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# Neuroethics: A Moral Approach Towards Neuroscience Research

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**Context:** Ethical issues have always been a topic of concern in basic science and clinical research. The ethical implications of neuroscience research and treatment have adopted the label "neuroethics," with great relevance and value.
**Evidence Acquisition:** Human subjects and patients undergoing research and treatment exhibit their naturally judgmental nature on what is "moral" or "ethical" and raise several questions pin pointing broader dilemmas in regarding moral and ethical issues posed by scientific research along with clinical treatment regimens.
**Results:** Neuroethics encompasses the numerous ways and diverse methodologies throughwhich developments in basic and clinical neuroscience traverse with social, legal, moral and ethical issues.
**Conclusions:** This review article puts forth emphasis on moral and ethical approaches regarding neuroscience research and treatment methodologies in the scientific arena.

*Keywords:* Ethics; Neurosciences; Biomedical Research

## 1. Context

Ethical problems emerging from neuroscience research and clinincal neurology have led to the development of a new discipline termed "Neuroethics". Neuroethics takes into account ethico-legal and socio-moral norms when performing basic science and clinical research in the field of neuroscience (1). There seems to be a tremendous increase in interest in the ethics of neuroscience as evidenced by numerous meetings, publications and organizations devoted to this area. In the contemporary scenario the field of neuroethics is depicted as empirical neuroethics and additionally methodological issues are considered in theoretical neuroethics (2). In the present scenario neuroethics is depicted in both empirical and theoretical forms considering practical issues and theoretical guidelines. The ethical challenges also put a great pressure on research investigators for their accountability as well as being answerable to the public about the implications of their work for health care and society (3). Moreover, these days modern researchers explicitly make a distinction between "ethics of neuroscience" and "neuroscience of ethics" (4). The former deals with ethical problems arising from new forms of interventions regarding the brain and the latter explores the neural mechanisms and treatment issues that may possibly underlie moral practices (4). This review article inspects pragmatic facts and guidelines with critical evaluation of the methodology underlying ethics in neuroscience research and treatment.

## 2. Evidence Acquisition

This review is based on review of relevant literature and search on Pubmed, Pubmed Central, Medline and Google scholar using the following key words: Neuroethics, ethical issues, basic neuroscience research, neurological and clinical treatment. Review of literature was extensively undertaken, by including the original research and review articles from 2002–2013.

### *2.1. Ethics of Neuroscience: Facts and Morals*

Neuroscience represents a dynamic area of biomedical research where neuroethical responsibilities for researchers are constantly growing (5). Latest neuro-technology such as neuroimaging, psychosurgery, deep-brain stimulation, and psychopharmacology carry potential promises for accurate prediction as well as diagnosis and more effective treatment of neurological and psychiatric disorders (6). Mapping the neural correlates of mind through brain scans, and altering these by the use of techniques like surgery, stimulation, or pharmacological interventions can affect subjects both in positive and negative ways (6). As stated earlier "ethics of neurosci-

**Implication for health policy/practice/research/medical education:**
Neuroethics is a moral approach towards ethical problems emerging from neuroscience research. It is imperative to address the ethicals concerns of neurological treatment and neuroscience research with experimentation.

ence" "deals with the implications of our mechanistic understanding of brain function for society. integrating neuroscientific knowledge with ethical and social concepts" (7). It points to the ethico-legal and socio-moral impact of neuroscience, together with the ways in which neurotechnology which can be used to visualize or alter brain function along with human behavior (7). As scientists head towards the more advanced knowledge of brain and also develop progressive and expanded latest technologies to measure, evaluate, and manipulate brain function, numerous questions arise from moral point of view as well as from religious principles regarding these practices (8). If neuroscientists can conclusively establish a functional network between neural impulses and an individual's capacity for moral evaluation, this will surly lead to queries about the relationship between these networks and moral values and ethically based human actions (8). Therefore, neuroethics considers a number of issues raised by the opportunities created by advances in knowledge and sophisticated techniques in the field of neurology and psychiatry (9).

### *2.2. Neuroscience of Ethics: Facts and Morals*

Another arena of neuroethics has emerged as "neuroscience of ethics" as stated earlier where ethical challenges and moral issues are raised by our understanding of neural bases of behavior, personality, consciousness, treatment and states of spiritual transcendence (7). This field focuses on multitude of neuroethical issues, such as informed consent from human subjects for treatment and research, diagnostic and prognosticpurposes , and also the subjectivity of data interpretation (1). Taking into account risk assessment and burdens as well as informed consent provision and capacity of patients (10), it becomes very important and necessary to follow the procedural ethics and morals in various domains of clinical neuroscience and research namely: clinical neurology, biomedical research, genetic studies, stem cell therapy etc.

## 3. Results

### *3.1. Ethics of Neuroscience: Approaches and Issues*

The following are the approaches and areas that might evolve from the ethical issues concerning tools, techniques and methods pertaining to neuro-scientific research involving human subjects/patients which most probably entail more refined validation and rationalization both morally and ethically.

#### *3.1.1. Brain Imaging Techniques*

Recent developments in modern neuro-imaging techniques such as Computerized Tomography scans (CT), functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) allow us to examine the structure and function of brain (11, 12). The introduction of powerful neuro-imaging tools and techniques has redefined the diagnosis, definition and understanding of various disorders of consciousness such as the vegetative and minimally conscious states (11, 12). Neuroscientists have started to untangle mechanisms of recovery after brain injury and tackle and struggle with ancient questions about brain, mind, their correlates, neural mechanisms and consciousness (11, 12). Several ethical challenges are posed by novel diagnostic and therapeutic neuroimaging applications against the broader needs of patients struggling with severe brain injury and their families (11, 12). One of the most widely discussed new applications of imaging is based on correlations between brain activity and intentional deception (as in the context of a lie detector) (13). Different research groups have identified fMRI correlates of intentional deception in laboratory tasks, and despite the cynicism and doubts raised by many, the technique has been commercialized (13). Another feasible application of brain imaging is "neuromarketing," in which people's conscious or unconscious desire for certain products can purportedly be measured (13). Also there is a broad range of relatively unexplored ethical challenges in functional neuroimaging either simple or complex, ranging from imaging the central nervous system of the fetus in utero to neural activation patterns associated with cognition and behavior in childhood as well as in adulthood (14). Another misconception is called "neuro-realism" according to which something is real because it can be measured with brain imaging and electronic equipment (15, 16). Researchers are also trying to find brain-imaging correlates of many psychological traits such as personality, intelligence, mental health vulnerabilities, attitudes toward particular ethnic groups, and predilection for violent crime. An added ethical problem is that brain scans such as CT or fMRI are often viewed as more accurate and objective than they realy are because of their eye-catching signal processing, statistical analysis (16). This has lead to the emergence of a potentially harmful strong belief in these techniques by the public figures (such as judges/juries, employers, insurers etc.) ignoring other complexities and treat brain images as a kind of undeniable and unquestionable piece of data. Keeping all these concerning moral issues in mind, the theoretical, practical, and ethical considerations at the heart of imaging healthy research subjects and cognitively compromised patients should be logically and responsibly explored (14).

#### *3.1.2. Brain Interventions*

With the advancements in neuroscience e and having the advantage of improved technology in the areas of neurosurgery, psychosurgery, deep-brain stimulation and brain implants, multitude of critical questions have raised regarding the issues that affects the individual's sense of privacy, autonomy and identity and may gradu-

ally change their concepts of mental health (17). Advancements of of neurosurgery have led researchers to talk about ethical implications of surgical techniques used to alter personality, personal identity, undesirable traits or enhancement of normal traits (18). Clinical neurology and neurosurgery pose impending challenges as how patients approach their identity following identity-altering procedures with potential confrontation for clinicians and researchers in the field of neuro-therapeutics (18). Another intervention known as "Deep Brain Stimulation" (DBS) is currently used to treat neurological disorders like Parkinson's disease, essential tremor, epilepsy and dystonia, and also is being explored as an experimental treatment for psychiatric disorders like major depression and obsessive compulsive disorder (19). The most prominent ethical and moral issues regarding DBS are balancing risks and benefits and ensuring respect for the patients autonomous decision making (19). This implies special attention to patient selection, psycho-social impact of treatment, effects on personal identity, treatment of children and careful informed consent process in which unrealistic expectations of patients and their families are addressed and special attention is given to the competence of the surgeon (19). Therefore, the potential benefits of applying neuroimaging, deep brain stimulation and other advanced neurotechnology methods to the mentally ill patients and healthy subjects have to be carefully balanced against their potential harm (17).

### *3.1.3. Stem Cell Research*

As we all are familiar, stem cell research poses many ethical questions concerning the allocation of stem cells, their source as well as their applications. Explicitly, the way stem cell research is mainly followed in neuroscience is through the treatment of neurodegenerative diseases and brain tumors, where scientists use neural stem cells to regenerate tissues and as carriers of vectors for gene therapy (20). Multiple studies evince the potential use of stem cells such as use of induced pluripotent stem cells (iPSCs) in various neurodegenerative disorders such as Parkinson's disease (20, 21), Multiple Sclerosis (20, 22) etc. Mostly, iPSCs have been used to treat animal models of Parkinson's Disease (21) and Cerebral palsy (23). This highlights the neuroethical issues concerning animal models used in research studies since most of their "diseases" are inflicted and not natural and also not a fully valid representative of the same disease in humans regarding disease features and response to therapy. Furthermore, basic and clinical research has focused on the use of stem cells as potential therapy for spinal cord injury (SCI), culminating in the initiation of clinical trials (24). A qualitative study on experimental stem cell therapy of individuals with spinal cord injury suggest profound difference related to the optimum timing of stem cell implantation in clinical trials (24). Therefore, bridging this gap is required with a number of considerations for timing disparity of trials and recommendations for improving informed consent procedure (24). In general, although the future looks promising for stem cell application in the field of neurology but still the probable complications prevail in overall ethics of the use of stem cells, including recipient rejection as well as over-proliferation of cells likely causing possible brain tumors (25). Ongoing research will further help to decide whether stem cells should be used in the treatment of brain disorders and whether their benefits truly outweigh their harms (25).

### *3.1.4. Cellular and Neurobiochemical Research*

The research community has been continuously performing research (such as experiments involving peripheral blood cells, neuronal cell lines etc.) to discover effective treatment approaches for neurodegenerative disorders (3). The prospect of using cell-based interventions (CBIs) in neurological conditions raises several important ethical and policy questions (26). Various issues related to the unique collection of traits characterizing CBIs targeted at the central nervous system implies that these cells alter recipients' cognition, mood, behavior and functioning of brain central to our concept of self and are causes for concern and careful ethical analysis (26). Moreover, neuroscientists working in the field of neurodegeneration (ND), and drug discovery are especially motivated to consider ethical issues related to their work, but the perceived lack of ethical resources halts their efforts (3). Also, experiments involving CBI's cell lines and that altering biochemical profile (i.e. neurotransmitters, hormones and enzymes) should also be ethically regulated.

### *3.1.5. Genetic Studies and Gene Therapy*

There are some major ethical issues surrounding emerging technologies in neuroscience and genetics (27). The field of gene therapy is rapidly evolving, with the hope of treating disorders of the central nervous system (28). Ethical questions are commonly expressed as fears about the impact of gene therapy on self and society and it seems that the acceptability of gene therapy varies depending on the specific applications (28). Researchers investigating the range of topics from normal brain functioning to pathological states are increasingly looking to genetics for clues on normal variations and disease aetiologies (29). It would be a mistake for neuroethicists to overlook or price out a plethora of relevant work just because it aims at treating genes rather than brains (30). Several issues such as the ethics of access and consent or who can obtain information about a person's genome or brain, and what information can be accessed, the social misuses of that information; questions of distributive justice, handling of probabilistic or statistical information about future health; and the perplexing question of how to conceptualize and identify pathology and normality are of considerable importance and common to

both neuroethics and genethics (30). Genethics, a branch emerged out from bioethics, has its own proprietary issues, among which are questions raised by the potential of making genetic changes to the germ line, that would affect not only the person but also future generations and, in unlikely scenarios probably the entire human race (30). Keeping all these points in mind, it is mandatory to make use of these advanced tools and techniques by recognizing, appreciating and protecting the rules and regulations regarding the rights of human subjects.

## 3.2. Neuroscience of Ethics: Approaches and Issues

Following are the approaches and area's emerging with important ethical issues concerning human subjects/ patients undergoing neurological treatment or neuroscientific research, possibly requiring refinement in validation and rationalization, both morally and ethically.

### 3.2.1. Neurological Treatment

Neurological disorders often encompass new treatments and medications to treat various disorders of Central Nervous System (CNS). Neurological disorders such as Parkinson's disease, amyotrophic lateral sclerosis, Alzheimer's disease, epilepsy, multiple sclerosis etc. exhibits multiple issues regarding ethical concerns. First and foremost is the issues pertaining to the treatment regimens, identification, assessment and level of education of the subjects. Correct identification and proper assessments of direct benefit, social value, and scientific quality should be ethically considered for the subjects undergoing clinical (neurological and psychiatric) treatment (10). Secondly, issues related to informed consent of minor subjects/patients, subjects with psychiatric disorders and obtunded cognition are extremely important and should be proposed to the subjects and family members at the earliest. Thirdly, reasons for treatment delays and incidental findings along with legal questions related to responsiveness and post study access of records should be revealed to the concerned subjects. Fourthly, many subjects claim to experience a special kind of side effect following neurological treatment called changes in "personal identity" (10). Furthermore, possibly patients undergoing treatments might lose parts of "themselves" such as memories or moods probably because of multiple treatment regimen as well as direct side effects drugs/ medications (31). Multiple drug treatment and their side effects should be kept in mind while treating a patient and all the information regarding the side effects should be revealed to the subjects before giving the medications. An added ethical dispute in neurological treatment is treatment stratification. For example, at times, an old aged patient is excluded despite the seriousness of the disorder simply because they are not as strong as others or as likely to benefit from the treatment or expected to live long enough for adequate follow up (31). It is reasonable that priority should be given to those who are most seriously impaired and who are at highest need ofthe intervention (10).

### 3.2.2. Neurological Research

The most pivotal role of addressing moral and ethical issues in neurological treatment and research on human subjects is promoting high-quality scientific research for the interest of patients. But at the same time, the rights and interests of the research subjects should be respected and safeguarded. First and foremost requisite for biomedical research involving human subjects is obtaining their consent to take part in the research. Another important ethical concern regarding the biomedical and neuroscience research in human subjects is hiding the reasons for research and non- responsible communication of research results (5). Regarding the collection of various kind of samples i.e. cerebrospinal fluid (CSF), blood, saliva, urine etc. or enrollment of study subjects, there should be honest and conscientious communication of purposes of involvement in the study as well as a sincere communication of results to them even if it is unrelated to their treatment regimen. This entire dependable framework would reflect fundamental role of scientific integrity regarding social responsibilities pertaining to the eventual use of neuroscience knowledge, and highlights the importance of self-reflection in research and training of researchers (5).

### 3.2.3. Neuropsychopharmacology

There is a need to explore, communicate and reveal the social and ethical implications within the frameworks of neuroethics and neuropsychopharmacology. Prominent issues stem out when new drugs are tested and the experiments incite ethical questions. Because the treatment affects CNS, e side effects might be very unique and sometimes they might also be severe such as psychiatric disorders such as mood changes, depression, anxiety and impaired cognition (31). Further to quote, pharmacological cognitive enhancers (PCEs) are used to improve cognitive functions, such as attention, learning, memory and planning in patients with impairments in cognition resulting from traumatic brain injury (TBI) or from neuropsychiatric disorders (31). Evidence suggests that PCEs are also being used as cognitive enhancers by healthy people and as the use of these drugs becomes very popular in the healthy population there is an emerging need to consider the current and future neuroethical concerns (31). These concerns include issues such as obtaining relevant empirical data, monitoring short- and long-term effectiveness, side-effects, and initiation of accurate surveys to determine current patterns and quantity of usage of PCE drugs by patients and healthy people (31).The three main ethical concerns around CE were identified in a Nature commentary in 2008 as "safety, coercion and fairness" (32). The debate was focused on helping cognitively disabled people and also on the issue of 'cosmetic neurol-

ogy', where people use these enhancers not because of a medical need, but because they want to use them (32). Challengers of cosmetic pharmacology believe that such drug usage is unethical and that the concept of cosmetic pharmacology is a manifestation of naive consumerism and moral enrichment might be more effective in reducing the health inequalities (32). From a socio-ethical view other means of enhancing cognition such as education, physical exercise (31), healthy diet, yoga and meditation should be used by the patients and healthy adults.

#### *3.2.4. Genetic Studies*

Issues concerning modern genetics, raise serious questions regarding prediction of disease, privacy and identity (33). On the other hand some issues pertaining to genetic studies may seem a bit peripheral to clinical practice, but they have unanticipated effects upon the care of patients with mental illnesses (27). Increasing attention is being paid to the ethical issues in contemporary neuroscience as applied to genetics and neuroimaging (34). Imaging genetics has emerged as a powerful and sensitive approach to the study of functional genetic variations and responses from brain and nervous system in various psychiatric and neurological disorders (34). Neuroimaging-genetic paradigms are a new approaches to investigate the pathophysiology and treatment of cognitive deficits in neurological as well as in psychiatric disorders such as schizophrenia (35) which feeds the argument that the ethical issues are very important in light of cumulative power of imaging genetics. Parallel to the clinical features, there are additional neuroethics features that have new implications for health care, justice, and policy making in genetic studies (35). Furthermore, genetic studies like determining the prevalence of gene polymorphism in a given population and studying familial patterns of inheritance of various neurological disorders also involves collection of blood samples from human subjects for extracting their DNA as a requisite for genetic analysis. These types of genetic studies should be accompanied safeguarding the moral and ethical concerns for human subjects by enrolling them only after getting their informed consent and eventually by honest reporting of results.

## 4. Conclusions

The field of neuroethics has emerged as a novel branch of bioethics that deals with ethical challenges of advancements in neuroscience and neuro-technology. This branch considers a number of issues created by progressions in knowledge and development of new techniques in the field of basic and clinical neuroscience research and treatment. Presently, two general categories of neuroethical issues can be considered including those emerging from what is to be done and what is already evident. Although currently neuroethics is practically oriented in a way that it not only includes empirical findings from neuroscience but also explores novel applications within neuroscience. However, socio-moral and ethico-legal contexts are rather neglected, which could be a subject of future approaches of neuroethics in basic and clinical neuroscience research as well as treatment. Hence, more studies are needed to address these concerns.

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## Authors' Contributions

Prof. Madhuri Behari: Study concept and design, analysis and interpretation of manuscript, critical revision of manuscript for intellectual content. Dr. Mohita Shrivastava: Literature review, acquisition of data, drafting of the manuscript.

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## References

1. Aggarwal NK, Ford E. The neuroethics and neurolaw of brain injury. *Behav Sci Law.* 2013;**31**(6):789–802.
2. Northoff G. [Methodological deficits in neuroethics: do we need theoretical neuroethics?]. *Nervenarzt.* 2013;**84**(10):1196–202.
3. Robillard JM, Federico CA, Tairyan K, Ivinson AJ, Illes J. Untapped ethical resources for neurodegeneration research. *BMC Med Ethics.* 2011;**12**:9.
4. Figueroa G. [Neuroethics: reflections on the latent principles of morals in medicine]. *Rev Med Chil.* 2012;**140**(8):1078–84.
5. Racine E, Illes J. Neuroethical responsibilities. *Can J Neurol Sci.* 2006;**33**(3):269–77.
6. Glannon W. Neuroethics. *Bioethics.* 2006;**20**(1):37–52.
7. Roskies A. Neuroethics for the new millenium. *Neuron.* 2002;**35**(1):21–3.
8. Tsomo KL. Compassion, ethics, and neuroscience: neuroethics through Buddhist eyes. *Sci Eng Ethics.* 2012;**18**(3):529–37.
9. Crozier S. [Neuroethics: ethical issues in neurosciences]. *Rev Prat.* 2013;**63**(5):666–9.
10. Anderson JA, Eijkholt M, Illes J. Neuroethical issues in clinical neuroscience research. *Handb Clin Neurol.* 2013;**118**:335–43.
11. Fins JJ. Neuroethics and neuroimaging: moving toward transparency. *Am J Bioeth.* 2008;**8**(9):46–52.
12. Fins JJ. Neuroethics, neuroimaging, and disorders of consciousness: promise or peril? *Trans Am Clin Climatol Assoc.* 2011;**122**:336–46.
13. Henry S, Plemmons D. Neuroscience, neuropolitics and neuroethics: the complex case of crime, deception and FMRI. *Sci Eng Ethics.* 2012;**18**(3):573–91.
14. Illes J, Raffin TA. Neuroethics: an emerging new discipline in the study of brain and cognition. *Brain Cogn.* 2002;**50**(3):341–4.
15. Goldacre B. *"Lost your libido? Let's try a little neuro-realism, madam: A study of women's libido raises questions about why brain imaging is used to make mental states 'real' for the public".*: The Guardian; 2010. Available from: http://www.theguardian.com/commentisfree/2010/oct/30/ben-goldacre-bad-science-neuroscience.
16. Gordijn B, Giordano James J. *Scientific and Philosophical Perspectives in Neuroethics.*Cambridge, UK: Cambridge University Press; 2010.
17. Fuchs T. Ethical issues in neuroscience. *Curr Opin Psychiatry.* 2006;**19**(6):600–7.
18. Lipsman N, Zener R, Bernstein M. Personal identity, enhance-

ment and neurosurgery: a qualitative study in applied neuroethics. *Bioethics.* 2009;**23**(6):375–83.
19. Schermer M. Ethical issues in deep brain stimulation. *Front Integr Neurosci.* 2011;**5**:17.
20. Barker RA, de Beaufort I. Scientific and ethical issues related to stem cell research and interventions in neurodegenerative disorders of the brain. *Prog Neurobiol.* 2013;**110**:63–73.
21. Chen LW, Kuang F, Wei LC, Ding YX, Yung KK, Chan YS. Potential application of induced pluripotent stem cells in cell replacement therapy for Parkinson's disease. *CNS Neurol Disord Drug Targets.* 2011;**10**(4):449–58.
22. Silani V, Cova L. Stem cell transplantation in multiple sclerosis: safety and ethics. *J Neurol Sci.* 2008;**265**(1-2):116–21.
23. Bell E, Wallace T, Chouinard I, Shevell M, Racine E. Responding to requests of families for unproven interventions in neurodevelopmental disorders: hyperbaric oxygen "treatment" and stem cell "therapy" in cerebral palsy. *Dev Disabil Res Rev.* 2011;**17**(1):19–26.
24. Illes J, Reimer JC, Kwon BK. Stem cell clinical trials for spinal cord injury: readiness, reluctance, redefinition. *Stem Cell Rev.* 2011;**7**(4):997–1005.
25. Hyun I. The bioethics of stem cell research and therapy. *J Clin Invest.* 2010;**120**(1):71–5.
26. Duggan PS, Siegel AW, Blass DM, Bok H, Coyle JT, Faden R, et al. Unintended changes in cognition, mood, and behavior arising from cell-based interventions for neurological conditions: ethical challenges. *Am J Bioeth.* 2009;**9**(5):31–6.
27. Hoop JG, Spellecy R. Philosophical and ethical issues at the forefront of neuroscience and genetics: an overview for psychiatrists. *Psychiatr Clin North Am.* 2009;**32**(2):437–49.
28. Robillard JM, Whiteley L, Johnson TW, Lim J, Wasserman WW, Illes J. Utilizing social media to study information-seeking and ethical issues in gene therapy. *J Med Internet Res.* 2013;**15**(3).
29. Brief E, Illes J. Tangles of neurogenetics, neuroethics, and culture. *Neuron.* 2010;**68**(2):174–7.
30. Roskies AL. Neuroethics beyond genethics. Despite the overlap between the ethics of neuroscience and genetics, there are important areas where the two diverge. *EMBO Rep.* 2007;**8 Spec No**:S52–6.
31. Mohamed AD, Sahakian BJ. The ethics of elective psychopharmacology. *Int J Neuropsychopharmacol.* 2012;**15**(4):559–71.
32. Shaw D. Neuroenhancing public health. *J Med Ethics.* 2013.
33. Illes J, Racine E. Imaging or imagining? A neuroethics challenge informed by genetics. *Am J Bioeth.* 2005;**5**(2):5–18.
34. Tairyan K, Illes J. Imaging genetics and the power of combined technologies: a perspective from neuroethics. *Neuroscience.* 2009;**164**(1):7–15.
35. Roffman JL, Weiss AP, Goff DC, Rauch SL, Weinberger DR. Neuroimaging-genetic paradigms: a new approach to investigate the pathophysiology and treatment of cognitive deficits in schizophrenia. *Harv Rev Psychiatry.* 2006;**14**(2):78–91.