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Deception and False Memory in Delinquency: An ERP Study

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Abstract

Delinquents are often associated with deception. However, there is another phenomenon which is far more menacing known as false memory. These two phenomena are different but resulting in the same detrimental consequences. Thus, the aim of this study was to examine the difference between normal individuals and delinquents in their performance during false memory and intentional deception tasks. Using DRM paradigm, both groups' performances were measured by analyzing their reaction time (RT), and percentage of 'Yes' responses (accuracy) to the different types of target words. EEG was used to measure P300 Event Related Potential (ERP) for false memory and deception. Findings showed that there was a significant difference between groups in terms of accuracy for false recognition. Non-delinquent participants took longer time in deciding a deceptive response compared to the delinquents, whereas the delinquent participants took more time in responding to false recognition. Finally, P300 event-related potential (ERP) analysis revealed amplitude differences between normal and delinquent participants for deception task; however, there was no significant difference in false memory condition. In conclusion, studies investigating reaction times and neural activities are important for better understanding of the mechanisms underlying false memory and deception.

Keywords: Deception, False Memory, Delinquents, P300, ERP, EEG

Introduction

Adolescence has long been associated with emotional turbulances (Hall, 1904). These emotional turbulances and the period of transisting from adolescence to adulthood may lead to various kinds of problems, especially those adolescents who are at-risk adolescents. Researchers have long studied problems associated with adolescents such as drug abuse and use, depression, eating disorders and delinquency (Santrock, 2005). With regard to delinquency, there has been a rise in the number of cases especially in Malaysia in just a year. For example, the most recent statistics from the children statistics was in 2016 where it was reported even though the number of juvenile offenders declined 10.3 % from 5,096 cases (2014) to 4,569 cases (2015), there was an increase in repeated offence (increase of 12.4 %) from 371 cases (2014) to 417 cases (2015) (Department of Statistics Malaysia) . Often, researchers studying juvenile delinquents focused on psychosocial factors, such as family functioning and resiliency, in relation to delinquency (e.g., Nasir, Zamani, Khairudin & W. Sulaiman, 2011; Nasir, Zamani, Khairudin & Latipun, 2010; Gorman-Smith, Tolan & Henry, 2000; Cashwell, & Nicholas, 1996). Previous studies adopted a correlational method using questionnaires. Such studies lacked convincing arguments as to the causes and effects of delinquency.

Recent advances in the field of psychology revolve around cognitive neuroscience. The development of new techniques, such as the direct study of the brain using advanced equipment like functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG) has allowed psychologists to gain better understanding of human consciousness and behaviour. The current study sought to discover the brain mechanisms underlying juvenile delinquents' decision making at a neurocognitive level that may lead to their delinquency. Consequently, the current study undertook a different approach to explore delinquency by adopting an experimental approach. More importantly, the EEG method was adopted as it is one technique that has gained much attention in the study of the mind (e.g., Shen & Jones, 2011; Evansa & Federmeier, 2009; Miasnikov & Weinberger, 2012). This technique allows a direct measurement of neural activities in the brain in relation to a task performance. It measures continuous brain-wave patterns, or electrical activity of the brain, as recorded with the placement of electrodes positioned on the scalp. The resulting outcome reflects the summation of the activity of millions of individual neurons (Peters, 2009). In short, the current study set to explore a new approach in the attempt to understand juvenile delinquency in Malaysia.

It has been shown that deliquents have a high tendency to make false confessions (Loftus, 2004; Gudjonsson, Sigurdsson, Asgeirsdottir & Sigfusdottir, 2006). This is significant as their statements in court may determine their future. A study by Warr (2007) has shown that juveniles who often lie to their parents are strongly correlated with delinquent behaviour. He went on stating that the violation of trust between parents and child often being understated for the association with delinquency. In another study, Sweeney-Reed, Riddell, Freeman and Nasuto (2012) have demonstrated changes in neural processing in mild cognitive impairment. In their study, EEG was used to measure neural processing in participants with mild cognitive impairment compared with typical, age-matched controls. They found a significant inter-group differences in neural processing during false memory tasks. Following a similar paradigm, the current study adopted Sweeney-Reed et al.'s method to study false memory and intentional deception in juvenile delinquents. Participants in the current experiment were 30 juvenile delinquents and 30 age-matched controls (N=60). The focus of delinquency in this study were on three categories: drug abuse, fights and rape.

Based on the above mentioned problem, hypotheses were established as follows:
There is a significant difference in false memory between juvenile delinquents and normal juveniles.

1. There is a significant difference in deceptive memory between juvenile delinquents and normal juveniles.
2. There is a difference in amplitude of P300 between delinquent and normal participants for false memory and deceptive memory.

This study embarked on the following objectives:

1. To investigate the difference in the recognition performance of false memory and intentional deception between juvenile delinquents and normal youth.
2. To examine the P300 ERP component differences in delinquent and normal participants in false memory and deceptive memory.

Methodology

Participants

Participants in the current experiment were 30 juvenile delinquents and 30 age-matched controls (total N = 60). The ages of participants ranged from 14-19 years old. All participants were males. The juvenile delinquents were trainees from Sekolah Tunas Bakti Sg. Besi, Kuala Lumpur (STB). STB is an Approved School that provides behavioural modification programmes for juvenile offenders. Trainees that were involved in the current study were prosecuted for stealing, selling and possessing drugs, involved in gang fights, and rape. Non-delinquent participants were recruited from high schools and university students from foundation studies via advertisements. The study adopted purposive sampling method.

Materials

False memory was measured using the Deese-Roediger-MacDermott (DRM) paradigm. It is a paradigm first introduced by Deese (1959) and extended by Roediger and MacDermott (1995). Participants in the experiment viewed a list of related words and then falsely recalled or recognizeed the presence of a word associated with the list termed the critical lure word. The experiment adopted a list of words taken from Roediger and McDermott's (1995) original DRM list (see Appendix). Ten lists of 15 words each were translated into Bahasa Malaysia using Brislin's back-to-back translation method (Brislin, 1970). Development and presentation of stimuli were done using a PsychoPy version 1.8 in a Windows 10 desktop. Presentation of the stimuli was done using the primary computer, whereas a secondary computer was used to record the brain activity data. EEG was recorded using Brain Products V-amp amplifier, which consisted of 8 channels with 2 additional channels serving as the ground and the reference. Data collection was done in the Cognition Lab, department of Psychology, Universiti Kebangsaan Malaysia (UKM).

Procedures

False memory task

Participants were debriefed about the study and were asked to fill up a consent form. Ten practice trials were conducted on participants to ensure that they fully understood the task. The experiment consisted of two phases: learning phase and test phase. In the learning phase participants viewed 15 words. After they have viewed all 15 words, participants were asked to complete a puzzle (distractor task) for 1 minute to reduce serial position effect.

After completing the distractor task, participants proceeded to the test phase. In this phase, participants had to recognize the items displayed in the learning phase. Unbeknown to the participants, there were distractor words added in the test phase (new words that were not in the original list). One of these distractors was the critical lure (an associated word with the words in the learning phase but was never included in the original list). An example of a critical lure was "tidur" (sleep) which did not appear in the list of words tilam (mattress), rehat (rest), terjaga (awake), penat (tired), mimpi (dream), bangun (get up), lena (deep sleep), selimut

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(blanket), lelap (nap), nyenyak (sleep well) , dengkur (snore), katil (bed), aman (peaceful), menguap (yawn) dan mengantuk (sleepy). Each word was displayed on the screen for approximately 1600ms followed by a 1000ms blank screen for the response (Figure 1). Participants had to press the key "Z" on the computer keyboard if they thought that the word was in the original list or "M" if they thought that the word was not in the original list. The task was repeated for 10 times with 10 different lists of 15 words in each list. Thus, there were a total of 150 trials divided into 10 blocks. EEG was recorded only in the test phase to record brain activity during false memory task.

(Trial 1)

(300ms) (1600ms) (1000ms)

(*Trial 1*)

Figure 1: Stimulus presentation sequence

Intentional deception task

The intentional deception task was adopted from deception task by Abe et al. (2008). Words were taken from the DRM task to be used in the intentional deception task. Similar to the false memory task, participants went through two phases, namely, learning phase and test phase. Participants viewed 15 words in the learning phase followed by a distractor task. In the test phase, participants had to recognize whether the words appeared in the learning phase. The only difference in the task was that participants were told to lie with their responses. Participants were told to say "no" if they thought the word was in the original list by pressing the 'Z' key or said "yes" if they thought that the word had never been in the original list by pressing the 'M' key. All key presses were counterbalanced between participants.

ERP recording

EEG was recorded only in the test phase to record brain activity during false memory and intentional deception tasks. A modular EEG recording cap from Brain Products was used with passive electrodes attached to the V-Amp amplifier. Electrodes were placed on the scalp using Nuprep EEG skin prep gel to the following locations: Fz, F3, F4, Cz, Pz, P3, P4. Forehead electrode acted as the ground, whereas the mastoid as the reference. EEG signals were amplified by the V-amp amplifier. Eye blink artefacts were removed with trials that contained larger deflections (90 mv). Signal was filtered with 12dB filter between 0.1 and 40 Hz low and high bandpass filters. Sampling rate was 500ms. Epochs between -200ms to 1500ms stimulus onset were extracted in both false memory and intentional deception tasks. ERP averages were calculated for the critical lure words for false memory, and intentional deception words in both groups of participants.

Results

Behavioural results

The data were analyzed using Mixed-model ANOVA. The between subject design was group types (delinquents vs normal), and the within subjects design was three Target types: critical lure, new items, and intentional deception of new items. Only "Yes" responses on targets were analyzed. Analysis revealed that there was no significant difference in RT for responding to different target types between delinquent group and normal group: $F(1, 58) = 0.42$, $p > 0.05$. However, 2-way ANOVA showed that there was a main effect of different target types: $F(1.68, 97.21) = 14.78$, $p < 0.05$. Both groups of participants exhibited the longest reaction times for new items, while the shortest reaction times were on critical lures ($M = 1.27$, $M = 1.06$ respectively). There was no significant interaction between group types and target types: $F(1.68, 97.21) = 0.60$, $p > 0.05$.

SPANOVA was carried out on the data to see the main effects groups and target types in the comparison of intentional deceptive memory. Refering to Abe et al (2008), only "Yes" responses on new items or targets for intentional deceptive task were recorded. When compared between false memory and intentional deceptive memory, results showed no significant main effect of different groups. In other words, delinquent group and normal group showed similar reaction times toward responding to critical lures (false memory) and new target for deception (intentional deceptive memory), $F(1, 58) = 0.42$, $p > 0.05$. However, Multivariate Pillai's Trace test showed a significant main effect of target types, $F(2, 57) = 20.69$, $p < 0.05$. The mean reaction times for new items for intentional deception were the longest and reaction times for new items were the shortest (Mean = 1.33, Mean= 1.06; new items for intentional deception, new items, respectively). There was a significant interaction between group types and target types, $F(2, 57) = 5.89$, $p < 0.05$. The interaction revealed that there was a difference in reaction times for delinquents and normal depending on the target types. When compared reaction times for critical lures (false memory), the normal participants responded faster than delinquent participants (Mean = 1.00, Mean = 1.12; normal, delinquents, respectively). This difference was not significant. However, for the intentional deceptive memory, the delinquents responded faster to new items than normal participants (Mean = 1.43, Mean = 1.24; normal, and delinquent respectively) (Figure 2). The mean scores for different target types and different group of participants are shown in Table 1 and Table 2.

Table 1: Mean reaction times for different target types in normal participants

Mean reaction times for "yes" responses	True items	Critical lures	New items for intentional deception
Mean	1.01	1.00	1.43

Table 2: Mean reaction times for different target types in delinquent participants

Mean reaction times for "yes" responses	True items	Critical lures	New items for intentional deception
Mean	1.03	1.12	1.24
SD	0.21	0.33	0.27

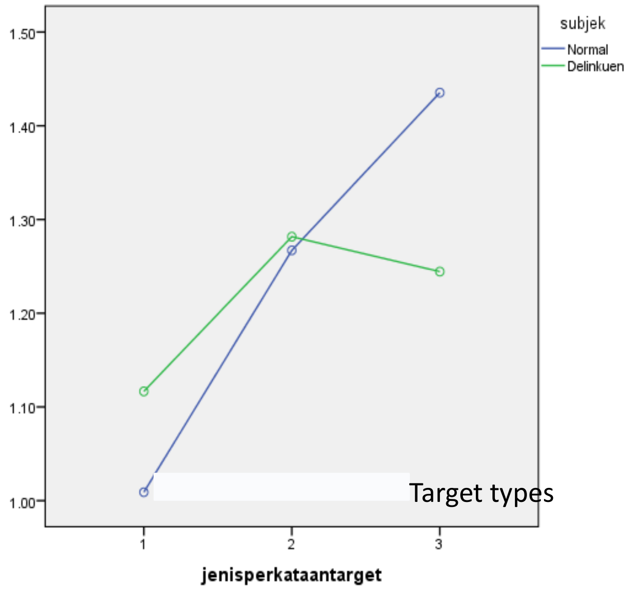

Figure 2: Interaction between group types (delinquent and normal) and target types (critical lures, new words, and new items for intentional deception).

P300 Analysis

ERP was obtained from EEG data analysis of each participant by getting the grand average. For the normal group of 30 participants, only data from 27 participants were included in the analysis. Data from the other 3 participants were excluded because there were too many head movements while recording the EEG. As for the delinquent group, data from 29 participants were included while data from 1 participant was excluded because of too many head movements.

ERP analyses for both false memory and deceptive memory were done using the 5th out of 10 lists of test words. The choice was done because all participants in both groups responded "yes" to the wrong target answer in the false memory test in this list (5th list) that proved all participants showed the occurrence of false memory (Table 3). New words for intentional deception were also added to the same stimulus position.

Table 3: Distribution of responses to wrong target words according to lists of words

List	1	2	3	4	5	6	7	8	9	10
'Yes'	4	55	52	36	60	50	38	40	39	56
'No'	56	5	8	24	0	10	22	20	21	4
Tota	60	60	60	60	60	60	60	60	60	60

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P300 is known as the positive component that elicits between 250 ms and 800 ms on stimulus onset. In scalp distribution, 2 (target type) X 7 (electrode site) repeated measures ANOVA, amplitude seemed larger at Pz channel (Pz > Fz). Independent samples t-test for false memory (group type X amplitudes) showed that the mean amplitude differences between groups (delinquent and normal participants) had no statistically significant difference $F(12) = 0.67$, $p = 0.55$. Figure 3 shows the grand average ERPs for delinquent and normal groups.

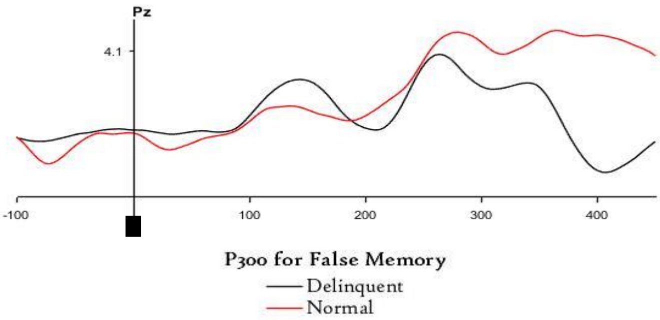
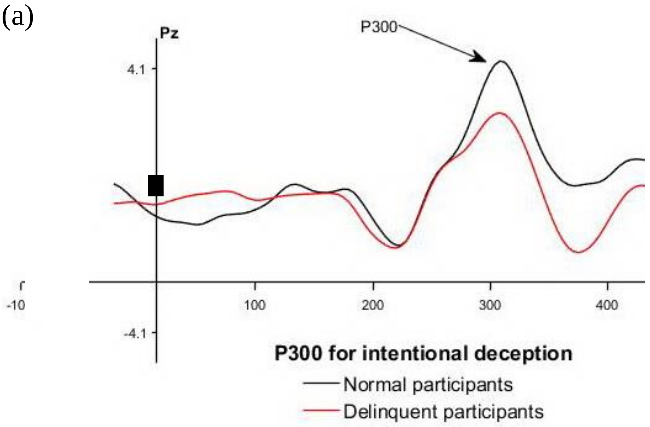


Figure 3: P300 ERP for false memory test using the 5th list of critical lure words. Positivity was plotted upwards.

However, for intentional deception, P300 amplitudes between the groups were significantly different, $F(12) = 2.7$, $p = 0.33$. Mean amplitude (M) for non-delinquent participants was higher (M = 3.9 µV) compared to the delinquent participants (M = 2.8 µV). Maximum P300 amplitude was seen in Pz electrode position (figure 4).

(a)



(a) (b)

Figure 4: (a) P300 ERP for intentional deception task using the 5th list of intentional deception new word. Positivity was plotted upwards. (b) P300 topographic map with scalp voltage distribution from the parietal area. The time point of the P300 component was between 300-350 ms.

Discussion

Results of the current study showed that there was no main effect of the different groups of participants (delinquent and normal) in their reaction times in responding to target words. This means that both groups of participants performed similarly in terms of reaction times for all conditions (new items, critical lures and new items for deceptive task). However, analysis on the reaction times revealed significant differences for different types of target items. Participants responded faster to critical lures than they did to new items (words that were not in the original lists). Lopes and Garcia (2014) have shown that participants in their experiment showed similar speed in responding to critical lures and true targets. The reason is that critical lures are semantically similar to words in the original lists, that is the true targets. Similar to Lopes and Garcia's (2014) results, the current results showed that participants exhibited priming effect to critical lures since these words are associated with words in the original lists. In other words, items in the original lists primed the critical lures in the test phase resulting in fast responses.

One of the objectives in the current study was to compare memory performances in the two groups of participants (delinquent and normal), particularly their performances in false memory and deceptive tasks. Analyses showed a significant interaction between group types and target types. Further analyses revealed that reaction times were different depending on the types of targets. Both delinquent and normal participants performed similarly in the false memory tasks. However, delinquents responded significantly faster to new items for deceptive task than normal participants. Based on this result, it can be suggested that delinquents could respond faster than normal participants when they were asked to lie about their responses. It seems that it was easy for delinquents to lie. Studies with normal participants have shown that people took time to think to make lie responses (Vrij & Mann 2001; Walczyk & Seemann 2003). For example, Henry and Roger (1960) stated that in normal participants, more feedback was needed to lie, resulting in slower responses. According to Henry and Roger (1960), drum memory theory states that complex responses need a lot of information resulting in slow reaction. In the current study, when the participants were asked to lie, normal participants, particularly, had to check whether new items were actually in the original lists then make another decision that is to lie about the presence of those target items. This is a complex process and it is manifested in the slow reaction times. However, this is not the case with the delinquents. They did not need much time to make lying responses.

This phenomenon can be further supported by the P300 ERP component results (when compared with reaction times). There were differences in P300 amplitudes between delinquent and normal participants. P300 amplitude was different for normal participants than that in delinquent participants when they detected critical lures (false memory task). However, this difference was not statistically significant. Interestingly however, results were contrary in the deceptive task. Here, delinquents showed low P300 amplitude than that of normal participants which was statistically significant. High amplitudes signified more attention given to certain stimulus types. It seems that normal participants showed high attention for the new deceptive words. In contrast, delinquents exhibited low attention in deceptive task. Even though the current results needed more in-depth study to arrive at a convincing conclusion, the outcome of this study did show some interesting data that suggested significant differences in information processing in delinquents when compared to normal participants. Indeed, the current findings shed some new insights in studies of delinquency.

Conclusion

In conclusion, the current study set to explore reaction times and neural activities in delinquent juveniles and compare them against those of normal juveniles. This was done during participants' recalling of true and false memory as well as an intentional deception task. The current results are expected to benefit and make a significant contribution to the understanding of juvenile delinquents.

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