



## Aggression, psychopathy and brain imaging – Review and future recommendations

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### ABSTRACT

Violent behavior appears to result from a complex web of interacting genetic as well as environmental factors. Psychopathy is a strong predictor for relapse in violent acts. The current review shed light on rapidly expanding knowledge in brain imaging related to violent behavior and psychopathy. A literature search was performed in PubMed, Cochrane and PsycInfo combining the key words: mentally disordered offender/aggression/violence/ crime/forensic psychiatry/brain imaging neuroimaging/ fMRI/MRI/PET/SPECT/lack of empathy/psychopathy and antisocial personality disorder. The reviewed material, which consisted of 48 articles, indicates a rather strong consensus on the connection between dysfunctional parts of the frontal and temporal lobes and violent antisocial behavior and psychopathy. In future studies, it would be useful to focus on the limbic system and to investigate which parts of the frontal lobes and cerebral networks that are of interest in the psychopathic personality. Moreover, the reviewed material highlights some of the methodological difficulties in this area of research such as selection bias in the recruitment of patients, inadequate matching of control subjects, and sometimes incongruous results. In the future we hope that brain imaging can be used to map biological deviations in different offenders in order to try to learn more about the different mechanisms behind violent behaviors.

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### 1. Introduction

Earlier studies have pointed to a complex web of biological and social risk factors underlying antisocial and violent behavior (Raine, 2002). Whether these risk factors eventually lead to antisocial and violent behavior in any single individual depends on a large set of possible interactions, which are still largely in need of further research (Raine, 2002). Specific traits in the personality may, regardless of diagnosis, be related to violent behavior. Accordingly, there are different motives and different triggers for violent behavior such as hatred, jealousy, perceived insult, fantasy, distortions of reality or the urge to gain money or dominance. Despite a strong consensus on the complex causes of violent behavior, general psychiatry and forensic psychiatry are often limited to referring violent behavior to specific psychiatric diagnoses defined in the diagnostic manual DSM-IV (American Psychiatric Association, 1994, 2000). According to DSM-IV, subjects have to fulfill a number of criteria in order to receive a certain diagnosis, and even then, two subjects assigned the same diagnosis could present very differently, since they may not share the same criteria. To illustrate this; in order to be assigned the diagnosis Borderline Personality Disorder (BPD), a subject has to fulfill five out of nine different criteria. In practice therefore, two BPD patients may only really share one of the specified criteria. Therefore, it would

probably be more interesting to consider functional differences, such as intentions and motives that control and trigger different types of offenders. Such differences could be explored with regards to factors such as impulse control and lack of empathy. Criminal investigative analyses (Hazelwood & Warren, 2000; Meloy, 2000) and case studies (Kristiansson, 1995), have already suggested differences in motives and triggers underlying violent behavior.

### 2. Aggression

Quite commonly throughout the literature, aggression is subdivided into affective (also called reactive) or predatory (also called proactive) aggression (McEllistrem, 2004; Meloy, 1988, 2006). Affective aggression is the mammalian response to a threatening situation and is therefore not inappropriate *per se*. It is enacted instantly as a direct response to provocation, such as during a verbal argument that turns into a physical fight. Physiologically, affective aggression is preceded by intense autonomic arousal manifested by pounding heart, racing pulse, shallow breathing, elevated blood pressure, and muscle tension, preparing the body for fight or flight.

Predatory aggression, on the other hand, is usually more planned and goal directed and is not preceded by heightened autonomic arousal. It can be a response to provocation, but it is not acted out directly, rather as revenge after a clear cool off period. In animals, predatory aggression and violence is used to hunt prey for food and survival. Humans can show lack of empathy and compassion and hunt one another in order to obtain rewards such as money, sex, or power. Predatory aggression is often associated with crimes such as serial

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murders or rape (Silva, Leong, & Ferrari, 2004). It has been suggested that predatory aggression is strongly connected specifically to psychopathy (Barratt & Felthous, 2003; Barratt, Stanford, Dowdy, Liebman, & Kent, 1999; Blair, Mitchell, Blair, 2005; Cornell et al., 1996; Williamson, Hare, & Wong, 1987). Importantly however, psychopaths are thought to act on impulse as well, which is reflected by the impulsivity item and the poor behavior control item in the Psychopathy Checklist Revised (PCL-R) (Hare, 2003, 1991). Subjects with Aspergers syndrome sometimes also act in a predatory way, for instance by stalking other people, maybe as a means of “communication” (Stokes, Newton, & Kaur, 2007).

### 3. Psychopathy

The present review will discuss contemporary research in brain imaging on offenders, with a specific focus on psychopathy. Psychopathy is a strong predictor of relapse in violent offences (Dolan & Doyle, 2000). In 1809, psychopathy was first introduced as a concept by Phillippe Pinel who introduced the term: “Mania sans délir”; “Insane without delirium”. The concept was further developed by Cleckley in 1976 in the book “the Mask of Sanity”, (Cleckley, 1976). Currently, psychopathy does not exist as a DSM-IV diagnosis (American Psychiatric Association, 1994, 2000). Quite often however, it is confused with antisocial personality disorder (APD), which is a defined diagnosis in DSM-IV (American Psychiatric Association, 1994, 2000). Although there are some overlapping items between the two diagnoses, they are not interchangeable i.e. not all individuals with antisocial personality disorder are considered psychopaths. Psychopathy is commonly assessed by use of the Psychopathy Checklist Revised, (PCL-R), developed by Robert Hare (Hare, 2003, 1991). PCL-R consists of two major parts; factor one and factor two. In factor one, personality traits such as superficial charm, grandiose sense of self-worth, shallow affect, lack of remorse, and lack of empathy are scored. In factor two, behavior and life style such as impulsivity, poor behavioral control, parasitic lifestyle, juvenile delinquency, and criminal versatility is scored. PCL-R has been criticized for mixing personality traits with lifestyle and behavior. In reference to the PCL-R, some authors subdivide psychopaths into primary and secondary psychopaths. The primary psychopaths have more pronounced psychopathic personality traits scoring high on factor one, and the secondary psychopaths are displaying antisocial behavior and lifestyle, scoring higher on factor two (Lykken, 1995; Skeem, Johansson, Andershed, Kerr, & Loudon, 2007).

Lack of empathy is one of the characteristics of psychopathy. There are many different aspects of empathy but it has been suggested that psychopaths specifically lack affective empathy specifically (Blair et al., 2005; Blair, 2006). Affective empathy constitutes non-conscious physiological reactions such as the fight or flight reaction, characterized by autonomic arousal, which is controlled by the amygdala. The amygdala is situated in the medial temporal lobe just in front of the hippocampus, and it is involved in emotional regulation, particularly of unpleasant emotions (Gross, 2007). A dysfunctional amygdala has been suggested as one of the core neural correlates of psychopathy (Blair et al., 2005; Blair, 2003, 2006). Impairments in the amygdala could lead to deficient emotional learning, which in turn could be one of the reasons behind the development of psychopathy (Blair, 2003, 2006; Blair, Peschardt, Budhani, Mitchell, & Pine, 2006). In addition, a rather large set of studies have shown that individuals with psychopathy fail to react to threatening stimuli (Birbaumer et al., 2005; Patrick, Bradley, & Lang, 1993; Patrick, Cuthbert, & Lang, 1994; Raine, 1996; Raine, Lencz, Bihle, LaCasse, & Colletti, 2000). It has been suggested that this could be due to a dysfunctional or slow autonomic nervous system or an inhibitory mechanism stemming from other parts of the brain. Aside from the amygdala, frontal lobe dysfunction has been suggested in psychopaths (Gorenstein, 1982; Raine, 2002).

### 4. Brain imaging

Currently, brain imaging techniques offer the possibility not only to measure brain volumes, but also to study neuronal processing behind specific actions through observation and measurement of brain activity during emotional and cognitive processing. Computer tomography (CT) and magnetic resonance imaging (MRI) are the most common ways of imaging the brain. In structural studies, various techniques such as segmentation, manual outline, semi-automatic combination of manual and automatic segmentation, and stereotactichal cavalieri principal (Barta, Dhingra, Royall, & Schwartz, 1997), can be used, in order to study volumes in different areas of the brain. Brain functioning can be studied using different techniques such as positron emission tomography (PET), single photon emission computed tomography (SPECT) or functional magnetic resonance imaging (fMRI). PET is a nuclear medical imaging technique which produces a three-dimensional image or map of functional processes in the body. The system detects pairs of gamma rays emitted indirectly by a positron-emitting radioisotope, which is introduced into the body on a metabolically active molecule. SPECT is a nuclear, tomographic imaging technique that enables the study of perfusion in the brain, either in resting state or during an active task. An indirect measurement of brain activity is obtained by fMRI, utilizing the hemodynamic response, related to neural activity in the brain, the so called Blood Oxygen Level Dependency, BOLD-technique (Ogawa et al., 1993).

### 5. Aim of the study

The aim of the present review is not to be a meta-analysis, but to provide a glimpse of the research field on psychopathy and brain imaging to date, this serving as a basis for discussion of the difficulties that face researchers in this field. Furthermore, the review aims to provide suggestions for future areas of research.

### 6. Methods

A literature search was performed in PubMed, Cochrane and PsycInfo by combining the following key words: mentally disordered offender/aggression/violence/crime/forensic psychiatry/brain imaging/neuroimaging/ fMRI/MRI/PET/SPECT/lack of empathy/psychopathy and antisocial personality disorder. The search yielded 58 articles, eight books, and two dissertations. From that material, only articles written in English were reviewed. Any studies focusing on topics outside our area of interest (studies of children or studies using methods other than brain imaging) were excluded. In all the articles included, the reference lists were searched and some additional references were added. The final material consisted of 48 articles divided into three categories; review articles, structural studies and functional studies.

### 7. Results

#### 7.1. Previous review articles

In the 12 review articles included, results suggested smaller brain tissue and decreased activity in the frontal lobes in individuals with antisocial and violent behavior (Anckarsater, 2006; Bassarath, 2001; Brower & Price, 2001; Hoptman, 2003; Pridmore, Chambers, & McArthur, 2005). There were also findings indicating that deviations in the temporal lobes and in the limbic system are more closely connected to psychopathic traits (Anckarsater, 2006; Blair, 2003; Dolan, 2002; Kiehl, 2006). Blair suggested, in his review article from 2006, that the reason why psychopathic individuals fail to avoid actions that harm others is a disrupted ability to form the stimulus-punishment associations, necessary for successful socialization (Blair, 2006). The disturbance in the limbic system, the insensitivity to punishment, and the extreme sensitivity to reward were further discussed in the latest review

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