ICRES 2022: 7th International Conference on Robot
Ethics and Standards, Seoul, South Korea, 18-19 July 2022.
https://doi.org/10.13180/icres.2022.18-19.07.001

THE CONTRIBUTION OF NEUROSCIENCE TO AI ETHICS AND MORALITY

HYOUNGBIN PARK
Seoul National University Of Education, South Korea
E-mail: profphb@snue.ac.kr

1. Introduction

Recent advances in AI have been remarkable. Artificial systems now outperform experts in video games and chess etc. They can also write articles indistinguishable from human ones, translate them into multiple languages, and even draw a picture in the style of Van Gogh. These advances are due to several factors, including the application of new statistical approaches and the improved processing power of computers. In particular, the contribution of neuroscience is notable.

Psychology and neuroscience have played an important role in the history of AI. Much of the major work developing neural networks in the second half of the 20th century was done in departments of psychology and neurophysiology, rather than in math or physics labs. The need for the neuroscience field and AI to work together is more urgent than ev-er. Getting inspiration from neuroscience in AI research is important in several ways. Neu-roscience can help validate existing AI technologies. For example, the connection between artificial neural networks and artificial intelligence can be considered. An artificial neural network (ANN) is a statistical learning algorithm inspired by neural networks in machine learning, cognitive science, and biology, especially the brain.

Neuroscience can also provide a rich source of inspiration for new types of algorithms and architectures to use when building artificial brains. AI researchers can use ideas from neuroscience to build new technologies. Indeed, recent advances such as optogenetics, which allow us to precisely measure and manipulate brain activity, could generate vast amounts of data for machine learning.

Artificial intelligence systems can be ethically very imperfect and vulnerable since they are affected by distortions and bias in learning data. In the research field for the realization of artificial moral agents (AMA), the issue that should be prioritized is philosophical and neuroscientific understanding of morality, rather than securing technical and scientific programming designability.

For example, developmental neuroscience plays an important role in clearly under-standing what mediates morality. Morality is a fundamental aspect of all human societies and regulates important areas in social interaction. Morality has been a topic of constant interest to psychologists and philosophers, with a focus on how individuals should inter-act and get along with others. Work across multiple disciplines converges with the view that morality is an innate general ability shaped by natural selection and arises from the process of reflection in interaction with the social environment. All normally developing individuals across cultures have the basic notion that some things are right and others are wrong. Certain actions are considered good and just and deserving of praise and rewards. Other behaviors, on the other hand, are considered bad and wrong and subject to re-proach and punishment. As social beings, humans possess intuitive fairness, concern for others, and cultural normative traits not found in other species.

Developmental neuroscience provides a neuroscientific interpretation of the occurrence and development of empathy and morality (Decety and Cowell, 2018).

The implementation of ethical AI essentially requires a neuroscientific understanding of human morality. It is also necessary to consider whether to create an AI with various moral personalities like humans or to realize the best moral human image that mankind should pursue. In addition, in order to provide materials that can explain moral decision-making to artificial moral actors production engineers, it is also necessary to have insight into specific moral principles such as mutual altruism and fairness in moral philosophy, ethics, moral psychology, and neuroethics. To implement ethical artificial intelligence, it is necessary to have the ability to design human intelligence and morality as an algorithm based on the investigation of the neuroscientific basis of morality. Consequently, develop-ing ethical AI requires a better understanding of how the human brain works, as well as strengthening the technological quest for designing AI. The need for neuroscience and AI research to work together is more urgent than ever.

Therefore, this study intends to discuss the requirements that ethical AI must have as an AMA based on the understanding of morality in neuroscience. To achieve this objective, the research questions to be addressed are the following: First, How is morality under-stood in neuroscience? Second, what are the qualifications of an ethical agent? Third, what are the challenges for ethical AMA design? To answer these questions, I will conduct an in-depth literature study following chapters

2. Neural mechanisms of morality

2.1. *Morality in neurophilosophy and developmental neuroscience*

Neurophilosophy has improved the understanding of the mind in psychology, genetics, evolutionary biology, philosophy, and ethics by understanding the work of the mind as the product of the work of the cranial nerves. In its simplest form, the central idea of neu-rophilosophy is that to understand the nature of the mind, one must understand the nature of the brain. One of the most striking features of neurophilosophy is that it rejects the dualism between the study of the mind and the study of the brain. From a neurophilosophical point of view, our brains make us think, feel, make decisions, sleep, and dream. Many neurophilosophers understand the philosophical and ethical workings of human intelligence as the workings of the brain.

Flanagan found positive effects of meditation in neuroscientific research. Patricia Churchland explored morality by studying the brain. By examining the biological sources of morality, she sought to find out the origins of human moral behavior. In other words, she sought to find the source of morality in the brain. Neurophilosophy deals with the nature of human consciousness, cognition and intelligence, moral knowledge, and moral reasoning from the perspective of neuroscience.

On the other hand, the developmental cognitive neuroscience approach is an interdis-ciplinary field of science dedicated to understanding psychological processes and their neurological underpinnings. This field bridges the gap between cognition and behavioral mechanisms and enriches our understanding of the manifestation of morality. Neurologi-cal lesions or dysfunction of brain anatomical connections result from atypical social and emotional processing. Damage to certain brain regions and neural circuits often results in deficits in moral development in normal psychological functioning. In particular, early lesions of vmPFC impair the development of moral knowledge and judgment. The connections between vmPFC and various domains such as the striatum, amygdala, and temporal-parietal junctions serve a key function across social and emotional domains (Decety and Cowell, 2018).

In the case of behavioral neuroscience, we increase our understanding of human think-ing and behavior through empirical investigations into microphysical structures and their anatomical functions. For example, the neuroscientific finding that the anatomy of the anterior cingulate cortex is composed of a different class of relatively large, spindle-shaped neurons indicates that this particular limbic structure is involved in emotion regulation, conflict resolution, and error detection (Tancredi, 2005). Neurophilosophy and neuroscience explain the evolution of the human brain as a social animal, which helps to find the basis of morality in the human brain. The human brain as a social brain has neu-rogenetic elements that are a platform for social life, such as cooperation and reciprocity.

2.2. *Moral characteristics as human moral agents*

To design ethical AI, it is necessary to explore human morality, ethics. The charac-teristics of human morality are deeply related to the definition of the concept of morality. Re-searchers view that morality is inevitably developed to minimize the damage that members inflict on each other and promote cooperation within a complex social structure. Researchers believe that morality has evolved in humans and many other species. Human attitudes toward other hu-mans and individu-als of other species are greatly influenced by this biologically based morality (Broom, DM., 2006, 20). Human morality reflects human beings as social beings, and the moral identity of an individual form's expectations and standards for how an individual should behave and feel. Moral identity is associated with moral behavior and moral feelings of guilt and shame (Stets, JE, & Carter, MJ., 2012, 120). Consequently, morality is a major factor in shaping human behavior, thinking, emotion, and attitude. Since AI morality has no choice but to use human morality as a model, it is necessary to confirm the following characteristics as a moral agent possessed by humans.

First, the morality of an individual is the accumulation of moral experiences experienced by the individual. Moral experience acts as a subjective experience that gives agency to human action. For this reason, in the implementation of AMA, a moral foundation and environment may be required for AI to grow as a moral actor. Moral experiences can be programmatically embedded in AI or de-livered using machine learning and deep learning.

Second, it is the realization of moral emotions deeply involved in moral development. Moral choice and moral will require an accompanying feeling, a moral emotion. Aside from more fundamental philosophical questions such as whether there can be moral emotions in AI, it is necessary to raise the question of whether AI's emotion design is possible. In other words, it is necessary to answer the question of how AI's emotions and emotional parts can be understood. This also suggests that emotional AI assumptions may be essential for AMA design.

Third, it is the complexity of human morality. Human morality has complex characteristics, and norms and taboos vary according to times and cultures. But at the same time, there are universal morals and immorality in all cultures. For this reason, human morality has a kind of 'intuition' about universal morality that penetrates cultures and times, and at the same time has 'specificity' of moral norms and elements required in individual societies and contexts. AMA may be required to possess these moral characteristics.

Fourth, human morality is inevitably related to relationships. Humans are social beings, and social neuroscientists describe the human brain as a social brain. Human brain development, especially the development of the cerebral cortex, served as a major basis for social formation in terms of evolution. Given the human understanding of social neuroscience, an understanding of the so-cial brain must be preceded for AI to have the same type as the human moral model. As an AMA, AI programs may be required to embed not only close interactions with other beings, such as some sort of social brain but also the traits that aspire to these interactions (Park, 2019, 2022).

3. Ethics beyond calculations: Possibility and limitations of algorithms for moral judgment

3.1. *Morality algorithm: Challenges to imbedding software morality*

AI algorithms are already being used to support or replace human judgment and expertise in numerous areas, including transportation such as airplanes and automobiles, and medical diagnosis and treatment. The trend of altering or replacing human judgment and expertise with increasingly sophisticated and powerful computer algorithms is now irresistible. However, this trend also raises serious ethical issues. Examples include personal privacy, the moral responsibility of certain groups for automated bias patterns, and harm caused by judgments made by computers, such as autonomous transportation or military hardware. However, another point to consider here is the distinction or difference be-tween computer judgment and human judgment.

In 1976, computer scientist and pioneer of artificial intelligence, Joseph Weizenbaum, published a book called Computer Power and Human Reason: From Judgment to Calcula-tion. He presented the author's ambivalent view of computer technology in this book. He thought that artificial intelligence was possible, but he believed that computers should not be allowed to make important decisions because they lack human qualities such as compassion and wisdom. Weizenbaum made a distinction between making a "decision" and "making a choice." Decisions are programmable computational activities. On the other hand, what makes us human is the ability to choose. However, the choice is a product of judgment, not calculation. A comprehensive human judgment can include non-mathematical factors such as emotions. For example, humans can judge by comparing apples and oranges without reducing the type of fruit to a factor necessary for mathematical comparison (Hasselberger, 2019). Humans are understood to have the capacity to act as autonomous agents who give meaning to their world. On the other hand, it seems difficult to conclude that artificial intelligence possesses emotional realization, non-quantitative thinking, and human intuition.

In the age of artificial intelligence and metaverse, humanity is faced with two important questions. First, it is whether all aspects of human thought can be reduced to logical formalism, no matter how disguised in technical terms. In other words, it is whether human thought processes can be fully calculated. Second, it is whether there are limits to what the computer can do. This raises the question of whether intelligent machines, even if built, can be used for important decisions. Third, is it possible to implement a morality algorithm for artificial intelligence like human moral judgment? All three of these questions are philosophical and empirical at the same time and are related to normative and ethical questions.

Among these questions, we should pay attention to the moral algorithm. To design human morality as an algorithm, it is necessary to first understand the analytical and empirical concept of human morality. However, it is not easy to draw a conclusion as this is a matter of both empirical and normative domains. At the same time, AI algorithms involve ethical issues that relate to key concepts such as bias and fairness. For this rea-son, the morality algorithm must consider both the search for morality itself and the eth-ical problems that the morality algorithm may cause.

3.2. *Neural machines for moral decisions*

One of the goals of artificial intelligence is in the design and construction of systems that work the way the human mind works. To produce an AMA, it is necessary to explore discussions from various viewpoints related to morality and moral judgment. This explo-ration is a prerequisite for the implementation of AMA. For the development of ethical AI and algorithm design, it is essential to explore the anatomy of morality.

It is an exploration of the neurobiological basis of morality. This is closely related to the study of the anatomy of morality. The latest research in fields as diverse as economics, sociology, neuroscience, and psychology has shown that humans are born with compassion and empathy for the needs and sufferings of others. Primatologist Frans de Waal, author of Good Natured: The Origins of Right and Wrong in Primates and Other Animals (1996), saw morality as firmly grounded in neurobiology. He understood morality as something established during the long course of human evolution (De Waal, 2006).

One of the neuroscience's most striking contributions is to shed new light on what enables us to make sophisticated moral decisions. Neuroscience studies have demonstrated that human moral decisions are the product of perceptual, cognitive, and socioemotional processes. These processes make independent and sometimes conflicting contributions to the final choice. For example, a famous set of studies on moral dilemmas found that deontological decisions (i.e., the decision to reject a harmful action that uses someone as a means, even if the goal is to save five lives) can be compared to emotional assessments such as vmPFC.

While it showed relatively strong activation of brain regions related to Additional evidence from neuropsychological and neuroimaging studies suggests that humans are more likely to shift towards pragmatic or deontological judgments due to disruption or impairment of vmPFC or dlPFC function, respectively. These early studies can be explained by two types of moral judgments. That is, moral decision-making can be divided into a fast and automatic emotional response and a slow and deliberate reasoning process. This can be captured by the "dual process" model of independently influencing choice behavior and fighting for hegemony when conflict arises (Kelly and O'Connell, 2020).

Cognitive science has established that our moral decisions are subject to many of the same biases, heuristics, and capacity limitations that are manifested in economic choices. A significant portion of recent research has employed economic utility and Bayesian rein-forcement learning models to investigate alternative ways to formulate moral decision processes. Crockett et al. (2017) suggest that moral behavior is not achieved by suppress-ing our temptation to pursue our own selfish interests, but by devaluing choices that may harm others. The findings suggest moral behavior is linked to a neural devaluation of re-ward realized by a prefrontal modulation of striatal value representations. Moral decisions also modulated functional connectivity between the lateral prefrontal cortex (LPFC) and the profit-sensitive region of DS (dorsal striatal) (Crockett et al., 2017).

The neuroscience of morality can contribute more directly to our understanding of moral decisions. Research so far has focused mainly on processes such as empathy, social communication, and emotion recognition. Because the evidence for the evolutionary conservation of these basic moral components is strongest. For example, such studies have revealed that identical mirror neurons respond to both direct experiences of positive (e.g. reward) and negative (e.g. pain) outcomes and observational experiences of identical outcomes. Remarkably, the intensity of nerve spikes in the anterior cingulate cortex (ACC) of a rat who witnessed a colleague receiving electrical stimulation can be used to decipher the intensity of the witnessed shock and the shock experienced by the rat directly (Carrillo et al., 2019). These data provide a powerful demonstration of a shared neural code for self and others' suffering, which is thought to provide a basis for empathic behavior.

The central message of the anatomical review of morality is that moral decisions are complex cognitive tasks whose outcomes are determined by neurocognitive processes, not solely by the values we hold. As Hume advised, the derivation of "should" from "is" should be avoided, but advances in the neurodynamics of morality can lay the groundwork for moral anatomy.

4. AMA design challenge

4.1. *An empirical and normative approach to artificial morality*

Modern technological advances include the increasing presence of artificial intelligence (AI) aimed at simulating the human intellect. Artificial intelligence is increasingly being asked to make moral and rational decisions in society. AI judges must decide who goes to jail. AI doctors must decide who is eligible for special health care. These situations raise questions such as how a machine can be moral and what principles should guide its decisions. To answer these questions, it is important to understand what morality is and how humans make moral decisions

Morality can be said to be a representative characteristic of the operation of the hu-man mind. Morality is an important feature of the human way of life and a central mechanism of society. According to the evolutionary or sociobiological position of morality, morality has evolved as a function that promotes cooperation and prosocial behavior. Morality is also a central theme in many interdisciplinary fields and often involves an exploration of the role of reason and emotion. Empirical evidence suggests that the deontological response is more closely related to the emotional component of moral cognition and is associated with increased activity in the ventromedial prefrontal cortex (VPC). In contrast, pragmatic responses are understood to be more dependent on more complex neural networks associated with reason and primarily associated with increased activity in the dorsolateral prefrontal cortex (DPFC). Currently, AI has successfully achieved certain elements of human cognitive stimulation (Nicklasson, 2020). However, the implementation of artificial morality still seems far away. It suggests that the anatomical understanding of moral judgment and morality indicates that the integration of reason and emotion is essential for morality and moral judgment, and that AI may be difficult to fully replicate human morality.

Nevertheless, the search for the biological brain, which can be said to be an organ of the human body, can be the basis for the algorithm design of artificial morality. Several explanatory models are needed to understand human moral thinking and behavior. For example, a significant amount of moral judgment and behavior may be the result of ac-quiring moral knowledge rather than reflecting the causal conditioning of evolution. It can be applied to universally held moral beliefs or distinctions that are often cited. This discussion concerns two very different meanings of 'morality': the empirical and normative meanings of morality. The empirical understanding of morality speaks of morality as something to be explained scientifically, as in the familiar story of how morality evolved. Here, morality refers to a person's observed ability to make normative judgments, a tendency to have certain emotions, such as sympathy, guilt, or condemnation, or a set of empirical phenomena, such as certain intuitions. We can explore the origins and functions of various psychological abilities and tendencies related to morality.

In contrast to this, the use of the term moral, which can be called the normative meaning, is very different. We can consider the following questions: Morality should we make significant sacrifices to help distant strangers. These questions arise from the point of view of the deliberation we seek to determine how we should live and are normative rather than empirical questions. We are not asking anthropological questions about the actual moral code of our society here, but rather a normative question that can lead us to a new moral code. When we use morality in the normative sense, we mean how we should live, that is a set of norms that we must adopt and follow (Fuller, 2019).

In artificial morality, we need to consider together what morality requires of us. This is because morality does not have a purely consequentialist structure as the utilitarian claim. As discussed above, the approach to morality in the normative sense requires an answer to what artificial morality itself should be. In other words, it is necessary to investigate the truth about morality in the normative sense, what it is based on, and how we can know it. This at the same time raises the question of whether morality is culturally relative or at least partially universal. Much discussion of morality and evolutionary biology focuses primarily on issues of altruistic feelings and behavior. Psychological altruism involves caring for the welfare of others and intentionally benefiting themselves. Although empirical approaches to morality seem useful for designing artificial morality, normative morality should not be overlooked in that humans are intelligent and reflective animals.

4.2. *Analytical calculations of computers and intuitive human decision-making*

From neural networks to speech and pattern recognition to genetic algorithms to deep learning, many applications and technologies fall into the broad category of AI. Examples of common elements that can extend AI cognitive utility and augment human tasks include natural language processing, machine learning, and machine vision. Natural language processing allows IBM's Watson to understand subtle human sentences and assign multiple meanings to terms and concepts. Watson can learn by interacting with experience and data by machine learning capabilities and develop intelligent solutions based on past experience. Through machine learning techniques and access to doctor records, Watson has learned to identify cancer patterns. AI is now accelerating its use for some knowledge-based tasks that not so long ago were considered the exclusive domain of humans. As a result, emerging AI systems are perceived as having an unparalleled ability to learn and improve on their own. People highlight the scale of the disruption caused by AI and even suggest that AI will replace most human jobs. However, we need to raise the question of whether such advances in AI depend on decision-making as a cognitive and information-driven process. In other words, we need to develop a discussion about how the unique strengths of humans and AI can synergize.

AI's problem-solving capabilities are more useful for analytical support than intuitive decision-making. AI encompasses a wide range of applications and algorithms. However, most human decision-making is not a direct result of intentional information gathering and processing, but rather occurs in the subconscious mind of the intuition realm. In a decision-making context, intuition is defined as the ability to generate direct knowledge or understanding and arrive at a decision without relying on rational thought or logical reasoning. Intuitive decision-making involves human abilities such as imagination, sensitivity, rumination, and creativity. Through an intuitive approach, individuals rely on past embodied practices, experiences, and judgments to react or make decisions without conscious attention.

Analytic approaches to decision-making rely on the depth of information, whereas intuitive approaches focus on breadth by solving problems from a holistic and abstract perspective. In the operation of the human brain, these two styles are not mutually exclusive and serve as decision-making systems to handle various contingencies more effectively. Human intuition is driven in part by implicit learning from previous mistakes and experiments. It should be noted that these unique and inexplicable perceptions that come from within the human body are often considered nearly impossible to simulate with AI. So far, machines cannot capture the inner logic and subconscious patterns of most human intuitions (Jarrahi, 2018).

However, AI has the advantage of being able to solve the complexity of decision-making. Complex situations are characterized by many factors or variables. What is re-quired in this situation is the processing of large amounts of information at a rate that exceeds human cognitive abilities. In recent years, AI with superior quantitative, computational and analytical capabilities has surpassed humans in complex tasks. Algorithmic decision-making combined with big data offers new opportunities to deal with complexity and a more effective way to provide comprehensive data analytics to human decision-makers. With greater computational information processing power and analytic approaches, AI can extend human cognition when dealing with complexity. On the other hand, humans can still provide a more holistic and intuitive approach to dealing with un-certainty and ambiguity in organizational decision-making.

5. Conclusion: Computational AI and intuitive brain symbiosis

Artificial intelligence has grown continuously since Alan Turing's paper Computing Machinery and Intelligence (Turing, 1950) discussed how to build intelligent machines and how to test intelligence. Since the 1970s, AI has expanded into various research fields such as machine learning, robotics, intelligent control, and pattern recognition. This includes AI neural networks developed by Google, IBM, Microsoft, Facebook, and Apple, criminal justice, the expanding use of facial recognition software in education and advertising, and autonomous systems programmed to make a variety of ethical decisions. The development of self-driving cars has further sparked ethical AI discussions.

For the implementation of moral AI, it is necessary to look at several academic fields that study the mind, brain, and computer. In general, AI is expected to mimic the human mind in computers. In this respect, cognitive neuroscience, the study of how the brain generates the mind, offers significant insights into the design of moral AI. Computer neuroscience uses computer analysis and simulation to analyze how the brain processes information. Artificial neural networks, including deep neural networks, achieve intelligent computation by mimicking the functions of the brain in a computer. Analyzing large amounts of personal data with artificial neural networks is the driving force behind A) systems in all areas of science and technology.

Neuroscience and neuromedicine serve as the basis for the implementation of moral AI while benefiting the development of many promising applications of AI. For example, dynamic user interface technologies that facilitate human-AI interactions provide a basis for applying AI to multiple applications in clinical medicine. This is one of the most dynamic areas of research in the field of neuro-technology. An AI-based brain-computer interface that could provide paralyzed individuals with the means to operate computer-based communication systems is a prime example. Moreover, recent neurotechnology is not limited to the adjuvant treatment of neurological disorders such as severe paralysis syndrome but is entering the consumer market with a variety of devices for neurofeedback-based well-being applications (Kellmeyer, 2019). As in most other research fields, in neuroscience, AI systems based on artificial neural networks have a wide range of applications. Machine learning using ANNs has proven successful, especially in computer vision tasks. In addition to its applications, neuroscience inspires the building of moral and ethical AI.

Although AI is affecting almost every field of industry, every field of academia, and every aspect of our daily life, given the phrase brain-based artificial intelligence, neuroscience is of paramount interest to the development of AI. The role of layered neurons, the structure of the biological brain, is a model for AI can also be found through models of deep learning and deep networks. But on the other hand, there is also debate about whether the biological brain is still a good model for artificial intelligence. Nevertheless, there is no denying that neuroscience has played a significant role in inspiring and guiding AI development. Deep networks and reinforcement learning approaches rely heavily on direct analogy to the brain. Additionally, recent AI tasks for review, attention, episodic memory, working memory, and continuous memory were inspired by neuroscience (Hildt et al., 2020). However, it is still unclear whether current AI models are suitable for achieving the complex human brain's cognitive abilities.

Nevertheless, as we have seen earlier, concepts developed through algorithms, neural networks, and reinforcement learning can provide new approaches to help better under-stand brain-based intelligence. Artificial neural networks can also serve as simulations, providing insights that help better understand brain processes. For example, it is the fact that both reason and emotion act as important factors in human morality and moral judgment.

In order to design ethical AI, it is necessary to focus on human morality, ethics, and morality. The characteristics of human morality are deeply related to the definition of the concept of morality. Researchers believe that morality is inevitably developed in or-der to minimize the damage that members inflict on each other and promote cooperation within a complex social structure. Given this, one of neuroscience's most notable contributions is the new perspective on what enables us to make sophisticated moral decisions. Neuroscience studies have demonstrated that human moral decisions are a complex product of perceptual, cognitive, and social-emotional processes.

Therefore, in order for human beings as biological beings and AI as physical beings to improve and develop each other's abilities, it is necessary to find a way for humans and machines to coexist. This is also the reason why the anatomical exploration of morality should not be overlooked for the realization of ethical AI. This will lead to a discussion of how to radically rethink the standard partnership between the human mind and increasingly intelligent machines. We can envision a new human-machine symbiosis that will transform the way AI advances can lead to human growth.

References

Broom, D. M. (2006). The evolution of morality. Applied Animal Behaviour Science, 100(1-2), 20-28.

Carrillo, M., Han, Y., Migliorati, F., Liu, M., Gazzola, V., & Keysers, C. (2019). Emotional mirror neurons in the rat’s anterior cingulate cortex. Current Biology, 29(8), 1301-1312.

Crockett, M. J., Siegel, J. Z., Kurth-Nelson, Z., Dayan, P., & Dolan, R. J. (2017). Moral transgressions corrupt neural representations of value. Nature neuroscience, 20(6), 879-885.

Decety, J., & Cowell, J. M. (2018). Why developmental neuroscience is critical for the study of morality. In K. Gray & J. Graham (Eds.), Atlas of moral psychology (pp. 505–515). The Guilford Press

Decety, J., & Cowell, J. M. (2018). Interpersonal harm aversion as a necessary foundation for morality: A developmental neuroscience perspective. Development and psychopathology, 30(1), 153-164.

De Waal, F. (2006). Morally Evolved. Primates and philosophers: How morality evolved, 1-80.

Fuller, S. (2019). The brain as artificial intelligence: prospecting the frontiers of neuroscience. AI & SOCIETY, 34(4), 825-833.

Hasselberger, W. (2019). Ethics beyond Computation: Why We Can't (and Shouldn't) Replace Human Moral Judgment with Algorithms. Social Research: An International Quarterly, 86(4), 977-999.

Hildt, E., Laas, K., & Sziron, M. (2020). Shaping ethical futures in brain-based and artificial intelligence research. Science and Engineering Ethics, 26(5), 2371-2379.

Hyungbin Park (2019). Neuroscience and Moral Education (Seoul: ullyeog)

Hyungbin Park (2022). AI Ethics and Moral Education (Seoul: C.I.R.)

Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. Business horizons, 61(4), 577-586.
Kelly, C., & O'Connell, R. (2020). Can neuroscience change the way we view morality?. Neuron, 108(4), 604-607.
Kellmeyer, P. (2019). Artificial intelligence in basic and clinical neuroscience: opportunities and ethical challenges. Neuroforum, 25(4), 241-250.
Nicklasson, E. (2020). Morality and artificial intelligence: The neural correlates of moral cognition and contributing findings from neuroscience to artificial intelligence. 1-39.
Stets, J. E., & Carter, M. J. (2012). A theory of the self for the sociology of morality. American Sociological Review, 77(1), 120-140.
Tancredi, L. 2005. Hardwired behavior: What neuroscience reveals about morality. New York, NY: Cambridge University Press To cite this article: Christian Carrozzo (2019) Scientific Practice and the Moral Task of Neurophilosophy, AJOB Neuroscience, 10:3, 115-117, DOI: 10.1080/21507740.2019.1632967