

## Neuroethics

### *A Conceptual Approach*

MICHELE FARISCO, ARLEEN SALLES, and KATHINKA EVERS

**Abstract:** In this article, we begin by identifying three main neuroethical approaches: neurobioethics, empirical neuroethics, and conceptual neuroethics. Our focus is on conceptual approaches that generally emphasize the need to develop and use a methodological *modus operandi* for effectively linking scientific (i.e., neuroscience) and philosophical (i.e., ethics) interpretations. We explain and assess the value of conceptual neuroethics approaches and explain and defend one such approach that we propose as being particularly fruitful for addressing the various issues raised by neuroscience: fundamental neuroethics.

**Keywords:** neuroethics; neuroscience; neurobioethics; empirical neuroethics; conceptual neuroethics

#### Introduction

Neuroscientific research and related technological applications raise a number of philosophical, ethical, social, and regulatory issues. The need to examine them has resulted in the development of a new field of research: neuroethics. Multiple explanations of neuroethics have been offered, and how to understand its nature, methodology, topics, and goals continue to be debated.<sup>1,2</sup> Indeed, even a particularly influential two-pronged understanding of the field (ethics of neuroscience and neuroscience of ethics<sup>3</sup>) has been challenged as being incomplete.<sup>4</sup> Taking this into account, a different approach to the field has been offered, arguing that the various forms and methodologies of neuroethics since its formal introduction 15 years ago allow for a distinction among three main approaches: neurobioethics, empirical neuroethics, and conceptual neuroethics<sup>5</sup>.

According to this view, “neurobioethics” is primarily normative. It applies ethical theory and reasoning to practical issues arising from neuroscientific research and its clinical applications, and issues raised by public communication of neuroscientific findings and their impact. “Empirical neuroethics” is descriptive and occasionally explanatory: it uses empirical data to inform theoretical (e.g., what is moral reasoning) and practical issues (e.g., who is really a moral agent).<sup>6</sup> Finally, “conceptual neuroethics” is primarily theoretical and foundational. Conceptual approaches use conceptual analysis of key notions to address issues such as how neuroscientific knowledge is constructed and why or how empirical knowledge of the brain can be relevant to philosophical, social, and ethical concerns.<sup>7</sup> In doing so, conceptual approaches generally emphasize the need to develop and use a methodological *modus operandi* for fruitfully linking scientific and philosophical interpretations. In this article, we argue for the value of conceptual approaches in

---

This research has received funding from the European Union’s Horizon 2020 Framework Programme for Research and Innovation under the Specific Grant Agreement No. 720270 (Human Brain Project SGA1) and Specific Grant Agreement No. 785907 (Human Brain Project SGA2). The first two authors contributed equally to the article.

neuroethics, focusing in particular on one such approach that we believe is particularly fruitful for addressing the various issues raised by neuroscience: fundamental neuroethics.

### **Conceptual Issues in Neuroscience**

Why is a conceptual neuroethics necessary? After all, it could be argued that the field of neuroscience itself already includes some type of conceptual examination and that this is sufficient for properly addressing the relevant issues.

And yet, although it is true that conceptual examination is not absent in neuroscientific practice, it is not clear that such examination is enough to fully address the kind of conceptual concerns and even conceptual limitations that we have in mind.

Neuroscience is conceptually limited for a number of reasons, both intrinsic and extrinsic. First, although neuroscience has a conceptual component, this is not as developed as in other more mature scientific disciplines such as physics, because neuroscience is a relatively young field and comparatively less developed. Conceptual neuroethics may to some extent help neuroscience refine and develop the kind of conceptual framework needed to better analyze neuroscientific assumptions, results, and interpretations.

Second, the distinction between third-person and first-person accounts of notions such as mind, consciousness, and normativity (e.g., moral judgement), is at the root of an epistemic insufficiency of neuroscience: even if a material correspondence between cerebral levels (the object of neuroscientific investigation) and mental levels exists,<sup>8</sup> the mental cannot be totally explained by third-person scientific accounts.<sup>9</sup> Informed by philosophical reflection, conceptual neuroethics makes use of third-person and first-person accounts complementing the third-person data emerging from neuroscience.

A third conceptual limitation of neuroscience has to do with the epistemological need to develop models and with how neuroscientific models are developed.<sup>10</sup> Considering human epistemological constraints, the world is not directly available to us: we need and typically construct models. Therefore, models, as the product of scientific knowledge and as epistemic tools for improving it, play a critical role in our understanding of the world.

As outlined by Nancy Cartwright, Ronald Giere, and more recently by Georg Northoff, scientific models can be characterized by three elements: (1) simulation; (2) scale-free features; and (3) interest- or purpose-drive as related to the scientist. Specifically, models refer to a causal structure, which is extrapolated from the collected empirical data.<sup>11</sup> This extrapolation is the basis for knowing the target object via its simulation. Thus, a model is an epistemic mediation between the world and us: it impacts and determines what we can know about the world.<sup>12</sup> Moreover, models are qualified as scale free because they use a spatiotemporal scale different from the target object, otherwise they would not model but replicate the target object.<sup>13</sup> A model is not isomorphic with the target object but is always selective of the details to be modeled: this selection is affected by the scientist's interest and purpose, which are scientific but also extrascientific.<sup>14</sup> In short, science in general, and neuroscience in particular, lead to conceptual models that are representative of the target object and selective at the same time. In light of the abovementioned, the kind of analysis offered by conceptual neuroethics might be able to complement

and help neuroscience build conceptual models that are not arbitrary and not inappropriate for explaining the target object.

Finally, because the brain is a complex and dynamic system that is intrinsically multiscale and multilevel (e.g., organized in different spatiotemporal scales, from molecules to cells to multicellular assemblies to long-distance networks to behavior), a development of a synthesis between these different levels is necessary. Such a synthesis requires a conceptual work of refinement and interpretation involving concepts (such as space, time, and level) that are not fully exhausted by neuroscientific analysis, (e.g., inferring from the available data general principles of organization or fundamental rules). Conceptual neuroethics can contribute to this task.<sup>15</sup>

The abovementioned are all intrinsic conceptual limitations. However, neuroscientific research is also constrained by extrinsic limitations (i.e., limitations deriving from external factors). To illustrate: several neuroscientific results are highly relevant to human beings' understanding of themselves at different levels, from psychological to social, legal, political, and moral. It is important for neuroscientists to be aware of the impact that their findings might have and how these findings can be used. This is not a minor point if we consider that historically science has repeatedly been politically hijacked: the more dangerously the stronger the science in question.<sup>16</sup> Scientific theories and findings can serve highly problematic and nefarious ends in the name of science and objectivity, as the misuse of Darwinism in developing evolutionary ethics illustrates<sup>17</sup> A conceptual/philosophical level of interpretation within neuroscience helps to raise awareness of this possibility and aids in designing solutions.

It is worth noting, however, that even if scientific purposes are ethically justified, as with any human activity, scientific research is not just about objective empirical evidence and methodology. All scientific activity is permeated by the values, including nonepistemic values, of its practitioners. Those values necessarily have an impact on the questions that neuroscientists seek to answer and on the interpretation, assessment, and presentation of the results that they attain. This is a particularly significant issue not only because overlooking the role played by nonepistemic values entails a lack of scientific self-awareness, but also because all too often scientific findings are intended to and used to support specific public policies.<sup>18</sup>

Taking into account both that science curricula typically do not include the kind of philosophical training that would help science students to discover the hidden values and assumptions that shape how they conduct their research and interpret existent scientific evidence, and considering the high degree of specialization within the field—which might lead to undervaluing the role played by nonepistemic values and emphasizing instead the importance of epistemic values—it might be difficult for neuroscience to detect and thus adequately address those “external” considerations on its own. The identification, examination, and conceptual clarification offered by conceptual neuroethics can be of great help in this respect.

A particular version of conceptual neuroethics was introduced in 2007 by Kathinka Evers: fundamental neuroethics. Next we explain this conceptual approach, its goals, and the role that it can play in both the natural and the human sciences, and propose that this conceptual approach is particularly appropriate for complementing and further developing dialogues between science, notably neuroscience, and a number of disciplines including philosophy.

### **Why Fundamental?**

Fundamental neuroethics is a specific form of conceptual neuroethics.<sup>19,20,21</sup> From the beginning, it was termed “fundamental” for one main reason: it is not just an examination of the potential impact of neuroscience on fundamental notions such as human identity, self, integrity, personal responsibility, and freedom (therefore not to be simply equated with Adina Roskies’s neuroscience of ethics<sup>22</sup>) but rather, it is intended to be a reflection on foundational elements (concepts and methods) including those of neuroscience.<sup>23</sup> In this sense, the term “fundamental” can be taken to mean foundational with regard to both methods and contents.

From this perspective, the interpretative challenges generally posed by scientific and neuroscientific discoveries arise at least at three levels: scientific, sociocultural, and, more generally, philosophical. At the philosophical level, the focus is on analyzing the meaning of neuroscientific terms, theories, and interpretations, as well as their relationship to how the same or similar terms are used in other disciplines and in ordinary, nonscientific discourse.<sup>24</sup>

Fundamental neuroethics method consists in a conceptual investigation of neurosciences’ linguistic and theoretical tools and of their possible impact on our understanding of notions such as identity, consciousness, and normative judgment (including moral judgment), among others. Accordingly, fundamental neuroethics is a multidisciplinary and interdisciplinary field. It is multidisciplinary because, as a reflection on the conceptual and linguistic toolkit of neuroscience, it uses tools and merges elements from several disciplines, including philosophy of science, philosophy of language, philosophy of mind, and moral philosophy. Its multidisciplinary aims at assessing whether and how neuroscience can contribute to unveiling notions traditionally explained within different disciplinary domains. Yet this conceptual approach is also interdisciplinary because it cannot be easily subsumed under any particular classical discipline. Insofar as conceptual analysis is its main tool, from a methodological perspective, fundamental neuroethics is in a sense philosophical. However, it would be inadequate to reduce this approach to philosophy. It can be better described as an interlevel analysis comprising both empirical and conceptual disciplines, specifically linking neuroscience and different domains (e.g., history, psychology, genetics). Therefore, although substantially, concerning its contents, fundamental neuroethics is multidisciplinary, formally, concerning the critical analyses it provides, it is interdisciplinary, and thus eludes traditional disciplinary classification.

This means that fundamental neuroethics recognizes the mutual relevance of philosophy and neuroscience: neuroscience may be better equipped to provide adequate explanations of its results when aided by appropriate conceptual interpretations, and philosophical analyses may benefit from taking relevant empirical data and their interpretations into account when addressing some issues. However, fundamental neuroethics shares some tools and contents with both neuroscience and philosophy and plays a significant role in the conceptual refinement necessary to neuroscience and to philosophical reflection in the discussion of a number of notions potentially affected by neuroscientific results. In other words, this type of conceptual approach operates within the two disciplines it aims to link, keeping at the same time a constructively critical attitude toward both of them.

### Why Neuro-“Ethics”?

The reference to “ethics” in fundamental neuroethics denotes more than the goal of shedding light on human moral reasoning and judgment. The “ethics” in fundamental neuroethics should rather be understood in the Spinozian sense, encompassing more than the topic of ethics as traditionally understood: it also covers topics typically addressed within classical branches of philosophy; for example, epistemology, metaphysics, and ethics. Even if fundamental neuroethics devotes special attention to moral reasoning, insofar as its overall focus is on the general evaluative and normative attitude of sentient beings, it is concerned with the origin of evaluative predispositions in its broadest sense.

Starting from the most recent neuroscientific models of the brain as an intrinsically and autonomously active, projective, and variable system in which emotions and values are incorporated as necessary constraints,<sup>25,26,27</sup> fundamental neuroethics identifies the root of our evaluative predispositions in the brain’s attitude to building models of the external world on the basis of the values that the brain itself develops in its interaction with external environments (e.g., social, cultural, and physical contexts).<sup>28</sup> We are neurobiologically predisposed to develop these complex and diverse systems of moral and other values enabling us to establish appropriate relationships in our social, cultural, and physical environments.<sup>29</sup>

Accordingly, the term “ethics” in fundamental neuroethics does not refer simply to an examination of human praxis or of the neural basis of ethical reasoning, but more broadly to an examination of the human innate predisposition to evaluate the world in order to satisfy specific needs. Seen thus, it is evident that fundamental-foundational questions arise, such as what does it mean for an animal (whether human or not) to act as a “moral” evaluator? Why and how did the evolution of higher cognitive functions produce moral rather than amoral beings?<sup>30</sup> The answer to these and other fundamental philosophical questions requires a multidisciplinary approach, involving both empirical and theoretical/conceptual disciplines. Therefore, although not embracing a naïve reductionism of ethics to neuroscience, fundamental neuroethics recognizes the need to involve neuroscience in the investigation of some fundamental issues in broadly understood ethics.

### Fundamental Neuroethics and Philosophy

To state that traditional philosophical approaches should pay more attention to empirical results is not uncontroversial. The philosophical relevance of the results obtained by neuroscience has been questioned, regardless of the method employed (e.g., empirical or simulation based). Consider, for example, the somewhat heated debate over the normative relevance of neuroscience, particularly of the alleged identification of brain areas involved in moral reasoning, and its possible impact on ethical and legal notions, such as responsibility and accountability.<sup>31,32,33,34</sup> There is no doubt that positing that science is important to philosophy can trigger protests from the philosophical communities that often emphasize their self-sufficiency and autonomy from empirical science.<sup>35,36,37</sup>

However, before objecting to fundamental neuroethics’s call for more empirically informed philosophical discussion, it is important to be clear about what this means in our discourse. It certainly does not mean that all philosophical notions

should or could be simplistically reduced to neuroscientific notions, nor does it mean that philosophy must be deferential to neuroscience in general: fundamental neuroethics does not take for granted that neuroscientific results are ipso facto relevant from a philosophical perspective, or that these results are sufficient to solve philosophical disputes. Rather, it means that the knowledge that neuroscience provides, together with the knowledge provided by other disciplines such as evolutionary psychology, sociology, and cultural anthropology, can be theoretically significant in helping us unveil some important notions typically discussed by philosophers. Even if not wholly explained by them, some conceptual frameworks need to be shaped by insights from the natural sciences if these frameworks are to be useful in addressing some philosophical issues. If the abovementioned need is true, the natural sciences, including neuroscience, can contribute important perspectives to the conceptual reflection on some of the notions traditionally confined to the philosophical field, such as consciousness, human identity, or the development of norms. This should not be taken as a naïve attempt to explain philosophical notions through neuroscientific knowledge, taking for granted the epistemic primacy of the latter. Striving for a critical analysis of neuroscientific language and concepts entails more than a philosophical translation of neuroscientific data. As noted, as a methodological-analysis fundamental, neuroethics is “inclusive” of both neuroscience and philosophy (interdisciplinarity), and regarding content, knowledge from different disciplines can be relevant (multidisciplinarity).

### **Why Fundamental Neuroethics?**

As noted, neuroscience might be fruitfully complemented by the analysis provided by a conceptual neuroethics approach, and fundamental neuroethics is one such productive approach. However, it is not the only possible version of a fruitful conceptual neuroethics, but is methodologically compatible with another interesting approach recently developed by Georg Northoff, who uses theoretical neuroethics and neurophilosophy in attempts to develop conceptual connections between neuroscience and philosophy.<sup>38,39,40</sup> Considering the rate of neuroscientific advances, the results attained, what they promise, and their potential impact and limitations, both neuroscience and society can benefit from this hybrid research field.

This discussion has thus far been kept at an abstract level, but at this point concrete illustrations of how fundamental neuroethics has developed and is used in addressing a number of issues will be useful. Here we briefly outline some preliminary results in the area of consciousness, brain simulation, and neuronal epigenesis.

#### *Fundamental Neuroethics and Consciousness*

The sometimes perplexing and age-old topic of consciousness has been widely discussed in philosophy. Advances in the scientific study of consciousness between the end of the last and the beginning of the new century have been impressive. New technological applications have led to important findings and the development of new theories at the intersection of science and philosophy. An overarching theory of consciousness grounded in the most recent scientific models of the brain,<sup>41</sup> and a critical interpretation of the increasing possibility of visualizing the

internal world of patients with disorders of consciousness<sup>42</sup> has been elaborated within a fundamental neuroethics approach. Starting from empirical data and related theoretical models depicting the brain as intrinsically active and predisposed to build models of extracerebral environments (both within the rest of the body and external to it), the proposal is that consciousness be identified with this attitude of the brain to build models and simulate the external environment; that is, with its intrinsic predisposition to go beyond itself. Accordingly, consciousness can be seen as an overarching brain characteristic not reducible to the cognitive dimension, implicitly (unaware, corresponding to unreflective consciousness; i.e., we can feel things without being focally, reflectively aware that this is taking place) or explicitly (aware, corresponding to reflective consciousness) manifested. Ethical analyses of recent scientific studies of residual consciousness in patients with disorders of consciousness have also been developed within fundamental neuroethics.<sup>43</sup>

#### *Fundamental Neuroethics and Brain Simulation*

Computer models and simulation have been increasingly used in the last years as tools for improving our knowledge about the brain and obtaining a more unified picture beyond the resulting fragmentation of traditional experimental approaches.<sup>44</sup> Using a fundamental neuroethics approach, a critical analysis of modeling and simulating the brain, with particular focus on the possibility of modeling and simulating the conscious brain, has been developed.<sup>45</sup> Two possible approaches for modeling and simulating the conscious brain have been identified: a global and a discrete approach, targeting the whole brain and specific brain regions, respectively. Advantages and limitations of both have been outlined, suggesting a combination of the two as a possible useful strategy. Fundamental neuroethics has offered the conceptual framework for critically analyzing the two strategies and speculating about their possible complementarity.

#### *Fundamental Neuroethics and Neuronal Epigenesis*

Recent advances in neuronal epigenesis studies promise to be key in understanding the relationship between the brain and its environment and in explaining a number of phenomena including moral compliance and the possibility of moral change. Fundamental neuroethics's approach to neuronal epigenesis and its emphasis on the need to achieve a deeper and more multifarious understanding of the symbiosis of the brain and its natural and sociocultural contexts have contributed to that discussion. Evidence shows that as a consequence of the brain's steady interaction with the physical, social, and cultural environments, an active epigenetic selection of neuronal networks results in the internalization of the cultural and ethical rules prevalent in the social community to which the child and her/his family belongs.<sup>46</sup> Together with other studies, notably of the brain's intrinsic activity and natural predisposition to explore the world,<sup>47</sup> this suggests that there is a reciprocal causality between the brain and its external environments, and a mutual epistemic relevance in understanding the two realms (biological vs. sociocultural). Understanding of the brain must involve reference to the experiences and social structures that shape it, and knowledge of the brain is also relevant to understanding the development of those social structures.<sup>48,49</sup> This in turn

opens the door to richer discussions on the possibility and potential desirability of epigenetic proaction and moral development.<sup>50</sup>

### **Fundamental Neuroethics, Neurobioethics, and Empirical Neuroethics**

Although separating different neuroethical approaches makes good analytic sense, this distinction should not obscure the fact that they are complementary dimensions of one and the same field with many aspects in common.

In this concluding section, we argue that the collaboration of neurobioethics, empirical neuroethics, and conceptual neuroethics is necessary in order to properly address the issues raised by brain research. Next, we present two concrete examples that illustrate how the analytic potential of conceptual neuroethics in general (including, of course, fundamental neuroethics) can be productively used in the direction of a common neuroethics research program that encompasses both applied and empirical issues.

#### *The Role of a Conceptual Approach in Neurobioethics*

One of the neurobioethical topics that has received widespread attention lately is the possibility of using neurotechnology to morally improve human beings. We take this particular topic to illustrate the role of a conceptual approach in neurobioethics. Indeed, a number of neuroethicists have proposed moral neuroenhancement—generally understood as being brain interventions intended to change moral dispositions, such as altruism or a sense of justice, or to boost or select moral capacities to act—as a solution to the morally dismal state of world.<sup>51</sup> Such proposals have generated a lively debate about the permissibility of such a means of moral improvement and the practical feasibility of moral enhancement neurotechnologies,<sup>52</sup> where a careful evaluation of the explanatory power of the neuroscientific evidence, its implications, and limits has often been wanting. In fact, as argued for elsewhere,<sup>53</sup> the conception of moral bioenhancement as a potential solution—whether such practice is permissible or not—to the human moral predicament is fraught with problematic framing assumptions about what morality, moral motivation, and moral actions are; about how to understand moral problems and their emergence; and about what the existent scientific evidence says and how it is interpreted.

From a conceptual approach, a careful scientific and philosophical interpretation of the core concepts and the unveiling of underlying assumptions are necessary conditions for conducting the discussion about whether moral neuroenhancement is feasible, justifiable, and ethical, or not. It is important to note, however, that this does not render neurobioethical work irrelevant. To the contrary, by contributing to its conceptual clarity, conceptual approaches help to prevent simplistic or unworkable suggestions for solving complex normative problems and thus contribute to making neurobioethics more practically significant.

#### *The Role of a Conceptual Approach in Empirical Neuroethics*

Empirical neuroethics takes neuroscientific findings as key in describing and eventually explaining a number of phenomena and experiences, including moral phenomena (such as moral agency). Often, empirical neuroethics also suggests



that neuroscientific results can illuminate fundamental philosophical questions, at times justifying a change in some beliefs that we hold about concepts such as autonomy and personhood<sup>54</sup> and even refine and enhance the moral tools that ethicists use.<sup>55</sup> The fact is, however, that these claims raise both translational and conceptual issues. First, they raise translational issues because unless one supposes that brain facts and normative concepts correspond one to one (and there is no reason to take this for granted) it is not self-evident that brain facts have such explanatory power. And yet, at times empirical neuroethics appears to overlook this fact and tends to expect us to accept that neuroscience has such explanatory power without explaining why and how. Second, they raise conceptual issues as well. Empirical neuroethics would greatly benefit from a deeper conceptual clarification of the relevant notions. How does it understand the brain and the mind and the relationship between them? What are the assumptions used as the basis of some of the main empirical neuroethics conclusions, and can they be reasonably grounded? Indeed, a particular understanding of “brain facts,” their correlation with mental events, their value, and their normative weight underlie the claim that neuroscience has such explanatory power and can even lead us to revise particular metaphysical and ethical notions.<sup>56,57</sup> Conceptual approaches, including fundamental neuroethics, can nicely complement empirical neuroethics by providing the necessary conceptual investigations to satisfy a key requirement: explaining how biological data can have either explanatory or normative relevance.

Therefore, in order to approach applied and empirical issues effectively and realistically, a partnership between the three dominant forms of contemporary neuroethics is actually ideal. The conceptual approach we favor, fundamental neuroethics, is not intended to privilege any particular mode of explanation, coming from natural or human sciences. Rather, it is intended to provide at least two important things: an attitude of constructive critical alertness and a thought-out methodology that is intended to achieve both substantial scientific ground and conceptual clarity.

## **Conclusion**

In this article, we have explained the role that a conceptual approach to neuroscience can play, notably in neuroethics. We also argued that such a role is necessary. We based this claim on two considerations. First, the significant potential impact of neuroscience on notions traditionally analyzed by other fields, including philosophy, and second, some of neuroscience’s intrinsic and extrinsic conceptual limitations that can be overcome by its complementarity with a conceptual neuroethics approach.

We further suggested that within the conceptual approach, fundamental neuroethics is a particularly productive option because of its inter- and multidisciplinary nature. After providing a description of the field, we tried to show its utility: fundamental neuroethics is making important contributions to specific areas of research such as consciousness studies, brain simulation, and neuronal epigenesis, among others.

We stressed that the relationship among the identified three forms of neuroethics, as well as the relationship between conceptual neuroethics and neuroscience, are not mutually exclusive, the distinctions being not so sharp and the respective

edges spurious. Indeed, conceptual work should always be (although only sometimes is) part of empirical neuroethics and neurobioethics. Conceptual neuroethics, and fundamental neuroethics as its particular version, is an inter- and multi-disciplinary effort to strengthen and develop further the conceptual refinement of the categories involved.

If this is true, further development of the conceptual approach of fundamental neuroethics, particularly through the collaboration with other fields besides neuroscience, will be very productive to help us achieve a more integrated picture of the brain.

## Notes

1. Racine E. *Pragmatic Neuroethics: Improving Treatment and Understanding of the Mind-Brain*. Cambridge, MA: MIT Press; 2010.
2. Racine E. *Debates about Neuroethics: Perspectives on its Development, Focus, and Future*. Dordrecht: Springer International Publishing; 2017.
3. Roskies A. Neuroethics for the new millenium. *Neuron* 2002;35(1):21–3.
4. Roskies A. Neuroethics. In: Zalta EN, ed. *The Stanford Encyclopedia of Philosophy*. 2016; available at <https://plato.stanford.edu/entries/neuroethics/> (last accessed 20 June 2017).
5. Evers K, Salles A, Farisco M. Theoretical framing of neuroethics: The need for a conceptual approach. In: Racine E, Aspler J, eds. *Debates about Neuroethics: Perspectives on its Development, Focus and Future*. Dordrecht: Springer International Publishing; 2017:89–107.
6. Northoff G. What is neuroethics? Empirical and theoretical neuroethics. *Current Opinion in Psychiatry* 2009;22(6):565–9.
7. Salles A, Evers K. Social neuroscience and neuroethics: A fruitful synergy. In: Ibanez A, Sedeno L, Garcia A, eds. *Social Neuroscience and Social Science: The Missing Link*. Dordrecht: Springer International Publishing; 2017:531–46.
8. In logical terms, given some conditions, a healthy brain is necessary and sufficient for mental life.
9. Evers K. *Neuroetique. Quand la matière s'éveille*. Paris: Odile Jacob; 2009.
10. Model and simulation are here assumed in their conceptual, not technical sense. For a taxonomy of models and simulation see Farisco M, Kotaleski JH, Evers K. Large-scale brain simulation and disorders of consciousness. Mapping technical and conceptual issues. *Frontiers in Psychology* 2018;9:585.
11. Cartwright N. If no capacities, then no credible worlds, but can models reveal capacities? *Erkenntnis* 2009;70(1):45–58.
12. Northoff G. *The Spontaneous Brain. From Mind–Body Problem To World–Brain Problem*. Cambridge MA: MIT Press; 2018.
13. Giere R. Using models to represent reality. In: Magnani LN, Thagard P, eds. *Model-Based Reasoning in Scientific Discovery*. New York: Springer; 1999:41–57.
14. See note 12, Northoff 2018.
15. We should note in parenthesis that this need for a conceptual synthesis is true for both a data-led hypothesis-generating strategy based on predictive computational simulation modelling within a Big Data science framework and the traditional hypothesis-lead approach based on the interpretation of empirical data. Regarding these different approaches see Frackowiak R, Markram H. The future of human cerebral cartography: A novel approach. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 2015;370(1668): pii: 20140171.
16. See note 9, Evers 2009.
17. See note 5, Evers et al. 2017.
18. Melo-Martin I, Intemman K. Interpreting evidence: Why values matter as much as science. *Perspectives in Biology and Medicine* 2012;55(1):59–70.
19. See note 9, Evers 2009.
20. Evers K. Towards a philosophy for neuroethics. An informed materialist view of the brain might help to develop theoretical frameworks for applied neuroethics. *EMBO Rep* 2007;8(Spec No):S48–51.
21. Evers K. Neuroethics: A philosophical challenge. *American Journal of Bioethics* 2005;5(2):31–3, discussion at W3–4.
22. See note 3, Roskies 2002.

23. See note 9, Evers 2009.
24. See note 20, Evers 2007.
25. Changeux J-P (transl Garey L). *Neuronal Man: The Biology of Mind*. New York; Oxford: Oxford University Press; 1986.
26. LeDoux JE. *Synaptic Self: How Our Brains Become Who We Are*. New York: Viking; 2002.
27. Edelman GM. *Neural Darwinism: The Theory of Neuronal Group Selection*. Oxford: Oxford University Press; 1989.
28. See note 9, Evers 2009.
29. See note 20, Evers 2007.
30. See note 9, Evers 2009.
31. Farisco M, Petrini C. The impact of neuroscience and genetics on the law: A recent Italian case. *Neuroethics* 2012;5(3):317–9.
32. Farisco M, Petrini C. On the stand. Another episode of neuroscience and law discussion from Italy. *Neuroethics* 2014;7(2):243–5.
33. Greene J. The secret joke of Kant’s soul. In: Sinnott-Armstrong W, ed. *Moral Psychology*. Cambridge, MA: MIT Press; 2008:35–79.
34. Berker AS. The normative insignificance of neuroscience. *Philosophy & Public Affairs* 2009; 37(4):293–329.
35. Scruton R. *The Soul of the World*. Princeton: Princeton University Press; 2014.
36. Bennett M, Hacker P. *Philosophical Foundations of Neuroscience*. Oxford: Blackwell; 2003.
37. Bennett MR, Dennett DC, Hacker PMS, Searle J. *Neuroscience and Philosophy: Brain, Mind, and Language*. New York: Columbia University Press; 2007.
38. See note 6, Northoff 2009.
39. Northoff G. *Minding the Brain: A Guide to Philosophy and Neuroscience*. Basingstoke: Palgrave Macmillan; 2014.
40. Wagner NF, Northoff G. A fallacious jar? The peculiar relation between descriptive premises and normative conclusions in neuroethics. *Theoretical Medicine and Bioethics* 2015;36(3):215–35.
41. Farisco M, Laureys S, Evers K. The intrinsic activity of the brain and its relation to levels and disorders of consciousness. *Mind & Matter* 2017;15(2):197–219.
42. Farisco M, Laureys S, Evers K. Externalization of consciousness. Scientific possibilities and clinical implications. *Current Topics in Behavioral Neurosciences* 2015;19:205–22.
43. Evers K. Neurotechnological assessment of consciousness disorders: Five ethical imperatives. *Dialogues in Clinical Neuroscience* 2016;18(2):155–62.
44. See note 15, Frackowiak, Markram 2014.
45. See note 10, Farisco et al. 2018.
46. Evers K. Can we be epigenetically proactive? In: Metzinger TWJ, ed. *Open Mind: Philosophy and the Mind Sciences in the 21st Century*. Cambridge, MA: MIT Press; 2015.
47. Changeux JP. *The Physiology of Truth*. Cambridge, MA: Belknap Press; 2004.
48. See note 7, Salles, Evers 2017.
49. Evers K, Changeux JP. Proactive epigenesis and ethical innovation: A neuronal hypothesis for the genesis of ethical rules. *EMBO Reports* 2016;17(10):1361–4.
50. See note 49, Evers, Changeux 2016.
51. Savulescu J, Persson I. Moral enhancement, freedom and the God machine. *Monist* 2012;95(3): 399–421.
52. Dubljevic V, Racine E. Moral enhancement meets normative and empirical reality: Assessing the practical feasibility of moral enhancement neurotechnologies. *Bioethics* 2017;31(5):338–48.
53. de Melo-Martin I, Salles A. Moral bioenhancement: Much ado about nothing? *Bioethics* 2015; 29(4):223–32.
54. Farah MJ, Heberlein AS. Personhood and neuroscience: Naturalizing or nihilating? *American Journal of Bioethics* 2007;7(1):37–48.
55. See note 3, Roskies 2002.
56. Shook JR, Giordano J. A principled and cosmopolitan neuroethics: Considerations for international relevance. *Philosophy, Ethics, and Humanities in Medicine* 2014;9:1.
57. See note 6, Northoff 2009.