

ARTICLE

The Moral Status of Cognitively Enhanced Monkeys and Other Novel Beings

Gardar Arnason

Institute of Ethics and History of Medicine, University of Tübingen
Corresponding author: Email. gardar.arnason@uni-tuebingen.de

Abstract

The discussion about the moral status of novel beings tends to focus on artificial intelligence, robots, and other man-made systems. We should, however, also consider a likelier kind of novel beings: animals that are genetically modified to develop human-like cognitive capabilities. This paper focuses on the possibility of conferring human characteristics on nonhuman primates (NHPs) in the context of neuroscientific research. It first discusses the use of NHPs for neuroscientific research and then, second, describes recent developments that promise to revolutionize the field and how that may lead to NHPs attaining human-like cognitive capabilities. Third, an account of moral status is developed to ground the central claim, that making the NHP brain more human-like is unproblematic as long as the NHPs do not become persons. In conclusion, this paper discusses the implications for the moral status of cognitively enhanced NHPs, as well as the implications for other novel beings.

Keywords: nonhuman primates; novel beings; moral status; personhood; genetic modification; CRISPR

Introduction

The academic literature on the possibility of encountering novel beings, that is, nonhuman intelligence or nonhuman consciousness, tends to focus on artificial intelligence (AI), robots, or other mechanical, man-made systems, with the occasional consideration of aliens. We might, however, have to deal with a different kind of novel beings before we create super-intelligent AI or encounter aliens from a distant planet. This more probable kind of novel beings consists of animals that are genetically modified to develop human-like cognitive capabilities. Nonhuman primates (NHPs) are the most likely candidate for such genetic modification.

NHPs are important animal models in neuroscience, for both normal functions of the brain as well as many brain disorders. Recent developments in developmental biology, genetic engineering and genomic editing, such as CRISPR/Cas9, cloning by somatic cell nuclear transfer, and human–monkey chimeras, open up new possibilities for manipulating the development of the primate brain in order to create better animal models for diseases and normal functions. One way of improving animal models of the brain is to make the NHP brain more like that of humans. This raises a number of ethical issues, but here I will be primarily concerned with the implications for the moral status of “cognitively enhanced” NHPs and what it might mean for other novel beings. The ethical worry is that cognitively enhancing NHPs, or conferring human-like characteristics to them, may affect their moral status in a way that makes such research or procedures unethical. My central claim in this paper is that manipulating NHP brains to make them more like human brains is not ethically problematic, at least with regard to their moral status, unless the NHPs develop the sort of self-consciousness that makes them *persons*. “Person” is used here in a technical sense for a specific category of moral status; so in order to argue for this claim, I need to

provide an account of both moral status and personhood. The account I sketch here is neither very original nor the final word on the matter, and I present it merely as one plausible and defensible account.

In order to make the case that NHPs may be conferred human characteristics in the context of neuroscientific research, I will first discuss the use of NHPs for neuroscientific research and then, second, I will describe recent developments that promise to revolutionize the use of primates for neuroscientific research and how they might be used to confer human characteristics. Third, I develop an account of moral status to ground my central claim, that making the NHP brain more like the human brain is unproblematic as long as the primates do not become persons. In conclusion, I discuss the implications of my account for the moral status of cognitively enhanced NHPs, as well as the implications for other novel beings.

The Use of Nonhuman Primates for Neuroscientific Research

The idea that NHPs might be genetically modified in such a way that their brain becomes more human-like may seem far-fetched. In this section and the next, I will explain how and why this could happen. In this section, I briefly describe the use of NHPs in neuroscience, both for normal functions of the brain and as animal models for brain diseases. In the following section, I will consider the recent and ongoing technical possibilities for genetically manipulating NHPs brains and the motivation and reasons for actually doing so.

The use of NHPs for research is exceedingly small compared to the total number of animals used for research. In the European Union, NHPs account for about 0.05% of the total number of animals used, according to the statistical report for the year 2011.¹ Only about 10% of those NHPs are used for basic research in biomedicine and about 23% for applied biomedical or veterinary research, most of them are used for toxicological testing and other regulatory purposes.² Despite these small numbers, NHPs are important animal models in biomedicine, including neuroscience, generally³ and for basic neuroscience in particular.⁴ The close phylogenetic relationship and physiological similarities between NHPs and humans make NHPs the best available animal models for many diseases and normal biological functions, especially when it comes to the brain.⁵

Primates are commonly divided into four groups: great apes, old-world monkeys, new-world monkeys, and prosimians. Prosimians are not widely used for neuroscientific research and of the great apes only chimpanzees have been widely used. In the European Union, chimpanzees have not been used for research since 1999,⁶ and in the United States, the National Institutes of Health has phased out their use over the last few years.⁷ Of the old-world monkeys, macaques are most commonly used, in particular rhesus macaques. Of the smaller new-world monkeys, the most commonly used species is the common marmoset. In what follows, my discussion of NHPs will apply primarily to macaques and marmosets.

A number of features make macaques and marmosets useful for basic neuroscientific research. Their brain is in many aspects similar to the human brain, in particular the relative brain size, as well as “the number and density of cortical neurons, a large prefrontal cortex, and greater myelination.”⁸ The Weatherall report, which investigated the scientific necessity and moral justification of primate research, also emphasizes the similarities in the structure and functions of the brain in human and NHPs, that are absent in other species: “Primates, both human and nonhuman, embody a major evolutionary step change in vertebrate brain architecture with the massive expansion of the neocortex. The subdivisions of the neocortex and the sheer number of interconnections in the primate brain are radically different from those of other vertebrates.”⁹ The report also points out similarities in the visual and motor systems, that have made rhesus macaques indispensable for neurological research on visual attention and other brain functions and structures related to vision, decisionmaking, and movement. Research on NHPs, in particular rhesus macaques, has contributed to many areas within cognitive neuroscience, such as “the neuronal mechanisms for object recognition, working memory, decisionmaking, the guidance of motor behavior by sensory information, the neural coding of categories and numerical quantities, the processing of reward and reward expectations for reinforcement and learning, and the difference between information that does and does not reach consciousness.”¹⁰ Although much of this research has focused on rhesus macaques, marmosets have in recent years become increasingly more important for both

practical and scientific reasons.¹¹ In terms of practical reasons, marmosets are smaller and easier to handle than macaques, they mature and breed earlier, and they have more offspring. With regard to their use for basic neuroscientific work, they share many of the neurological features that can only be found in primates and they have social structures and processes that have parallels in humans but not in macaques.¹²

NHPs are of significant use not only for basic neuroscientific research, but also for research on neurological diseases and related translational or preclinical research. NHPs are important models for Alzheimer's disease (AD), in particular macaques (rhesus monkeys and cynomolgus monkeys),¹³ but other primate species such as Caribbean vervets may also provide useful models for at least some aspects of the disease.¹⁴ Other animal models are also used in Alzheimer's research, including zebrafish and rodents, and much research is conducted on humans as well. Still, NHP models are the only models available for some types of AD research.¹⁵ NHPs also provide important albeit imperfect animal models for Parkinson's disease,¹⁶ amyotrophic lateral sclerosis,¹⁷ and stroke.¹⁸

Old Problems, New Possibilities, and Primate Models

Recent technical and scientific developments may lead to significant changes in neuroscientific research on NHPs.¹⁹ These developments include affordable genome analysis, genome editing, such as CRISPR/Cas9, and cloning. Transgenic mice have become ubiquitous in biomedical research, but applying genome editing techniques to NHPs and other large mammals has proved to be more difficult. The first transgenic monkey, a rhesus macaque, was born in 2001 in the United States.²⁰ In 2008, the first transgenic disease model in an NHP was created, resulting in brain and behavioral impairments in a rhesus monkey similar to those caused by Huntington's disease in humans.²¹ The first germline transmission in NHPs was not reported until 2009, in a study that used marmosets.²² It was only in 2014, after the introduction of the CRISPR/Cas9 technique, that genome editing in NHPs took off. That year, the first gene knockout cynomolgus monkey was generated using CRISPR/Cas9 targeting one-cell embryos.²³ The same year, TALEN-based genome editing was used to target the gene coding for Methyl-CpG Binding Protein 2 (the MECP2 gene), creating a potential disease model for the Rett syndrome.²⁴ In 2015, an NHP model of Duchenne muscular dystrophy was created by using CRISPR/Cas9 to disrupt the so-called dystrophin gene in a rhesus monkey.²⁵ In the last 4 years, the number of transgenic monkey models has multiplied as knockout (deleting genetic material) efficiency has improved and knockin (inserting genetic material) is rapidly becoming more feasible.²⁶

One of the technical problems with using CRISPR/cas9 in NHPs is mosaicism, which is when some of the cells have the modified genotype and some cells have the original genotype. In mice and other smaller animals, breeding from the founder animals can be used to dilute mosaicism. This is impractical in NHPs because of the long generation time.²⁷ One solution is to use somatic cell nuclear transfer to clone monkeys and this has now been shown to be possible. A study published in 2018 reported the birth of two cloned cynomolgus monkeys, created with somatic cell nuclear transfer using fetal fibroblasts (fibroblasts are cells that produce the structural framework of tissues; fetal fibroblasts have proved to be useful as donor cells for cloning pigs and other large mammals²⁸ as well as the monkeys in this case). Although not carried out in this study, the fetal fibroblast can be genetically modified and screened before it is inserted in the enucleated oocyte (immature egg cell). Once it has developed *in vitro* to the blastocyst stage, it is transferred to a surrogate monkey and carried to term. The study started out with 129 oocytes, which produced 2 live births. The results "pave the way for the generation of genetically uniform monkey models for basic research and biomedical applications."²⁹

What all this amounts to is that we are coming increasingly closer to the possibility of producing a significant number of genetically modified NHPs for the purpose of basic and applied biomedical research. It may not be clear how that could lead to the creation of human-like brains in NHPs. Why would anyone want to genetically modify NHPs to make their brains more like human brains? This could happen, in my view, either as an unintended consequence of making better disease models of the human

brain or as an intended consequence of making a more human-like brains for basic research. Let me consider these two possibilities in turn.

First, NHPs are for some aspects of research on brain disorders and diseases important animal models, but imperfect. Millions of people suffer or die from neurodegenerative diseases and psychiatric disorders, while therapies are in many cases few or nonexistent, and little progress has been made over the years. Animal research on neurological disease mechanisms and preclinical animal research of potential therapies, even when it is promising, rarely result in an effective treatment. Better NHP models could revolutionize the development of medical treatments.³⁰ As one review of the application of CRISPR/Cas genome editing in neuroscience put it:

Mouse and rat models thus provide a bridge between our understanding of the molecular underpinnings of the nervous system gleaned from studies in non-mammalian systems and the complex phenotypes observed in brain disorders. In some cases, however, a comprehensive understanding of the human brain will require primate models, which are more similar to the human brain in terms of neuroanatomical, physiological, perceptual, and behavioral characteristics.³¹

Although about half of all human genes have a role in the development and function of the nervous system, some genes may make a particularly significant difference both for the uniquely human features of the brain and for brain disorders. Genetically modifying an NHP by adding such a gene, in order to produce a certain brain disorder, could confer both that disorder and some human-like features to the NHP brain. One example is the NOTCH2NL gene, or trio of genes, which appears to be important for the larger brain size in humans, compared with other primates, and it may also make humans more susceptible to some neurological disorders.³²

Second, although the NHP brain is in many ways similar to the human brain, there are still important differences that make them imperfect models of some normal functions of the brain, in particular the highest cognitive functions. Two recent studies suggest that there is a significant interest in manipulating the NHP brain in ways that may make it more like the human brain. The first study, published online in March 2019, has the title “Transgenic rhesus monkeys carrying the human MCPH1 gene copies show human-like neoteny of brain development.”³³ Chinese scientist Lei Shi and colleagues generated 11 transgenic rhesus monkeys carrying the human gene MCPH1, which is important for the development of the human brain. The transgenic monkeys showed some human-like features in brain development, but tests also revealed better short-term memory and shorter reaction time compared to normal rhesus monkeys. The authors note: “The presented data represent the first attempt to experimentally interrogate the genetic basis of human brain origin using a transgenic monkey model and it values the use of NHPs in understanding unique human traits.”³⁴ A second study involving the first ever human–monkey chimeras, which has been reported in the media but has at the time of writing yet to be described in a scientific publication, suggests a slightly different way in which NHPs may be given human-like features. In this study, genome editing was applied to prevent a specific organ from developing in the NHP embryo. Human stem cells were injected into the embryo, in order to develop the missing organ, which would then be human and the resulting organism a human–monkey chimera.³⁵ One worry is that the human stem cells could also develop in other parts of the NHP embryo, such as the central nervous system, possibly giving it human-like features by accident. None of the chimeric embryos were carried to full term.

So far I have tried to show that it is becoming technically possible to create transgenic NHPs with human-like features and that this may happen by accident or by design in the not too distant future. Among the ethical problems arising from these developments are questions about the moral status of NHPs with human-like neurological features, and the potential suffering of such primates for example by becoming social outcasts in both human society and in NHP groups, or by a greater subjective awareness of their own nature, position, and fate.³⁶ In what follows, I will focus on the question of moral status, developing an argument for the claim that moral status is only a significant problem if the transgenic monkeys develop self-consciousness. This focus is not meant to exclude the possibility of other ethical problems, such as the question of increased suffering.

Moral Status, Personhood, and Cognitively Enhanced Monkeys

The question I am attempting to answer here is whether cognitively enhancing monkeys have any effect on their moral status. I argue that it does not, unless they become self-conscious. The same argument applies to other novel beings, and I argue that they matter morally only if they develop either sentience or self-consciousness (or both). To make this argument, I need to give a brief account of moral status and the moral significance of self-consciousness.

By *moral status*, I mean the extent to which someone or something has a claim to be included in the moral deliberations of a moral agent for their own sake, because of some specific, morally relevant, inherent characteristics or intrinsic properties.³⁷ In contrast, something or someone may matter morally not for their own sake but on relational or symbolic grounds, in which case they have no inherent characteristics that are relevant to moral status. Such things or beings still have *moral value* but no moral status.³⁸ Some things or beings that have a moral status may also have added relational or symbolic moral value, that makes them matter more morally than if they had only their moral status. Finally, some things or beings have neither a moral status nor any other moral value and hence do not matter morally at all.

The paradigmatic case for moral status is unimpaired, adult, human beings. They are typically thought to have basic rights, including a right to life, freedom, and physical integrity (or a strong morally relevant interest in such basic conditions of existence). This is often referred to as full moral status.

The paradigmatic case for having neither moral status nor other moral value, that is, not mattering morally at all, is any material object of no consequence such as a random pebble at the beach. Assuming, safely I think, that the pebble has no awareness or feelings, it matters neither to the pebble nor to anyone or anything else if I throw it in the ocean or shatter it with a larger stone. That particular pebble does not matter morally at all.³⁹

The idea of moral value without moral status, that is, as mattering morally for relational or symbolic reasons and not for its own sake, is more contentious than the basic distinction between full moral status and no moral worth at all. I think it does nonetheless make intuitive sense. One example of moral value without moral status could be a work of art that is historically and culturally important, such as the two statues carved in a mountain in Afghanistan known as the Buddhas of Bamiyan. The statues were blown up by the Taliban in March 2001. It was morally wrong to destroy them, not because their destruction mattered in any way to the statues themselves, but because they mattered to us, to humanity. Similarly, it may be wrong to destroy or significantly alter certain natural sites, such as rivers, mountains, forests, or coastlines, because of their beauty or significance—apart from any instrumental reasons for preserving them. Their destruction would make no difference to those sites, but it would make a difference to us. They have moral value, although they have no moral status.

One combination of moral status and moral value remains, namely where someone has moral status but also added moral value through special relations. Assuming that at least some nonhuman animals have moral status, some of them may also have moral value over and above their moral status. Companion animals are one example; they have special relations to their guardians, that arguably confer greater moral value on them than possessed by similar animals in the wild. A person's dog matters more morally than a wolf in a region where wolves are abundant, even if their moral status may be argued to be the same.

I hope that the basic idea behind the concepts of moral status and moral value is clear, but quite a few questions and problems remain. The way I defined moral status as being grounded in some inherent characteristics immediately raises the question what these characteristics are and how exactly they ground moral status. This is a basic question about moral status, if moral status is supposed to be grounded in specific attributes of the relevant moral patient, that is, the being that is the object of the moral consideration of moral agents. Yet, much of the literature on moral status shies away from analyzing the relationship between moral status and the inherent characteristics supposed to ground it, and merely points vaguely to rationality, consciousness, sentience, subjective experience, or something like that.

My proposal here is that very specific cognitive characteristics ground rights and moral status through morally relevant interests: a specific cognitive characteristic (or combination of cognitive characteristics) grounds a morally relevant interest, that in turn grounds specific rights or aspects of a moral status. This

proposal adds two ideas to the common view that moral status is grounded in cognitive characteristics. One idea is that these cognitive characteristics are specific, as opposed to general characteristics such as intelligence or rationality. The other idea is that there is an intermediate step between moral status and cognitive characteristics, namely morally relevant interests. This second idea, that morally relevant interests bridge cognitive characteristics and moral status, has a utilitarian side and a deontological side. The utilitarian side follows lines of argument like that of Peter Singer, where the ability to experience pain and pleasure (i.e., sentience, here understood as a cognitive characteristic) and higher cognitive characteristics like the ability of temporal self-awareness ground morally relevant interests, that in turn decide moral status.⁴⁰ The deontological side follows interest-based theories of rights (that ground rights in morally relevant interests), such as that of Joseph Raz, but adding a connection or a prior step between cognitive characteristics and morally relevant interests.⁴¹ Other deontological views of moral status may not need the intermediate step of morally relevant interests.⁴²

My proposal suggests that moral status is not grounded in general cognitive characteristics like intelligence or rationality, but in specific cognitive characteristics. Nonetheless, many of the relevant specific cognitive characteristics can be subsumed under a combination of two general cognitive characteristics. The combined capacity for self-consciousness (awareness of oneself as a subject of experience in time and space) and metacognition (the ability to think about one's thoughts) involves a range of cognitive capacities that give rise to a number of significant morally relevant interests.⁴³ Let me give four examples of how specific cognitive characteristics, which are aspects of self-consciousness and metacognition, ground morally relevant interests: (1) The capacity to be aware of oneself as a subject in time, with a memory of the past, awareness of the present, and ability to anticipate the future, is a necessary and sufficient condition for the ability to make plans and projects for the future and value one's life, which leads to a morally relevant interest in seeing another day, that is, in continued life. This morally relevant interest in continued life grounds in turn a basic right to life.⁴⁴ (2) The capacity to be aware of one's physical and social position, and one's life story, in addition to having the ability to make plans and projects for the future, is a necessary and sufficient condition for the ability to be aware of and to value one's existential situation, which leads to a morally relevant interest in not being physically coerced or constrained, that is, an interest in freedom. That morally relevant interest in freedom grounds in turn a basic right to freedom. (3) The capacity to be aware of one's physical body and value its integrity leads to a morally relevant interest in physical integrity. That morally relevant interest in physical integrity grounds in turn a basic right to physical integrity. (4) The capacity to reflect on one's thoughts, actions, and self, and in particular the reasons for one's actions, in other words, the capacity to deliberate, leads to a morally relevant interest in making one's own decisions, that is in personal autonomy. That morally relevant interest in personal autonomy grounds in turn a basic right to have one's autonomy respected, including the right not to be instrumentalized.⁴⁵ In short, the capacity for self-consciousness (with metacognition) grounds basic rights to life, freedom, physical integrity, and respect for autonomy. These are the sort of basic moral rights that are fundamental to moral status and that follow from self-consciousness with metacognition, but there may certainly be other rights that determine some aspect of moral status. On this view of moral status, they would need to be grounded in a similar way on specific cognitive characteristics.

There are other characteristics, apart from self-consciousness, that ground morally relevant interest, most importantly sentience. Sentience as the capacity to experience pleasure/happiness and pain, and to suffer, leads to a morally relevant interest in pleasure/happiness and in not suffering. That morally relevant interest grounds in turn a basic right not to be wrongfully harmed (physically or psychologically).

There is still the problem of how cognitive characteristics or capacities ground morally relevant interests, and it may seem that I am deriving moral value from a description, an ought from an is. Cognitive capacities do not ground morally relevant interests directly, there is no immediate logical implication from one to the other.⁴⁶ There are some short answers that are not entirely satisfactory. One is to claim that it is self-evident that the interests discussed above are morally relevant, that is, it is self-evident that these kinds of interests (in particular in view of the ability of the beings in question to value

their interests) make a claim on all moral agents to take them into moral consideration. Very similar appeals can be made to moral intuition or, more plausibly, to the very nature of morality (the *moral point of view* itself is exactly to take such interests of others into one's moral consideration). To give a full account of the relationship between certain capacities and morally relevant interests requires placing it within a comprehensive theory of value or rights, which is outside the scope of this paper.⁴⁷

I have given a few examples of how certain cognitive capacities can lead to morally relevant interests, that ground rights or aspects of moral status. But how does personhood fit into this? The combined capacity for self-consciousness and metacognition, and the specific cognitive abilities that follow from it and ground the morally relevant interests discussed above, can for convenience be given the technical term "personhood." It can also be called "Lockean personhood" as it comes very close to Locke's view of the person as "a thinking intelligent Being, that has reason and reflection, and can consider itself as itself, the same thinking thing in different times and places [...]."⁴⁸ On the picture sketched above, Lockean personhood implies full moral status understood as the basic rights to life, freedom, and physical integrity, as well as the right not to be (wrongfully) harmed, physically or psychologically, and respect for autonomy. Any being, whether a nonhuman animal, human, or a novel being, either has the capacity for self-consciousness (with metacognition) or it does not. Personhood and full moral status are therefore threshold concepts. It follows that NHPs that are genetically modified to have human-like cognitive features are persons if and only if they have the capacity for self-consciousness (with metacognition). The same applies to any novel being, such as a super-intelligent AI, and they are persons if and only if they have the capacity for self-consciousness (with metacognition).

It may be objected that self-consciousness is both a matter of degree and contingency. We are born without it and may lose it before we die, and some humans are even born with brain disorders that prevent them from developing self-consciousness at all. We fall asleep or in coma or faint, and sometimes we are just barely conscious. What happens to personhood and the claim to full moral status in those circumstances? I am putting significant theoretical weight on the word "capacity" here, possibly too much, but my reply is that full moral status is dependent on the *capacity* for self-consciousness (with metacognition). All humans are born with the capacity for self-consciousness (with metacognition), even in the case where it does not develop into the ability to be self-conscious and self-reflective, or it does and we lose that ability, or when we are not exercising that ability—in all those cases we still have the innate capacity for self-consciousness as human beings. There remain at least two problems for this account of personhood as a threshold concept, with regard to human development on the one hand and evolution on the other hand. One is the question of whether the human fetus has the capacity for self-consciousness and if so then from what point in its development. The second question is when the capacity for self-consciousness emerged in human evolution and whether that could possibly have been a discrete evolutionary step. I merely acknowledge these problems and leave them open, and they require much more detailed discussion than I can offer here.

It follows from this view of capacity for self-consciousness (with metacognition) that there is no such thing as a human nonperson, all humans, and nonparadigmatic humans are persons and have as such full moral status. I have suggested that all humans have the capacity for self-consciousness (with metacognition), even in the case where an individual does not have the physical potential to develop self-consciousness. Capacity is understood here as a species-typical innate or natural disposition.⁴⁹ If this nonindividualistic view of capacities is rejected, the capacity for self-consciousness would be limited to individuals' physical abilities, and that would exclude many nonparadigmatic humans from full moral status, such as (maybe) very young children, people with radical cognitive impairments, coma patients, and the like. In these cases, there are nonetheless excellent reasons to treat (at least some of) them *as if* they had full moral status or even to give them additional moral protections. Yet, these reasons would be based on their moral value (and sentience, if applicable) rather than personhood and full moral status.

According to the account I have sketched here, personhood and full moral status are threshold concepts and form therefore a discrete category of moral status. The capacity for experiencing pleasure and pain, that is sentience without personhood, forms a different category of moral status. Sentience grounds a morally relevant interest in not being wrongfully caused to suffer and a corresponding moral

right. There may be gradual differences in sentience, which then ground a difference in the strength of that right. Nonhuman animals that are complex enough to have a strong awareness of their pain within integrated, subjective experience, have a stronger interest in and hence a stronger claim to not being (wrongfully) harmed than simpler animals that are barely capable of sensing pain as a part of subjective experience. It is not clear, however, how to estimate the level of sentience of nonhuman animals. The same uncertainty arises for novel beings, in particular AI, if it is possible that they have acquired or developed sentience. How could we know whether or to what extent they are sentient? In the case of a nonbiological system, there is the additional problem that it lacks natural pain behavior on the one hand, and, on the other hand, that it may be designed to emulate human emotive or affective behavior even in the absence of emotions or feelings.

As nonpersons, sentient nonhuman animals have a morally relevant interest in not suffering, which grounds a right not to be wrongfully harmed. Since they do not possess the necessary grounding characteristics, animals that are sentient nonpersons do not have a morally relevant interest in continued life, freedom, or physical integrity, and hence not the corresponding moral rights. Taking the life of nonhuman animals, constraining them or interfering with their physical integrity may cause them to suffer and would in that case be *prima facie* morally wrong. A moral agent might also be obliged to refrain from such actions, even if no suffering is involved, if the animals' moral value (that is, the extent to which they matter morally because of their special relationships) provides strong moral reasons against it. Nonhuman animals that are not sentient have no moral status, unless they have some other inherent characteristics that can ground morally relevant interests. One might argue that being a self-organizing, living being, with its own goals and well-being is such a characteristic, as it is sufficient to ground a morally relevant interest in not having their goals thwarted or well-being set back. This would apply not only to insects, but also to plants and lower organisms. Given that such nonsentient beings are not aware of their goals or well-being and cannot value them, I find this view highly implausible.

I have now considered beings that have a lower moral status than (human) persons, but it is possible that there are or there will be beings that have a higher moral status than (human) persons. What if we meet novel beings, aliens, or super-intelligent AI systems, who turn out to be cognitively superior to humans in a way that gives them higher moral status than what we now recognize as full moral status—would they be justified in exploiting and killing us?⁵⁰ I cannot imagine any characteristics that would result in a higher moral status than what I have here described as full moral status (which it would then no longer be), but maybe that is just a matter of my limited imagination.⁵¹ Even if this would be the case, a novel being's moral status would not take anything away from personhood and the moral status that humans have, including basic rights to life, freedom, and physical integrity. On my account, such novel beings could not be justified in exploiting and killing us.

Let me now finally come back to transgenic, cognitively enhanced monkeys. On this account, conferring characteristics on monkeys that fall short of the characteristics that constitute personhood (self-consciousness with metacognition) does not affect their moral status. If, however, genetic modification of monkeys confers self-consciousness, they will be persons and have full moral status as humans do. In that case, they could not be used in such research if humans could not be used. Conferring self-consciousness on NHPs for research purposes is in that sense self-defeating; it would exclude them from being used for this kind of research at all, independently of any harms that conferring consciousness on them might cause.

The implications of my account for other novel beings, such as AI systems, are that we would have to consider what characteristics they may have that could ground morally relevant interests. This would have to be done on a case-by-case basis. There is a familiar epistemic problem with regard to knowing what cognitive capacities such systems may have, in particular at what point they become self-conscious and able to reflect on their own processes.⁵² One particularly interesting possibility is if a system develops self-consciousness without sentience or even any affective properties. Such a system would neither experience pain nor pleasure, neither boredom nor anxiety nor happiness in any sense. It might have plans and goals, but it would not have any psychological interest in or motivation for seeing plans or projects through or reaching its goals. It would have no psychological interest in continued existence, and

it would not care either way. It is questionable whether it could truly value its continued existence and more generally whether a being without affective properties can value anything at all. This may suggest that sentience or at least some affective properties are necessary for having any moral status at all.

Conclusion

Genome editing techniques are developing at a great pace and are increasingly applied to NHPs. Since NHPs are particularly important for neuroscientific research, both for normal functions and for brain disorders, genome editing may be used to improve NHPs as animal models in neuroscience. This could lead to human-like characteristics being conferred on them by accident or design. I argue that in terms of moral status, conferring human-like characteristics is not problematic, provided it does not include the characteristics that constitute personhood, that is, the capacity for self-consciousness with metacognition. To make that argument, I have sketched an account of moral status and personhood, that grounds moral status in morally relevant interests, which in turn are grounded in specific inherent characteristics. Using genome editing to confer human characteristics, whether human-like brain functions or brain disorders, on NHPs may be morally problematic for a variety of other reasons than those affecting moral status. It may cause increased pain and suffering, in particular when generating models for neurodegenerative diseases, and may also lead to a significant increase in the number of NHPs used for harmful research, increasing aggregate suffering. Such increase in suffering of NHPs is only justifiable if there is a realistic chance that the research will lead to treatments that will reduce human suffering and save lives on such a scale that the increased animal suffering is a morally acceptable trade-off.

Other novel beings matter morally only to the extent that they have cognitive capacities that ground moral status, in particular sentience and self-consciousness with metacognition. It may be highly difficult to determine whether a super-intelligent AI, for example, has become sentient or self-conscious, but in those cases where we understand the design well enough to know that systems in question cannot be sentient or self-conscious, we need not worry about their moral status.

Acknowledgments. This research was supported by the German Research Foundation (DFG) research unit grant FOR 1847.

Notes

1. European Commission. Seventh Report on the Statistics on the Number of Animals Used for Experimental and Other Scientific Purposes in the Member States of the European Union, COM (2013) 859 final. Brussels: European Commission; 2013.
2. European Commission. Commission staff working document, accompanying document to the Report from the Commission to the Council and the European Parliament, Seventh Report on the Statistics on the Number of Animals Used for Experimental and Other Scientific Purposes in the Member States of the European Union, part 1/5, SWD(2013) 497 final. Brussels: European Commission; 2013.
3. Phillips KA, Bales KL, Capitanio JP, Conley A, Czoty PW, tHart BA, et al. Why primate models matter. *American Journal of Primatology* 2014;**76**:801–27; SCHEER (Scientific Committee on Health, Environmental and Emerging Risks). Final opinion on “The need for non-human primates in biomedical research, production and testing of products and devices (update 2017)”; 2017; Weatherall D. *The Use of Nonhuman Primates in Research*. London: Academy of Medical Sciences; 2006.
4. Roelfsema PR, Treue S. Basic neuroscience research with nonhuman primates: A small but indispensable component of biomedical research. *Neuron* 2014;**82**:1200–4.
5. See note 3, Phillips et al. 2014, at 802.
6. See note 1, European Commission 2013, at 3.
7. Reardon S. NIH to retire all research chimpanzees. *Nature News* 2015 Nov 18; available at <https://www.nature.com/news/nih-to-retire-all-research-chimpanzees-1.18817> (last accessed 13 Sep 2019).

8. See note 3, Phillips et al. 2014, at 814.
9. See note 3, Weatherall 2006.
10. See note 4, Roelfsema, Treue 2014.
11. Prins NW, Pohlmeier EA, Debnath S, Mylavarapu R, Geng S, Sanchez JC, et al. Common marmoset (*Callithrix jacchus*) as a primate model for behavioral neuroscience studies. *Journal of Neuroscience Methods* 2017;**284**:35–46.
12. French JA. The marmoset as a model in behavioral neuroscience and psychiatric research. In: Marini RP, Wachtman LM, Tardif SD, Mansfield K, Fox JG, eds. *The Common Marmoset in Captivity and Biomedical Research*. London: Academic Press; 2019:477–91.
13. Van Dam D, De Deyn PP. Non human primate models for Alzheimer’s disease-related research and drug discovery. *Expert Opinion on Drug Discovery* 2017;**12**(2):187–200.
14. Latimer CS, Shively CA, Keene CD, Jorgensen MJ, Andrews RN, Register TC, et al. A nonhuman primate model of early Alzheimer’s disease pathologic change: Implications for disease pathogenesis. *Alzheimer’s and Dementia* 2019;**15**(1):93–105.
15. See note 13, Van Dam D, De Deyn PP 2017; also note 3, Weatherall 2006.
16. Capitanio JP, Emborg ME. Contributions of non-human primates to neuroscience research. *The Lancet* 2008 Mar 29;**371**(9618):1126–35; Morissette M, Di Paolo T. Non-human primate models of PD to test novel therapies. *Journal of Neural Transmission* 2018;**125**(3):291–324.
17. Uchida A, Sasaguri H, Kimura N, Tajiri M, Ohkubo T, Ono F, et al. Non-human primate model of amyotrophic lateral sclerosis with cytoplasmic mislocalization of TDP-43. *Brain* 2012;**135**(3):833–46.
18. Cook DJ, Tymianski M. Nonhuman primate models of stroke for translational neuroprotection research. *Neurotherapeutics* 2012;**9**(2):371–9; Sughrue ME, Mocco J, Mack WJ, Ducruet AF, Komotar RJ, Fischbach RL, et al. Bioethical considerations in translational research: Primate stroke. *The American Journal of Bioethics* 2009;**9**(5):3–12.
19. Vallender EJ, Miller GM. Nonhuman primate models in the genomic era: A paradigm shift. *ILAR Journal* 2013;**54**(2):154–65.
20. Chan AW, Chong KY, Martinovich C, Simerly C, Schatten G. Transgenic monkeys produced by retroviral gene transfer into mature oocytes. *Science* 2001;**291**(5502):309–12.
21. Yang SH, Cheng PH, Banta H, Piotrowska-Nitsche K, Yang JJ, Cheng EC, et al. Towards a transgenic model of Huntington’s disease in a non-human primate. *Nature* 2008;**453**(7197):921–4.
22. Sasaki E, Suemizu H, Shimada A, Hanazawa K, Oiwa R, Kamioka M, et al. Generation of transgenic non-human primates with germline transmission. *Nature* 2009;**459**(7246):523–7.
23. Xin LU, Min LI, Bing SU. Application of the genome editing tool CRISPR/Cas9 in non-human primates. *Zoological Research* 2016;**37**(4):214–9; Niu YY, Shen B, Cui YQ, Chen YC, Wang JY, Wang L, et al. Generation of gene-modified cynomolgus monkey via Cas9/RNA-mediated gene targeting in one-cell embryos. *Cell* 2014;**156**(4):836–43.
24. Liu H, Chen Y, Niu Y, Zhang K, Kang Y, Ge W, et al. TALEN-mediated gene mutagenesis in rhesus and cynomolgus monkeys. *Cell Stem Cell* 2014;**14**(3):323–8. TALEN stands for “Transcription activator-like effector nuclease.”
25. Chen YC, Zheng YH, Kang Y, Yang WL, Niu YY, Guo XY, et al. Functional disruption of the dystrophin gene in rhesus monkey using CRISPR/Cas9. *Human Molecular Genetics* 2015;**24**(13):3764–74.
26. Zhao J, Lai L, Ji W, Zhou Q. Genome editing in large animals: Current status and future prospects. *National Science Review* 2019;**6**(3):402–20.
27. Yan S, Tu Z, Li S, Li XJ. Use of CRISPR/Cas9 to model brain diseases. *Progress in Neuro-Psychopharmacology and Biological Psychiatry* 2018;**81**:488–92.
28. Akagi S, Matsukawa K, Onishi A. Nuclear transfer technology in cattle, sheep, and swine. In: Pinkert CA, ed. *Transgenic Animal Technology: A Laboratory Handbook*. 3rd ed. London: Elsevier; 2014:387–98.
29. Liu Z, Cai Y, Liao Z, Xu Y, Wang Y, Wang Z, et al. Cloning of a gene-edited macaque monkey by somatic cell nuclear transfer. *National Science Review* 2019;**6**(1):101–8.

30. Park JE, Silva AC. Generation of genetically engineered non-human primate models of brain function and neurological disorders. *American Journal of Primatology* 2019;**81**(2):e22931. doi:10.1002/ajp.22931.
31. Heidenreich M, Zhang F. Applications of CRISPR–Cas systems in neuroscience. *Nature Reviews Neuroscience* 2016;**17**(1):36–44.
32. Fiddes IT, Lodewijk GA, Mooring M, Bosworth CM, Ewing AD, Mantalas GL, et al. Human-specific NOTCH2NL genes affect Notch signaling and cortical neurogenesis. *Cell* 2018;**173**(6):1356–69.
33. Shi L, Luo X, Jiang J, Chen Y, Liu C, Hu T, et al. Transgenic rhesus monkeys carrying the human MCPH1 gene copies show human-like neoteny of brain development. *National Science Review* 2019;**6**(3):480–93.
34. See note 33, Shi et al. 2019, at 480.
35. Ansele M. Spanish scientists create human–monkey chimera in China. *El Pais* 2019 July 31; available at https://elpais.com/elpais/2019/07/31/inenglish/1564561365_256842.html (last accessed 23 Sep 2019).
36. Coors ME, Glover JJ, Juengst ET, Sikela JM. The ethics of using transgenic non-human primates to study what makes us human. *Nature Reviews Genetics* 2010;**11**(9):658–62.
37. The understanding of moral status as mattering morally for its own sake is a common understanding of the term in the literature, see, for example, the Stanford Encyclopedia entry “The Grounds of Moral Status”: Jaworska A, Tannenbaum J. The grounds of moral status. In: Zalta EN, ed. *The Stanford Encyclopedia of Philosophy* (Spring 2018 Edition); available at <https://plato.stanford.edu/archives/spr2018/entries/grounds-moral-status/> (last accessed 8 Nov 2019); see also the chapter “Moral status” in Kamm FM. *Intricate Ethics: Rights, Responsibilities, and Permissible Harm*. Oxford: Oxford University Press; 2008. Limiting moral status to intrinsic properties as opposed to relational properties is less common but see, for example, the entry by Jaworska and Tannenbaum (Section 5.5), who consider special relations as grounds for moral status, but suggest that what they provide grounds for is not truly moral status.
38. This distinction between moral status and moral value is somewhat unusual, but a similar distinction has been made by others albeit with different terminology; for example, Morris CW. The idea of moral standing. In: Beauchamp TL, Frey RG, eds. *The Oxford Handbook of Animal Ethics*. Oxford: Oxford University Press; 2011:255–75, at 256–7.
39. Mary Anne Warren gives a similar basic account of the intuitive basis of moral status in Warren MA. *Moral Status: Obligations to Persons and Other Living Things*. Oxford: Oxford University Press; 1997.
40. Singer, P. Speciesism and moral status. *Metaphilosophy* 2009;**40**(3–4):567–81.
41. Raz J. *The Morality of Freedom*. Oxford: Clarendon Press; 1988. See also Cochrane A. Animal rights and animal experiments: An interest-based approach. *Res Publica* 2007;**13**(3):293–318.
42. See, for example, Korsgaard, CM. *The Sources of Normativity*. Cambridge, UK: Cambridge University Press; 1996.
43. A similar case for the importance of self-consciousness and metacognition is made in Chan S, Harris J. Human animals and nonhuman persons. In: Beauchamp TL, Frey RG, eds. *The Oxford Handbook of Animal Ethics*. Oxford: Oxford University Press; 2011: 304–27. For another account of how self-consciousness is related to moral status, see Tooley M. Are nonhuman animals persons? In: Beauchamp TL, Frey RG, eds. *The Oxford Handbook of Animal Ethics*. Oxford: Oxford University Press; 2011: 332–370.
44. For some, this is all we need for personhood and full moral status, see, for example, Harris J. *The Value of Life: An Introduction to Medical Ethics*. London and New York: Routledge; 2006.
45. This point constitutes roughly the Kantian view of moral status, see Kant I. *Groundwork of the Metaphysics of Morals*, Gregor M, trans. and ed. Cambridge: Cambridge University Press; 1998 [1785].
46. Beauchamp TL. The failure of theories of personhood. *Kennedy Institute of Ethics Journal* 1999;**9**(4):309–24.

47. For example, a substantial Kantian account of moral relevance is Korsgaard's *The Sources of Normativity*, see [note 42](#), Korsgaard 1996.
48. Locke J. *An Essay Concerning Human Understanding*. Oxford: Oxford University Press; 1975 [1689/1694], at 2.27.9.
49. My account of personhood and full moral status is therefore based on the species and not the individual. Similar accounts have been developed by others, see, for example, Liao SM. The basis of human moral status. *Journal of Moral Philosophy* 2010;7(2):159–79; and Kagan S. What's wrong with speciesism? (Society for Applied Philosophy Annual Lecture 2015). *Journal of Applied Philosophy* 2016;33(1):1–21.
50. Williams B. The human prejudice. In: Schaler JA, ed. *Peter Singer Under Fire: The Moral Iconoclast Faces His Critics*. Peru, IL: Open Court; 2009:77–96.
51. Agar N. Why is it possible to enhance moral status and why doing so is wrong? *Journal of Medical Ethics* 2013;39(2):67–74.
52. For a very recent discussion of this and related problems, see Harris J. Reading the minds of those who never lived. Enhanced beings: The social and ethical challenges posed by super intelligent AI and reasonably intelligent humans. *Cambridge Quarterly of Healthcare Ethics* 2019; 28:585–91; and Lawrence D. On understanding novel minds. *Cambridge Quarterly of Healthcare Ethics* 2019; 28:599–602.