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Research Article

Measuring Aggressiveness of Human Subject by Using BPAQ Survey and Brain Signals

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ABSTRACT

Aggression is a human behaviour that has the potential to injure another person physically or emotionally. The aggression states of the human could be identify by using BPQ, however, some of the subjects are not honest while answering the survey. This effects the precision of the survey. In this studies, experimental works have been conducted to investigate the aggression states of the 10 subjects. The experimental protocol is proposed for inducing aggression while brain signals are recorded by using an electroencephalogram (EEG). The subjects are experience 4 states which are relaxing state before starting the experiment, aggression state when playing a video game in muted, aggression state when playing video game in a maximum volume, and post gaming state which is similar with the relaxing state but the time is after playing the video game. The subjects are asked to play a video game "Subway Surfers" while the brain signals are recorded. The original data may contain noises and a Butterworth filter is used to screen it. Then, the signals are cut into pieces called the window to extract significant features of the brain signals. The experimental protocols and signal processing techniques proposed can generate the aggression pattern.

1. INTRODUCTION

The term "aggression" is used in literature to refer to all aggressive hostilities. Aggression is a human behaviour that has the potential to injure another person physically or emotionally [1],[2],[3],[4].
The aggression states of the human could be identified by using Buss-Perry Questionnaire (BPAQ) [1]. However, in the recent years, Electroencephalogram (EEG) was used by the researchers to measure the aggression [5],[6],[7],[8].

This paper proposes an experimental study to measure the aggression through brain signals analysis. The designed experimental protocol aims to induce aggression. Signal processing techniques are used to process the raw brain signal. The proposed experimental protocol and signal processing techniques can generate the aggression pattern.

The flow of this paper is followed. The introduction covered the history of the research, as well as any pertinent information that has been published by prior researchers. The Methodologies discuss the experimental protocol and signal processing technique to extract aggression signature from human brain. The result discusses the performance of the proposed methods.

2. METHODS

2.1. Aggressiveness survey (BPQA) and an electroencephalogram (EEG)

The proposed investigation involved subjects to conduct aggressiveness survey and follows by EEG experiments to collect brain signals. The experiment starts with the subjects to answer the survey [5],[7],[9]. This evaluation survey was conducted manually before the EEG recording experiments to record the aggressiveness score of the subjects.

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2.2. EEG Recording Materials

The Mindset 24 EEG amplifier was used for the EEG data collection as shown in Figure 1. The EEG electrode placement is shown in Figure 2. The reference electrode was positioned on the left and right mastoids, and the 19 channel electrodes were placed on the scalp using the 10-20 electrode positioning method. The silver chloride (AgCl2) disc electrodes sensors used in the experiments. The Lycra Stretch Cap was used to fix the 19 electrodes tightly to the subject's head.

Fig. 1. 24 EEG amplifier

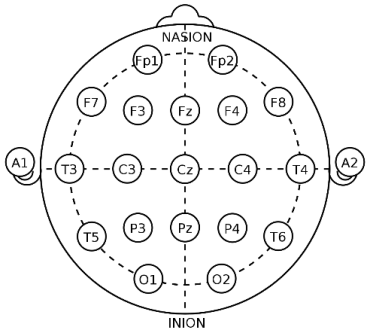

Fig. 2. Electrode's location (10/20 system)

2.3. Subject selections

Ten (10) subjects were selected to perform several tasks in the experiments.

2.4. Video game for aggression induction

Before the experiment, the subjects were instructed to play the video game "Subway Surfers" for 5 min [9]. In the experimental protocol, the first task was playing the game in silence mode or muted mode. The subjects were asked to complete the game with the score or 500 gold coins. The gold coin collected while playing the game was meant to induce aggressiveness onto the subject.

After multiple unsuccessful attempts to accomplish the goal, the desire to play the game is a sort of aggression that this experiment hopes to track. The game must be repeated until the aim was successfully reached, if it has not yet been accomplished. For subjects who did not achieve the minimum goal after multiple training sessions and who found it difficult to cope with that and desired to opt-out, their recording was excluded from the research analysis as the training and trying out process may have applied too much stress for the subjects, affecting adding more uncertainty into the statistic pool.

2.5. Aggression induction experiments

The aggression induces experiments consist of 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. EEG signals were recorded during the experiments. For each experiment task, three trial sessions were recorded for each subject.

Table 1. Four experimental states / Four tasks

Task	State / Task of the experiment
#1	Resting state [before playing the game]
#2	Aggression state [sound muted]
#3	Aggression state [Maximum sound]
#4	Resting state [Post game].

2.6. Filtering EEG Signals in pre-processing

Unwanted signals and noises were eliminated using a Butterworth bandpass filter with cut-off frequencies of 0.5 Hz and 49 Hz. For the investigation purpose, the filter orders 2, 4 and 6 were applied. To validate the effectiveness of different order filter used, data loss was calculated by taking the ratio of the filtered and raw / original data. The filtered and raw signals from 19 channels are compared. The experiments involve 120 recording trials, formed by 10 subjects, which performed 3 trials for all 4 tasks (10 x 3 x 4=120).

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

Where $i = \{1,2,3, \ldots,i,\ldots,19\}$ and $k = \{1,2,3, \ldots, k, \ldots, 120\}$.

F is a filtered data and G is a raw data, i is the number of channel and k is the number of recording. Analysis was done on the Butterworth filter's effect on the EEG signals.

2.7. 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 = abs ($R_{iB} - R_{ik}$) (2)

A= Sum of D (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 type of R_{iB} which are 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 states

Table 2. Aggressiveness level universal rest state as reference

Subject	Task #1: Resting	Task #2: Muted	Task #3: Max sound	Task #4: Post-game	BPQA
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

The aggressiveness level of all 10 subjects are shown in Table 2. The hypothesis states that Tasks #2 and #3 had the highest levels of aggressiveness. However according to the findings, subject #3 was less aggressive at Tasks #2 and #3 than at Tasks #1 and #4. As the subject is in a relaxing state, the subject's aggressiveness throughout Tasks #1 and #4 should be reduced.

Instead of employing a universal reference, further research is undertaken to determine the particular reference value for each subject. Table 3 shown the investigation results. The table demonstrates that the aggressiveness levels of all 10 subjects are lower during their resting states than during their gaming states. Tasks #1 and #4 are less aggressive than Tasks #2 and #3 in terms of level of aggressiveness.

The reason it happens is the effect of the individuality when inducing aggression. To determine how much the subjects' aggression levels differ from one another, more research could be done.

Table 3. Aggressiveness level individual rest state as reference

Subject	Task 1: Resting	Task 2: Muted	Task 3: Max sound	Task 4: Post-game	BPQA
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

3.2 Comparison of BPQA and EEG

Subject #2 and Subject #8 recorded the highest BPQ score as shown in Figure 3. Meanwhile, Subject #1 and #5 obtained the lowest BPAI results. Figure 4 is the results from EEG analysis. Subject #2's 0.11 Net Aggressiveness Index (NAI) score is the lowest of all subjects. Subject #8's NAI of 0.35 is the highest value reported. Based on the results obtained a comparison with BPQA 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 BPQA. The reason why the BPQA recorded a low BPAI is because the

respondents of Subject #2 were unprepared and responded randomly.

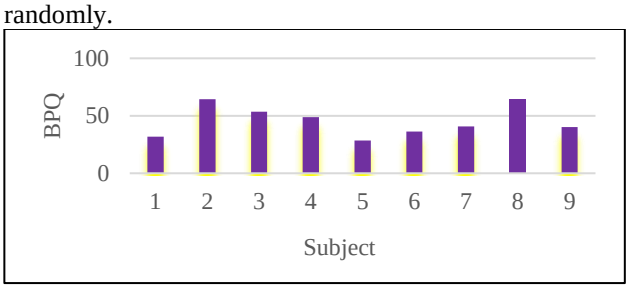

Fig. 3. BPAI analysis for 9 subjects

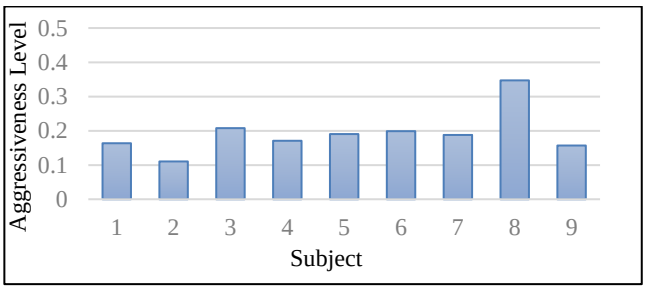

Fig. 4. EEG analysis for 9 subjects

4. CONCLUSIONS

The paper proposes the methodologies to measure the aggression level of the human subject. In the investigation, the subjects are asked to do BPQA survey. The designed experimental protocol used to induce aggression. In the pre-processing, the Butterworth filter are used to reduce the unwanted noises. The significant order of Butterworth filter are examined in the experiments and the performances are measured by using *Data_loss* measurement, however, the results show that isn't affect the performance the filtering results. From the results, the proposed methodologies have the ability to measure the aggressiveness and may be applied in future research.

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