Malaysian Military Special Forces Qualification Course Trainees: A Preliminary Study

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Decades of personality study has focused on the relationship between personality traits and individual differences. Recent interest has advanced in finding the connection between personality and brain waves, but the relationship between NEO-PI-R and its neuro mechanism has not been verified. Here we present a preliminary study to determine the reliability of the Malay version of NEO-PI-R (n=171) and to optimize the EEG data collection procedure (n=3) of the Malaysian Special Forces Qualification Course trainees, batch series AK1/2023. The reliability of NEO-PI-R inventory determined by Cronbach's alpha coefficient and optimization of EEG testing will ensure whether these methods are suitable to be used for the mainstream batch series AK2/2023. The pre-training Cronbach's alpha coefficient values for neuroticism, extraversion, openness, agreeableness, and conscientiousness were 0.823, 0.796, 0.504, 0.628, and 0.847 respectively. The reliability of the Malay version of NEO-PI-R is indicated as good and acceptable for all traits except for openness. The optimized EEG readings performed on 3 participants successfully produced reasonable data. These preliminary findings are crucial to produce reliable and verified data for the mainstream batch AK2/2023, in creating a psychological profile for each soldier from entry to the end of service in the military.

Keywords: personality traits, brain waves, military, and special forces qualification course.

In the 19th century, personality was regarded as a topic not compatible with the subject matter or the methods of the new scientific psychology. This was due to the

emergence of psychology as a science dominated by the experimental science (Schultz & Shultz 1998). Nevertheless, the rise of the unconscious mind study gave light to the importance of personality. Personality theorists were inspired by the works of Sigmund Freud where they established new conceptions of human nature away from the experimental psychology. Later in the 20th century, the study of personality was formalized by the American psychologists such as Henry Murray and Gordon Allport (Schultz & Schultz 1998). The five basic personality traits theory was first developed by D. W. Fiske in 1949. The theory was expanded in the 80's by theorists like McCrae & Costa (1987). To date, the big five personality traits theory was one of the most dominant theories used in personality research. Recently, psychophysiological techniques such as electroencephalography (EEG) have become one of the most preferred methods to study neurobiological processes underlying human mind and behaviour (Parera et al., 2021). Although studies in personality have advanced and gave insights to human behaviour, there is much about the brain mechanism that underlies a person's personality that is not yet known. The present paper will examine the idea by presenting current related literature and preliminary methods used to determine the association between personality traits and brain waves of the Malaysian Special Force's trainees.

Personality Traits and Neuroscience

The core personality traits of neuroticism, extraversion, openness, agreeableness, and conscientiousness reflects the characteristic pattern of thoughts, feelings, and behaviours in a person (Costa & McCrae 2008). These traits are consistent, stable, unique, and significantly determine a person's behaviour professionally and personally (Willie 2013). Neuroticism is characterized by the experience of various negative emotions, low tolerance for stress, and negatively associated with subjective well-being and psychological health. A person who scored low level of neuroticism is more likely to feel confident, and emotionally reactive. An extravert is inclined to search for novel experiences and social connections, while an introvert is quiet, introspective, quiet, and considerate. A person with high scores in openness to experience is classified as intellectually and creatively curious, while low scorers may prefer routine than diversity. A person with a high score in agreeableness tends to appreciate social harmony and less likely to be involved in criminal behaviour. On the other hand, those who are at the lower level of the spectrum of suitability are less likely to be reliable. A person classified as high conscientious reflects the tendency to have a strong spirit of duty, self-discipline, orderly and achievement. Low conscientious person is more likely to delay, rush and impulsive (Shuttleworth 2020).

The extraordinary variety of behaviours, summarized into the five major personality traits arise from different patterns of brain function and structure (McCrae & Costa 2008, Li 2020, Booth, 2014). Despite the advancement in the study of psychology, it is unclear on how personality and characteristics are represented by the brain. Personality psychology encourages a systematic approach to understand individual tendency in exhibiting difference patterns in behaviour, emotions, motivation, and cognition through the development of comprehensive taxonomic nature (McCrae & Costa 2008, Li 2020). Descriptive taxonomic is usually not associated with empirical data from neuroscience research despite deriving from regularity in the function of related brain system (DeYoung 2010). The practical assessment of individual personality depends primarily on self-reported scale. A series of the most reliable and valid scales are NEO Factor Inventory (NEO-FFI), Revised NEO Personality

Inventory (NEO-PI-R) (Costa & McCrae 2008) and Big Five Inventory (BFI) (Li 2020). Despite providing simple and reliable method of using questionnaires, it does not explain personality as stable patterns of behaviour, motivation, emotions, and cognition (DeYoung 2010, Markett 2018, Li 2020).

Recent advances in information technology suggested the potential for automatic assessment of individual personality. The principle of this approach is based on representation of personality traits with a definite daily life data collected by social media systems such as websites, mobile phones, and video cameras. However, this method is subjected to forgery due to self-reported scale. Neurophysiological data might be the promising alternative in developing an automatic personality assessment method. Compared to the former-mentioned behavioural methods, nerve-based methods are more objective and less likely for an individual to deliberately fake his or her nerve data. Neural-based methods can be performed using (i) magnetic resonance imaging (MRI) and (ii) electroencephalograph (EEG) (Li 2020).

(i) Personality Trait and Brain Structure

A human brain is divided into three main structures i.e., cerebrum, cerebellum, and brainstem. Cerebrum is the largest structure and generally associated with functions related to thoughts, movements, emotions, and motor functions. Cerebrum is divided into four lobes i.e., frontal, parietal, temporal, and occipital. The outermost layer of cerebrum consisted of neural tissues or cerebral cortex (Purves 2004). Frontal lobe contributed to a range of vital roles including personality, emotions, problem solving, motor development, reasoning, planning, parts of speech and movement. Parietal lobe is responsible for sensation, sensory comprehension, recognition, perception of stimuli, orientation, and movement. Occipital lobe is vital for visual processing, while temporal lobe is involved in dealing with the recognition of auditory stimuli, speech, perception, and memory (Siuly 2016). Cerebellum is responsible for motor control, sensory perception, and co-ordination, while brainstem (midbrain, pons, and medulla oblongata) controls vital functions including breathing, consciousness, movements of eyes and mouth, and relaying of sensory messages, heartbeat, blood pressure and hunger (Siuly 2016).

The potential association between each of the five major personality traits with variability in cortical anatomy such as cortical thickness, surface area and folding were supported by MRI results obtained from young and healthy white Americans with a non-Hispanic or Latinos background. Neuroticism was associated with thicker cortex and smaller area and folding in prefrontal-temporal regions. Extraversion was related to thicker precuneus (part of parietal lobe) and smaller superior temporal cortex area, openness was associated with thinner cortex and greater area, and folding in prefrontal-parietal regions. Agreeableness correlated to thinner prefrontal cortex and smaller fusiform gyrus (part of temporal and occipital lobes), while conscientiousness was linked to thicker cortex, smaller area and folding in prefrontal regions (Riccelli 2017).

(ii) Personality Trait and Brain Waves

Cerebral cortex is the most relevant location for EEG reading as its surface position permitted electrical activity to be recorded by EEG (Siuly 2016). Majority of the electrical activity measured by EEG recordings was generated from the synchronous activation of cerebral cortical pyramidal neurons located near the

placement of EEG electrodes. Neurons communicated through electrical impulses that generated both electrical and magnetic fields which were categorized into five different EEG spectrum bands or brain waves i.e., alpha (α), beta (β), delta (δ), gamma (γ), and theta (θ). As each area of the brain has its own set of functions, different areas will be more active compared to others depending on a person's state of mind or physical activities. EEG potentials for these specific areas will be higher and the observed frequency will be different based on the type of brain wave that was most prominent. These brain waves were characterized based on the frequency ranging from 1 to 80 Hz (δ: 1 Hz to 3 Hz, θ: 4 Hz to 8 Hz, α: 8 Hz to 12 Hz, β: 12 Hz to 30 Hz, and γ: 25 Hz to 100 Hz) (Nunez 2006, Hoole 2012).

The potential link between descriptive taxonomic differences of personality traits with empirical data from neuroscience were indicated by research using neural-based data obtained from EEG (Li 2020). Dimensional characteristics of different components on specific EEG frequency bands were observed among college students in China. Both left temporal and left parietal theta as well as central beta and gamma activities were the major contributors for neuroticism. Extraversion was related to frontal beta and delta, and occipital delta and theta activities. Openness was associated with major contribution from frontal alpha, beta, and gamma spectrum bands, as well as occipital delta and theta. Agreeableness was associated with major contributions from frontal and central alpha, beta, and gamma activities. Conscientiousness was link to theta activities over the left temporal, central and left parietal areas, and beta over the right temporal area (Li 2020).

Our current preliminary study aimed to determine the reliability of the Malay version of NEO-PI-R (n=171) and to optimize the EEG data collection procedure (n=3) performed on the Malaysian Army, batch series AK1/2023 before undergoing the Special Forces Qualification Course training.

Method

Participants

A total of 171 out of 200 army soldiers who registered at Camp Terendak, Sungai Udang, Malacca for the Special Forces Qualification Course training, series AK 1/2023, fulfilled both the inclusion and exclusion criteria participated in the preliminary study. The inclusion criteria include healthy male soldiers who had served in the Army for at least 11 months with excellent record, aged between 19 to 26 years (mean age = 21.29 ± 1.66), have normal hearing and normal vision or corrected-to-normal and passed the Schutte Scale of Emotional Intelligence (SSEIT) IQ test (Schutte, 1998). Participants were pre-screened to exclude anyone with a history of neurological or psychiatric disorders or psychoactive drug usage. Participation was voluntary, and free to withdraw without penalty and prejudice.

Determination for the Reliability of NEO-PI-R

Participants were briefed and given a set of questionnaires to answer, which consisted of Part A: Sociodemographic Information, and Part B: Revised NEO Personality Inventory (NEO-PI-R) (Costa & McCrae, 2008) before undergoing training. Sociodemographic information includes age, identification number, state of birth, ethnicity, religion, education, rank, marital status, and duration of service. Personal data provided was protected and respected with confidentiality. The Malay version of the NEO-PI-R consisted of 240 items corresponding to the Big Five personality traits (neuroticism, extraversion, openness, agreeableness, and conscientiousness).

Each trait consisting of 6 facets. Each item was scaled according to a 5-point Likert scale as the following possible responses: 1 (strongly disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree) and 5 (strongly agree). Scoring for each personality trait was the sum of the items.

Complete data collection was transferred into the SPSS Statistics program version 25 and analysed at a significance level of $p<0.05$. The reliability of the inventory was calculated and determined using Cronbach's alpha analysis (Pérez, 2005). The briefing session on the implementation of the NEO-PI-R test (online) to the participants from batch series AK1/2023 is illustrated in Figure 1.

*Figure 1*Briefing session and implementation of the NEO-PI-R test (online), batch series AK1/2023

Optimization of EEG Recording

Resting-state EEG recording was performed on 3 participants at EEG Cubicle, Cognitive Laboratory, PsiTra, Faculty of Social Science & Humanities, Universiti Kebangsaan Malaysia. Resting-state brain activity is significant transmission of signal generated by functionally related brain regions in the absence of any stimulus or task. EEG components were from Brain Products GmbH (Germany). EEG equipment's such as cap and electrodes were disinfected with envirocide (Metrex® Research, USA), while the surfaces of amplifier, and adaptor boxes were wiped with 70% isopropanol (Sigma-Aldrich, Germany), in accordance with protocol for reducing the risk of COVID-19 transmission (Simmons, 2020).

EEG neural readings were derived from an eight-electrode system corresponding to the EEG International 10-20 System (Figure 2) (Jasper, 1958; Montoya-Martinez, 2019). The electrodes were attached to specific spots on the Quik-cap placed on the scalp by adhesive gel (Super Visc 1000 gram high-chloride electrolyte gel, Neurospec, Switzerland). A participant was seated comfortably and complete relaxed state in a quiet and light attenuated room, set in an ambient temperature of 24˚C. He was advised to remain as static as possible during recording to avoid artifacts from ocular and muscular movements (Figure 3).

The procedure consisted of three one-minute recordings (three with eyes closed and three with eyes open) alternating pseudo-randomly, with five one-minute breaks. Horizontal eye movements were recorded with electrodes placed 1.5 cm lateral to the outer canthus of each eye. Vertical eye movements were recorded with electrodes placed 0.3 cm below the middle of the left bottom eyelid. The middle electrode placed on the forehead served as ground. Electrode resistance was kept below 5 kΩ. The signal was amplified with a multi-channel bio signal amplifier with a bandwidth of 0.05 - 30 Hz, -6 dB/octave and digitized continuously at 125 Hz. A low pass filter with an attenuation of 40 dB per decade above 100 Hz was used prior to digitization.

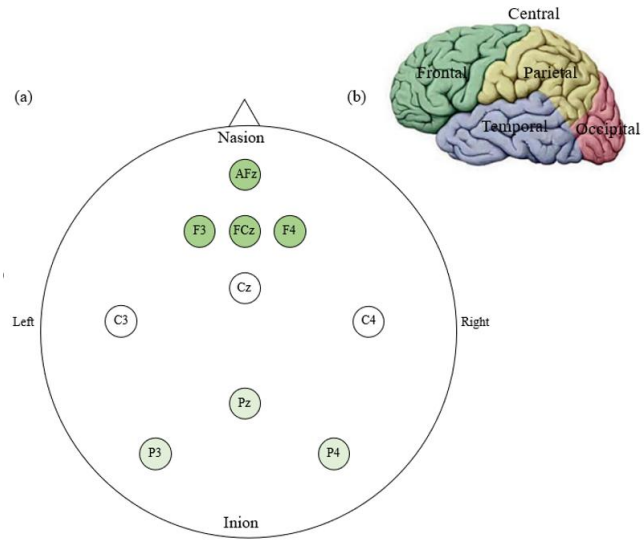

Figure 2 (a) The recommended placements for an eight-electrode system according to the 10-20 EEG International System (Jasper, 1958; Montoya-Martinez, 2019). Frontal, central, parietal and midline were referred to as F, C, P and Z, respectively. Ground and reference electrodes were labelled as AF_z and FC_z, respectively. (b) Superolateral surfaces of cerebrum (Netter, 2020).

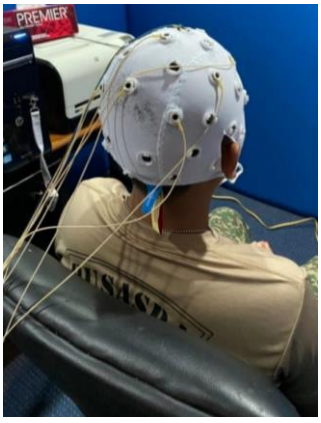

Figure 3 A participant undergoing an EEG test during a resting-state.

The reliability of NEO-PI-R inventory and the optimization of EEG recording procedure conducted on participants from batch series AK1/2023 will determine the suitability of both methods for the mainstream batch series AK2/2023. Flow chart of research study for the mainstream batch, series AK2/2023 is illustrated in Figure 4.

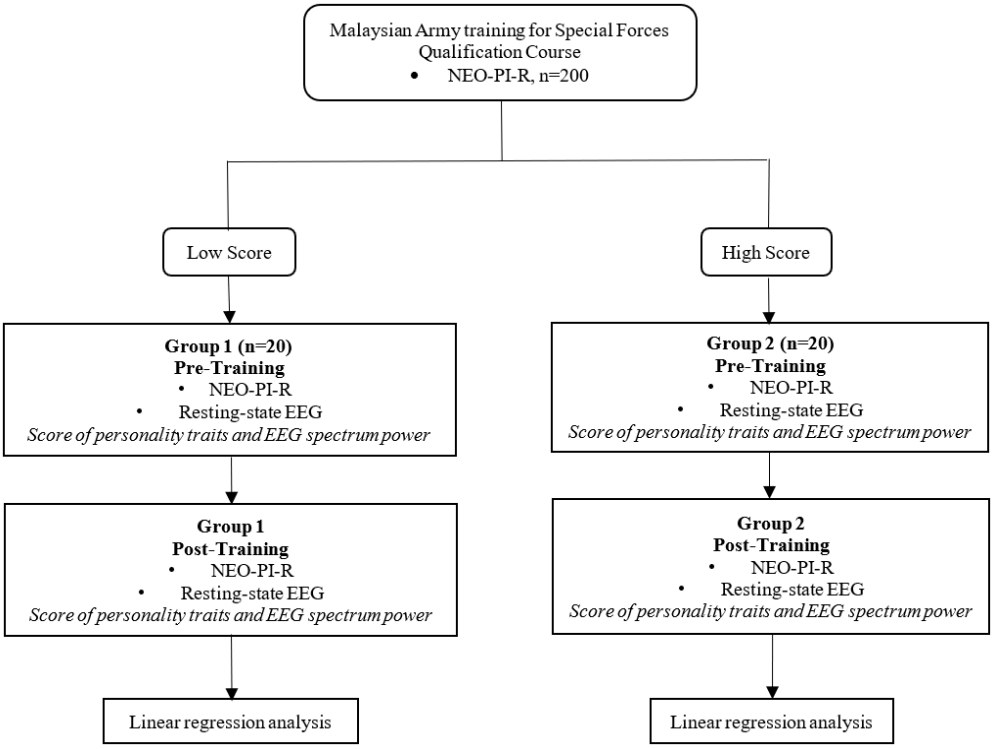

Figure 4 Flow chart of research study for the mainstream batch, series AK2/2023.

As illustrated in Figure 4, a total of 200 army soldiers (batch series AK2/2023) will register in November 2023 for similar training as the previous batch (series AK1/2023) after fulfilling the criteria of inclusion and exclusion as in the preliminary study. Participants will be divided into two groups i.e., Group 1 consisting of those with less than or equal to 25% of pre-training NEO-PI-R scores, while Group 2 are those scoring more than 25%. Participants from both groups are required to answer another set of NEO-PI-R after the completion of their training. Based on G*power calculation (Version 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany), 20 participants from each group will be selected for EEG recording at resting state, pre- and post-training. The parameters of G*power for default power level, default alpha level (α err prob) and power (1-β err prob) were 0.8, 0.05 and 0.95, respectively.

Pearson's correlation coefficient and simple linear regression analysis will further determined and predicted the relationship between different dimensions of personality traits and brain waves.

Results

Table 1
Reliability coefficients for personality traits

Personality traits	Number of items	Cronbach's alpha
Neuroticism	48	0.823
Extraversion	48	0.796
Openness	48	0.504
Agreeableness	48	0.628
Conscientiousness	48	0.847

The reliability coefficient (Cronbach's alpha) for each factor of the personality traits obtained from participants, batch series AK1/2023 using the NEO-PI-R inventory in the preliminary study is presented in Table 1. Each of trait consisted of 48 items. Except for openness, the consistency of neuroticism and conscientiousness is indicated as good (α=0.823 and 0.847, respectively), extraversion as good and acceptable (α=0.796), and agreeableness as acceptable (α=0.628). Overall results and comparison coefficients for each 48 facets of neuroticism, conscientiousness, extraversion, and agreeableness were applicable for the participants, batch series AK1/2023. However, the openness to actions and value facets were not replicated well.

Pre-processed EEG spectrum power results

The EEG raw data of each participant was pre-processed for better signal-to-noise ratio. The pre-processing procedure include the following standardized steps; re-reference, resampling, filtering, artifact rejection, and epoching. Reasonable pre-processed data obtained from 3 participants using the optimized EEG test is presented in Table 2.

Table 2
Pre-processed EEG spectrum power results obtained during resting-state.

Alpha

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File	1-FFT	2-FFT	3-FFT	4-FFT	5-FFT	6-FFT	7-FFT	8-FFT	FCz-FFT
Participant 1	0.066799	0.087511	0.029739	0.061359	0.027022	0.031605	0.100835	0.078745	0.043592
Participant 1	0.130837	0.017130	0.054501	0.075089	0.070963	0.018032	0.094355	0.091943	0.070115
Participant 2	0.055310	0.079919	0.031232	0.015470	0.029555	0.003266	0.039914	0.033462	0.029930
Participant 2	0.007786	0.015019	0.026230	0.034312	0.024920	0.022553	0.039968	0.083317	0.028654
Participant 3	0.150241	0.128464	0.029257	0.091954	0.084349	0.110766	0.160287	0.109034	0.086963
Participant 3	0.569120	0.334240	0.224327	0.255584	0.086036	0.912457	0.178301	0.071301	0.186282

Beta

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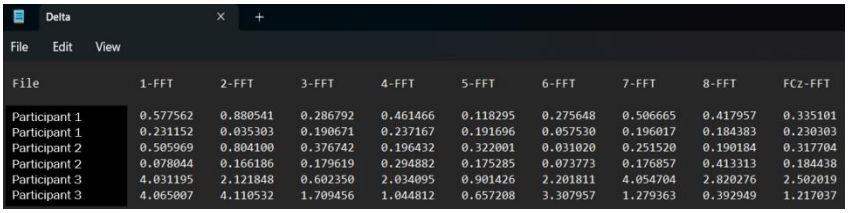
File	1-FFT	2-FFT	3-FFT	4-FFT	5-FFT	6-FFT	7-FFT	8-FFT	FCz-FFT
Participant 1	0.041249	0.041097	0.010762	0.020606	0.016549	0.017812	0.029263	0.025915	0.015453
Participant 1	0.171490	0.003316	0.021241	0.013451	0.052591	0.011418	0.020664	0.015077	0.040326
Participant 2	0.028472	0.045663	0.023150	0.006834	0.020717	0.001647	0.018492	0.012764	0.018730
Participant 2	0.003738	0.006318	0.009435	0.012475	0.020074	0.011508	0.014600	0.032066	0.010598
Participant 3	0.192365	0.209521	0.036959	0.143768	0.120087	0.155332	0.260294	0.204211	0.089680
Participant 3	0.184013	0.123386	0.072063	0.055897	0.031115	0.191651	0.039474	0.017749	0.058367



Delta

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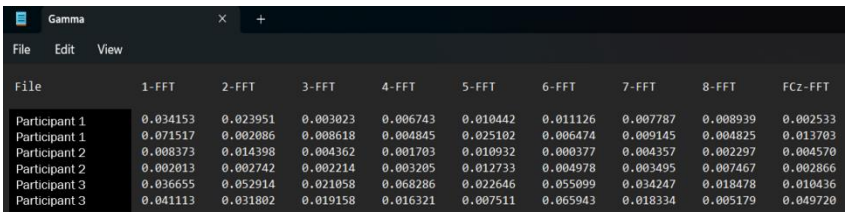
File	1-FFT	2-FFT	3-FFT	4-FFT	5-FFT	6-FFT	7-FFT	8-FFT	FCz-FFT
Participant 1	0.577562	0.880541	0.286792	0.461466	0.118295	0.275648	0.506665	0.417957	0.335101
Participant 1	0.231152	0.035303	0.190671	0.237167	0.191696	0.057530	0.196017	0.184383	0.230303
Participant 2	0.505969	0.804100	0.376742	0.196432	0.322001	0.031020	0.251520	0.190184	0.317704
Participant 2	0.078044	0.166186	0.179619	0.294882	0.175285	0.073773	0.176857	0.413313	0.184438
Participant 3	4.031195	2.121848	0.602350	2.034095	0.901426	2.201811	4.054704	2.820276	2.502019
Participant 3	4.065007	4.110532	1.709456	1.044812	0.657208	3.307957	1.279363	0.392949	1.217037



Gamma

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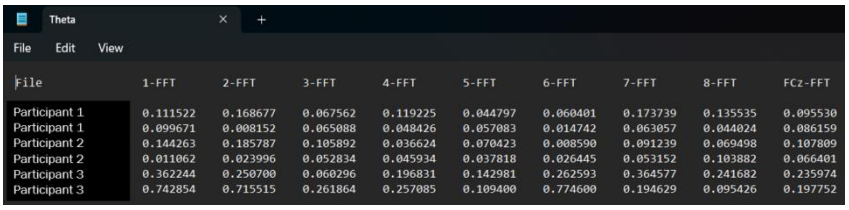
File	1-FFT	2-FFT	3-FFT	4-FFT	5-FFT	6-FFT	7-FFT	8-FFT	FCz-FFT
Participant 1	0.034153	0.023951	0.003023	0.006743	0.010442	0.011126	0.007787	0.008939	0.002533
Participant 1	0.071517	0.002086	0.008618	0.004845	0.025102	0.006474	0.009145	0.004825	0.013703
Participant 2	0.008373	0.014398	0.004362	0.001703	0.010932	0.000377	0.004357	0.002297	0.004570
Participant 2	0.002013	0.002742	0.002214	0.003205	0.012733	0.004978	0.003495	0.007467	0.002866
Participant 3	0.036655	0.052914	0.021058	0.068286	0.022646	0.055099	0.034247	0.018478	0.010436
Participant 3	0.041113	0.031802	0.019158	0.016321	0.007511	0.065943	0.018334	0.005179	0.049720



Theta

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File	1-FFT	2-FFT	3-FFT	4-FFT	5-FFT	6-FFT	7-FFT	8-FFT	FCz-FFT
Participant 1	0.111522	0.168677	0.067562	0.119225	0.044797	0.060401	0.173739	0.135535	0.095530
Participant 1	0.099671	0.008152	0.065088	0.048426	0.057083	0.014742	0.063057	0.044024	0.086159
Participant 2	0.144263	0.185787	0.105892	0.036624	0.070423	0.008590	0.091239	0.069498	0.107809
Participant 2	0.011062	0.023996	0.052834	0.045934	0.037818	0.026445	0.053152	0.103882	0.066401
Participant 3	0.362244	0.250700	0.060296	0.196831	0.142981	0.262593	0.364577	0.241682	0.235974
Participant 3	0.742854	0.715515	0.261864	0.257085	0.109400	0.774600	0.194629	0.095426	0.197752

Discussion

The participants undergone a gruelling 12-week duration of Special Forces Qualification Course to qualify as GGK commandos, Malaysian elite special force regiment. The mandatory course consisting of five phases to be completed. Phase One (Camp Phase) is vital for the development of physical and mental characteristics. Phases Two (Jungle Phase), Three (Survival, Fitness March, and Swamp Phase) and Four (Maritime Phase) exposed the participants to real-life combat condition, survival, and coastal assault, respectively. Finally, in Phase Five (Escape and Evasion), the participants applied their knowledge and skills to identify, infiltrate and launch an attack into enemy targeted area. Once achieved, they are required to escape or otherwise tortured as real-life war condition. Upon graduation, each commando is awarded with a green beret, blue lanyard, and a Fairbairn and Sykes Commando Dagger (*Gerup Gerak Khas* archive, 2022). These commandos were highly educated and trained with high-level of war skills on land, sea, and air combat for high-stake missions. They were at high risk to pressure and internal conflicts with serious impact to physical and mental health compared to infantry.

The need and opportunity for a combined study between the fields of neuroscience and psychology is vital in predicting the effects of training or exercise among the Malaysian army, especially the special forces. Lack of scientific evidence regarding the association between personality traits with performance post Special Forces Qualification Course training leads to a neglect in the importance of psychological profile among the Malaysian Army's Special Forces.

Personality traits prospectively predicted the decision to enter military service among the German male citizens. Candidates with lower scores on openness to experience, agreeableness and neuroticism during high school were more likely to enter military after graduation. Military training reinforces changes in the behaviour patterns of recruits to meet the expectations of military work. Military experience was associated with changes in personality among recruits as indicated by decreased level of agreeableness after training. This study was among the earliest to identify life experiences in relation to changes in

personality traits (Jackson, 2012). Generally, there appeared to be a positive relationship between military experience and good health (Wilmoth, London, & Parker 2010). However, post-traumatic stress disorder (PTSD) was a major problem among German military veterans who had engaged in extreme combat (Aldwin, Levenson, & Spiro 1994). These changes can also be predicted by personality traits and have a lasting influence on their trait levels (Settersten 2006; Jackson, 2012; Huijzer, 2022).

Military candidates from the Netherlands who successfully completed the special force training were less neurotic and more conscientious than candidates who failed (Huijzer, 2022). Conscientiousness among cadets from three Norwegian military academies was related to both military and academic performance. This performance may be mediated by self-efficacy beliefs (Fosse, 2015). The high-intensity training experienced by the U.S. reconnaissance marines caused direct and indirect changes in thinking, behaviour patterns and feelings as indicated by higher extraversion scores upon graduation (Saxon, 2020). High scored in openness to experience among Dutch special forces suggested these commandos preferred routines, consistency, traditions, and familiarity, and approach new things with great caution and less likely to be overwhelmed by emotions compared to civilians. This was in lined with the novel contribution to the literature on military selection and psychology. Overall, successful special force candidates were more likely to score higher on openness to experience, conscientiousness, extraversion, and agreeableness, while lower on neuroticism (Huijzer, 2022).

The reliability of the inventory and optimization of EEG testing performed in this preliminary study were vital to ensure the suitability of both methods to be used for the mainstream batch series AK2/2023. Except for openness (Cronbach's alpha = 0.504), all the other four traits were good and acceptable with the minimum Cronbach's alpha obtained between 0.628 to 0.847. Therefore, some modifications were required to improve the reliability of the items especially for openness. Extra clarification will be focus on the terms used in the inventory including optimistic, opportunistic, etc. In addition, appropriate and conducive conditions need to be considered during the question answering session. The optimization of EEG recording procedure has successfully yield reasonable data and ready for the mainstream study.

Conclusion

The preliminary study has successfully provided with validated and optimized methods to measure the concept of personality traits and its neuro mechanism in the Malaysian Military Special Forces context. The reliability of the measures was consistent with minor modifications. The validated measures can be used for future mainstream study.

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