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On the moral status of humanized chimeras and the concept of human dignity

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Abstract: Recent advances in the technology of creating chimeras have evoked controversy in policy debates. At centre of controversy is the fear that a substantial contribution of human cells or genes in crucial areas of the animal's body may at some point render the animal more humanlike than any other animals we know today. Authors who have commented on or contributed to policy debates specify that chimeras which would be too humanlike would have an altered moral status and threaten our notion of 'human dignity'. This setting offers a productive opportunity to test the notion of human dignity and to emphasize some of its weaknesses as an ethical tool. Limiting chimerism experiments on the basis of whether or not it undermines or challenges human dignity implies a clear demarcation of those characteristics which are typically, and importantly, human. Evidence of our evolutionary ties and behavioral similarities with other animals seem to annul all attempts to define the uniquely human properties to which human dignity may be attributed. Hence, it has been suggested that the particular moral status associated with humans cannot be explained for beyond an intuitive basis. In what follows, we will argue that the difficulties inherent in the notion of human dignity lie not in the impossibility to acquire a list of properties which are unique to humans, but rather in the difficulty to demonstrate the moral relevance of these properties, and particularly the relevance of their being human. We offer an alternative interpretation of the concept of dignity which is not necessarily related to being human.

Key words: chimeras, human dignity, evolved capacities, nonhuman animals, evolutionary theory

Were I (who to my cost already am)
One of those strange, prodigious creatures, man
A spirit free to choose for my own share
What case of flesh and blood I pleased to wear,
I'd be a dog, a monkey or a bear,
Or anything but that vain animal
Who is so proud of being rational.[1]

1. Introduction

Our cultural history shows a great fascination for imaginary creatures that transgress supposed species boundaries. The mythologies, legends and arts of ancient and modern cultures are abundant with imagery of fantasy beasts, a great number of which contain features of both nonhuman animals (hereafter 'animals') and humans. Examples range from the animal-headed gods of ancient Egypt to Greek mythology depictions of the Centaur, Triton, Siren, satyr, sphinx and medieval legends of werewolves and vampires. The meanings and values attached to these fantastic creatures are as diverse as the distinctive cultures from which they are generated and the audiences they are aimed at. More often than not, however, particularly within the western traditions, human/animal composites represent evil or at least misconduct (Spiderman and Batman excluded). Indeed, the devil has commonly been depicted as a composite of human and snake, dragon, or goat features and according to medieval legends, possession of the devil transformed the unfortunate human into a werewolf. Current-day science fiction narratives of human/animal combinations often rehearse the logic that intermixing human and animal characteristics is sinister. With H.G. Well's 'The Island of Dr. Moreau' as a classic prototype, some of the most horrifying science fiction tales today sketch the gruesome effects of suppressing or altering an animal's nature by raising it to a level more proximate to that of humans. Recent works draw upon the topicality of genetic engineering and cloning to recount the emergence of aggressive, rebellious freaks, or oppressed, suffering subhumans[2],[3]. Their dreadful destiny is depicted as the backlash of attempting to reconcile bestial instinct with human intelligence or as the side-effect of purposely enhancing a species for refined slave labor. Note that, according to recent media coverage, the creation of such a subhuman species has been

actively and intently pursued in the past, under the order of Jozef Stalin. Secret documents are said to show that Ilya Ivanov experimented (in vain) on human-ape crossovers in the mid-1920s in an effort to create an invincible breed of Red Army warriors and new labor forces[4].

We now possess the potential to transgress the biological boundaries between humans and other animals in ways which were unthinkable during the Stalin reign. Recent advances in technology have brought fears surrounding the creation of enhanced animals to the forefront of current policy debates. At centre of controversy is the anticipation that the blending of animal and human material will be so profound that the resulting chimeras will verge on what it means to be 'human'. It is this concern, and in particular the difficulty of construing what is included in the notion of 'humanness', that we address in this paper.

2. The moral worth of an ambiguous entity: A 'mind-bending' controversy

The chimeras we refer to here are, in the strictest sense, entities characterized by the side by side presence of both human and animal cells in embryonic, fetal, or adult individuals. Often broader interpretations are used interchangeably in the literature to include genetic forms of commingling: organisms which consist of an exogenous, human gene (transgenics, or genetic chimeras) and organisms created from cross-species gametes (genetic hybrids) or from somatic cell nuclear transfers between humans and animals (nucleocytoplasmic hybrids). Such chimeras prove to be of great utility for many research and prospective therapeutic purposes. One medical therapy currently under development involves the creation of 'animal-to-human chimeras' through the transplantation of animal-derived grafts into human bodies (i.e. xenotransplantation). The use of cells, tissues and organs from animal sources is considered to be a possible alternative for the transplantation of human grafts, of which there is a growing shortage. Most chimeras, however, are 'human-to-animal chimeras' which are created by adding human cells or genes to an animal's genome or developing body. The source animals from which transplantable grafts are to be obtained, for instance, may be partially 'humanized' in order to inhibit or reduce rejection of

the animal grafts by the human immune system upon transplantation. One strategy to prevent that the human immune system recognizes the grafts as foreign consists of genetically manipulating the source animals so that they express human anti-complementary proteins. Alternatively, human stem cells can be inserted into developing animals so that the grafts will consist of both animal and human cells. Experiments of this sort have provided promising results. After insertion of human stem cells in sheep embryos, human cells integrated in almost all of the animal's tissues, including blood, bone, liver, heart and nervous system[5]. The ultimate goal of this latter approach is to use stem cells from the very patients for which the resulting grafts are intended. These grafts would be genetically similar to all cells of the prospective patient's body and would be 'rejection-proof'.

Most chimeras are developed as research models to enhance our understanding of the etiology and progression of human disease and to test new treatments. Although the best animal model for humans are humans, animals with close proximity to human physiology or animals which – through artificial means – exhibit significant human cell and tissue populations provide the next best study environment. The use of chimeras as research tools initiated with the creation of mice with fully human immune systems for the study of HIV in 1988[6]. Today, they are a particularly promising method for further exploring the ways in which stem cells develop, contribute, integrate and react to the host environment and various chemical influences before stem cell technology can be of established clinical use for human patients. This field of research has generated a range of remarkable experiments. Scientists have injected human embryonic stem cells labeled with a fluorescent protein into mouse blastocysts which later developed into embryos and were carried to term by foster mice. The fluorescence in the offspring's tissues allowed the researchers to study cell line contributions to the various tissues, organs and the nervous system[7]. Human fetal neural stem cells have been transplanted in rat and mouse models for research which may potentially be the basis for effective stem-cell based treatments of various neurodegenerative diseases[8],[9]. In a study of the distribution and integration of human neural

stem cells, mice have been created whose brain are almost 1 percent human[10]. The researcher hope to eventually create chimeric mice whose brains will consist of 100 percent human neurons[11]. Human neural stem cells have also been injected into the brains of vervet monkeys and Old World Monkey fetuses[12],[13].

Although a mouse brain consisting of exclusively human neurons is not a feasible prospect in the near future, this sort of research has elicited a sense of moral unease. The controversy is conveyed by popular media coverage titles such as 'Scientists put a bit of man into a mouse,' 'Human-brained monkeys,' and 'The laws of man and beast,'[14],[15],[16]. Much of the concern relates to the (theoretical) possibility that a substantial contribution of human cells or genes in crucial areas of the animal's body will render the animal more humanlike than any other animals we know today. Particularly disquieting in this respect is the potential to commingle human and animal genetic material at pre-fertilization and pre-natal stages and to insert substantial amounts of human neural (stem) cells into developing animal brains whose body plans have not yet been fully completed.

Past experiments of cross-species neural tissue transplantation have demonstrated the feasibility of transferring so-called species-specific behavior. For instance, Evan Balaban and colleagues transplanted brain tissue from developing quails into the brains of fetal-stage chickens. The tissue contained the neural circuitry relating to auditory perception. When born, the chickens exhibited the vocal trills that are unique to quails[17]. The concern about the potential to create more humanlike animals is also supported in reference to reports of successful transfer of human nuclei into enucleated cow and rabbit oocytes[18],[19]. While the resulting nucleocytoplasmic hybrids would consist of an entirely human nuclear genome, the nonhuman mitochondria could indeed leave some traces of animal DNA[20]. The successful fertilization of non-enucleated frog eggs with human nuclei even evokes the theoretical possibility of creating embryos with equal contribution of both sets of chromosomes[21].

On a policy level, the question that arises is whether, and on what basis, certain chimerism experiments should be constrained. In the U.S., the current prohibition of experiments which involve the implantation of human embryonic stem cells into nonhuman primate blastocysts or vice versa[22] emerged as a response to the U.S. President's Council on Bioethics' request for clear lines when the mixing of gametes or early blastomeres is concerned. They motivated this request stating that "(…) we do not wish to have to judge the humanity or moral worth of such an ambiguous hybrid entity."[23] Authors who have commented on or contributed to policy debates specify that chimeras which would be so humanlike that they would have an altered moral status and threaten our notion of 'human dignity' are at the forefront of the ethical controversy[24],[25]. If the chimeras were to share the characteristics which are otherwise unique and important to human beings, human dignity would be undermined and the chimeras would be worthy of the same respect that humans are.

3. Begging the question of human dignity

The notion of 'human dignity' is essentially a deontological one, indicative of a standard by which all people should be treated. It is based on the idea that there is something unique about the human race in comparison to the rest of the world that entitles all humans to an inherent moral worth and exclusive protection. The ethical mandate to respect the dignity of every human being forms the foundation of universal human rights and has played a role in the constitutional legislation of various nations. The concept is also increasingly applied within the context of bioethics. Nevertheless, it is a problematic tool for resolving bioethical questions of the sort we describe here.

The controversy surrounding chimeras requires that we mark a threshold for those organisms which are so human that they undermine or transfer the dignity due to humans. This suggests that we have a precise demarcation of those aspects of being human to which the dignity is attributed. Nonetheless, human dignity is among the least clearly defined notions[26]. The use of

this concept in the policy of this[27] and other emerging scientific advances[28] has been criticized to the extent that it fails to indicate or sufficiently support what exactly is so unique about the human race that all of its members, and at the same time no others, merit a special, profound moral worth. The criticism applies even to the legislative context. Legally, a violation of human dignity occurs when a human being, or a part of a human being closely associated to the whole human being, is treated as a commodity[29]. This rationale was originally why Stuart Newman's human/animal chimera patent application – a strategic attempt to force the US Patent and Trademark Office to decide on the theoretical creation of chimeras containing up to fifty percent human DNA[30] – was denounced. The PTO ruled that such chimeras would imply a violation of the Thirteenth Amendment, which forbids slavery and the ownership of human beings. It was not at all clear where the threshold for humanness was to be placed and how human an animal-human mixture must be for human legislation to apply. The argumentation for the denial of the patent has since shifted towards another principle, the beneficial-utility doctrine, according to which inventions are excluded when harmful for society's well-being, good policy, or good morals[31].

In a position paper on the ethics of transplanting human stem cells into nonhuman embryos, Karpowicz, Cohen and van der Kooy attempt to resolve the problem by referring to the fact that humans posses certain *functional and emergent psychological capacities* more than any other animals[32]. They suggest that the acceptability of chimerism experiments is dependent on whether the functional and psychological characteristics associated with human brains develop in the chimeric experimental subject. The three authors define a working concept for human 'dignity' that relates to a rough list of capacities[33]. Included in this list are the capacities for reasoning, choosing freely, acting for moral reasons and on the basis of self-chosen purposes. Also included in the cluster are capacities to engage in sophisticated forms of communication and the possession of certain emotions, language, social relations and world-views.

Intuitively, we all grasp that the cluster of capacities that they list cannot be excluded from what it means to be human rather than any other animal. Nevertheless, this attempt to give content to the notion of dignity does not provide support of these characteristics beyond a purely intuitive basis. The cluster of properties deemed distinctively and importantly human is presented as self-evident and lacks argumentation as to why it is superior to another filling-in and as to what degree these characteristics are lacking in other animals. As a consequence, it seems that we would be well advised to look again at the notion of human dignity, and particularly at the criteria of 'humanness' on which it is based, before we can deploy it as a threshold marker for chimerism experiments.

4. The downfall of human uniqueness

Before we can determine how a specific biotechnology may threaten the human moral status, we need to know what behavioral, functional and psychological capacities this status is attributed to. Over two thousand years of philosophical thought on human nature have not provided general agreement on a list of characteristics or capacities which distinguish human beings from other animals[34].

Ever since early Greek philosophy, the changeability and variability of the world motivated a quest for stability and a hidden, unchanging essence which constituted the true nature of living things. Whether it be in reference to the true and universal Forms, an inherent natural telos, or the general belief that each species was independently created by God, species boundaries existed and humans could be distinguished from all other animals. Indeed, the precise humanesque essence which was identified from the outset, not only distinguished humans from other animals, it elevated humans closer to the level of the divine, as the genesis narratives of the creation of humans in the image of God demonstrate. For centuries, the Great Chain of Being viewed humans as having a fixed place between the earthly and the heavenly creatures. Humans were connected to animals in terms of instinct and desire, but our capacity to transgress this

animal nature through rationality marked the line in terms of what makes us 'humans' and what allows our unique position in nature as that closest to God[35]. The human possession of reason and understanding was both carrier and vehicle of our human nature, be it in terms of human flourishing or capacity for knowledge of the divine. Reason was as much a moral as an intellectual faculty, granting us the power to evaluate natural events and allowing us to freely and rationally control the motives from which we act and achieve our ends. Starting from the notion that other animals are ruled by 'instinct' whereas we humans have surpassed our instincts and replaced them with 'reason', 'intelligence', or 'learning', more specific distinctions were put forward as the main 'essence' of *Homo sapiens*. Among the most prominent historically sanctified qualities are our tool-making, social, emotional, lingual, moral, political, cultural, economical and aesthetical capacities. Our capacities for reasoning have also given rise to attributing to humans, and to humans only, an ability for abstract thought, which in turn is the basis of science, religion, and conceptions of mortality.

One of the obstacles in distinguishing humans from animals in terms of instinct and reason was the lack of a natural foundation for this dichotomy. In 1698, for instance, Edward Tyson dissected a male chimpanzee – the first recorded great ape to be brought to England – and found more anatomical and functional similarities than differences between the chimpanzee and humans, in particular in terms of the large brain. In publishing his observations, Tyson was compelled to explain the difference between humans and the so-called Pygmie[36] in terms of an immaterial principle or rational soul in humans, independent of a physical organ:

> …if all depended on the *Organ*, not only our *Pygmie*, but other *Brutes* likewise, would be too near akin to us. … in truth *Man* is part a *Brute*, part an *Angel*; and it is that *Link* in the *Creation*, that joyns them both together.[37]

The sharp distinction between humans and other animals was not left unchallenged, even predating Darwinian theory. David Hume, for instance, denied that reason was a uniquely human capacity and that it provided us with anything more than a means to achieve the natural desires

we share with other animals[38]. And whereas Tyson felt challenged by the anatomical similarities discovered between chimpanzees and humans, three quarters of a century later, Lord Monboddo published the view that 'Ourang Outangs' were related to humans and capable of acquiring language[39]. The theory of evolution nonetheless provided the starting shot for fully undercutting attempts to ascribe a fixed essence or set of traits which is unique to our species and common to all members.

The theory of natural and sexual selection allows for elucidating the commonality of features across species boundaries. All species overlap to some extent as the result of their common descent and of the adaptive problems that led evolution without any definite direction and without any sharp break amongst species. Rather than the fixed creation of distinguished species, species evolved over evolutionary time through the gradual variation between individual organisms and in particular through the natural selection of those traits which provided the better solution for recurring environmental demands posed by their particular ecological niche. If the traits were able to solve these adaptive problems, they may have – directly or indirectly – promoted a better prospect of survival and possibilities for reproduction, whether it be in the effect of the organism's own offspring or the offspring of kin[40]. By the spreading of genes, the traits that formed the better response to the adaptive problems were passed on to later generations. Over evolutionary time, the selection of favorable traits accumulated and gradually developed an integrated, functional response to the adaptive problem.

The origin of human capacities for reason and related faculties, such as the psychological characteristics listed by Karpowicz *et al.*, are as much as any traits of a given species the result of this process. They are the product of circuits which – systematically, and over many generations – have become incorporated into our neural design for their ability to cause adaptive behavior. Hence, to the extent that various species share the phylogenesis and social and ecological adaptive problems with our hominid hunter-gatherers, they can be expected to share some of

these traits. In this respect, the chains amongst animals, including humans, appear interweaved rather than linearly sequenced[41].

Indeed, a grasp from studies of the behavior and cognition of animals, most significantly of great apes, reveals the ways in which animals border on or overlap with the so-called typical human characteristics. Many of the complex cognitive, emotional and psychological capacities which underlie the concept of *Homo politicus* or *Homo economicus* – such as the capacities to reason, abstract, generalize, generate symbolic representations, engage in sophisticated social bonds and to have a concept of self – have to a certain extent been recognized in other animals, most notably in the great apes. Observations of chimps in the wild and in captivity have long described how chimps solve problems, use and modify tools to retrieve food in their surroundings[42],[43]. Recently, the first documented use of tools among gorillas in the wild showed how they fathom the depth of a swamp with sticks and stumps[44]. Ape language experiments strongly suggests that great apes can acquire symbolic communication and basic aspects of grammar, although without syntax[45]. Great apes and dolphins recognize a paint spot on their face in their own mirror reflection[46],[47], which some authors suggest is indicative of a level of self-awareness. Frans de Waal has provided many indications of basic human economic tendencies in animals, particularly in capacities for resolution, reciprocity, and political cooperation[48],[49]. Chimpanzees use various media of exchange, such as grooming, sex, support in fights, food, and babysitting. They act in a way that suggests implied reciprocity, not only for positive, but also negative acts. Empirical data even suggest that the value attributed to the currencies is dependent on their availability. De Waal and many others also argue that great apes are cultural beings, in defining culture as the social rather than genetic transmission of behavior[50]. Some degree of moral behavior has also been suggested by indications of reconciliation, empathy, and acts based on the concept of fairness[51]. While already non-experimentally observed by Darwin and described in his 'The Descent of Man' (1871), the first experimental indications of a capacity for empathy in monkeys were derived in the 1960s. Rhesus monkeys refused to pull a chain that delivers food for themselves if doing so

gives a shock to a companion. One monkey persevered for 12 days after witnessing another monkey receive a shock[52]. Capuchin monkeys have been reported to respond negatively to previously acceptable awards when another monkey arbitrarily gets a better reward[53]. This suggests a relative notion of fairness in terms of the distribution of gains and on the various alternatives to a given outcome. Furthermore, examples have been provided of nonhuman volitional or motivational behavior. Great apes seem to have desires and preferences which they want to fulfill and the mental abilities for satisfying these, suggesting that they have some degree of autonomy[54].

Our evolutionary ties with other animals and the evidence of a gradual behavioral continuum seem to annul all attempts to set out those uniquely human traits to which human dignity may be attributed. The lack of distinctive, fixed boundaries draws Robert and Baylis, in an explorative paper on the biology of species identity and the morality of crossing species boundaries, to reconcile with the idea that:

> We all know a human when we see one, but, really, that is all that is known about our identity as a species. [55]

As the authors indicate, since everything about evolution points toward variability and not essential sameness, attempts to identify what is uniquely human cannot even appeal to a complete sequence of the human genome. Our genome is for a great part shared by a huge variety of apparently distantly related creatures and for the remaining part lacking of a genetic essence which is as yet identifiable as absolutely common to all *Homo sapiens*[56]. Moreover, given the differing intellectual abilities, moral capacities, communication skills, etc, among humans, we are a far cry from identifying a specific functional or psychological property on which to base human nature.

5. Defining humans as a set of mental and emotional adaptations

If we do not know how to define a human, surely we cannot resolve the question whether or not a future chimera expresses a distinctively human trait. Nor can we even begin to discuss whether it thereby challenges our notion of human dignity. However, while it is one thing to establish that a distinctive essence shared by all and only the members of a given species is lacking, it is quite another thing to assume that we cannot describe our human nature or even draw some unique differences with the nature of other species. Although Darwin is known for arguing that humans share many of the same mental properties with non-human animals, natural selection can just as well serve as a research tool for establishing distinctively human features.

As was noted above, we can expect any given species to express those traits which proved *functional* in solving specific adaptive problems. The entire anatomical, physiologic, cognitive, psychological and emotional architecture of humans – or any other species for that matter – is thus the result of a set of adaptations that were gradually 'engineered' to respond to the specific adaptive problems of our hunter-gatherer ancestors. Were we able to construct the entire list of adaptations with insight of their functional history, we would have a very rich notion of what typifies our species. An understanding of the neural adaptations that have given rise to our cognitive, psychological, and emotional architecture would also allow for a specification of those complex mental characteristics that constitute what most people will relate to human nature.

Of course, not all aspects of our architecture are clearly adaptations in the technical sense of the word[57]. Particularly very specific and 'higher' cognitive functions did not develop directly for adaptive reasons, but nevertheless built on adaptations which came about for different purposes. Natural selection did not select any mental devices to create Non-Euclidean geometry, for instance, given that it does not seem to reflect a relevant adaptive problem for our evolutionary ancestors. Indeed, in a famous debate between Darwin and Wallace about the origin of our capacities for mathematics and science[58], Wallace argued that human cognition must be an exception to the theory of evolution – our ability to engage in higher reasoning must be the result of 'a higher intelligence'. However, in the development of skills to create geometry, we

utilize the same adaptations that proved useful in the prehistory, such as the capacities for abstraction, orientation, and elementary calculations.

Attempts to derive a list of those adaptations that compromise our human nature involve 'reverse engineering' the structure of the human mind and behavior by working out the adaptive problems that needed to be solved by our ancestors[59]. Every one of our evolved neural adaptations – which range from our capacity to perceive color and dimensions to capacities to form social bonds through sophisticated communication and to order our world in abstract categories – allowed us to interact with a particular domain or to resolve a particular difficulty of our environment. By identifying the specific environmental demands which required a specific type of information-processing, an adapationist perspective can provide testable hypotheses to determine the nature of the traits which accumulated into neural programs and were incorporated into our behavior.

A full typology of human nature will necessarily consist of characteristics that are shared by other animals. Nevertheless, an adaptationist perspective could also demonstrate some of the characteristics that are uniquely human. The degree to which humans differ from other animals can be drawn from those adaptations that arose in response to the particular adaptive problems *not* shared by the ancestors of other species[60]. The *distinctively 'human' nature* can then be defined as the accumulated set of psychological, cognitive and emotional adaptations that arose in response to adaptive problems that only the ancestors of our species were confronted with.

6. Discussion: Implications for the concept of dignity

Although research in the origin of evolved human neural modules is relatively new, the tools and means to derive a list of those adaptations that characterize human behavior exist and the possibility of eventually acquiring such a list is, at the very least, feasible within the future. The problem that remains, then, for our purposes, is not so much how to acquire a list of the traits that typify humans and distinguish them from other animals. The problem is rather how to

use such a list to define human dignity and to weigh the acceptability of cross-species experiments. It is not clear which of the characteristics that typify humans merit the superior dignity and respect and why this may be so. The philosophical-anthropological question of 'what is human nature?' and 'what is distinctively human about it?' now shifts to the question what the moral relevance of these human characteristics is.

Various problems arise when attempting to attribute privileged moral status to factual descriptions of (characteristics of) human nature. Philosophical criticism of the is-ought problem will hold that there is simply no acceptable basis on which to relate moral status to biology[61]. It is arguable that ethics should not be entirely independent of a biological understanding of the nature of our species. Nonetheless, while an evolutionary psychology approach may to some extent reflect fundamental factual aspects of human nature, the value of that particular nature does not follow directly from such a description.

Before we can weigh the degree to which certain human characteristics merit respect, we need to construct a hierarchy of those characteristics. Any such moral ranking will always be subject to dispute rather than an objective truth. In this sense, the property cluster proposed by Karpowicz *et al.* seems as good a shot as any. The functional and psychological capacities they sum up (capacities for emotions, reasoning, choosing freely, acting for moral reasons and on the basis of self-chosen purposes, …) intuitively evoke higher notions of respect. These capacities resonate with descriptions of 'personhood', the notion which underlies an individual's unique personal identity and serves as the starting point for the indication of various basic moral principles[62].

Provided that we can achieve a consensus view on how to rank human capacities in terms of moral worth, it will remain difficult to ethically evaluate the permissibility of a chimerism experiment in the event that a human-to-animal chimera expresses some of these characteristics. The problem lies in the difficulty of achieving a *minimum* basis for human dignity and of demonstrating that the relevant capacities included in such a minimum basis are exclusively

human. As demonstrated above, some of the so-called human capacities are expressed by other animals in varying degree. As such, it is in no way clear that a minimal conditions for human dignity lie beyond the reach of 'non-enhanced' animals. Limiting human dignity to those capacities which are distinctly human will not resolve the problem. It may be pointed out that whether or not a certain chimerism experiment does or does not elicit the expression of distinctively 'human' capacities is beside the point and errs on speciesist convictions. The dignity is not attributed to the mere fact that a certain trait is typical for humans; it relies on how that trait is ranked according to moral worth.

Many philosophers have argued that the prevailing reasons to distinguish between the treatment of humans and that of animals fail the test of moral relevance. Peter Singer has advocated that the moral category which is of central importance for assessing the respect due to all living creatures relates to the interests and capacities they have[63]. In this respect, the most minimal criterion of moral relevance lies in a being's capacity to experience pain and happiness. This was identified by Jeremy Bentham as the prerequisite to having interests to begin with. This 'minimal' notion of dignity does not necessarily strip the concept of human dignity to a single, most rudimentary capacity. There is a vast variation in capacities to suffer and in their moral weight. The moral worth of the capacity to suffer is dependent on the specific type of suffering, be it merely physical suffering, or more advanced forms that require emotional and rational capacities and that are of greater influence on the interests of any given individual. The acceptability of chimerism experiments would thus depend on the degree to which the experiments cause the animals to suffer and affect their interests.

In conclusion, several implications can be related to the weaknesses that are inherent in 'human dignity' and the use of this notion to evaluate the acceptability of chimerism experiments. While it is not *in se* impossible to distinguish between uniquely human characteristics and characteristics shared with other species, no such distinction will be a direct guide for our moral actions. Rather, a typification of what it means to be human or some other type of species will be

the starting point for discussing the particular moral relevance of the characteristics and for comparing the degree to which various species-typical characterizations overlap. Since we do not yet have a solid description of species-typical features, nor a consensus on the moral ranking of those features, and since we lack insight in the impact of chimerism experiments on the alteration or transfer of potentially morally relevant features, questions regarding the dignity of chimeras and the acceptability of far-reaching experiments remain highly debatable. At the very least, given that it is certain types of capacities (minimally, capacities related to suffering) to which we attribute higher notions of respect, and given that these capacities are not necessarily unique to humans, nor shared by all humans, it makes more sense to speak of 'capacity dignity' rather than 'human dignity'. This approach allows to discuss moral worth as a matter of varying degree, rather than an all or nothing state.

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References

[1] EARL OF ROCHESTER. A Satyre against Mankind. In : Loptson P (ed). Readings on human nature. Essex : Broadview Press, 1998 : 30.

[2] See for instance : GALLACHER S. Chimera. New York : St. Martin's Press, 1982.

[3] See also : COOK R. Chromosone 6. Thorndike, ME : Thorndike Press, 1997.

[4] STEPHEN C, HALL A. Stalin's half-man, half-ape super-warriors. Scotsman.com News. December 20, 2005. Retrieved online at : http://news.scotsman.com/international.cfm?id=2434192005.

[5] ALMEIDA-PORADA G, PORADA C, ZANJANI ED. Plasticity of human stem cells in the fetal sheep model of human stem cell transplantation. International Journal of Hematology 2004 ; 79(1) : 1-6.

[6] NAMIKAWA R, KANESHIMA H, LIEBERMAN M et al. Infection of the SCID-human mouse by HIV-1. Science 1988 ; 242(4886) : 1684-1686.

[7] BOYCE N. Mixing species – and crossing a line? usnews.com. Oct 27, 2003. Retrieved online at : http://www.usnews.com/usnews/issue/031027/misc/27chimeras.htm?track=rss

[8] KELLY S, BLISS TM, SHAH AK et al. Transplanted human fetal neural stem cells survive, migrate, and differentiate in ischemic rat cerebral cortex. Proceedings of the National Academy of Sciences USA 2004 ; 101(32) : 11839-11844.

[9] CUMMINGS BJ, UCHIDA N, TAMAKI SJ et al. Human neural stem cells differentiate and promote locotomor recovery in spinal cord-injured mice. Proceedings of the National Academy of Sciences USA 2005 ; 102(39) : 14069-14074.

[10] TAMAKI S, ECKERT K, HE D et al. Engraftment of sorted/expanded human central nervous system stem cells from fetal brain. Journal of Neuroscience Research 2002 ; 69(6) : 976-986.

[11] WEISS R. Of mice, men and in-between : Scientists debate blending of human, animal forms. Washington Post. November 20, 2004. Retrieved online at : http://www.washingtonpost.com/wp-dyn/articles/A63731-2004Nov19.html

[12] JENTSCH JD, TAYLOR JR, REDMOND DE et al. Dopamine D4 receptor antagonist reversal of subchronic phencyclidine-induced object retrieval/detour deficits in monkeys. Psychopharmacology 1999 ; 142(1) : 78-84.

[13] OUREDNIK V, OUREDNIK J, FLAX JD et al. Segregation of human neural stem cells in the developing primate forebrain. Science 2001 ; 293(5536) : 1820-1824.

[14] KRIEGER LM. Scientists put a bit of man into a mouse. Mercury News. December 09, 2002. Retrieved online at : http://www.mercurynews.com/mld/mercurynews/4698610.html

[15] BUCHANAN N. 'Human-brained' monkeys. News.com.au. July 11, 2005. Retrieved online at : http://www.news.com.au/story/print/0,10119,15891104,00.html

[16] HOFFMAN KE. The laws of man and beast. TechnologyReview.com. May 12, 2005. Retrieved online at : http://www.technologyreview.com/articles/05/05/wo/wo_051105hoffman.0.asp

[17] BALABAN E. Changes in multiple brain regions underlie species differences in a complex, congenital behaviour. Proceedings of the National Academy of Sciences USA 1997 ; 94(5) : 2001-2006.

[18] ANONYMOUS. Advanced cell technology announces use of nuclear replacement technology for successful generation of human embryonic stem cells. Press release. 12 November, 1998. Retrieved online at : http://www.advancedcell.com/pr_11-12-1998.html

[19] CHEN Y, HE ZX, LIU A et al. Embryonic stem cells generated by nuclear transfer of human somatic nuclei into rabbit oocytes. Cell Research 2003 ; 13(4) : 251-264.

[20] NATIONAL ACADEMY OF SCIENCES. Guidelines for human embryonic stem cell research. Washington, D.C. : National Academies Press, 2005. Retrieved online at : http://www.nap.edu/catalog/11278.html : 32.

[21] SCOTTISH COUNCIL ON HUMAN BIOETHICS. Embryonic, fetal and post-natal animal-human mixtures : An ethical discussion. Edinburgh, 2005. Retrieved online at: http://www.cbhd.org/downloads/SCHB_animal-human-mix.pdf : 16.

[22] See ref. 20 : 46.

[23] U.S. PRESIDENT'S COUNCIL ON BIOETHICS. Reproduction and responsibility: The regulation of new biotechnologies. Washington, D.C., March 2004 : 220. Retrieved online at : http://bioethics.gov/reports/reproductionandresponsibility/_pcbe_final_reproduction_and_responsibility.pdf

[24] GREENE M, SCHILL K, TAKAHASHI S et al. Moral issues of human-nonhuman primate neural grafting. Science 2005 ; 309(5733) : 385.

[25] KARPOWICZ P, COHEN CB, VAN DER KOOY D. Is it ethical to transplant human stem cells into nonhuman embryos? Nature Medicine 2004 ; 10(4) : 331-335.

[26] KILNER JF. Human dignity. In : Post SG (ed). Encyclopedia of bioethics, third edition. New York : MacMillan Reference, 2003 : 1193.

[27] SCHAUB D. Council Discussion. Session 6 : Human-animal chimeras. Friday, March 4, 2005. PCBE Transcripts. Retrieved online at : http://bioethicsprint.bioethics.gov/transcripts/march05/session6.html .

[28] CAULFIELD T, CHAPMAN A. Human dignity as a criterion for science policy. Public Library of Science Medicine 2005 ; 2(8) : e244.

[29] RESNIK DB. Patents on human-animal chimeras and threats to human dignity. American Journal of Bioethics 2003 ; 3(3) : 35.

[30] MARSHALL E. Legal fights over patents on life. Science 1999 ; 284(5423) : 2067.

[31] KOPINSKI NE. Human-nonhuman chimeras : A regulatory proposal on the blurring of species lines. Boston College Law Review 2004; 45(3): 619-666. Retrieved online at : http://www/bc.edu/schools/law/lawreviews/meta-elements/journals/bclawr/45_3/03_FMS.htm

[32] See ref. 25 : 333.

[33] KARPOWICZ P, COHEN CB, VAN DER KOOY D. Developing human-nonhuman chimeras in human stem cell research : Ethical issues and boundaries. Kennedy Institute of Ethics Journal 2005 ; 15(2) : 120.

[34] TRIGG R. Ideas of human nature. An historical introduction. Oxford : Basil Blackwell, 1988 : 169.

[35] LOVEJOY A. The Great Chain of Being. A study of the history of an idea. Cambridge : Harvard University Press, 1936, 1974.

[36] Tyson confusingly used the term 'Pygmie' in the title, convinced that the notion referred to apes rather than men.

[37] TYSON E. Orang-Outang sive Homo sylvestris : Or the Anatomy of a Pygmie. In : McCown TD, Kennedy AR (eds.). Climbing man's family tree : A collection of major writings on human phylogeny, 1699 to 1971. Englewood Cliffs, NJ : Prentice-Hall, 1972 : 46.

[38] NORTON DF, NORTON MJ (eds). A treatise of human nature / David Hume. Oxford : Oxford University Press, 2001.

[39] MONBODDO L. Of the origin and progress of language. 6 vol. Edinburgh, London, 1773-1792.

[40] We are aware of the debate on the mechanisms that cause adaptations. Gould and Lewontin, for instance, believe that certain traits are rather by-products or the result of spandrels. See GOULD SJ, LEWONTIN R. The spandrels of San Marco and the Panglosian paradigm : A critique of the adaptionist programme. Proceedings of the Royal Society 1979 ; B295 : 581-598. However, in this paper, we follow the Darwinian line of reasoning which states that functionally complex mechanisms are most likely the result of natural or sexual selection.

[41] HAUSER M. Our chimpanzee mind. Nature 2005 ; 473(7055) : 60-63.

[42] GOODALL J. Tool-using and aimed throwing in a community of free-living chimpanzees. Nature 1964 ; 201 : 1264-1266.

[43] ANONYMOUS. Timeline: A brief history of chimps. Nature 2005(7055) ; 437 : 48.

[44] ROACH J. Wild gorillas use tools, photos reveal. National Geographic News. September 30, 2005. Retrieved online at : http://news.nationalgeographic.com/news/2005/09/0930_050930_gorilla_tool.html

[45] SNOWDON CT. From primate communication to human language. In : de Waal FBM (ed). Tree of origin : What primate behavior can tell us about human social evolution. Cambridge, MA : Harvard University Press, 2001 : 205-206.

[46] GALLUP GG Jr. Chimpanzees : Self-recognition. Science 1970 ; 167(914) : 86-87.

[47] MARTEN K, PSARAKOS S. Using self-view television to distinguish between self-examination and social behavior in the bottlenose dolphin (Tursiops truncates). Consciousness and cognition 1995 ; 4(2) : 205-224.

[48] DE WAAL FBM. Chimpanzee politics : Power and sex among apes. London : Jonathan Cape, 1982.

[49] DE WAAL FBM. How animals do business. Scientific American 2005 ; 292(4) : 72-79.

[50] DE WAAL F. The ape and the sushi master : Cultural reflections of a primatologist. New York : Basic Books, 2001.

[51] DE WAAL F. Good natured. The origins of right and wrong in humans and other animals. Cambridge, MA : Harvard University Press, 1996.

[52] DE WAAL FBM. Do humans alone 'feel your pain'? Chronicle of Higher Education 2001; 48(9). Retrieved online at : http://chronicle.com/free/v48/i09/09b00701.htm

[53] BROSNAN SF, DE WAAL FB. Monkeys reject unequal pay. Nature 2003 ; 425(6955) : 297-299.

[54] MARGODT K. The moral status of great apes : An ethical and philosophical-anthropological study. Dissertation Dept of Philosophy, Ghent University 2005 : 270.

[55] ROBERT JS, BAYLIS F. Crossing species boundaries. American Journal of Bioethics 2003 ; 3(3) : 5.

[56] See ref. 55 : 4.

[57] WILLIAMS GC. Adaptation and natural selection. A critique of some current evolutionary thought. Princeton : Princeton University Press, 1966.

[58] GOULD SJ. Natural selection and the human brain : Darwin versus Wallace. In : Gould JS. The panda's thumb : More reflections in natural history. New York : Norton, 1980 : 47-58.

[59] DUCHAINE B, COSMIDES L, TOOBY T. Evolutionary psychology and the brain. Current Opinion in Neurobiology 2001 ; 11(2) : 225-230.

[60] Ibid.

[61] SAVULESCU J. Human-animal transgenesis and chimeras might be an expression of our humanity. American Journal of Bioethics 2003 ; 3(3) : 23.

[62] TOOLEY M. Personhood. In : Kuhse H, Singer P (eds.). A Companion to Bioethics. Oxford : Blackwell Publishing, 2002 : 120.

[63] SINGER P. All animals are equal. In : Kuhse H (ed). Unsanctifying human life. Essays on ethics : Peter Singer. Oxford : Blackwell Publishers, 2002 : 79-94.