Investigating the Effect of Individuality Factors in Measuring Aggression induced by Human Brain

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Abstract

Aggression is a behaviour of human that may cause physical or emotional harm to others. Several factors that cause aggressive behaviour such as physical health, mental health and socioeconomic. Many previous researchers reported that aggression could be measured through either questionnaire or the brain signals. This paper proposes the experimental studies to collect the brain signal of the human subject for investigating the effect of individuality in aggression. Ten subjects are selected to perform the aggression activities. The experimental protocol for inducing aggression is proposed. In general, there are four tasks which is collecting brain data in relaxing state before and after the experiments, and data collection while playing game in muted and maximum volume levels. In the experiments, the subject are required to play a popular non-violence smart phone game named "Subway Surfers" and at the same time the EEG signals are recorded from the subject's brain. In the signal pre-processing stage, a Butterworth filter is used to remove the noises contain in the signals. A windowing technique is employed for extracting significant features. A Pearson correlation technique is used to reduce and remain the less and most significant features. In the methodologies, the aggressiveness level *A*, is defined to investigate the effect of individuality in inducing the aggression signals. The proposed experimental protocol and signal processing techniques are seen able to generate level of aggression.

Keywords: Aggression, EEG, Aggression measure, Aggression level

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1. INTRODUCTION

The word aggression is interpreted in the literature to reflect all the actions of aggressive goal hostilities. Instead, the term aggressiveness extracted from aggression is not limited to violence and hostility but has been used to quantify positive behavioral responses from the emotions of a subject [1,2,3,4]. To test the aggressiveness of the subject, traditional approaches use questionnaires method, which is Buss Perry Aggressive Questionnaire, (BPAQ) [1], however, recently the researchers start measuring the aggression by using EEG [5,6,7,8].

This paper proposes the experimental studies to measure aggression through brain signals. An experimental protocol is designed to induce aggression. The raw brain signals are processed by using signal processing approaches. The aggressiveness level is defined and is used to measure it in the aggression experiments.

The flow of this paper is followed. Introduction discusses the background including the related information to the research as published by the earlier researchers. Methodologies discuss the proposed experimental studies for inducing and obtaining aggression. Result discusses the finding from the investigation, and the paper is concluded in the conclusion.

2. METHODS

2.1. Traditional survey (BPQA) and brain signal experiments (EEG)

The experiment included in this research aimed at investigating and measuring aggressiveness through their effect on the human brain. The evaluation starts with the

subjects to answer Buss Perry Aggressive Questionnaire (BPQA) questionnaire without the involvement of EEG data collection [5,7,9]. The evaluation was done before the EEG recording experiments to analyze their survey-based aggressive score.

2.2. EEG Recording Materials

The data collection for the analysis moment was taken by using the mindset 24 amplifier as presented in **Figure 1**, which able to cover most of the EEG points according to the "10-20 electrode placement system" as shown in **Figure 2**. The 19 channel electrodes (FP1, FP2, F7, F3, FZ, F4, F8, T3, T5, C3, CZ, C4, T4, T6, P3, PZ, P4, O1 and O2) were placed on the scalp using 10-20 electrode positioning system and the reference electrode were placed on the left and right mastoids. The sensors that were used in this experiment were the silver chloride (AgCl2) disc electrodes. The Lycra Stretch Cap fix 19 electrodes closely to the subject's head. Electrodes were pre-positioned following the international 10/20 montage, helping novice EEG researchers to minimize electrode placement errors.

Fig. 1. Mindset 24 EEG amplifier

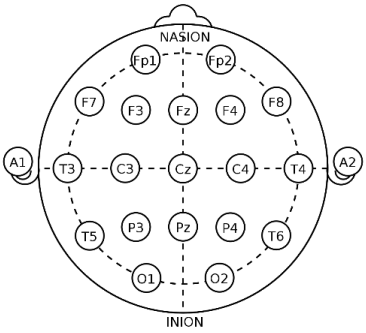

Fig. 2. EEG electrode's location according to 10-20 system

2.3. Subject selections

In the experiments, 10 subjects were chosen to perform the tasks. The subjects were asked to fill up the Buss-Perry Questionnaire (BPQA) and to involve in the Electroencephalography (EEG) experiments.

2.4. Aggression Induction Via Mobile Game

The subjects were taught to play the smartphone game "Subway Surfers" until he/she is familiar with the game for 5 min [9]. Firstly, the game was played in the silence of mute mode. The subjects were asked to achieve a certain score (1500m/500gold coin collected) for the game and survive for at least one minute. The gold coin collecting while surviving the game was meant for inducing aggressiveness onto the subject. The urge to play the game after several fail attempts to achieve the goal is a form of aggressiveness that intent to be monitored through this experiment. Provided the goal is yet to be achieved, the game has to be repeated until the goal was successfully met. For subjects that fail to achieve the minimal goal after multiple training session and they felt hard to cope with that and wish to opt-out, their recording was excluded from the research analysis as the training and trying out process might apply too much stress for them affecting adding more uncertainty into the statistic pool.

2.5. Aggression induction experiments

For the whole EEG recording, the subjects had to complete four mental tasks, including resting tasks (Task #1 and Task #4) and mental active tasks (Task #2 and Task #3), the brief description of each task is explained in **Table 1**. Three trials session were recorded per experiment task for every subject. All trial sessions were conducted on the same day.

During experiment period, facial expression and posture of the subject while playing game and writing were recorded. This is important to record the moment where the subject was producing significant body movement that might induce noise in the signal recorded.

Table 1. List of tasks completed by each subject

Task #	Condition of Experiment
1	Resting state of subject before playing the game.
2	Playing "Subway Surfers" with sound muted.
3	Playing "Subway Surfers" with maximum volume sound.
4	Resting state of subject after finishing the game.

2.6. Filtering the raw EEG Signals

In this work, the Butterworth bandpass filter was used at cut-off frequencies of 0.5 Hz and 49 Hz to filter the signal from unwanted signals and noise. The Butterworth filter with orders 2, 4 and 6 was applied to filter the EEG signals of Task #1 to Task #4. To validate the effectiveness of different filter used, data loss was calculated by taking the ratio of the filtered data to the raw data. The 19 channels from both filtered and raw signal are being compared out of the 120 recording trials, which formed by 10 subjects performed 3 recordings for all 4 tasks (10 x 3 x 4=120).

$$Data\_loss = F_{ki} / G_{ki} \quad (1)$$

Where i = {1,2,3, …,*i*,…,19} and k = {1,2,3, …, k, …, 120}.

F is a filtered data and G is a raw data, *i* is the number of channel and *k* is the number of recording. The effect of Butterworth filter on the EEG signals was analysed by comparing the average time used for filtering and the ratio of data loss after filtering using the Butterworth filter.

2.7. Measuring the aggressiveness level, *A*

The point relationship of the task, R_k, was then compared to the baseline signal, R_B, to find out the differential signal, D_i, and was summed up to measure the aggressiveness level, *A*. The *D* is a row vector consisted of 171 values and *A* is a value that indicates the aggressiveness level.

$$D_i = \text{abs}\,(R_{iB} - R_{ik}) \quad (2)$$
$$A = \text{Sum}D \quad (3)$$

Where i = {1,2,3, …,*i*,…,19} and k = {1,2,3, …, *k*, …, 120}.

In measuring aggressiveness level, *A*, R_{ik} induced by the brain are compared with R_{iB} at the rest state. Two R_{iB} values are tested, which is the universal and the individual R_{iB}. The universal R_{iB} are measured by averaging the values of individual reference data.

3. RESULTS AND DISCUSSIONS

3.1. Universal and individual rest signal as the reference

Table 2. Aggressiveness level of subjects using universal rest data as reference

Subject	Task #1: Pre-game rest	Task #2: Mute gaming	Task #3: Max sound gaming	Task #4: Post-game rest	BPAI
1	24.70	33.27	35.05	36.39	32.60
2	16.89	48.28	43.69	25.06	42.68
3	35.72	20.95	19.47	35.67	48.48
4	21.96	18.20	23.05	20.41	32.74
5	47.05	22.95	23.86	46.26	22.01
6	14.22	21.54	22.22	36.14	41.99
7	14.63	19.75	22.22	37.14	36.51
8	47.76	22.50	20.91	45.93	53.81
9	34.16	22.18	24.03	28.21	31.27
10	50.01	46.22	42.97	75.48	29.57

Table 2 shows the aggressiveness level for all 10 subjects. The hypothesis is the aggressiveness level at the highest level at Task #2 and #3. However, look at the subject #3, the aggressiveness level at the Task #2 and #3 lower than the Task #1 and #4. The aggressiveness level at the Task #1 and #4 should be lower because the subject is at the relaxing state.

The further investigation is conducted to use the reference value of individual subject instead of using the universal reference. The investigation results are shown in Table 3. The table shows that for all 10 subject, the aggressiveness levels at the resting states are lower compared with the gaming state. The aggressiveness level at Task #1 and Task #4 are lower than the level at the Task #2 and #3.

The reason it happens is the effect of the individuality when inducing aggression. Further investigation could be conducted to see how far is the aggression level different among subjects.

Table 3. Aggressiveness level of subjects using individual rest as reference

Subject	Task 1: Pre-game rest	Task 2: Mute gaming	Task 3: Max sound gaming	Task 4: Post-game rest	BPAI
1	15.51	40.19	40.33	23.50	32.60
2	18.99	51.21	46.52	29.55	42.68
3	27.08	35.34	34.21	19.95	48.48
4	13.98	39.24	52.53	27.03	32.74
5	10.89	40.56	39.54	14.32	22.01
6	26.76	59.88	55.49	47.70	41.99
7	15.74	43.95	47.74	37.48	36.51
8	10.97	79.88	77.75	12.81	53.81
9	17.49	28.99	32.80	48.84	31.27
10	11.72	56.81	43.16	52.10	29.57

4. CONCLUSIONS

The paper proposes the design of an experimental protocol and the signal processing approach to measure aggressiveness level of the human subject. An experimental protocol is designed to induce aggression and the brain signals are measured by using EEG. The filtering technique which is Butterworth filter are employed in the investigation to remove the noises. Several parameters of Butterworth filter are tested in the experiments and the performance is measured by using Data_loss measure, however, its do not affect the performance the filter. The proposed aggressiveness levelling technique is capable to index the aggressiveness level and could be used for conducting further investigation in the future.

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