An Aggressiveness Level Analysis Based On Buss Perry Questionnaire (BPQ) And Brain Signal (EEG)

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Abstract. Aggression is the most important human aspects that make daily things possible for individuals, to succeed and have a better level of behaviour. Aggression is feelings of anger or antipathy resulting in hostile or violent behaviour. The importance of aggression is to increase an individual dominance of the subject in their social environment. Traditionally, the subject's aggression is usually measured by using a survey through Buss-Perry Questionnaire (BPQ). Considering the variability of the aggressiveness level, this study proposes investigation of aggression by using BPQ and Electroencephalography (EEG) to evaluate the aggressiveness level of the subjects. The results of the BPQ are analysed based on the final score that are responded by the subjects. In EEG experiment, the evaluation of subject's aggressiveness while playing a smart phone game “Subway Surfers”, a basic method has been employed, namely correlation coefficient method. The EEG signals are recorded while the subject playing the game. The number of subjects involves in the experiment is 9 and they are the UniMAP’s male students at the age of 21-25 years old. In the analysis, the induced aggression is compared between BPQ with Net Aggressiveness Index (NAI), which is obtained from brain signals (EEG). The BPQ obtains the subjects #2 and subject #8 are the highest Buss-Perry Aggresiveness Index (BPAI) scores, which are 0.32244 and 0.32223 respectively. Meanwhile in EEG analysis the subject #8 only achieves the highest score of 0.34713. From the results of the investigation, it could be concluded that the use of EEG to identify the aggressiveness level will overcome the disadvantage of the conventional methods.

1. Introduction

Aggression is a term used in the literature to describe both violent and hostile behavior [1]. The term aggressiveness, which is derived from aggression, is used to quantify the positive behavioral responses to a subject's mood rather than violence and hostility [2]. Questionnaires are used in traditional approaches to assess a subject's aggressiveness. Questionnaire-based research is often criticized, as the test respondent may provide false or socially acceptable responses. Since 1957, the development of a questionnaire for evaluating aggression has been ongoing, resulting in the current Buss Perry Questionnaire (BPQ) [3]. Some researchers question the accuracy of self-reported aggressiveness measures, claiming that social desirability and self-presentational concerns lead to inaccuracy [4]. Furthermore, one disadvantage of the questionnaire-based method is that it is a passive assessment method that can only be used to assess aggressiveness through a series of questionnaires. These questionnaires are unable to assess an individual's aggressiveness level while they are engaged in an
active task [5]. Because the source of aggressiveness can be assessed in the brain, more experimentally oriented research on aggressiveness will provide a comprehensive understanding of the different levels of aggression [6]. Measuring a person's aggressiveness level provides useful information about how aggressive the individual is during a task.

When the brain performs a job, brain waves are nothing more than electrical activities created by brain cells. Electroencephalogram (EEG) is a measurement method that uses metal electrodes and conductive media to monitor brain signals on the scalp, which are then enormously amplified [7]. Only when a significant number of brain cells in a region are stimulated that can be used to quantify their activity. This also means that the participants in the study cannot actively hide their emotions to influence the EEG signal during the given tasks [8,9].

The assumption that the person taking part in the conventional questionnaires-based aggressiveness measurement research is honest with their private feedback is a huge problem which presents in earlier research [10]. Even though the person is honest with their private feedback, problem still exists where participants with a different thinking perspective has a different tolerance to aggressiveness which will result in different rating of aggressiveness level in their questionnaire feedback. With the inconvenient as discussed above, earlier research required a huge number of subjects for an experiment to make a conclusion on the behaviors of human. The proposed investigation makes use of the information from earlier researchers to compare the aggressiveness level of the human by using Buss-Perry Questionnaire method and Electroencephalogram (EEG).

This paper consists of the 5 sections. Section 1 is an introduction to the research works. Section 2 focuses on the related works to the research title. Section 3 describes method that has been carried out along this investigation. Section 4 discusses the finding of the research and section 5 describes the overall summary of the investigation.

2. Literature review

Aggressive activity is distinguished by its intrinsic motivation (to damage or harm any living being), not by its impact whether harm or injury occurs. This suggests that if it was motivated by the intent to injure, even if no harm was done to the target, an action is perceived to be hostile. Aggression is described by social psychologists as actions intended to harm another person who does not want to be harmed [7]. Aggression as any form of behaviour directed toward the goal of harming or injuring another living being who is motivated to avoid such treatment.

Arnold H. Buss and Mark P. Perry, scholars of the University of Texas, in a 1992 study for both the Journal of Personality and Social Psychology, designed the Buss-Perry Aggression Questionnaire (sometimes referred to as the AGQ or simply the Aggression Questionnaire) [8]. The main purpose of this Buss-Perry Questionnaire is to know the aggressive level of the subject. The questionnaire consists of seven continuum points which are "Don't agree at all," "Strongly disagree," "Slightly disagree," "Neutral," "Slightly agree," "Strongly agree" and "Totally agree" [9]. The BPQ has subdivided in four factors, which are “Physical” (PA), “Anger” (AN), “Hostility” (HS) and “Verbal” (VA).

EEG would be a medical imaging procedure that reads the scalp's electrical impulses created by brain areas. Once metal electrodes and conductive media have been obtained, the EEG is characterized as an alternative form of electrical activity reported from the scalp surface. The EEG measured directly from the cortical surface is referred to as an electrocortiogram, whereas it is called an electrogram when using depth probes. The EEG reading is a fully non-invasive technique which can be frequently administered to patients, as well as normal adults and infants, with practically no chance of restriction. Medically, EEG refers to the recording over a duration of time of the instant electrical brain activity, as tracked from few electrodes mounted on the scalp. Due to its surface location, the electric activity of the cerebral cortex has the greatest effect on EEG.

3. Methodology

3.1. Research block diagram
Figure 1 shows the research block diagram of the proposed research. The research is divided into three parts, which is investigation of aggressiveness level by using BPQ, brain signal analysis by using EEG and the comparison of results between BPQ with EEG.

3.2. Subject selection

Nine male subjects were selected in the investigation. The subjects were given the BPQ and asked to complete the questionnaire on Google Survey Form. The questionnaire was written fully in English. Before beginning the experimental, the subjects were informed in detail about the aim and objective of the investigation, and an agreement to participate in the experimental was gained. The peer reviewer’s assessment was conducted for achieving more accurate BPQ ratings.

In EEG experiments, none of the subject were addicted to video or smart phone games [10]. The subject who did not get at least 6 hours of sleep the night before the experiment or who became sick were eliminated. The EEG signal was first recorded with the subject’s eyes closed for 60 s, followed by another 60 s of EEG recording with their eyes open to confirm the participants’ relevant data was obtained during the initial trial run.

3.3. Buss-Perry Questionnaire (BPQ)

There were 29 aggressiveness questions that the subject was requested to fill up. The seven continuums in the Buss-Perry Questionnaire were “Don’t agree at all,” “Strongly disagree,” “Slightly
disagree,” “Neutral,” “Slightly agree,” “Strongly agree,” and “Totally agree”. The responses from the seven continuums of each subject were scaled from 1 to 7. Each question from standard BPQ having 3 categories which is factor, self, and peer. For the factor category, all values were constant. This was because the questions #7 and #18 were opposite relation to other questions. For the self-category, the inverted and non-inverted values were different. The inverted values were opposite from non-inverted with a score minimum score (1) for all questions except questions #7 and #18 with a maximum score (7). Similar method was applied to all the subjects. The questionnaire was divided into 4 factor which are Anger, Physical, Hostility, and Verbal. Each question consists of their own percentage of anger, physical, hostility and verbal from BPQ.

The peer score follows the self-score for all the 29 questions which will be answered by all the 9 subjects. Once completing the category calculation, the weighted score, value was calculated by using Eq. (1) below. The ‘p’ represent factor, ‘q’ represents self-value, ‘r’ represents peer value and μ representes average.

\[
\text{Weighted score} = \frac{\mu(q+r)}{2} \times p
\]  

(1)

Then, to obtain the actual values of PA, AN, HS, VA (physical, anger, hostility, verbal) the weighted score in Eq. (1) was multiplied on each factor from standard BPQ (PA, AN, HS and VA) values for each question. To sum up all 29 questions to obtain the actual result, Eq. (2) was applied to calculate the aggressiveness level of BPQ.

\[
\frac{\sum \text{Subject}(x)}{\sum x (ni) - \sum x (i)} \times 100\%
\]  

(2)

The x value is PA, AN, HS, VA. The (ni) represented non-inverted value and the (i) represent the inverted value. This data of (ni) and (i) are taken from the standard BPQ. Once the formula successfully applied in Eq. (2), the PA, AN, HS and VA with the actual result of each subject will be obtained.

3.4. Electroencephalography (EEG)

![Figure 3. Channel electrodes position in the scalp](image)
Similar subjects that participated in BPQ was then required to play a popular non-violence smart phone game named “Subway Surfers” which is available in every phone. To measure the aggressive level, the subjects were asked to play [14] the “Subway Surfers” game and at the same time the EEG signal was recorded from the brain. The experiment setup includes a Minset-24 EEG amplifier and electrode cap. The 19 channel electrodes (FP1, FP2, F7, F3, FZ, F4, F8, T3, T5, C3, CZ, C4, T6, P3, PZ, P4, O1 and O2) were placed on the scalp using 10-20 electrode positioning system [11] and the reference electrode were placed on the left and right mastoids as shown in Figure 3.

In the experiments, the subject was asked to perform three different tasks in sequential manner. The first task was the relaxation stage. During this task, the subject was asked to remain seated ideally in a relaxed state without making any movement. The EEG signals were then recorded for 60 s and only last 10 s were extracted. Then, the second task the subject was asked to play the “Subway Surfers” game in muted mode continuously for 60 s and the signals recorded during the last 10 s of the play game was extracted and used for analysis. After playing game, the third task subject was asked to remain seated in a relaxed manner without making any movement for 10 s at the same time EEG signals were recorded. As the subjects has completed all the three tasks successfully, the recording made during this trial session was considered for further analysis of 9 subjects. Each task was divided into 3 trials. In total, the overall data was 9 trials and 90 windows for each subject. Each window consists of 512 recordings for the time duration of 0-2 s. This process continues to record the 513th recording with the duration of 1-3 s.

3.5. Single trial correlation

The experimental study consists of three different task and each task has three trials. Since the data was recorded for 10 s at a sampling frequency of 256 Hz, the total number of samples in one channel, N is 2560 [22]. The EEG signal recorded from the $i^{th}$ channel for the $r^{th}$ trial, $t^{th}$ task of the $s^{th}$ subject, $X_i^{rs}$ is written as $X_i^{rs} = x_{i1}^{rs}, x_{i2}^{rs}, x_{i3}^{rs}, ..., x_{iN}^{rs}, i=1, 2, 3, ..., 19; r=1, 2, 3; t=1, 2, 3$ and $s=1, 2, 3, ..., 9$. The correlation between the $j^{th}$ and $k^{th}$ channel signal, $X_j^{rs}$ and $X_k^{rs}$ can be written as

$$C_{jk}^{rs} = \frac{\Sigma(x_j x_k)-(N \Sigma x_j^{rs} \Sigma x_k^{rs})}{(N-1)\sigma_j^{rs} \sigma_k^{rs}} \quad (3)$$

3.6. Correlation between electrode(channel) in different brain section

Generally, there are 3 parts on a basic brain of human being which are left brain, right brain, and centre brain. In this investigation, the parts of brain are boarded to 5 parts includes cross centre brain and from centre brain. Each brain part from the 5 brain parts will be placed by the specific number of electrodes. The left brain (yellow) will be placed by 8 electrodes while another 8 electrodes will be placed on the right-side brain (blue) and 3 electrodes on the centre brain (green). Then, the electrodes were placed on the brain parts that correlate with each and another to produce total pair channel correlation for the right brain, left brain, only centre brain, from centre of the brain and cross brain with the total pair channel correlation of 28, 28, 3, 48 and 64 respectively.
3.7. Evaluating aggressiveness level

The average of total 3 trial subject was calculated. To obtain the difference of aggressiveness level between 2 tasks, the absolute difference is acquired between average of task and the following task’s trials to obtain the aggressiveness level. The average value of 3 trials on each task was calculated from the $j$th channel for the $r$th task of the $s$th subject, $\mu_{i, j, r, s}$ is written as $\mu_{i, j, r, s} = \{\mu_{i, 1, j, r, s}, \mu_{i, 2, j, r, s}, \mu_{i, 3, j, r, s}, \ldots, \mu_{i, N, j, r, s}\}, j = 1, 2, 3, \ldots, 171; r = 1, 2, 3; t = 1, 2, 3 and s = 1, 2, 3, \ldots, 9$.

$$\mu_{i, j, r, s} = \frac{X_{j, t, r, s} + X_{j, t + 1, r, s} + X_{j, (t+1), r, s}}{3}$$

(4)

$$\Delta \text{Absolute difference} = \left| \mu_{i, j, r, s} - (X_{j, t + 1, r, s}) \right|$$

(5)

From eq. (4) and (5) the average values for 3 tasks, the aggressiveness level difference for each task per subject was calculated. The absolute difference between average of total 3 trial for task #1 and correlation of (Task #2, Trial #1), (Task #2, Trial #2), (Task #2, Trial #3) was calculated until Task #3. Task #1 is a relaxation mode, so the absolute difference for each task won’t be calculated. The total of each Task #2 and #3 for all the 9 subjects is then divided by the number of pair correlation for each part of brain. As the final step, both the percentage value for the BPQ and EEG scores was compared and contrasted and the best method to determine a person’s aggressiveness level.

4. Results and discussion

4.1. Buss-Perry Aggressive Questionnaire (BPQ)

As can be observed from Figure 3, the highest BPAI score is recorded from the Subject #2 and Subject #8 which is 64%. Meanwhile, the lowest BPAI results were obtained from Subject #1 and #5, which is 32% and 28%, respectively.

**Figure 5.** Overall BPAI score among 9 subjects
4.2. Electroencephalography (EEG)

![Figure 6](image_url)

**Figure 6.** Aggressiveness level of all section of the brain for every subject

![Figure 7](image_url)

**Figure 7.** Overall aggressive level for 9 subjects

The Net Aggressiveness Index (NAI) is obtained by sum up the average values of subject including every task and trial and divide into the total pair channel correlation. Figure 4 shows the results of the total NAI among 9 subjects. This procedure is measured to all 9 subjects and its respective brain section part. From the graph it is clearly visible that Subject #8 during Task 2 on right of the brain and only center of the brain has reached the maximum point of this graph. Based on the bar chart analysis, the lowest score of NAI is recorded by Subject #2 which is 0.11. The highest NAI is recorded by Subject #8 which is 0.35. Based on the results obtained a comparison with BPAQ can be made as both Subject #8 recorded a high BPAI and NAI but the Subject #2 for NAI recorded a lower result compared to BPAQ. The reason why the BPAQ recorded a low BPAI is because the respondents of Subject #2 were not well prepared and answered the survey randomly.

4.3. Comparison of BPAQ and EEG

The highest BPAI results obtained are from Subject #2 and #8, which is 64%. Meanwhile, for the NAI, Subject #2 and #8 has the aggressiveness level which is 22% and 69%, respectively. The reason why the BPAQ recorded a low BPAI is because the respondents of Subject #2 were not well prepared and answered the survey randomly.

5. Conclusions

Based on the hypothesis, both BPAQ and EEG (NAI) will obtain similar results. BPAQ shows the Subject #2 and Subject #8 obtained the highest scores. Unfortunately, EEG (NAI) shows that the Subject #2 has lower score. This is probably, while conducting the BPQ survey the subject is not honestly answered the questions or the subject is not understanding the questionnaire well. In the future,
the BPQ could be upgraded by adding more languages to ease the participants understand the questionnaire.

![Figure 8. Comparison result of BPQ vs EEG](image)

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