Brain activation associated with video gaming stimuli in Internet gaming disorder (IGD) among Malaysian adolescents

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Abstract. The rapid development of Internet gaming technology in Malaysia has come with a cost of greater vulnerability in becoming addicted to video games especially for an adolescent whose mental abilities were not matured yet. This study aimed to investigate the differences in human neural activation using fMRI that being triggered by gaming video among Malaysian young adult. The 16 participants with Internet addiction were recruited. They undergo approximate 10 minutes of task-based fMRI scanning that will be presenting an ordered games-related and control short video simultaneously. Data were analyzed using MATLAB 9.3 (R2017b) and Statistical Parametric Mapping 12 (SPM 12) to evaluate brain activation. Based on the result, these the regions activated are known to be linked in visuospatial, somatosensory, semantic memory processing, emotional response, reward, integrating information process, memory retrieval, spatial navigation, and orientation. These findings may yield more in-depth in this study and provide a deeper understanding in developing appropriate guidelines and interventions to treat Internet gaming addicts community, especially in the Malaysian population.

1. Introduction

In Malaysia commune, playing video games was on rising speedily and becoming a new trend nowadays as the rapid development, accessible and affordable equipment of gaming technology in Malaysia has come with a cost of greater vulnerability in becoming addicted to video games especially for a high-risk group. In adolescent, the critical stage happens where they tend to take risky decisions behaviors as well to exhibits significant emotional reactivity compare to adults nor children [1]. So, this study aimed was to investigate the differences in human neural activation using fMRI that being triggered by gaming video among Malaysian young adults as today youth generation are easy to be influenced by surroundings or trends without proper guidance. The IGD individual demonstrates many similarities in physical and psychosocial manifestations with substances use disorder, including
cerebral changes in fMRI scanning [2]. Meanwhile, the resting-state functional connectivity (rsFC) of the DLFC (dorsolateral prefrontal cortex) between nicotine-dependence smokers and IGD showed that both addictions shared alike of neural mechanism in impulsive inhibitions and craving towards nicotine and games [3]. Hopefully, this study can able to contribute a new piece of knowledge to Malaysian society regarding the Internet gaming disorder and capable to construct appropriate guidelines of Internet gaming usage among adolescents.

2. Materials and Methods

A total of 16 participants were recruited to partake in this study. This study applied a convenience sampling method. All participants have been explained and notified with risks of the study before the scanning session began. Participants with metal implants or claustrophobic were immediately excluded from taking part in this study. The Internet Addiction Test (IAT) contains 20 items that assess the intensity of problems associated with Internet usage such as compulsive use, withdrawal symptoms, psychological dependence on a 5-point scale [4]. The total score of 43 was a suitable cut-off points in determining Internet and non-Internet dependence users in Malaysian community [5]. The Internet Gaming Disorder Scale—Short Form (IGDS9-SF) were self-reported scale with the nine items about any gaming-related activity played in any kind of devices with total score range between 9 to 45 points with a higher score and met five or more criteria out of nine correspond to a higher degree of IGD [6].

2.1. MRI Acquisitions

This study was conducted using a non-invasive functional magnetic resonance imaging (fMRI) of 3.0 Tesla Siemens Magnetom Verio machine which benefits in increasing signal-to-noise ratio. These are following acquisition parameters for tb-fMRI according to Wang et al. (2017): repetition time (TR) = 2000 ms, echo time (TE) = 30 ms, flip angle = 90°, field of view (FOV) = 220 x 220, matrix size = 64 x 64, interleaved sequence: 33 slices per volume. In this study, we applied a gaming-related short video in tb-fMRI scanning. Participants were required to respond to a 552-seconds of video game-related block-design task which it consisting of six-block segments. There are three types of 20-seconds video games conditions used as a stimulus that showing a selected gaming scene. The conditions represented in each block was defined as massively multiple online role-player (MMORPG) video clips (M), general games video clips (G) and mosaic clips as a control (C). Each condition was followed simultaneously by strength scale, where participants are asked to respond their cravings towards the video shown. Each blocks have a fixation state (F). Meanwhile, general games video was a video game that not involving MMORPG, violence, war or shooting and more required thinking skills.

2.2. Statistical Analysis

All descriptive statistical analyses were performed using SPSS Statistics 23.0 for Windows (SPSS Inc., Chicago, IL, USA; https://www.ibm.com/my-en/products/spss-statistics) while raw data from functional MRI scanning were analysed by using MATLAB 9.3 version of R2017b (MathWorks Inc., MA, USA; https://www.mathworks.com/products/matlab) and Statistical Parametric Mapping 12 (SPM12) package (Functional Imaging Laboratory, Wellcome Department of Imaging Neuroscience Institute of Neurology, University College of London, UK; https://www.fil.ion.ucl.ac.uk/spm/software/spm12) with Wfu-PickAtlas software toolbox to producing a best quality of ROI masks results (ANSIR Laboratory, School of Medicine, Wake Forest University, North Carolina, USA; https://www.nitrc.org/projects/wfu_pickatlas/).

3. Results and Discussion

For the neurological assessment, the 81.25% (n=13) of participants was moderate Internet users with 12.5% (n=2) are severe depend upon Internet usage and 6.25% (n=1) is normal Internet user. The average score for IGDS9-SF score was 23 with a range score between 11 and 37. The higher score in
IGD will determine the higher degree of IGD [6]. From this results, it informed that majority of the participants were average Internet and online gaming consumers. Through this data, it can describe the addictive online gaming have relevance directly or indirectly with Internet addiction as both have a moderate IAT and IGD average scoring. As Malaysia is known as a multi-ethnic country, so our participants were consists of 11 Malay, 4 from Chinese ethic and an Indian. Neither gender, ethnicity, employment status IQ nor education performance has played a major role in IGD as there are no significant differences in those factors [7, 8]. Meanwhile, a contradict study claimed that gender differences do affect the motives for online gaming as males have higher tendency to get addicted to gaming with their low self-esteem and lower life satisfaction compare to female [9]. The difference in yield is probably due to the different sample sizes used in the study.

Brain activation happen on the left occipital middle, parietal superior, temporal middle, hippocampus and postcentral. Meanwhile in the right hemisphere, only activated on occipital middle, thalamus, and parietal superior. Those regions are known to function efficiently in visuospatial, somatosensory, semantic memory processing, emotional response, motivation, reward, integrating information process, memory retrieval, spatial navigation, and orientation. The results obtained was correspond to our previous preliminary study on brain pattern towards the gaming cue which participants demonstrated a higher activation on the temporal, occipital and parietal lobe regions stimulated by general games videos while MMORPG activated more on the temporal, frontal and parietal lobe [10]. The role of right middle occipital gyrus (MOG) is including spatial processing in both auditory and haptic sensation and involves semantic processing prone to pictures than words [11, 12]. As activation of middle temporal gyrus (MTG) occur in word and picture semantic processing [13]. In our perspective, MTG and occipital lobe have been mostly activated during the gaming cue-induced during fMRI as most gamers recognized and familiar with their avatar feature in video games shown. Our findings similar that recorded there was a significant increase an activation MTG and concluded that MTG has a significant relationship with gaming craving [14, 15]. These findings suggest that functional connectivity of occipital lobe especially in the right hemisphere and also MTG may be contributing to the gaming cue-induced craving as its showed bias on picture presentation during fMRI scanning.

![Figure 1](image1.jpg)  
**Figure 1.** Brain activation by conditions ((a) MMORPG, (b) General, (c) Control) analysed under corrected cluster level

![Figure 2](image2.jpg)  
**Figure 2.** Comparison between MMORPG and Control ((a) right hemisphere, (b) left hemisphere) (p < 0.001)
4. Conclusions
To be concluded, the brain activity is likely activated on similar regions for conditions; MMORPG and General but overall MMORPG do give a higher brain activation compared to other conditions. In the future, this study can contribute to the proper implementation of alternative non-invasive treatment neurobiological in IGD.

5. References
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