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Frontal Lobe and Psychopathy

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Frontal Lobe and Psychopathy

Abstract

This research paper presents an analysis of the functions of the frontal lobe and how damage to the frontal lobe correlates to psychopathy. Initially, it will look at how damage to the frontal lobe obstructs frontal lobe functions. The decrease in executive function, due to a reduction of blood flow to the frontal lobe following a subarachnoid hemorrhage, is explored. The correlation between cortical thickness and impulsiveness in adolescence is examined. Subsequently, the issue is then examined through the observation of groups with psychopathy and how the diagnosis relates to their frontal lobes. One study compares individuals with psychopathy to individuals who suffered lesions to their frontal cortex. Another study discusses the correlation between cortical thickness and frontal information processing; it also compares the location of where the information processing occurs for individuals with psychopathy versus non-psychopathic individuals. Lastly, the functions of the frontal lobe are compared with the characteristics of psychopathy to further understand their correlation.

Keywords

psychopathy, frontal lobe, neuroscience

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This research paper presents an analysis of the functions of the frontal lobe and how damage to the frontal lobe correlates to psychopathy. Initially, it will look at how damage to the frontal lobe obstructs frontal lobe functions. The decrease in executive function, due to a reduction of blood flow to the frontal lobe following a subarachnoid hemorrhage, is explored. The correlation between cortical thickness and impulsiveness in adolescence is examined. Subsequently, the issue is then examined through the observation of groups with psychopathy and how the diagnosis relates to their frontal lobes. One study compares individuals with psychopathy to individuals who suffered lesions to their frontal cortex. Another study discusses the correlation between cortical thickness and frontal information processing; it also compares the location of where the information processing occurs for individuals with psychopathy versus non-psychopathic individuals. Lastly, the functions of the frontal lobe are compared with the characteristics of psychopathy to further understand their correlation.

THEMIS

Introduction

The frontal lobe contains the primary motor cortex and participates in cognitive processes such as executive decision-making, planning, behavior, attention, judgment, working memory, and impulse control. Research has shown that people with damage to the dorsolateral prefrontal cortex experience apathy, personality change, and lack the ability to plan. Additionally, people with damage to the orbitofrontal cortex experience emotional disturbances and impulsivity (Freberg, 2010). A psychopath is described as a person who exhibits abnormal or violent social behavior (Hirstein, 2013). A correlation can be made between the dysfunction of the frontal lobe and how that dysfunction may manifest itself in the social behaviors and impulses of an individual. This research paper will discuss the association between frontal lobe dysfunction and psychopathology.

Manifestation of Frontal Lobe Dysfunction

One of the earliest cases documenting the connection between the functions of the frontal lobes and social behavior is the case of Phineas Gage. In the middle of the 1800s, Gage was a railroad worker who was pierced in the head by an iron tamping rod that entered below his left eye and exited out the top of his skull. Prior to this accident, Gage was polite, friendly and responsible. However, following the accident, it was said that he was irritable and had difficulty maintaining employment (Freberg, 2010).

Uchikawa et al. (2014) conducted a study on the correlation between a decrease in blood flow to the frontal lobe due to subarachnoid hemorrhages and executive dysfunction. During the study, the prevalence of executive dysfunction in survivors of subarachnoid hemorrhages ranged from 3-76%. The

152

broad range was attributed to the timing of the assessment, the method utilized to measure executive dysfunction, and patient population. Executive dysfunction is more prominent in older patients and those with less formal education (Uchikawa et al., 2014).

Participants of the study included individuals who had suffered a subarachnoid hemorrhage and subsequently had undergone microsurgical clipping to repair ruptured aneurysms. Additionally, the participants were at least three months post-clipping, discharged to their home without motor weakness, and were able to lead independent daily lives. Patients over the age of 75 who had previous histories of neurological or psychiatric illness were excluded from the study (Uchikawa et al., 2014).

The participants of the study were classified in one of two groups: Group 1) patients with reduced cerebral blood flow (CBF) in the frontal lobes and Group 2) patients with undamaged CBF. CBF was determined using single photon emission computed tomography (SPECT). Patients were evaluated using Behavioral Assessment of Dysexecutive Syndrome (BADS), the Wechsler Adult Intelligence Scale-III (WAIS-III), and an assessment regarding activities of daily living (ADL). The results of this study revealed the two groups contained no abnormalities when evaluated using WAIS-III and ADL. However, when evaluated using BADS, there was a correlation between executive dysfunction and reduced CBF (Uchikawa et al., 2014).

Executive dysfunction is a result of interruption of higher-order cognitive functions, which are essential in the processes of initiation, planning, execution, and long-term goal-oriented activities. Individuals with frontal lobe damage are inclined to choose short-term benefits without considering future

THEMIS

consequences (Uchikawa et al., 2014). This study demonstrates the association between frontal lobe damage and the reduced ability for executive functions.

The control of impulses is also attributed to the functions of the frontal cortex. A study found cortical thickness of the superior frontal cortex predicts impulsiveness and perceptual reasoning in adolescents (Schilling et al., 2013). Impulsivity regulates cognitive processes in tasks requiring the management of large amounts of information. Impulsiveness plays a role in alcohol consumption, binge drinking, driving violations, delinquency, substance addiction, eating disorders, and psychiatric disorders, such as borderline personality disorder and attention-deficit/hyperactivity disorder. Impulsiveness, as a part of the personality, has been able to predict individual behavior as well as psychopathological syndromes (Schilling et al., 2013).

Findings in animal studies have suggested tasks that require waiting or processing large amounts of information were not conducive to good performance with those rated with higher levels of impulsiveness (Dalley, 2011). Similarly, children who are more reflective tend to score substantially higher on the attention-concentration subtests and the visual organization subtests of the Wechsler Scale of Intelligence for Children versus children who are impulsive (Brannigan, 1980). This indicates that impulsiveness has an impact on perceptual reasoning.

In this study, adolescent participants were submitted to a computerized, self-rating personality questionnaire, a perceptual reasoning assessment, and a high-resolution magnetic resonance scan by which the individual cortical thickness was estimated. The frontal cortex was tested for association with performance in perceptual reasoning tasks from the Wechsler Intelligence Scale

154

for Children (WISC IV). The cortical thickness of the left superior frontal cortex was negatively associated with trait impulsiveness, and positively associated with cognitive functioning within impulse-related neurobiological substrates (Schilling et al., 2013).

The negative correlation between impulsiveness and cortical thickness is exhibited in the decrease of cognitive functions such as attention, efficient information processing, and reasoning. People with impulsiveness-related disorders perform worse in perceptual reasoning and tend to have slower reaction times while committing more errors. Psychophysiological statistics indicate that impulsive individuals have difficulty inhibiting irrelevant information in intelligence testing. The correlation between cortex thickness and perceptual reasoning indicates that personality, spatial reasoning, and response selection stem from a neurobiological basis (Schilling et al., 2013).

Psychopathy in the Brain

Ethan Gorenstein (1982) conducted a study based on the functional similarities between the behavior of humans with impulse control disorders and the behavior of organisms with lesions in the septum, hippocampus, and frontal cortex. He hypothesized that psychopaths would show a deficit in tasks pertaining to frontal lobe functions, such as perseverance and cognitive flexibility.

The participating individuals consisted of psychopaths, psychiatric controls and college students. The individuals were classified as psychopathic or non-psychopathic, based on a self-report behavioral checklist and the socialization scale of the California Psychological Inventory. The participants then performed the following tasks: Wisconsin Card Sorting Test

THEMIS

(WCST), Stroop Color-Word Interference Test, sequential matching memory task, anagrams, spontaneous reversal of the Necker Cube, and an activity preference questionnaire. In relation to the control group, the psychopaths exhibited similar performance patterns to frontal lesion patients on all measures empirically related to frontal dysfunction. The similar performance patterns included perseverative errors on the WCST, errors on the sequential matching memory task, and a great number of Necker Cube reversals. The patterns were not differentiated from the control group on measures empirically unrelated to frontal impairment, such as WCST non-preserved errors and anagrams. These results support the hypothesis that psychopaths have deficits in cognitive processes associated with the functions of the frontal lobe (Gorenstein, 1982).

Based on the correlation between cortical thickness and executive functions, a study was conducted which observed the processing of frontal lobe information and the connectivity to psychopathy (Yang et al., 2012). Novel graph theory-based methods were applied to assess information flow and connectivity based on the measurements of the participants' cortical thickness. The participants were separated into two categories: those with psychopathy and those without psychopathy. Each participant was submitted to structural magnetic resonance imaging (MRI). From the results of the MRI, the brain was divided into 34 regions of interest and the cortical thickness was estimated for each region. Through a series of calculations, the structural connectivity was estimated and two regions were defined as anatomically connected if the calculated correlation was significant (Yang et al., 2012).

Overall, the group of individuals with psychopathy displayed considerably different interregional connectivity

156

patterns compared to the control group. The location of where information flow was processed was different between the psychopathy group and the control group. In the control group, frontal information flow was processed in the medial orbitofrontal cortices. In the psychopathy group, the bilateral superior frontal cortices were identified as the core for information flow. This remapping suggests that information flow regions, along with cortical thickness, may be significant in the neuropathology of psychopathy (Yang et al., 2012).

Conclusion

Characteristics of psychopathy include lack of sympathy, shallow emotions, irresponsibility, insincere speech, overconfidence, narrowing of attention, selfishness, inability to plan for the future, and violence (Hirstein, 2013). The functions of the frontal lobe are executive decision-making, planning, behavior, attention, judgment, working memory, and impulse control (Freberg, 2010). A correlation between damage to the frontal lobe and psychopathy traits is evident. When the frontal lobe does not function properly it will manifest symptoms of psychopathy.

The assertion correlating damage to the frontal lobe with psychopathy is further supported by the studies summarized above. Uchikawa et al. (2014) demonstrated the correlation between decreased blood flow and executive function within the frontal lobe. The decrease in executive functions inhibits the ability to plan for the future and increases irresponsibility. Schilling et al. (2013) established an inverse correlation between cortical thickness and impulsivity. It was determined that a thinner cortex leads to a decrease in the ability to executive process, which causes an individual to be more prone to impulse and shallow emotions and the narrowing of attention. Gorenstein

THEMIS

(1982) conveyed the inability of cognitive flexibility and perseverance in the psychopath when asked to perform tasks that would identify frontal impairment. Lastly, Yang et al. (2012) demonstrated how the cortical thickness in the frontal lobe affects where frontal information is processed and how that region is different in those with psychopathy.

For further research, a comparison between individuals with psychopathy and individuals engaging in binge drinking, substance abuse, or taking psychotropic drugs should be conducted. This comparison will allow future researchers to determine if the participants' decision-making processes are affected similarly or differently in the frontal lobe.

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158

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Shawna Germain will be graduating from San Jose State University with her bachelor's degree in Forensic Science with an emphasis in Biology, and minors in Chemistry and Psychology in May 2015. For the last year she has interned with the San Mateo County Sheriff's Office Forensic Laboratory as a Latent Print Processing Technician. Although grateful for the opportunity, Shawna laments how internships are a legally acceptable version of slavery. Following graduation she hopes to gain work experience and pursue a doctorate in Forensic Psychology, but that may be subject to change as finishing one degree has left her mentally weary and the current desire to use a doctorate as a bragging tool at future family functions has yet to motivate her to actually fill out any graduate school applications.

THEMIS