APPLYING EYE TRACKING DEVICE ON THE GAZING BEHAVIOUR AND ITS EFFECTS ON EMOTIONS ATTRIBUTES

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ABSTRACT: Recent eye-tracking technology has grown popularity in various field of research and industry. However, it has been a challenge to identify human emotional states using eye tracking method. The purpose of this study is an empirical attempt to apply the eye tracking device and method to investigate the relationship between human emotions and eye-gaze behaviors. In order to achieve this purpose, nine emotional video stimuli such as Amusement, Joy, Neutral, Sad and Fear are used to stimulate two types of emotions which are positive and negative. These stimuli are displayed and emotions are measured using eye- tracker, Tobii TX 300. Fifteen students from Malaysian-Japan International Institute of Technology (MJIIT) are randomly chosen for the study. The results obtained are in the form of fixation duration and pupil dilation. The results are filtered and tabulated to analyze the related behavior. Mean fixation duration and pupil dilation are calculated to identify the video stimuli with the highest count. ANOVA analysis shows that the significance, p-value is 0.43 for fixation duration. Whereas, p-value 0.003 for pupil dilation indicating there is a significant relationship between eye-gaze behavior and emotion. This study might be favorable in usability issues in human-computer interaction (HCI) contexts.

KEYWORDS: *Eye Tracking; Emotions; Gaze Behavior; Pupil Dilation; Fixation Duration*

1.0 INTRODUCTION

The word "emotion" denotes to relations among external incentives, thoughts, and variations in internal feelings [1]. The emotions expressed by humans can be distinguished into two inclusive groups which are negative and positive. When human involves in dreadful situations, negative emotions are aroused. Similarly, when we see or involve ourselves in pleasurable or appealing situations, positive emotions are induced.

Emotion recognition has received considerable research attention since the 90s. In the past few decades, the development in eye tracking technology have enabled an increasing number of researches on emotion recognition since emotion recognition has great significance and wide applications [2]. Emotion recognition is an important issue to be addressed for understanding human behavior, exploring the mental state and deciphering social relations. However, automatic emotion recognition has become a great challenge to achieve. Automatic recognition of emotions might even be advantageous to sustain psychological studies. As an example, such studies might provide a baseline of emotional response of healthy subjects that can be used and compared to diagnose mental disorders like syndrome, or depression [3].

This response quoted as "the eyes are the mirror to the human soul" which meant emotions are not only distinguished by facial expressions, but can also be deduced from the eye gaze [4]. Eye tracking technique has been used as a medium for eye gaze behaviors and emotions.

Eye tracking as a research tool is more accessible than ever, and has been gaining in popularity over the past decade among researchers all over the world especially as a window into observers' visual and cognitive processes [5]. The word eye tracking as it is used here means the approximation of orientation of the user's gaze [6]. Hence, eye tracking has been chosen as the method to measure and to reveal information about underlying cognitive processes in eliciting the emotions [7].

Using the eye tracker, we can study how fixations (looking at the static place for a certain period of time), saccades (eye movements in a short period of time) and pupil dilation (variation in pupil sizes) are associated with the display on the screen and behavioral choices during an experiment. It has been proposed that eye motion can aid in

forecasting subjective emotional experience [8]. Therefore, in this study, besides taking pupil size into consideration, fixation will also be explored to distinguish the emotional condition.

Previous studies in [9-13] indicated that, while viewing emotional scenes, more fixations are prompted compared when viewing neutral stimuli. Within emotional stimuli, study by [14] found that negatively valence stimuli are viewed longer than positive ones whereas the study by [15] indicated the exact opposite pattern.

Whereas, several studies by [16-20] have demonstrated that emotional arousal during affective picture or film viewing is associated with enlarged pupil sizes. Besides that, work by [21] has indeed illustrated that the pupil is delicate to the emotional content of pictures. These findings also correlates with study by [22]. Within emotional stimuli, some authors [23] and [24] found that negatively valence stimuli (such as fear) trigger larger pupil dilations than positive stimuli (like laughter).

In the existing study, we therefore aim to investigate the relationship between eye-gaze behavior such as fixation duration and pupil dilation and expressions to positive and negative emotions; to analyses the relationship between different types of emotional stimuli (positive, neutral and negative) and its corresponding eye activities; and, to study the difference of eye gaze behavior between positive and negative emotions. Unlike most of the previous studies which only use one type of eye gaze behavior for investigation, this study used two types of eye gaze behaviors to find which one portrays emotion better. We expect higher fixation and pupil dilations on emotional stimuli. Within emotional stimuli, we expect negative stimuli to fixate longer than positive ones whereas negative stimuli to have larger pupil dilations compared to positive ones. Lastly, we expect pupil dilation to portray emotion better than fixation duration.

2.0 METHODOLOGY

2.1 Stimuli

In this study, nine video clips have been chosen to trigger the five types of relevant emotions. The five types of video stimuli shown were joy, amusement, neutral, sad, and fear. The first video clip, displayed as "JOY1" is a compilation of dance videos around the world for Pharell Williams's hit song, Happy followed by the second clip "JOY2" which is an American Idol video of a girl singing with her puppet. The third

video on the list was "AMUSEMENT1" which is the recording of an experience of two men going on a roller coaster ride followed by the fourth video "AMUSEMENT2" which is a comedy video of Mr. Bean preparing a Christmas Eve dinner. The fifth video displayed was "NEUTRAL" where it the scenery of the ocean was shown for at least a minute. The sixth video displayed is "FEAR1" where it played a part of the scene from the movie of Final Destination 6, Candice's death during her gymnastic training followed by the seventh video "FEAR2" which is a scene from the movie Carrie, of a disaster happened during her prom and her killing her friends despite of anger. The next video displayed was "SAD1" where it displays a short scene from the movie of Raja Rani during the accident of Nazriya and her death was shown, followed by the last video "SAD2" which is a sad scene of a small boy crying to his mother for being ugly and bullied. These nine videos were displayed not according to the order. The order is randomly arranged.

2.2 Subjects

15 healthy and young people were chosen as the subjects for this study. Out of the 15 subjects, 10 are females and others are males. The subjects are from age range 20 to 30 years and are students from MJIIT. All of them are free from any disease and medication. All subjects were asked to remove their spectacles or lens before the experiment. They were also required to sign an informed consent before beginning the experiment.

2.3 Software and Hardware

Eye gaze data was recorded while performing the task by using Tobii TX300 eye tracker. Tobii TX 300 is a standalone eye tracker. The sampling rate was set at 300 Hz. The eye tracker collects and records all the data in its system. The data used for this study is fixation duration (duration of each fixation in milliseconds), and pupil dilation (estimated size of pupil in millimeters).

2.4 Experimental Procedure

The experiment was organized in a closed room in Bio cognition Laboratory at a room temperature of 25 degrees. Subjects were instructed to sit at their own comfortability. Then, the subjects were displayed with nine emotional video stimuli which trigger the five types of emotions such as Joy, Amusement, Neutral, Sad and Fear. Each video will be played for around one minute on average. Hence, the subject will be required to spend about nine to ten minutes in total to watch the sequence of nine videos. The subjects were briefed on the flow of the experiment.

They were asked to observe the video as they would routinely do at home. The subjects were taken through a calibration procedure before the experiment started. This calibration was repeated if recalibration was required. Once the calibration is completed, subjects were displayed with an instruction element screen which asks the subjects to clear their thoughts and then the video stimuli would start. The gaze data was recorded by the eye tracker while the subjects watched the video stimuli. Once the experiment completed, the live recording playback with the fixation was shown to the subjects. The gaze data recorded from the experiment were then extracted from Tobii Studio to Microsoft Excel for further analysis. The collected data was analyzed and filtered. Raw data that capture less than 70% from the subjects were excluded due to insufficient eye gaze data.

The raw eye gaze data from fifteen subjects were filtered. Filtering process includes rearranging the data based on the video stimuli type. The analysis was focused on the fixation duration (duration of each fixation in milliseconds), and pupil dilation (estimated size of pupil in millimeters). The fixation index was filtered and its duplicates were removed. This is because there were more than one data for every fixation count, and all these data shows the same value in terms of fixation duration and pupil dilation. Each subject has nine sets of data where each set represents the data from one type of emotional video. ANOVA analysis has been done on the result obtained from fixation duration and pupil dilation.

3.0 RESULTS AND DISCUSSION

3.1 Fixation

Figure 1 shows the mean fixation duration of subjects from positive video stimuli whereas Figure 2 shows the mean fixation duration of subjects from negative video stimuli. According to Figure 1, the video with highest fixation duration is “Joy1”. According to Figure 2, the video with highest fixation duration is “Fear1”. When comparing negative and positive video stimuli, “Joy1” shows the highest mean fixation duration of (3835.197581 ± 2714.183806) ms whereas “Sad1” shows the lowest mean fixation duration of (1724. 296924± 1400.06235) ms. The data shown in Figure 1 and Figure 2 are the exact taken from the calculation done in Microsoft Excel.

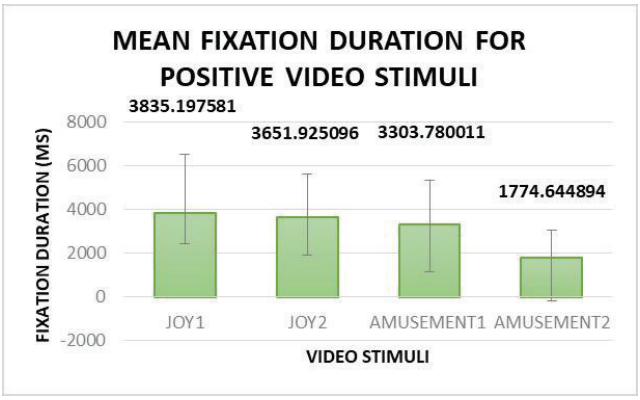

Figure 1: Mean fixation duration of subjects from positive video stimuli

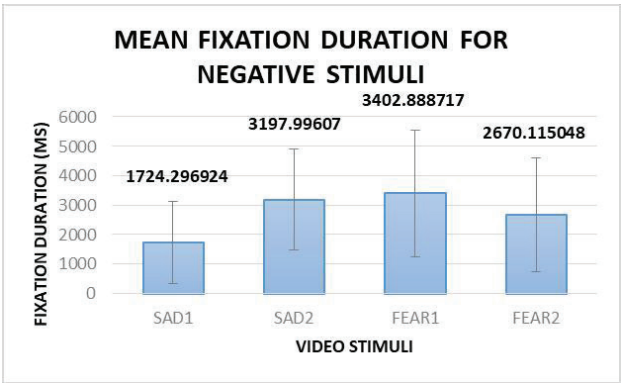

Figure 2: Mean fixation duration of subjects from negative video stimuli

Figure 3 shows the mean fixation duration of subjects on types of emotions. Results show the mean fixation duration of subjects on types of emotions. Results show that neutral video stimuli has the highest mean fixation duration (3418.803799 ms) and the lowest mean fixation duration is found in negative video stimuli (2748.82419ms). This result also shows the neutral video stimuli has attracted more interest among the subjects compared to other video stimuli.

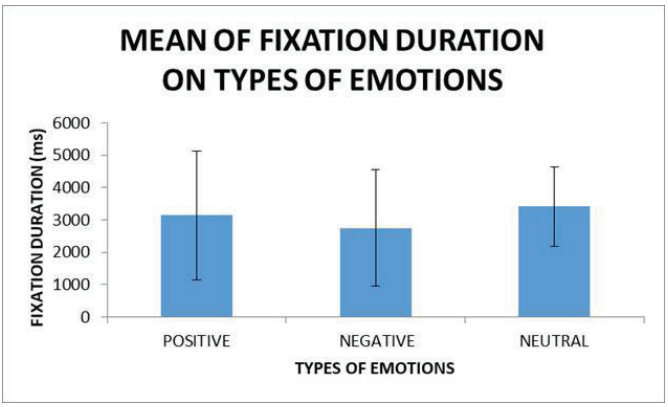

Figure 3: Mean fixation duration of subjects on types of emotion

Kaspar et al. [11] showed that subjects fixated mostly on emotionally neutral pictures when they are in a positive mood condition which correlated with this study. Besides that, Nummenmaa et al. [13] also depicted that emotional pictures endorse attentional engagement and directly capture the subjects' interest, resulting in fixation durations mostly on emotional pictures. Therefore, the present study shows that video stimuli which projects positive stimuli has higher fixation duration compared to video stimuli which projects negative stimuli which correlates with the study by [15].

Whereas, according to the ANOVA analysis for fixation duration, the significance value, p is more than 0.05 which indicates that there is no significance between human emotions and eye-gaze behavior as the p value for this analysis is 0.4265.

3.2 Pupil Dilation

Figure 4 shows the mean pupil dilation of subjects from positive video stimuli whereas Figure 5 shows the mean pupil dilation of subjects from different video stimuli. According to Figure 4, the video with highest pupil dilation is "Amusement2". According to Figure 5, the video with highest pupil dilation is "Fear1". When comparing negative and positive video stimuli, results show that highest mean pupil dilation shown in "Fear1" video stimuli whereas lowest mean pupil dilation shown in "Amusement1"video stimuli.

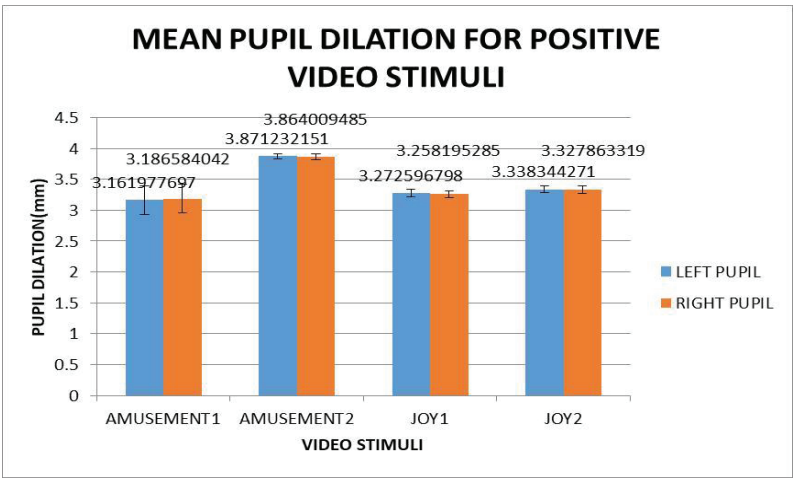

Figure 4: Mean pupil dilation of subjects from positive video stimuli

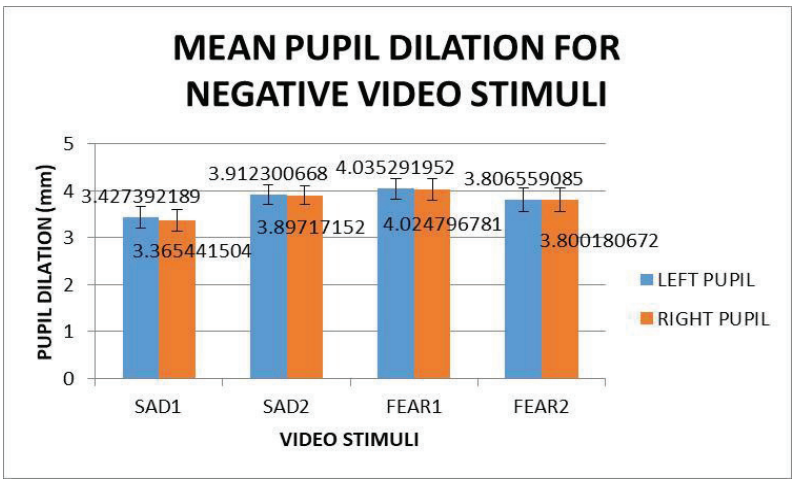

Figure 5: Mean pupil dilation of subjects from negative video stimuli

Negative video stimuli shows the highest mean pupil dilation (3.79050 ± 1.02192 mm) when compared to positive video stimuli and neutral video stimuli. The data shown in Figure 4 and Figure 5 are the exact taken from the calculation done in Microsoft Excel.

Pupil size is one of the indicators of the brain's activity. Prior studies have suggested that the cognitive processing and affective information affect the size of pupils in humans. For example, it was found that pupil size increased when cognitive load was increasing [3]. The studies by [16-22] have supported with our study as they noted that pupil dilated during viewing of emotional stimuli. Hess [25] also reported that the pupil constricted when people viewed pictures that evoke negative emotions and dilated when they viewed pictures which evoke positive emotions. These findings contradicted with our present study as the negative emotions showed the higher pupil dilation whereas positive emotions showed the lower pupil dilation. These results correlated with the studies in [23-24].

However, the ANOVA analysis for the pupil dilation shows the significance value, p is 0.0029 which is less than 0.05 indicates that there is a significance between human emotions and eye-gaze behavior.

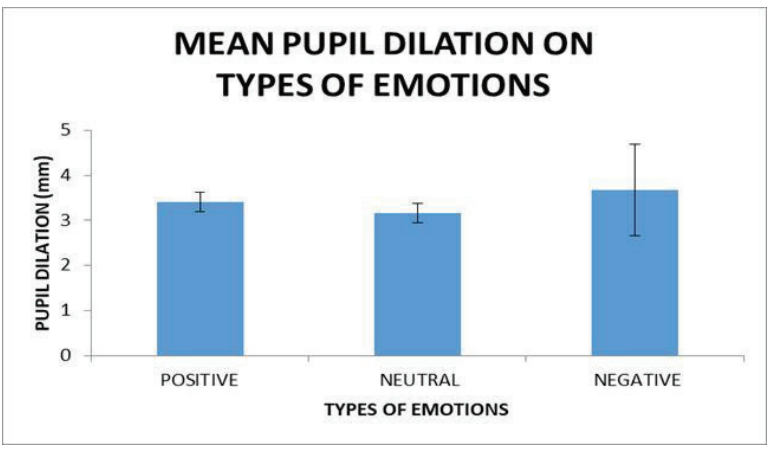

Figure 6: Mean pupil dilation of subjects on type of emotions

4.0 CONCLUSION

Automatic recognition of the human emotional state had a boundless concern recently for its applications not only in the Human Computer-Interaction (HCI) field, but also for its applications in psychological field. In this study, we investigated eye tracking in response to different emotional arousals. In particular, the goal was to investigate a set of eye activities, including pupil size, fixation duration and fixation count to detect the emotional state. In detail, we used Tobii TX300 eye tracker to acquire pupil size and fixation duration. In this experiment, we investigated whether eye activities in positive and negative stimuli can be a viable mean to categorize different affective states. Results showed

that significant differences were found in pupil size for positive and negative films however, fixation duration for both positive and negative were not significantly different. Therefore, it shown that there is relationship between eye-gaze behavior such as fixation duration and pupil dilation and expressions to positive and negative emotions was achieved. This shows that pupil dilation is better in portraying emotions. Secondly, the relationship between different types of emotional stimuli (positive, neutral and negative) and its corresponding eye activities were also shown. Lastly, there is difference of eye gaze behavior between positive and negative emotions shown for both pupil dilation and fixation duration. Overall, these results suggest that further researches of fixation to detect different emotional states are needed.

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