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BRAIN IMAGING OF PSYCHOPATHY: A NARRATIVE LITERATURE REVIEW

Katharina Merry Apriliani Angkawidjaja,[1*] Rivan Virlando Suryadinata[2]

[1] Department of Psychiatry, Medical Faculty of Surabaya University, Surabaya, Indonesia.
[2] Department of Public Health, Medical Faculty of Surabaya University, Surabaya, East Java, Indonesia
[*]Email: merryapriliani@staff.ubaya.ac.id

Abstrak

Definisi psikopatik secara umum adalah individu yang memusatkan cara pandang pada diri sendiri, tidak berperasaan, tanpa belas kasihan, kurang empati, kurang/ tidak setia, dan kurang memiliki kemampuan membentuk hubungan dekat (kurangnya keintiman). Psikopatik juga dikenal sebagai gangguan kepribadian psikopat, antisosial, disosial, dan sosiopat.Di Indonesia, pedoman diagnosa klinis untuk individu Psikopatik masih mengacu pada Gangguan Kepribadian Dissosial menurut Pedoman Penggolongan dan Diagnosis Gangguan Jiwa Edisi III (PPDGJ-III), ditambah dengan pemeriksaan penunjang lain yang umum digunakan yaitu MMPI (Minnesota Multiphasic Personality Inventory), LSRP (Levensone Self-Report Psychopathy Scales), PCL:SV (Psychopathy Checklist: Screening Version).Tujuan Review Literatur Narasi ini adalah untuk merangkum temuan terkait pencitraan otak pada Psikopatik. Pencitraan otak terkait psikopatik yaitu didapatkan aktivitas otak menyimpang di daerah prefrontal, korteks temporal, limbik (kompleks amygdala-hippocampus), striatum, corpus callosum, dan insular. Temuan ini diharapkan mampu menjelaskan dasar etiologi perilaku menyimpang pada pelaku Psikopatik.Dengan demikian, neuroanatomi psikopati adalah bidang penelitian yang berpotensi untuk berkontribusi sebagai langkah preventif dan kuratif dari psikopati dengan basis sains.

***Kata Kunci**: kepribadian antisosial; psikopat; pencitraan otak psikopati.*

Abstract

The general definition of psychopathic is an individual who focuses on self-perspective, is feelingless, without compassion, lacks empathy, lacks/disloyalty, and lacks the ability to form close relationships (less intimacy). Psychopathy is also known as psychopathic, antisocial, disocial, and sociopathic personality disorder. In Indonesia, clinical diagnosis guidelines for psychopathic individuals still refer to Dissocial Personality Disorder according to the Guidelines for Classification and Diagnosis of Mental Disorders Edition III (PPDGJ-III), coupled with other commonly used supporting examinations, namely the MMPI (Minnesota Multiphasic Personality Inventory), LSRP (Levensone Self-Report Psychopathy Scales), PCL:SV (Psychopathy Checklist: Screening Version). This Narrative Literature Review aims to summarize findings about brain imaging in Psychopath. As for psychopathic-related brain imaging, namely aberrant brain activity was found in the prefrontal area, temporal cortex, limbic (amygdala-hippocampus complex), striatum, corpus callosum, and insular. These findings hope to be able to explain the basic etiological of deviant behavior in psychopathic perpetrators. Thus, psychopathic neuroanatomy is a research area that has the potential to contribute as a preventive and curative measure of psychopathy on a scientific basis.

Keywords: antisocial personality; psychopath; psychopathic brain imaging.

1. INTRODUCTION

Since the 21st century, technology and science have led to important discoveries in brain imaging. In general, psychiatrists use brain imaging to explain the causes and symptoms of psychiatric illnesses. Neuroimaging findings are not limited in that scope, they are also evidence in court. In some cases, neuroimaging is used as evidence to support the diagnosis of neuropsychiatric condition. Some professionals argue that neuroimaging can establish the current or past presence of certain mental capacities, or to delve into a person's mind as a person who is honest or deceitful (Sadock, 2017). In other words, brain imaging can be used in determining the basic etiology of a psychopath's behavior. This can also be used as reference material

in determining future behavioral tendencies. This narrative article aims to give some informations about psychopathic's brain imaging. Thus, brain imaging is expected to be able to explain the basic etiology of the behavior of psychopathic offenders.

2. PSYCHOPATHY DEFINITION

The most common definition of psychopathy is: individuals who focus their perspective on themselves, are callous, without compassion, lack empathy, are lacking/disloyal, and lack the ability to form close relationships (less intimacy). A person who acts without conscience, has limited emotional capacity, and has no or relatively little fear and anxiety. Their sole focus is the satisfaction of their personal needs. They often engage in criminal behavior. Psychopaths have intact cognitive capacity, and even tend to have high intelligence, able to distinguish right from wrong, but lack empathy and lack self-control/impulse. There is a general consensus on the characteristics of Callous and Unemotional (CU traits) psychopaths, namely when personality traits are found such as a lack of empathy, no feelings, a tendency to be cruel, and a lack of sense of responsibility. Psychopaths have severe deficits in the ability to recognize and experience their own social emotions, namely positive-negative emotions felt in relationships with others, including shame, guilt, empathy, love, fear and sadness. This makes psychopaths have poor insight capacity in modifying and directing normal activities, as well as encouraging themselves and others in achieving important goals (Englebert, 2015; Gonzalez-tapia, Obsuth and Heeds, 2017; Patrick, 2019). Some study found that Antisocial Behaviour with CU traits were associated with abnormal white matter microstructure primarily in association pathways (Uncinate Fasciculus, Cingulum, Inferior Fronto-occipital Fasciculus, Superior Longitudinal Fasciculus, Inferior Longitudinal Fasciculus), and thalamic pathways (Anterior Thalamic Radiations) (Dotterer *et al.*, 2019).

The psychopathic picture can appear as an individual who is almost devoid of the minor reactions we know as 'neurotic' or 'anxious', and far from attempting suicide. Psychopathic appearance is still clinically debated, but what is certain is the general appearance as an individual who is full of charismatic charm and almost flawless. Many scientists define psychopaths in various definitions, but what is certain is that all of them believe that psychopaths are individuals with chronic moral defects. Psychopaths have Machiavellian traits, a dimension in the Dark Triad, that include anti-sociality and narcissism traits (Raue *et al.*, 2017; Sirgiovanni and Garasic, 2020)

Cleckley in his book "The Mask of Sanity" (1976) concluded that psychopathic characteristics are: (1) no anxiety in almost all cases; (2) aggressive-violent behavior as the dominant display in some cases; (3) behavior that violates the law (such as fraud, theft, forgery, arson, drug violations, drunkenness/ disorderly behavior, vandalism, truancy, reckless driving, even for small profits. Below in table 1.1 are the Psychopathy diagnostic criteria according to Cleckley. Here Cleckley explains that the clinical appearance of Psychopathy is not only the absence of symptoms of mental disorders but also social calm and emotional stability. The only "mask" of Psychopathy is strong mental health. (Patrick, 2019)

Item category	Item number and descriptive label
Mask features	1. Superficial charm and good "intelligence"
	2. Absence of delusions and other signs of irrational thinking
	3. Absence of "nervousness" or psychoneurotic manifestations
	14. Suicide rarely carried out
Behavioral deviance features	7. Inadequately motivated antisocial behavior
	8. Poor judgment and failure to learn by experience
	4. Unreliability
	13. Fantastic and uninviting behavior with drink and sometimes without
	15. Sex life impersonal, trivial, and poorly integrated
	16. Failure to follow any life plan
Shallow–deceptive features	5. Untruthfulness and insincerity
	6. Lack of remorse or shame
	10. General poverty in major affective reactions
	9. Pathological egocentricity and incapacity for love
	11. Specific loss of insight
	12. Unresponsiveness in general interpersonal relations

Table 1. Psychopathic Diagnostic Criteria according to Cleckley (1941/1976)

Psychopathy is also known as psychopathic, antisocial, disocial, and sociopathic personality disorder. The following is an explanation of each: (Maramis and Maramis, 2009)

- Antisocial is actively violating social customs, norms and laws
- Asocial is passively harming society because they do not want to help or cooperate
- Disocial is strange, eccentric, does not comply with social customs, norms, and laws, but not yet antisocial (formerly considered sociopathic).

According to Karpman (1941), the division of types of psychopathy is primary psychopathy and secondary psychopathy. 'Primary' psychopaths or 'idiopathic psychopaths', are individuals who born as heartlessness, unemotionalism, and a lack of remorse. He also called "white collar crimes" and more involved in 'instrumental' (relational) aggression and aimed at self-satisfaction. 'Secondary' or "blue collar crime" psychopaths are individuals, who are not born psychopaths, but acquire in response to negative childhood experiences such as abuse. (Gonzalez-tapia, Obsuth and Heeds, 2017; Pujol *et al.*, 2019)

Antisocial personality disorder can be presented as a subcategory of narcissistic personality disorder, but in terms of antisocial pathological narcissism (malignant narcissism) (Gabbard, 2014). Psychopathy is generally associated with low empathy and tends to repeat the abuse of its victims at every opportunity. Several studies also prove that psychopathic have deficits in recognizing facial emotional expressions. (Englebert, 2015; Blair, 2018; Gomez-Leal *et al.*, 2018)

3. DIAGNOSE OF PSYCHOPATH

In Indonesia, clinical diagnosis guidelines for psychopathic individuals still refer to Dissocial Personality Disorder according to the Guidelines for Classification and Diagnosis of Mental Disorders third edition (PPDGJ-III), which is: (Maslim, 2014)

• This personality disorder is usually cause for concern due to the large discrepancy between behavior and prevailing social norms, and characterized by:

(a) being indifferent to other people's feelings;
(b) a very irresponsible and persistent attitude and disregard for social norms, rules and obligations;
(c) unable to maintain a relationship, even though there is no difficulty in developing it;
(d) very low tolerance for frustration and a low threshold for venting aggression, including violence;
(e) is unable to experience guilt and benefit from experience (punishment);
(f) highly inclined to blame others or offer plausible rationalizations for behavior that puts the patient in conflict with society

• For diagnosis required at least 3 of the above. Meanwhile, in the Diagnostic and Statistical Manual of Mental Disorders edition V (DSM-V) it is included in Antisocial Personality Disorder with the following criteria: (DSM-V, 2013; Gabbard, 2014)

A. A pattern of neglect and violation of the rights of others, occurring since age 15, as evidenced by three (or more) of the following:

1. Failure to comply with social norms with respect to lawful behavior, as indicated by repeatedly committing acts that are grounds for arrest.
2. Deception, indicated by repeated lying or deceiving others for personal gain or pleasure.
3. Impulsivity or failure to plan ahead.
4. Irritability and aggressiveness, as shown by repeated physical fights or attacks.
5. Reckless disregard for the safety of oneself or others.
6. Consistently irresponsible, as indicated by repeated failure to maintain consistent work behavior or honor financial obligations.
7. Lack of remorse, as shown by being indifferent to or rationalizing being hurt, mistreated, or stolen by someone else.

B. The individual is at least 18 years of age.

C. There is evidence of conduct disorder with onset before the age of 15 years.

D. The occurrence of antisocial behavior is not exclusive to the course of schizophrenia or bipolar disorder.

Several psychometric tests that can be used as screening are: MMPI (Minnesota Multiphasic Personality Inventory), LSRP (Levensone Self-Report Psychopathy Scales), PCL:SV (Psychopathy Checklist: Screening Version). Psychopathic traits that significantly refer to ASPD are 3-factors namely Interpersonal, Affective, Lifestyle (Jalava, Griffiths and Maraun, 2015; BO, SUNE, 2019). The MMPI code 49/94 does not specifically mention Antisocial Personality Disorder, but refers to the characteristics of disregard for social values and standards, no conscience, low morals, and fluctuating ethical values, alcoholism, quarrels, marital problems, conspicuous sexual appearances, and various introduction action. As for narcissistic, selfish, and impulsive, self-centered, poor judgement, impulsive, irresponsible, lack of rationalization, failure, and blaming others for their difficulties. They tend to be selfish, not easy to trust, very superficial relational relationships and not useful (Graham, 1987; Basant K.Puri, 2018)

4. BRAIN IMAGING IN PSYCHOPATHY

Psychopathy is a complex clinical condition characterized mostly by symptoms of affective, interpersonal, and antisocial-impulsive disorders. For this reason, brain imaging is expected to be able to explain the appearance of the symptoms of these psychopathic disorders. An important key lies in the brain region of the prefrontal cortex (including part of the ventromedial), temporal cortex, amygdala-hippocampus complex, striatum, and corpus callosum which are most strongly correlated with antisocial (psychopathic) tendencies (Jalava, Griffiths and Maraun, 2015; Basant K.Puri, 2018; Patrick, 2019; Pujol *et al.*, 2019). Another study found any relationship with Cavum Septum Pellucidum (CSP) which related to the interpersonal and affective traits of psychopathy (Crooks *et al.*, 2018).

On Magnetic Resonance Imaging (MRI), Raine et al. (2000) found that patients with ASPD had an 11% reduction in PFC Gray Matter (GM) volume. The structural deficits are associated with low autonomic arousal, limited insight, and difficulty making decisions, typical of ASPD and psychopathic individuals. In psychopaths, there is also a significant increase in the volume and length of the callosal white matter, a 15% reduction in callosum thickness and an increase in interhemispheric function. By Fractional Anisotropy (FA), show the reduction that expressing the delayed of white matter's structural maturation (Gabbard, 2014; Patrick, 2019; Pujol *et al.*, 2019; Nummenmaa *et al.*, 2021).

According to Raine (2018), neuromoral theory states that the main areas involved in moral decision-making and the spectrum of antisocial behavior include the dorsal and ventral prefrontal cortex, amygdala, hippocampus, angular gyrus, posterior cingulate, temporal cortex subregions including the anterior-superior gyrus, and temporoparietal junction. Common areas for ASPD and morality are the ventromedial prefrontal cortex, amygdala, superior temporal gyrus, and angular gyrus. (Raine, 2018)(Johanson *et al.*, 2020)

Previous studies have shown aberrant brain activity associated with psychopathy in the prefrontal, insular, and limbic regions (Jalava, Griffiths and Maraun, 2015; Basant K.Puri, 2018; Poeppl *et al.*, 2019). The following are some of the specific brain imaging findings found in psychopaths:

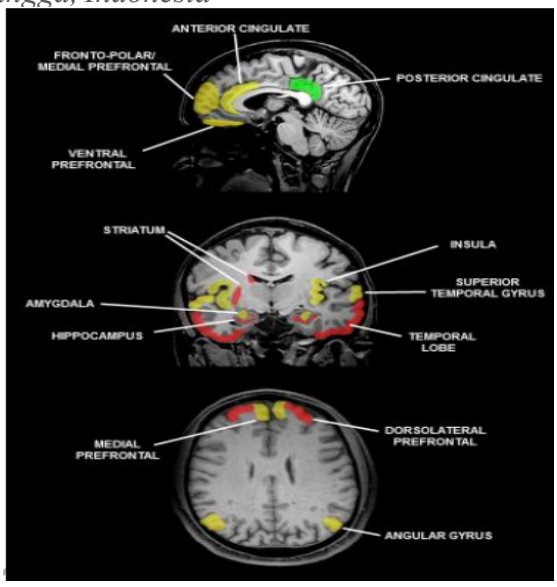

Figure 1. Brain deficits in ASPD.
Source*: *Raine A. The Neuromoral Theory of Antisocial, Violent, and Psychopathic Behavior. Psychiatry Research. 2018.

PREFRONTAL

Much literature points to structural disorders of the fronto-limbic system, which reduced volume and activity in the amygdala, OFC and Ventromedial Pre-Frontal Cortex (VmPFC) in individuals with psychopathic traits (Figure 1). Amygdala hypoactivity has been associated with fear, disturbances in the reinforcement-stimulus response and in response to the expression of emotions. The decrease in VmPFC activity, which is responsible for executive function deficits (including learning, behavioral flexibility, working memory and attention), indicates that psychopaths are also impaired in decision making through the "inability" to bind the cognitive and emotional networks of the brain together (Gonzalez-tapia, Obsuth and Heeds, 2017). The reduced connectivity between the amygdala and PFC (Pre Frontal Cortex) leads to impulsivity, lack of social-emotional integration and antisocial behavior (Raine, 2018).

In particular, several areas that share morality function and antisocial traits are the VmPFC and temporal lobe regions, including the anterior, superior, temporoparietal, and amygdala subregions. (Jalava, Griffiths and Maraun, 2015; Basant K.Puri, 2018; Raine, 2018; Pujol *et al.*, 2019)

Psychopathy is characterized by aberrant brain connectivity between affective and cognitive processes, especially in the dorsomedial prefrontal cortex, for cognitive-behavior control, such as work adjustment, inhibition and self-impulse control due to reward circuit hypersensitivity. Substantial differences between individuals who fail (unsuccessful psychopathy) and successful (successful psychopathy) at the neural, physiological, cognitive and behavioral levels are frontal damage and high-level cognitive deficits that are greater in unsuccessfull psychopathy (Geurts *et al.*, 2016; Johanson *et al.*, 2020).

On PET (positron emission tomography), a decrease in glucose metabolism in the frontal cortex is seen which is associated with impulsive-aggressive behavior and crime in psychiatric patients and murder suspects. In SPECT (single-photon emission computerized tomography), the study found a reduction in cerebral blood flow in the frontal brain region in ASPD with alcoholics and patients with ASPD. Another study (Critchley et al, 2000) using MRS (Magnetic Resonance Spectroscopy) found lower concentrations of N-Acetyl Aspartate (NAA) and Creatine Phosphocreatine in the PFC, indicating a decrease in neural density, in repeat

offenders with mental retardation. Whereas in the latest fMRI (Functional Magnetic Resonance Imaging) imaging, found disturbances in response time and different patterns of activity associated with conflict and error in the anterior cingulate region, dorsolateral prefrontal cortex, superior temporal cortex, putamen, and amygdala. Another fMRI study (Jiang et al., 2013) found some activation of the dorsolateral prefrontal cortex, fronto-medial gyrus, and bilateral anterior cingulate gyrus/ mediosuperior frontal gyrus associated with lying. In line with these findings, using aMRI and resting-fMRI, Ly et al (2012) found thinner cortices in the right inferior frontal, anterior temporal, and anterior cingulate which associated with reduced functional connectivity with the left insula in psychopathic criminals (Patrick, 2019).

TEMPORAL CORTEX

Relatively poor cortical function in the temporal lobe was found in antisocial offenders. Reduced glucose metabolism in the medial temporal region and temporal lobe abnormalities have been reported in aggressive versus non-aggressive psychiatric patients. Aggressive patients with dementia also found decreased blood flow in the left anterior temporal lobe as measured by SPECT. The temporal lobe functional abnormalities reported in the aggressive population reflect frontotemporal dysfunction, which is consistent with frontal deficits. With resting-state fMRI, one study found regional homogeneity to be higher in the left inferior temporal gyrus and lower in the right middle frontal gyrus in individuals with ASPD. In terms of structure, reduced temporal volume has been found in patients with impulsive-aggressive traits and personality disorders (Patrick, 2019)

AMYGDALA AND HIPPOCAMPUS

Ermer, et al., (2012), found reductions in regional gray matter volume bilaterally in the parahippocampal gyrus, amygdala, hippocampus, and orbitofrontal cortex. Yang, et.al., (2009) reported bilateral volume reduction and shape deformation in the amygdala, especially in the Basolateral Amygdala (BLA) and central subnucleus, in psychopathy. Further research (Yang et al., 2010) shows that amygdala deformation is more severe in psychopathic individuals with criminal convictions (unsuccessful psychopath) compared to successful psychopath. Accordingly, Boccardi et al (2011) found reduced BLA nucleus volume in psychopathic criminals with substance abuse, and found that the medio-lateral amygdala nucleus was larger in psychopathic offenders compared to controls (Jalava, Griffiths and Maraun, 2015; Patrick, 2019).

In PET study (Raine et al., 1997) of homicides, demonstrated abnormal left inferior amygdala-hippocampus function and increased function of the right amygdala-hippocampus. Through fMRI (Kiehl et al, 2001), found a reduction in the activation of the amygdala-hippocampal complex during affective arousal processes. Another study (Müller et al, 2003) observed reduced activation in the left parahippocampal gyrus in psychopathic offenders, in line with studies (Birbaumer et al, 2005) reporting reduced activity of limbic-frontal circuits, including the amygdala and OFC. In the SPECT study on abusers, a decrease in bilateral hippocampal function, as well as a decrease in NAA concentration in the amygdala-hippocampal complex, indicating reduced nerve density (Patrick, 2019).

The interpersonal characteristics of psychopaths are associated with increased connectivity of the BLA and Centromedial Amygdala (CMA) with the formation of the corticostriatal network (amygdalo-cortico-striatal circuit), which is important for processing the reward system. The reward system is related to dopamine which contributes to the regulation of the reward system, motivation, and decision making. The majority of dopamine neurons are located in the ventral region of the brain, where the mesocortico-limbic and nigrostriatal dopamine systems originate (Mertens *et al.*, 2019). Within this circuit, the cortical and striatal regions

accommodate the reward system's evaluation and action planning, while the BLA and CMA accommodate the modulation of attention and the stimulus-reward system's learning. Psychopaths are overly concerned with personal needs and gains, which are driven in large part by the hyperfunctionality of the reward system. The increasing association between BLA and CMA is consistent with the view of psychopaths as "social predators" who possess a self-centered, hedonistic neurobiological profile, and develop sociocognitive skills to act egocentrically. Hyperconnectivity/overregulation of top-down BLA neurons by the frontoparietal control system inhibits action control and supports executive dysfunction and disinhibition of psychopathic behavior. The amygdala-paralimbic relationship is thought to be highly relevant to the psychopathic phenotype profiles of egotistical, emotionally cold, and behavioral inhibition disorders. (Jalava, Griffiths and Maraun, 2015; Aghajani *et al.*, 2016)

STRIATUM

Early fMRI studies agree with structural imaging findings in demonstrating striatal dysfunction in antisocial and psychopathic individuals. Early research (Barkataki et al., 2006) reported an increase in putamen volume in antisocial individuals, in line with another study (Schiffer et al, 2011) found that abusers had a 9.6% increase in total striatal volume (including caudate, putamen, and globus pallidus), and Boccardi et al (2013) who reported that the volume of the nucleus accumbens was 13% smaller in psychopathic individuals. Other findings (Finger et al, 2008), are consistent with the notion of striatal dysfunction where children with psychopathic traits show increased activity in the caudate nucleus in response to punishment due to mistakes, compared to non-psychopathic children (Patrick, 2019).

The ventral striatum is connected with the paralimbic, cortical, and ventral tegmental, as a bridge between cognition, emotion and action. These processes are associated with ventral striatal rewards and deficits involved in impulsivity, attention seeking and increased sensitivity to self-reward of antisocial behavior. Greater ventral striatum reactivity associated with increased retaliatory aggression. (Geurts *et al.*, 2016)

CORPUS CALLOSUM

In an early study (Raine et al. 1997) using PET found that individuals convicted of murder showed reduced metabolic activity in the corpus callosum compared to normal controls. Other study (Sundram et al., 2012) using DTI, found decreased Fractional Anisotropy (FA) and increased mean diffusivity (MD) in the corpus collosum, uncinate fasciculus, inferior occipitofrontal fasciculus, and anterior corona radiata in adults with ASPD. Rarely, callosal abnormalities are consistent with findings of impaired interhemispheric transfer times in antisocial/psychopathic offenders (Hiatt & Newman, 2007) (Patrick, 2019).

Psychopathic/ antisocial individuals demonstrated 22.6% increase in estimated callosal white matter volume, 6.9% increase in callosal length, 15.3% reduction in callosal thickness, and an increase in functional interhemispheric connectivity. Greater callosal volume is associated with affective and interpersonal deficits, lower autonomic stress reactivity, and lower spatial abilities. Recently, using DTI (Diffusion Tensor Imaging), others (Craig et al., 2009) reported reduced FA in the uncinate fascicles, which connect the OFC to the amygdala (Patrick, 2019)

5. IS BRAIN DEFICIT MAKE PSYCHOPATHIC BEHAVIOUR?

The important issue here is brain deficits cause of psychopathic behavior? Findings from imaging of adult neurological patients, pediatric neurological cases, studies of head injuries, and patients with degenerative brain disease have similar to psychopathy and antisocial behavior so that it can be concluded that brain damage may directly contribute to this etiology. VmPFC damage is involved in poor decision making, autonomic deficits, and sociopathic

behavior. Focal frontomedial lesions are generally aware of their aggressive behavior, whereas those with focal orbitofrontal lesions are unaware. Impulsive psychopaths have dominant frontal area disorders such as Fronto-Temporal Dementia (FTD) or Huntington's disease. The aggressive dementia showed significant hypoperfusion in the left and right dlPFC, left anterior temporal cortex, and right superior parietal. SPECT studies in patients with right-sided (but not left-sided) frontotemporal dementia revealed evidence of disocial behavior, including criminality, aggression, and sexually deviant behavior. (Patrick, 2019).

Several studies have shown that ASPD meets the criteria for a neurodevelopmental disorder, since its initial onset and develops stably throughout life resulting in impaired functioning of life. Brain abnormalities, neurocognitive deficits, and significant heritability of the MAO-L gene underlie antisocial behavior (McSwiggan, Elger and Appelbaum, 2017). However decreased GM volume on MRI, including disturbances of the OFC, dlPFC, ACC, Amydala, hippocampus, were areas of neuroimaging markers that significantly uncorrelated to psychopathic's violent behavior. All of these behaviors can be evaluated by not just a single neuroimaging marker (Lamsma, Mackay and Fazel, 2017; Poeppl *et al.*, 2019).

The increased and decreased activity in the left fronto-insular area and lateral PFC, reflecting an imbalance of brain networks related to psychopathic pain perception, tolerance, and empathy. The cortical areas of the dLPFC are related to social cognition (empathy, morality and theory of mind). The decrease of BLA activity associated with emotional reward processes, psychopathic traits, and the right fronto-insular cortex associated with cognitive reward processing (Jalava, Griffiths and Maraun, 2015; Poeppl *et al.*, 2019).

The correlation between brain abnormalities and psychopathic behavior is that the brain abnormalities are consistent with pattern of relevant mental reduced capacities, then Neuroimaging can provide useful information about the functional or dysfunctional neural basis of that behavior. Disruption of PFC-amygdala connectivity has been widely known linked to increased antisocial/criminal behavior, typically thought to be due to the impaired topdown regulation of amygdala functioning by the PFC. (Ling, Umbach and Raine, 2019; Glannon, 2020)

6. CONCLUSION

The presence of brain deficits, especially in the frontal cortex, temporal cortex, amygdala and hippocampus, corpus callosum, and striatum, was reported to be strongest in antisocial, violent, and/or psychopathic individuals. Decreased activity occurred in areas important for semantic language processing (left lateral prefrontal cortex), action execution and pain processing (right lateral prefrontal cortex), social cognition (dorsomedial prefrontal cortex), and emotional reward processing (right amygdala). In contrast, increased activity occurred in regions for cognitive reward processing (right fronto-insular cortex) and other areas related to language semantics and pain processing (left fronto-insular cortex and right fronto-insular cortex). Future research efforts in this area are still widely open, either anatomical or functional imaging studies, to elucidate the etiology of psychopathic behavior.

BIBLIOGRAPHY

Aghajani, M., et al. (2016). Dissociable relations between amygdala subregional networks and psychopathy trait dimensions in conduct-disordered juvenile offenders. *Human Brain Mapping, 37*(11), 4017–4033. https://doi.org/10.1002/hbm.23292

Basant, K. P., & I. H. T. (2018). *Forensic psychiatry, Criminal Justice Matters* (I. H. T. Basant K. Puri, Ed.). UK: Taylor & Francis Group. https://doi.org/10.1080/09627259008553059

Blair, R. J. R. (2018). Traits of empathy and anger: Implications for psychopathy

and other disorders associated with aggression. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1744). https://doi.org/10.1098/rstb.2017.0155

Bo, S., et al. (2019). Health and disability psychopathy in a forensic sample: The factor structure of the PCL: SV in a Danish forensic sample. *Scandinavian Journal of Psychology*. https://doi.org/10.1111/sjop.12566

Crooks, D., et al. (2018). The relationship between cavum septum pellucidum and psychopathic traits in a large forensic sample. *Neuropsychologia, 112*(March), 95–104. https://doi.org/10.1016/j.neuropsychologia.2018.03.015

Dotterer, H. L., et al. (2019). Antisocial behavior with callous-unemotional traits is associated with widespread disruptions to white matter structural connectivity among low-income, urban males. *NeuroImage: Clinical, 23*(April), 101836. https://doi.org/10.1016/j.nicl.2019.101836

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author. https://doi.org/10.1176/appi.books.9780890425596.744053

Englebert, J. (2015). A new understanding of psychopathy: The contribution of phenomenological psychopathology. *Psychopathology, 48*(6), 368–375. https://doi.org/10.1159/000437441

Gabbard, G. O. (2014). *Psychodynamic psychiatry in clinical practice* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Geurts, D. E. M., et al. (2016). Neural connectivity during reward expectation dissociates psychopathic criminals from non-criminal individuals with high impulsive/antisocial psychopathic traits. *Social Cognitive and Affective Neuroscience, 11*(8), 1326–1334. https://doi.org/10.1093/scan/nsw040

Glannon, W. (2020). Psychopathy and responsibility: Empirical data and normative judgments. *Philosophy, Psychiatry, & Psychology, 24*(1), 13–15. https://doi.org/10.1353/ppp.2017.0001

Gomez-Leal, R., et al. (2018). The relationship between the three models of emotional intelligence and psychopathy: A systematic review. *Frontiers in Psychiatry, 9*(July), 1–15. https://doi.org/10.3389/fpsyt.2018.00307

Gonzalez-Tapia, M. I., Obsuth, I., & Heeds, R. (2017). A new legal treatment for psychopaths? Perplexities for legal thinkers. *International Journal of Law and Psychiatry*. https://doi.org/10.1016/j.ijlp.2017.04.004

Graham, J. R. (1987). *The MMPI: A practical guide* (3rd ed.). New York: Oxford University Press.

Jalava, J., Griffiths, S., & Maraun, M. (2015). *The myth of the born criminal: Psychopathy, neurobiology, and the creation of the modern degenerate*. Toronto: University of Toronto Press.

Johanson, M., et al. (2020). A systematic literature review of neuroimaging of psychopathic traits. *Frontiers in Psychiatry, 10*(February), 1–20. https://doi.org/10.3389/fpsyt.2019.01027

Lamsma, J., Mackay, C., & Fazel, S. (2017). Structural brain correlates of interpersonal violence: Systematic review and voxel-based meta-analysis of neuroimaging studies. *Psychiatry Research: Neuroimaging, 267*(July), 69–73.

https://doi.org/10.1016/j.pscychresns.2017.07.006

Ling, S., Umbach, R., & Raine, A. (2019). Biological explanations of criminal behavior. *Psychology, Crime and Law, 25*(6), 626–640. https://doi.org/10.1080/1068316X.2019.1572753

Maramis, W. F., & Maramis, A. A. (2009). *Catatan ilmu kedokteran jiwa* (2nd ed.). Surabaya: Airlangga University Press.

Maslim, R. (2014). *PPDGJ-III: Pedoman penggolongan dan diagnosis gangguan jiwa* (Edisi III). Jakarta, Indonesia.

McSwiggan, S., Elger, B., & Appelbaum, P. S. (2017). The forensic use of behavioral genetics in criminal proceedings: Case of the MAOA-L genotype. *International Journal of Law and Psychiatry, 50*, 17–23. https://doi.org/10.1016/j.ijlp.2016.09.005

Mertens, C. E., et al. (2019). Pathways relating the neurobiology of attachment to drug addiction. *Frontiers in Psychiatry*. https://doi.org/10.3389/fpsyt.2019.00737

Nummenmaa, L., et al. (2021). Brain basis of psychopathy in criminal offenders and general population. *Cerebral Cortex, 31*(9), 4104–4114. https://doi.org/10.1093/cercor/bhab072

Patrick, C. J. (2019). *Handbook of psychopathy* (2nd ed.). New York: The Guilford Press.

Poeppl, T. B., et al. (2019). A view behind the mask of sanity: Meta-analysis of aberrant brain activity in psychopaths. *Molecular Psychiatry, 24*(3), 463–470. https://doi.org/10.1038/s41380-018-0122-5

Pujol, J., et al. (2019). The contribution of brain imaging to the understanding of psychopathy. *Psychological Medicine, 49*(1), 20–31. https://doi.org/10.1017/s0033291718002507

Raine, A. (2018). The neuromoral theory of antisocial, violent, and psychopathic behavior. *Psychiatry Research*. https://doi.org/10.1016/j.psychres.2018.11.025

Raue, P. J., et al. (2017). Advances in psychotherapy for depressed older adults. *Current Psychiatry Reports, 19*(9). https://doi.org/10.1007/s11920-017-0812-8

Sadock, B. J., et al. (2017). *Kaplan & Sadock's comprehensive textbook of psychiatry* (10th ed.). New York: Wolters Kluwer.

Sirgiovanni, E., & Garasic, M. D. (2020). Commentary: The moral bioenhancement of psychopaths. *Frontiers in Psychology, 10*, 59–67. https://doi.org/10.3389/fpsyg.2019.02880