

## Will neuroscience ever enter the courtroom?

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### Abstract

Advances in research into the neurobiological determinants of the human mind have raised questions concerning the factors underlying moral judgement and responsibility. The present work addresses both neuroscientific and legal issues and analyses the results of studies on brain structure and function in conditions such as psychopathy, paedophilia and aggressive behaviour. The associations between the existing nervous system abnormalities and the nature and type of the crime committed are discussed, as is the culpability of the perpetrator. The authors also address cost restrictions, which prevent more extensive use of fMRI in forensic psychiatry.

fMRI data have already been used in the legal process and could be applied to establish the prognosis of aggressive behaviour and in simulation and long-term abstinence testing.

*Keywords:* forensic psychiatry, fMRI, neuroscience

### Streszczenie

Rozwój i postępy w zakresie badań nad neurobiologicznymi uwarunkowaniami życia psychicznego i zachowania człowieka powodują pojawienie się pytań dotyczących podłoża wyborów moralnych i odpowiedzialności.

Autorzy poruszają problemy z zakresu neuronauki i prawa, poddają analizie wyniki badań nad strukturą i funkcją mózgu w wybranych stanach klinicznych, jak psychopatia, pedofilia, zachowania agresywne. Omawiane są związki pomiędzy istniejącymi anomaliami w układzie nerwowym a charakterem i rodzajem czynów przestępczych i zdolnością do zawinienia sprawców tych czynów.

Autorzy podnoszą trudności w prowadzeniu na szerszą skalę badań fMRI w psychiatrii sądowej z uwagi na koszty. Jednak podkreślają, że niektóre dane z tego typu badań bywają już używane przy orzekaniu przez sądy. Ponadto propozycje stosowania fMRI dotyczyć mogą badania symulacji, prognozy zachowań agresywnych, trwałości abstynencji.

*Słowa kluczowe:* psychiatria sądowa, fMRI, neuronauka

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### Introduction

In his prayer for wisdom, King Solomon asked God for understanding to discern what is right. In legal doctrine, wisdom and discernment are key elements in the concept of truth. Although this concept has changed over the centuries, the desire to know and discover the truth and to apply it in practice remains unchanged.

In recent decades, forensic neuropsychiatry has developed in parallel with the progress of research into human brain structure and functioning. This specialty aims to identify and integrate the complex relations between brain functioning, mind, behaviour and social phenomena [26].

The law addresses primarily the rationality, responsibility and culpability of an individual. The role of rules in human behaviour is also an area of interest for forensic psychiatry, which evaluates how the structure and function of the brain affect human behaviour and social phenomena. If we consider freedom, morality and guilt as epiphenomena of cerebral processes, questions arise concerning legal decisions and their effect on patients' lives.

### The role of neuroscience in law

It is thought that neuroscience will never discover the relationship between the responsibility and the structure and functioning of the brain, as the concept of responsibility is related to the individual as a whole, not only to physiological functions of the brain. In other words, the role of society seems to carry more weight than the anatomy and physiology of the brain [15]. In contrast, the increasing influence of the findings of biological and anthropological studies on reforms of legal doctrine reveals conflicts in the relationship between the mind and the brain and between freedom and determinism. The use of medical imaging in forensic psychiatry is promising, as new techniques make it possible to examine brain function in such detail that both the conscious mind and the unconscious mind are accessed.

Introduced in the 1990s, functional magnetic resonance imaging (fMRI) makes it possible to visualize blood flow in the active areas of the brain. This technique provides large amounts of data (approximately 100 000 3-D pixels, known as voxels, in one image), which can be further analysed. Cerebral activity in a given situation is a

key object of research. The introduction of multi-voxel pattern analysis (MVPA), which identifies patterns in the data generated by fMRI, proved to be a breakthrough in the analysis of brain activity, as it provided us with a tool that can link a mental phenomenon with specific observable patterns. Additionally, specific thoughts have been shown to have quite reproducible patterns, leading some people to refer to the technique as "brain reading". MVPA has helped us to interpret how the activity of the brain generates a conscious thought. These discoveries have a practical application in lie detection and in the analysis of the decision-making process. When we process complex information using the pre-frontal and parietal cortices, the intense signal generated suggests activity in these areas, particularly a few seconds before a specific decision is made. These discoveries have increased interest in free will and dependence of decisions on the functional potential of specific areas of the brain.

Magnetic resonance tomography and other techniques for the structural and functional imaging of the central nervous system (CNS), such as single proton emission computed tomography and positron emission tomography, play a key role in clinical diagnosis. However, although their high cost prevents routine use in forensic psychiatry [12], the results obtained in clinical practice are of interest to professionals working with criminals.

### Neuroimaging and forensic psychiatry

Neuroimaging techniques may be used to evaluate the decision-making process, intense emotional states, moral judgement, choice-related risk and readiness to use violence [1,7,18]. Most studies involve individuals with a psychopathic personality whose disturbed emotional and moral judgement leave them less able to draw conclusions from their illegal conduct. Findings suggest the existence of structural abnormalities or functional changes within the CNS, and, in some cases, the coexistence of both [2,9,21,23].

Structural lesions in the pre-frontal cortex are associated with decreased ability to empathize and limited response when making moral judgements [6,8,11,16,28].

When imaging was performed in alcohol-dependent individuals and in individuals with an anti-social personality and tendency toward violent behaviour, lesions were found within the pre-frontal and temporal cortices and cognition interaction was observed.

Additionally, structural abnormalities in the amygdala and dysfunction of the neuronal system supporting regulation of emotions have been observed in individuals with a predilection for aggressive behaviour [5,20,27,28]. A link between genetic and neurostructural changes has also been observed in these individuals [4]. Brunner et al [3]

reported abnormal behaviour associated with a mutation in the MAO-A gene on chromosome X. Structural abnormalities and dysfunctional regulation of emotions have also been observed in the amygdala and pre-frontal cortex of patients with borderline personality disorder and in patients with attention-deficit/hyperactivity disorder (ADHD) [10,13,17]. Persistent symptoms of ADHD were observed in almost 50% of prison inmates in Germany [13].

Few reports analyse neurostructural and functional brain abnormalities in paedophiles or discuss limited ability to control emotions by specific brain stimulation [25]. fMRI is also subject to ethical objections, for example, in lie detection and testing for racial prejudice or a tendency toward deviant sexual behaviour. Moreover, the use of neuroimaging techniques and detection of CNS abnormalities may not always be beneficial for criminals. Some lawyers claim that courts and their judgements should protect society against criminals with a high risk of re-offending due to biological abnormalities. Therefore, fMRI has the potential to be used as a supplementary tool for prognosis and detection of the risk of re-offending, especially in terms of regulation of emotions and long-term abstinence. The combination of the Implicit Association Test with fMRI could prove useful in such an evaluation.

### Summary

The limitations of current technology and the significant costs of neuroimaging, especially fMRI, prevent extensive use of imaging techniques for legal purposes. Nevertheless, in some countries (e.g. the US), the courts accept the results of imaging as evidence, and structural/functional abnormalities – if found – are considered mitigating circumstances. In each and every case, however, the offence committed and the relevant circumstances should be judged taking into account the clinical and mental status of the perpetrator at the moment of commission. The results of additional tests, including neuroimaging techniques, should not be directly transposed, as these techniques are subject to certain limitations [22]. The results of fMRI are characterized by relatively low reproducibility and a high risk of misinterpretation. In addition, evaluation of decision-making processes or the risk of moral judgement is affected by latency periods, which differ in duration – some are only a few seconds long – and are prone to artefacts and interpreting errors. Finally, it is important to remember that the results of additional tests (for example, IQ tests) must be interpreted with caution when assessing sanity or attempting to establish a prognosis and that structural and functional CNS abnormalities also occur in mentally healthy individuals who have never broken the law.

Also important is the fact that analysis of structural and functional abnormalities in legal practice reveals a

larger population of mentally healthy, but difficult and socially unadapted individuals in closed institutions. This is the case in some mental hospitals in Austria [24]. Nevertheless, despite their importance, these limitations should not prevent application of neuroimaging in forensic psychiatry.

Current knowledge and the potential practical application means that neuroimaging techniques (especially fMRI) can be recommended in selected cases, such as the study of the neurobiological basis of specific behaviours in simulation testing, assessment of long-term abstinence or detection of latent sexual deviations.

## References

- Birbaumer N, Ver M, Lotze M. Deficient fear conditioning in psychopathy: a functional magnetic resonance imaging study. *Arch Gen Psychiatry*. 2005;62:799-805.
- Blair RJ. Neurobiological basis of psychopathy. *Br J Psychiatry*. 2003;182:5-7.
- Brunner HG, Nelen M, Breakefield XO, Ropers HH, van Oost BA. Abnormal behaviour associated with a point mutation in the structural gene for monoamine oxidase A. *Science*. 1993;262:578-80.
- Capsi A, Mc Clay J, Moffitt TE, Mill J, Martin J, Craig IW, et al. Role of genotype in the cycle of violence in maltreated children. *Science*. 2002;297:851-4.
- Davidson RJ, Putnam KM, Larsson CL. Dysfunction in the neural circuitry of emotion regulation – a possible prelude to violence. *Science*. 2000;289:591-4.
- Decety J, Jackson PL. The functional architecture of human empathy *Behav Cogn Neurosci Rev*. 2004;3:71-100.
- Dressing H, Sartorius A, Meyer-Lindenberg A. Implication of fMRI and genetics for the law and routine practice of forensic psychiatry. *Neurocase*. 2008;14(1):7-14.
- Farrow T. Neuroimaging of empathy, In: Farrow T, Woodruff P, editors. *Empathy in mental illness*. Cambridge University Press; 2007. p. 201-16.
- Fince C, Kennett J. Mental impairment, moral understanding and criminal responsibility: psychiatry and the purposes of punishment. *Int J Law Psychiatry*. 2004;27:425-43.
- Garland B, Glimcher PW. Cognitive neuroscience and the law. *Curr Opin Neurobiol*. 2006;16:130-4.
- Haidt J. The synthesis in moral psychology. *Science*. 2007;316:998-1002.
- Heitzman J. *Psychiatria i prawo*, In: Hales RE, et al, editors. *The American psychiatric publishing textbook of psychiatry*. Warszawa: Medipage; 2010. p. 337-406.
- Jacob CP, Philipsen A, Ebert D, Deckert J. [Multidodal treatment of adult attention-deficit hyperactivity disorder]. *Nervenarzt*. 2008;79:801-8. German.
- Laakso MP, Gunning-Dixon F, Vaurio O, Repo-Tiihonen E, Soininen H, Tiihonen J. Prefrontal volumes in habitually violent subjects with antisocial personality disorder and type 2 alcoholism. *Psychiatry Res*. 2001;114:95-102.
- Markowitsch HJ. Neuroscience and crime. *Neurocase*. 2008;14:1-6.
- Mool J, de Oliveira-Souza R, Bramati JE, Grafman J. Functional networks in emotional moral and nonmoral social judgments. *Neuroimage*. 2001;16:696-703.
- Minzenberg MJ, Fan J, New AS, Tang CY, Siever LJ. Fronto-limbic dysfunction in response to facial emotion in borderline personality disorder: an event-related fMRI study. *Psychiatr Res*. 2007;155:231-43.
- Müller JL. [Forensic psychiatry in the era of neuroscience: present status and outlook for neurobiological research]. *Nervenarzt*. 2009;80:241-51. German.
- Müller JL, Sommer M, Döhl K, Weber T, Schmidt-Wilcke T, Hajak G. Disturbed prefrontal and temporal brain dysfunction during emotion and cognition interaction in criminal psychopathy. *Behav Sci Law*. 2008;26:131-50.
- Phelps EA, O'Connor KJ, Cunningham WA, Funayama ES, Gatenby JC, Gore JC, et al. Performance on indirect measures of race evaluation predicts amygdala activation. *J Cogn Neurosci*. 2002;12:729-38.
- Raine A, Ishikawa S, Arce E, Lencz T, Knuth KH, Bihle S, et al. Hippocampal structural asymmetry in unsuccessful psychopaths. *Biol Psychiatry*. 2004;55:185-91.
- Reeves D, Mills MJ, Billick SB, Brodie JD. Limitations of brain imaging in forensic psychiatry. *J Am Acad Psychiatry Law*. 2003;31:89-96.
- Rilling JK, Glenn AL, Jairam R, Pagnoni G, Goldsmith DR, Elfenbein HA, et al. Neural correlates of social cooperation and non-cooperation as a function of psychopathy. *Biol Psychiatry*. 2007;61:1260-71.
- Schanda H, Stompe T, Ortwein-Swoboda G. Dangerous or merely difficult? The new population of forensic mental hospitals. *Eur Psychiatry*. 2009;24:365-72.
- Schiffer B, Peschel T, Paul T, Gizewski E, Forsting M, Leygraf N, et al. Structural brain abnormalities in the frontostriatal system and cerebellum in pedophilia. *J Psychiatr Res*. 2007;41:753-61.
- Silva JA. Forensic Psychiatry, Neuroscience and the Law. *J Am Acad Psychiatry Law*. 2009;37:489-502.
- Weber S, Habel U, Amunts K, Scheider F. Structural brain abnormalities in psychopaths: a review. *Behav Sci Law*. 2008;26:7-28.
- Yang Y, Raine A, Lencz T, Bihle S, LaCasse L, Colletti P. Volume reduction in prefrontal gray matter in unsuccessful criminal psychopaths. *Biol Psychiatry*. 2005;57:1103-8.

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