# Chimeras

## The Ethics of Creating Human-Animal Interspecifics

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# Preface

In summer 2004, I had the pleasure of attending a seminar by Julian Savulescu and Nick Bostrom about "Human Enhancement, Artificial Beings, and the Future of Humanity" at the University of Oxford. Among other quite exotic topics, chimeras were the subject matter of one of our seminar meetings. This was a concept that was completely new to me at the time and apparently denoted some kind of mixture between human and animal, which was to be used in biological research. What struck me about the seminar was the immediate, visceral and resolute reaction the topic aroused in many of my fellow students, at a time when none of us were actually very informed about chimeras. While the typical discussion in a philosophy seminar allows for grey areas, undecidedness and reserved interest, even regarding hotly debated issues like abortion or death penalty, the topic of mixing humans and animals elicited immediate rejection and concern in most of us – excluding Savulescu and Bostrom, who tried to frame the topic in neutral or positive terms. Since then, I have made a very similar observation in countless situations whenever casually introducing a colleague, friend or acquaintance to the subject of chimeras: most will have an immediate, strong and negative response to the idea of mixing animals with humans. Yet at the same time, few can produce arguments to support this knee-jerk reaction, even among bioethicists.

It was this discrepancy between a strong, unambiguous intuitive reaction to chimeras and the diffuseness and vagueness of the arguments brought forward that made me become (and stay) interested in the topic. In 2005, human-animal mixtures became relevant for my M.Phil. thesis, where I discussed whether the ethical position that being human makes a difference in regard to the moral status of a being ("speciesism") is defensible.[1] The notion that there could be beings in between human and animal, after all, should be thrilling for anyone who is concerned with the question of moral status difference between humans and animals. Accordingly, a short excursus in my M.Phil. thesis was devoted to human-animal chimeras: I argued that speciesist approaches had difficulties coping with species-ambiguous individuals, and that, in a nutshell, chimeras were a point in case for giving up

[1] In the following, "speciesism" will denote any *general attitude or approach* which assumes that being human makes a difference in regard to how we should treat an entity. The *ethical principle* of Speciesism and its different varieties will be properly introduced, defined and analyzed in chapter 3, section B.
The concept of moral status will also be used losely up until its explanation and definition in chapter 3, section A.

speciesism (I will come back to this question in chapter 3, section B below). The topic of chimeras remained in the focus of my philosophical work after my M.Phil. and I immediately settled on this area for my dissertation.

At the centre of this thesis is the question whether there is one, persuasive moral argument that can be used to veto the creation of (human-animal) chimeras or similar interspecifics. While responses to the issue of creating human-animal chimeras are almost univocally and strongly negative, at a second glance it seems at least extremely hard, if not impossible, to come up with such a fundamental argument against chimera creation – a result I hope to establish in chapter 2, where a variety of possible arguments are closely scrutinised.

Before working on moral aspects of chimeras, it is crucial to lay out the biological basics. A considerable portion of this dissertation is therefore devoted to making clear what chimeras actually are, what other interspecific constellations exist naturally, artificially and which interspecific entities might come to exist in the future. By this, I hope to avoid the allegation of writing about speculative, hypothetical Science Fiction. Also, I want to clear the path for philosophical discussion by visibly laying out what is at issue. In a debate as young as the one about chimeras, many philosophical problems are at risk of being obscured by conceptual vagueness or misunderstandings, e.g. about the concepts "chimera", "hybrid", "species membership" etc., but also about the actual research done and its motives. This is problematic not only because it leads to futile debates about non-topics, but also because there is actually urgent demand for ethical guidance and analysis in the field of interspecific research.

An issue that is a necessary corollary to the analysis of arguments against chimera creation is that of human-animal chimeras' moral status, and that of speciesism. Moral status will be discussed not only in the limited context of the question whether the creation of human-animal chimeras should be prohibited or allowed, but also from a more abstract point of view, regarding the advantages and disadvantages of using this concept. A connected question that I will look at in an in-depth excursus is that of speciesism, i.e. the idea that the moral status of humans is fundamentally different from that of nonhumans. I will show that the very idea of mixtures between humans and animals, and our reaction to this idea, tells us something meaningful about our understanding of the moral status of animals as opposed to that of humans. It questions and may even undermine our way of seeing the world in categories of "human" and "nonhuman". The question of defensibility of speciesism is, as I will show, at the bottom of several of the typical objections to chimera creation.

Scientists working in the various fields of research that involve the creation of human-animal mixtures have pointed out that they are in need of ethical ground rules, and, even more urgently, concepts and methods to work with when discussing the issue of human-animal mixtures from an ethical standpoint. So the issue of chimeras is directly, practically relevant in the sense that society will have to decide on whether and how to regulate or prohibit the creation of such beings, and needs toe-holds (and maybe whole new conceptual step irons) in order to enter an informed debate. I hope to deliver such starting points and contribute to this debate in a way that elucidates the ethical questions that arise from the creation of chimeras. Rather than persuading the reader of my specific personal views (although these will necessarily influence my analysis), I would mainly like to help them with reaching their own conclusions regarding this complex issue by giving an objective and detailed overview of the field.

In retrospect, the topic of chimeras has turned out to be an exciting, at times surprising, complex and often mind-blowing subject that kept me fascinated until the very last page of this dissertation. I hope that some of my enthusiasm for this area of bioethics will rub off on my readers.

# Acknowledgements

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# Chapter 1: Biological Basics

This chapter will offer a comprehensive overview of chimeras and a whole array of other mixed organisms or entities. These preparations are necessary for a reasonable discussion of the "chimera" debate, which, as we will see, actually concerns only some types of chimeras, but includes several types of non-chimeric interspecific beings.

Section A will give an outline of natural occurrences of chimerism, distinguishing it from other forms of mixing, while section B will address artificial chimeras and mixtures of all kinds. The primary focus of this section will be on providing an insight into technical possibilities in experimental biology's employment of chimeras, and explaining the motives behind chimera and other interspecific research. In section C, I will assess currently used definitions of the term "chimera" and try to offer suitable concepts of "chimera" and "interspecific" for bioethical debate. Section D will give a short introduction to the legal and political situation of (human-animal) interspecific research, especially regarding embryonic chimeras and so-called cybrids.

## A. Naturally occurring chimeras and other mixtures

Biological laymen understand the expression "chimera" to denote either figures of Greek mythology or phantasms and illusions.[2] In common usage, the term "chimera" denotes impossible beings which, by their very existence, disrupt categories.

In biology, "chimera" is a technical term.[3] It denotes, as we will see, not only creatures whose mixed and artificial nature is obvious, but also inconspicuous beings and entities that result from natural processes. The concept and use of "chimera" in biology is complex and multiple. Settling on a definition seems not advisable at this point. In this and the following section I will give an overview of possible mixtures, and explain what chimeras are *not* by distinguishing them from other mixtures – not all mixed beings are chimeras. By Section C, we will have an outline of this complex area at hand that should suffice for assessing possible definitions of "chimera" and for settling on the future use of "chimera" and related terms.

[2] In German, the latter meaning is distinguished from the former by a different spelling - "Schimäre" denotes the phantasm, "Chimäre" the mythological (or actual) being.
[3] The somewhat antiquated spelling "chimaera" is used rarely today. Confusingly, "chimaera" also denotes a type of cartilaginous fish (order Chimaeriformes) which is related to sharks.

As a crude first approximation, one can say that chimeras are organisms which are the product of mixing materials from two (or more) genetically different organisms. (As you may have noticed, this approximation includes all organisms that are a product of sexual reproduction, but let us set this objection aside for the moment.)

Rather, let us have a look at what biologists consider naturally occurring chimeric organisms: both in animals and humans, twin embryos often exchange cells in the womb, sometimes leading to intra-species chimeras whose chimerism usually goes undetected, only sometimes showing in the form of strange iris coloration or fur patterns. Chimerism, on a small level, also occurs when fetal cells enter the maternal organism ("fetomaternal microchimerism"). Twin embryos also sometimes fuse in the uterus. These cases of so-called "disappearing twins" can result in an adult that carries a "parasitic" twin in its body (which leads to strange results in blood tests); it can also in rarer cases lead to noticeable deformations like hermaphroditism or supernumerous limbs. Likewise, conjoined twins exhibit a composition resulting from a fusion of two embryos. They are not regarded as chimeras, though, because they are the product of identical twins' fusion: unlike normal twins, identical twins stem from one common zygote (fertilized egg).

Probably the most well-known and obvious chimeras within the human species are patients who have undergone transplantation of tissues, body parts or organs from other (deceased or alive) human beings. Human-to-human transplantation is nowadays so common that allocation of organs is almost the only ethical question discussed in this area (maybe with the exception of the transplantation of whole body parts, specifically the face, which raises other issues as well). By contrast, animal-to-human transplantation or xenotransplantation, which produces animal-to-human interspecific chimeras, is still regarded as highly controversial – apparently not only because of its medical riskiness (for an overview of xenotransplantation research, see B.5).

Note that genetically differing sets of cells are not only found in chimeric organisms. Chimerism should not be confused with mosaicism, i.e. organisms which have genetically distinct sets of cells, but whose differing cell populations originate from just one zygote. Mosaicism is normal in female mammals, where x-chromosome inactivation leads to an organism which partly consists of cells where, randomly, either the paternal or maternal X chromosome is inactivated. These two cell types are scattered over the female mammal's body (visibly so in female cats with tortoiseshell or calico fur patterns). Mosaicism does also occur when identical twins exchange cells in the womb.

We can note that chimeric organisms consist of cells that have differing genetic information. These genetically differing cells do not originate from one zygote, as is the case with female mosaicism and mosaicism in identical twins, but from two or more differing sources.

*Picture 1: Chimera. Etruscan Bronze, 5th century BC.*

In Greek mythology, the main characteristic of chimeras is their compositeness, or more specifically, that they are made from different species of animal, human or mythological creature. According to Homer, the original Chimera was slain by Bellerophon with the help of Pegasus (another chimeric creature!) in Asia Minor. The mythical monster consisted of lion, goat and dragon or snake.[4] A village on the south coast of turkey is still called "Chimaira" in honour of the mythical Chimera. The naturally occurring chimeras I mentioned above do not exhibit other species' characteristics because they are intraspecific chimeras, and, as such, wholly inconspicuous to layman observers (apart from conditions like hermaphroditism that are present in some of them). Are there naturally occurring mixtures between species at all? Some think that lichen can be regarded as the chimeric symbiosis of algae and fungus. And in plants, production of interspecific chimeric organisms is not restricted to high-tech laboratories: graftage of fruit trees is a low-tech, traditional method resulting in chimeric plants which – for example – lets us grow pears on one and apples on another branch of a tree, or different-coloured roses on one rose stem. The bioethical debate about chimeras is focused on animal chimerism, as we will see in the discussion below. So, do inter-species animal chimeras occur naturally, too?

There are, indeed, mixes between different species: interspecific hybrids. These hybrids – also called "cross" or "bastard" – result from sexual reproduction between individuals of different, but closely related species and are often (not always) sterile themselves. To give but two examples, mules are the offspring of female horses and male donkeys, ligers and tions result from crossing tigers with lions. Many undomesticated species produce hybrids in the wild, without human intervention. Hybrids are not regarded as chimeras because

[4] Homer, in the Illiad (VI. 179-182), describes the chimera as "lion-fronted and snake behind, a goat in the middle, and snorting out the breath of the terrible flame of bright fire." For a comprehensive overview of mythological chimeric creatures' appearance in art, see Mode (1974), Fabeltiere und Dämonen in der Kunst. Die fantastische Welt der Mischwesen.

they do not contain genetically distinct cell populations. Instead of consisting of inhomogeneous sets of genetically different cells, they are wholly composed of homogenous cells that are (genetically) intermediary in type. This is because they result from the fusion of an egg and a sperm of different species into a single zygote, from which all other cells of the hybrid organism originate. In hybrids, the mixture takes place on *inner-cell level*, typologically resulting in an animal which is *sui generis* but not a mixture on the cell or organ level, since all cells of the hybrid animal carry the same genetic fingerprint. In chimeras, the mixture takes place on the level of *cells*, resulting in an organism whose cells keep their disparate genetic identity. If we, because of this difference, exclude hybrids from the area of chimeric beings, it becomes apparent that interspecies animal chimeras exclusively come to exist through artificial means.

Artificial chimeras – especially animal-human chimeras resulting from manipulation and mixing of embryos and stem cells – are at the centre of the bioethical chimera debate. Why, how and under what circumstances those creatures are, today, produced and used in research laboratories all over the world will be described in the next section.

## B. Human-made chimeras and other interspecifics

### 1. Roots of chimera research

What scientific roots did current chimera research, especially inter-species chimera research, emerge from, and what are the deeper motivations for today's experiments with human-nonhuman mixtures? One can subsume current chimera research under three areas of particular interest.

Firstly, researchers have been trying for several decades to create animal models for all kinds of diseases; i.e. animals in which human diseases can be emulated. Many of the chimera experiments that are done today, especially human-animal chimera experiments, are directed towards imitating human diseases in animals. One prominent example of this practice is the SCID-hu mouse, a scientific breakthrough of the 1980s, which is regarded as a cornerstone of immunology research. Researchers grafted human stem cells as well as human fetal liver cells, fetal thymus cells and bone marrow into immuno-deficient mice in order to "humanize" the animals. The resulting mice have a human immune system.[5] The SCID-hu model was necessary to isolate human hematopoietic stem cells that are now

[5] McCune, Namikawa, et al. (1988), "The SCID-hu mouse: murine model for the analysis of human hematolymphoid differentiation and function", Science, **241**(4873).

commonly used in therapies of leukaemia.[6] It is also still widely used in HIV and other immune system research.[7] Newer chimeric models are often used to emulate neurodegenerative and psychiatric diseases.[8] Creation of "humanized" disease models is also done with methods of genetic engineering – a prominent example is the Harvard OncoMouse, which was "genetically engineered to contain a human cancer-causing gene" in 1988.[9] Transgenically humanized animals – which are not chimeric beings – will be further discussed in section 6.a below.

A second strain of research that lead towards today's chimera experiments is that of developmental biology, which has, over the last 150 years, introduced methods of tissue transplantation in order to find out about various developmental phenomena.[10] Some chimera experiments continue this search for explanations of how and why different types of cells (e.g. varying somatic cells, precursor cells or stem cells) develop, fuse, aggregate, diversify, change their level of potency, develop anomalies, or are influenced by their microenvironment, offering a model for research which cannot be done in human beings for ethical reasons and is carried out in animals instead.[11]

Another motive for induction of chimerism in research is due to the fact that scientific consensus and regulation (e.g. by the United States Food and Drug Administration, FDA) requires that stem cell therapies, before being applied to human subjects, first be tested in animals. Such testing results in human-to-animal chimeras. This is specifically relevant for the development of treatments for neurodegenerative disorders.[12] Chimeras as assay systems, which are used to find out about tumorigenicity and to test stem cell applications with therapeutic potential, can be created in adult and fetal animals *in vivo*, but also in embryonic *in vitro* experiments. The chimeric subjects are usually euthanized after

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[6] Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5), p. 31.
[7] Ibid., p. 32.
[8] Cf. Muotri, Nakashima, et al. (2005), "Development of functional human embryonic stem cell-derived neurons in mouse brain", Proceedings of the National Academy of Sciences, **102**.
[9] Sagoff (2003), "Transgenic Chimeras", American Journal of Bioethics, **3**(3).
[10] Robert (2004), "Model Systems in Stem Cell Biology", Bioessays, **26**, p. 1010.
[11] Examples: Stern (1973), "Chimaeras obtained by aggregation of mouse eggs with rat eggs", Nature, **243**(5408); Fehilly, Willadsen, et al. (1984), "Interspecific chimaerism between sheep and goat", Nature, **307**; Brüstle, Choudhary, et al. (1998), "Chimeric brains generated by intraventricular transplantation of fetal human brain cells into embryonic rats", Nature Biotechnology, **16**; Ourednik, Ourednik, et al. (2001), "Segregation of human neural stem cells in the developing primate forebrain", Science, **293**.
[12] Baylis and Fenton (2007), "Chimera Research and Stem Cell Therapies for Human Neurodegenerative Disorders", Cambridge Quarterly of Healthcare Ethics, **16**(2), p. 196f; Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5), p. 28.

transplantation of human cells and undergo histological or genetic analysis.[13] This motive of testing of possible hESC treatment methods can be subsumed under the second branch of finding out how human cells develop and differentiate in vivo.

The third root of chimera research prevalent today can be found in the search for substitute tissue or organs for patients in need of transplantation due to illness or injury. Although porcine heart valves are nowadays routinely used as replacement for human heart valves, the use of living animal organs and tissues, in the past, has not been as successful as one had hoped for, since animal organs, unfortunately, do not properly integrate into the human organism. Therefore, human-animal chimeras are created in order to grow human organs or tissues within animal organisms.[14] In the future this method could be used for more successful xenotransplantations due to a reduced immune response of the human host (for further discussion, see 5 below).

Accordingly, one can see current chimera research as contributing to three main projects: that of emulating human diseases in animals, that of finding out about (human) cell development in vivo without harming human beings, and that of producing human organs or tissue substitutes in vivo. These research interests frequently overlap: research with human stem cells introduced in injured animal organisms (e.g. in stroke-affected brains of mice[15] and damaged spinal cords of mice[16]) is as interesting from the viewpoint of stem cell development as it is from the viewpoint of replacing damaged tissue in human organisms in the future.

Let us now look at the different types of entities that are created in these branches of research. They will be arranged in order of the direction of the chimeric manipulation (i.e. animal-to-animal, animal-to-human, or human-to-animal) and the developmental stage of the recipient. After analyzing chimeras, we will also have a look at non-chimeric animal and human-animal interspecifics, including hybrids and "transgenic chimeras".

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[13] Robert (2006), "The science and ethics of making part-human chimeras in stem cell biology", Journal of the Federation of American Societies for Experimental Biology, **20** p. 840.

[14] Bianco and Robey (2001), "Stem cells in tissue engineering", Nature, **414**; Dekel, Burakova, et al. (2003), "Human and porcine early kidney precursors as a new source for transplantation", Nature Medicine, **9**; Almeida-Porada, Porada, et al. (2004), "Formation of human hepatocytes by human hematopoietic stem cells in sheep", Blood, **104**(8); Taylor, Cowin, et al. (2006), "Formation of human prostate tissue from embryonic stem cells", Nature Methods, **3**(3).

[15] Kelly, Bliss, et al. (2004), "Transplanted human fetal neural stem cells survive, migrate, and differentiate in ischemic rat cerebral cortex", Proceedings of the National Academy of Sciences, **101**(32).

[16] Cummings, Uchida, et al. (2004), "Behavioral improvement, differentiation, and immuno-electron microscopy of human central nervous system stem cells in spinal cord injured NOD-Scid and NOD-Scid/Shiverer mice", Society For Neuroscience Abstracts.

## 2. Intraspecific animal-to-animal (and human-to-human) chimeras

The beginnings of animal-to-animal chimera research within species (intraspecific animal-to-animal chimeras) are in the grafting experiments of Murray and Huxley, in the 1920s,[17] and the first embryonic mouse chimeras, created by Andrzej Tarkowski[18] and Beatrice Mintz in 1960s.[19] Intraspecific mouse chimeras were made by fusing two mouse embryos.[20] More elaborate techniques allowed not only the combination of two embryos, but also the combination of embryos with embryonic cells from a later stage (e.g. inner cell mass cells), cells from embryonic carcinoma, embryonic stem cells and embryonic germ cells.[21] Modern techniques produce chimeras by "sandwiching" cells of different provenience in layers.[22] Many of these experiments do not only result in chimeric blastocysts or embryos, but also in viable adult chimeric mice; they were also carried out in animals other than mice, such as rats, sheep and bovines.[23]

While the focus of the first intraspecific chimera experiments was on studying normal early development of cells and on finding out about phenomena such as hermaphroditism (which is sometimes based on intraspecific chimerism), intraspecific chimeras today often have a different role: transgenic germ line chimeras are used as carriers in the production of genetically modified animals. Manipulated embryonic stem cells are transplanted into host embryos which incorporate them into their germ line, producing genetically modified gametes.[24]

This is by far not the only area of chimeric intra-species experimentation. To give another example for the utility of animal-to-animal chimerism in research, British scientists transplanted retina cells from a particular ontogenetic stage in murine fetal development ("photo receptor precursors") to the retinae of blind adult mice in 2006 in an effort to advance the possible treatments for blindness. The cells apparently integrated into the adult mouse organism, enabling the transfer of information to nerve tissue and, accordingly, the

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[17] Murray and Huxley (1925), "Self-differentiation in the grafted limb bud of the chick", Journal of Anatomy, **59**.
[18] Tarkowski (1961), "Mouse chimaeras developed from fused eggs", Nature, **190**.
[19] Mintz (1962), "Formation of genetically mosaic mouse embryos", American Zoologist, **2**.
[20] Tarkowski (1998), "Mouse chimaeras revisited: recollections and reflections", International Journal of Developmental Biology, **42**.
[21] Ibid., p. 904.
[22] Ibid.
[23] Ibid.
[24] Ibid., p. 906f. For an example of transgenic pig germ line chimeras, see Piedrahita, Moore, et al. (1998), "Generation of Transgenic Porcine Chimeras Using Primordinal Germ-Cell Derived Colonies", Biology of Reproduction, **58**.

mouse brain.[25] By determining the particular stage in development at which precursor cells succeed at integrating into the alien organism, the scientists hope to find out at which point in development stem-cell generated human cells should be transferred to blind patients' eyes (this would constitute a human-to-human, intraspecific chimera).[26]

These are all quite foreign procedures for the non-bioengineer, and some might think that chimeras, apparently, are something that one rarely encounters as a layman. This is misleading: As mentioned above, there are also intraspecific human-to-human chimeras among us whose existence is well-known even to the non-expert. Allotransplantation, be it cardiac, renal, or hepatic, be it from a living or a deceased donor, leads to a human being whose cells are partly of a different genetic set-up. These cases of intraspecific chimerism within our own species lead to particular ethical problems, mainly, the problem of organ allocation, which shall not interest us here because it is not a corollary of chimerism as such but a matter of the scarcity of donor organs. Apart from allocation problems, human-to-human transplantation nowadays rarely leads to reactions of horror or moral indignation. An exception to this rule might be face transplantation. The case of the first face transplant carried out on a Frenchwoman in 2005[27] demonstrates that, ultimately, loss of identity of the recipient or an inadvertent transfer of social identity of the deceased donor were not the central problems. The question whether informed consent actually took place or whether the patient was used as a guinea pig for not yet perfected therapeutic methods played a much greater role in this case.[28]

Another spectacular case of allotransplantation practice that typically elicits ethical concerns is that of therapeutic use of human fetal tissue – e.g. transplants of fetal brain tissue into the brains of Parkinson's patients[29] – which have, so far, been unsuccessful and even detrimental to the patients' health. One problematic aspect of this method is the use of human fetuses: it is feared that these fetuses could be reduced to their role as raw material for drugs, or that, in the case of scientific success, increasing demand could lead to induction of pregnancies for the sake of producing fetal material. There is a general debate around the propriety of use of fetal tissue in research, which also comes up regarding

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[25] Die Zeit (2006), "Erforscht und Erfunden: Blinde Mäuse", 2006/11/09; MacLaren, Pearson, et al. (2006), "Retinal repair by transplantation of photoreceptor precursors", Nature, **444**.
[26] MacLaren, Pearson, et al. (2006), "Retinal repair by transplantation of photoreceptor precursors", Nature, **444**, p. 207.
[27] BBC News (2005), "Woman has first face transplant", 2005/11/30.
[28] For a discussion of ethical and psychological problems surrounding face transplantation, see Jungblut (2005), "Gesichtstransplantation - Ärztlicher Ehrgeiz oder Interesse des Patienten", ZeitWissen **2005** (2).
[29] Freed, Greene, et al. (2001), "Transplantation of Embryonic Dopamine Neurons for Severe Parkinson's Disease", New England Journal of Medicine, **344**(10).

interspecies xenografts (i.e. injection of fetal material into nonhuman materials) – for some comments on this problem, see chapter 2, section C.2.b below. In Germany, the ZEB (Zentrale Ethikkommission bei der Bundesärztekammer) dismissed therapeutic use of fetal/embryonic tissues in Parkinson's patients as ethically dubious out of a combination of numerous reasons and voiced a square refusal to such practices in 1998.[30] The transfer of material from one organism to another (i.e. the causation of chimerism per se) was not an issue in the moral concerns regarding neural transplants; the debate focused on the proper management of health risks.

My focus in this work will, as I have previously pointed out, be on interspecific chimeras, i.e. a type of creature where the individual being contains live material from two or more species. Let us first have a look at animal-to-animal chimeras which do not involve human material and then, in sections 4 and 5 below, at chimeras between humans and animals.

## 3. Interspecific animal-to-animal chimeras

Since the 1970s, numerous experiments have been carried out that resulted in interspecific chimeras. One of the first interspecific chimeras was brought about by M. Susan Stern, who created a chimeric rat-mouse blastocyst in 1973.[31] Many interspecific chimeras have been created since then; many of them reached adulthood and some were even fertile.

*Picture 2: Sheep-goat chimera*

One experiment of this kind which gives a very tangible illustration of chimerism was the sheep-goat chimera (see picture 2). In 1984 such an animal was created by artificially fusing a sheep and a goat embryo, which was then brought to term.[32] The creature, which is sometimes called "geep", displays characteristics of both sheep

[30] Zentrale Ethikkommisson bei der Bundesärztekammer (1998), "Übertragung von Nervenzellen in das Gehirn von Menschen."
[31] Stern (1973), "Chimaeras obtained by aggregation of mouse eggs with rat eggs", Nature, **243**(5408).
[32] Fehilly, Willadsen, et al. (1984), "Interspecific chimaerism between sheep and goat", Nature, **307**.

and goat, but these are not evenly distributed, resulting in an intermediate type (as would be the case in a sheep-goat hybrid). Instead, they are scattered, puzzle-like, over the animal's body depending on where in the organism sheep cells or goat cells prevailed. Thus, a geep has sheep parts which are woolly (or display other sheep characteristics) and goat parts that are hairy (or display other goat characteristics).

The creation of interspecific chimeras which live to later embryonic or even adult stages does not work between randomly selected species. Veteran chimerism researcher Andrzej Tarkowski notes that the attempt of a colleague at creating sheep-cow chimeras resulted in severely malformed lambs, and that reabsorption of implanted, non-viable chimeric blastocysts is a very common occurrence.[33] It soon became clear that the viability of such interspecific chimeric embryos depends mainly on whether the two species are closely genetically related.[34]

A notable step in chimera research – which might be especially interesting in regard to ethical questions – was the creation of "quail-brained chicken" by Balaban, Teillet and Le Douarin in 1988.[35] Parts of the neural tube of quail embryos (the structure that later develops into the central nervous system) were implanted in chick embryos. This resulted in chicks whose behaviour indicated a transfer of species-specific inborn properties: The quail-chick chimeras crowed similarly to quails. The extent of this chicken-atypical behaviour depended on how extensive the insertion of quail cells had been. This was "the first demonstration of cross-species behavioral transfer brought about by neuronal transplantation."[36] A transfer of "inborn auditory perceptual preference"– i.e. response to species-specific maternal calls – in the brain-transplanted chicks was observed in later experiments.[37] The example of the quail-brained chicken is often used to demonstrate that a transfer of behavioural characteristics from one species to another is possible, in principle.

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[33] Tarkowski (1998), "Mouse chimaeras revisited: recollections and reflections", International Journal of Developmental Biology, **42**, p. 905.
[34] Ibid.
[35] Balaban, Teillet, et al. (1988), "Application of the quail-chick chimera system to the study of brain development and behavior", Science, **241**.
[36] Ibid., p. 1341.
[37] Long, Kennedy, et al. (2001), "Transferring an inborn auditory perceptual preference with interspecies brain transplants", Proceedings of the National Academy of Sciences, **98**.

## 4. Human-to-animal chimeras

The development and possibilities of artificial manipulation of diverse human cells, above all, stem cells, is of great interest to researchers. Because there obviously are ethical limits regarding the study of such cells within the human body, many scientists have seized the opportunity to create human-to-animal chimeras – i.e. chimeras consisting of an adult, fetal or embryonic animal host into which genetically human parts of cells, unconnected single cells or cell structures/tissues are artificially introduced.

*a. Human-to-animal chimeras (adult recipient)*

*Picture 3: "Vacanti Mouse"*

An (alleged) example of this development which stays in collective memory was the infamous "earmouse", a naked mouse with an ear-like structure on its back, created by Charles Vacanti and Linda Griffith-Cima in 1997.[38] Iconic pictures of the "earmouse" (see picture 3) were publicized widely via the internet, allegedly symbolizing the horrors of "genetic manipulation". How and why did this strange creature come into being? Vacanti and Griffith-Cima seeded a scaffold of biodegradable polymer with cartilage cells and transplanted it onto the back of an immunodeficient mouse, whose organism then nurtured the auricle. Their research was aimed at the future possibility of re-growing ears or other cartilage structures in vitro, or even directly on human patients who need such a substitute because of accidents or genetic defects. Charles Vacanti is still working on making this "tissue engineering" approach ready for application in humans. Because the host, in the case of Vacanti's and Griffith-Cima's mouse, was an adult individual, this kind of chimera would be called an adult chimera. It was not a human-to-animal chimera, though. Despite its appearance, the ear on the mouse's back did not contain human, but bovine cartilage cells. The iconic image of the "earmouse" may be a powerful symbol for human-animal mixing, but the creature in question did not even contain human material.

Experiments resulting in actual human-to-animal adult chimeras employ techniques that differ from Vacanti's tissue engineering approach. Human material is introduced in animal organisms, but instead of somatic human cells, researchers use precursor cells or stem

[38] Cao, Vacanti, et al. (1997), "Transplantation of Chondrocytes Utilizing a Polymer-Cell Construct to Produce Tissue-Engineered Cartilage in the Shape of a Human Ear." Plastic & Reconstructive Surgery, **100**(2).

cells.[39] Let me first give some examples for the use of human precursor cells in transplantations to nonhuman hosts:

In 2002, Benjamin Dekel and colleagues from the Weizman Institute in Israel succeeded in inducing the growth of miniature kidneys in mice by transplantation of kidney precursor cells taken from human and pig embryos.[40] This experiment ultimately aims at the production of substitute organs for humans in need of transplantation, and it was a main point of interest for researchers to find out at what point in time kidney precursor cells are best transplanted to the alien organism in order to flourish.

To give another example of this kind of research, Angioi and colleagues transferred embryonic human stomachs, tracheas, intestine and lungs into adult mice in 2002, which led to the development of functional "micro-organs".[41]

Another human-to-animal chimerism experiment in which precursor cells were used focused on growing human prostrate tissue in mice by implanting specially manipulated human embryonic stem cells ("prostate tissue precursor cells"). This experiment was carried out by Renea Taylor and Prue Cowin in Melbourne in 2005.[42] Here, the focus was on finding out how benign prostate disease (BPH) and prostate cancer develops in order to be able to treat it more successfully in the future.

Similar research has also been carried out in Germany. Scientists at the Max Delbrück Center for Molecular Medicine (Berlin) transplanted liver cells derived from human embryonic stem cells into mice with partially damaged livers. Among other objectives, the researchers wanted to find out whether transplantations of liver cells prepared in this manner could be used for liver regeneration therapy in human patients.[43]

Ahmed Mansouri at the Max Planck Institute for Biophysical Chemistry (Göttingen) obtained a licence to conduct similar research in 2003. The MPIbpc project involved the

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[39] Stem cells are less developed than progenitor cells and have greater potential for differentiation. In technical terms, progenitor cells are "multipotent" (can create only some kinds of cells), while stem cells are "pluripotent" (can develop into all kinds of cells). "Precursor cell" is a generic term for both "stem cells" and "progenitor cells", used in cases where it is not clear whether the cells at issue have stem cell or progenitor cell properties, i.e. are pluripotent or multipotent, which can be hard or impossible to ascertain. For a detailed explanation of terminology and an overview of current stem cell research, see Kempermann (2008), Neue Zellen braucht der Mensch: Die Stammzellforschung und die Revolution der Medizin.

[40] Dekel, Burakova, et al. (2003), "Human and porcine early kidney precursors as a new source for transplantation", Nature Medicine, **9**.

[41] Angioi, Hatier, et al. (2002), "Xenografted Human Whole Embryonic and Fetal Entoblastic Organs Develop and Become Functional Adult-Like Micro-Organs", Journal Of Surgical Research, **102**.

[42] Taylor, Cowin, et al. (2006), "Formation of human prostate tissue from embryonic stem cells", Nature Methods, **3**(3).

[43] Robert-Koch-Institut (2004), "7. Genehmigung nach dem Stammzellgesetz (erteilt am 21.10.2004)", Register genehmigter Anträge nach §11 Stammzellengesetz.

implantation of dopamine-producing human neural precursor cells obtained from human embryonic stem cells in fetal rats' brains (for this part of the project, done by Oliver Brüstle, see p. 16), and implantation of similar human cells into marmoset monkeys' brains which have been manipulated to mimic Parkinson's.[44] A somewhat sensational report[45] on these experiments (describing them as injection of human embryonic stem cells, while actually only differentiated cells were transplanted, and mentioning the startled and appalled reaction of the president of the "Nationaler Ethikrat" to these allegations) was vehemently disputed by the MPIbpc.[46] The institution's assertion that only blastocysts fused with alien cells lead to chimerism while the experiments discussed were "just transplantations"[47] is not without controversy: common definitions of "chimera" would include the creatures created in the MPIbpc experiments (cf. section C below).

Researchers also make use of chimeras to test stem cell-based therapies for diabetes – one U.S. research team based in San Diego derived a cell type from human embryonic stem cells that was capable of synthesizing pancreatic hormones, such as insulin. These insulin-expressing cells were implanted into mice with diabetes and damaged kidneys, leading to improved blood sugar levels – it is suspected that this was caused by the human stem cells integrating into and thereby repairing the mouse kidneys.[48] Similar experiments were carried out by a team of researchers at Tulane University, who used multipotent human stem cells derived from bone marrow which they injected in diabetic mice.[49] Diabetes researchers hope that in the future, cells derived from the patients' own bone marrow could be used to treat diabetes.[50]

Regarding spinal cord injuries (the cause of paraplegia), Cummings, Uchida et al., transplanted human stem cells to the injured portion of a mouse's spinal cord in order to

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[44] See Robert-Koch-Institut (2003), "5. Genehmigung nach dem Stammzellgesetz (erteilt am 27.10.2003)", Register genehmigter Anträge nach §11 Stammzellengesetz.
[45] Traufetter (2005), "Der Mensch im Tier", Der Spiegel, 2005/05/02. On the events that followed the SPIEGEL article, see also Löhr (2005), "Chimären aus dem Labor", die tageszeitung, 2005/05/06.
[46] Max-Planck-Institut für biophysikalische Chemie (MPIbpc) (2005), "Richtigstellung und Stellungnahme - Informationen zum SPIEGEL-Artikel 'Der Mensch im Tier' und zur dpa-Meldung 'Nationaler Ethikrat will sich mit Chimären-Experimenten befassen'."
[47] "Bei den genannten Versuchen handelt es sich keineswegs um die Generierung von Chimären, sondern lediglich um eine Transplantation. Chimären sind Organismen, deren Gewebe nach der Injektion von undifferenzierten Stammzellen in den frühen Embryo (Blastocyste) aus unterschiedlichem Erbgut zusammengesetzt sind." - Ibid., p. 2.
[48] D'Amour, Bang, et al. (2006), "Production of pancreatic hormone-expressing endocrine cells from human embryonic stem cells", Nature Biotechnology, **24**.
[49] Lee, Seo, et al. (2006), "Multipotent stromal cells from human marrow home to and promote repair of pancreatic islets and renal glomeruli in diabetic NOD/ scid mice", Proceedings of the National Academy of Sciences, **103**(46).
[50] BBC News (2006), "Stem cell cure hope for diabetes", 2006/11/12.

"repair" it in 2004. The transplanted material apparently differentiated and survived, and an improvement of the animal's ability to climb along a horizontal ladder could be observed.[51]

Stem Cells Inc., a company that contributed to this research, and its leading scientist Irving Weissman, were also involved in a project researching the integration of human neural stem cells in the ischemic (post-stroke) brain of rats; the ultimate aim of the investigations was the question whether the transplantation of human stem cells into patients' brains could be a therapeutic option for stroke in the future.[52]

Transplantation of human stem cells in adult animals' brains is not only done in mice, but also in primates: Yale psychiatrist Eugene Redmond hopes to contribute to finding a cure to Parkinson's by carrying out transplantations of human neural stem cells in adult African green monkeys' brains.[53] The stem cells are hoped to morph into dopamine-producing cells when implanted at the right place. Dopamine is a substance that Parkinson's-affected brains lack, and the procedure apparently leads to an improvement of Parkinsonism in animals.[54] Just like Mansouri's experiments, Weissman's and Redmond's neural stem- or precursor cell xenograft experiments have been discussed in the media[55] and were ethically controversial enough to trigger a general interest of ethics' commissions regarding the topic of chimera research.[56]

*b. Human-to-animal chimeras (embryonic or fetal recipient)*

Many chimera experiments described so far involve only "discrete functions and organs" of the (adult) host, as Robert and Baylis put it.[57] Such "old school" chimeras are basically just animals with a few human cells or humans with a few animal cells (even if these few cells are in the brain). When compared to the introduction of differentiated somatic cells, using human progenitor or stem cells as transplantation material leaves a much bigger margin for unforeseen reactions and interactions of the introduced cells. And as biotechnology

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[51] Cummings, Uchida, et al. (2005), Human neural stem cells differentiate and promote locomotor recovery in spinal cord-injured mice", Proceedings of the National Academy of Sciences, **102** (39).
[52] Kelly, Bliss, et al. (2004), "Transplanted human fetal neural stem cells survive, migrate, and differentiate in ischemic rat cerebral cortex", Proceedings of the National Academy of Sciences, **101**(32).
[53] For coverage of Redmond's experiments, see Bearden (2005a), "Extendend Interview: Eugene Redmond", Online NewsHour - A NewsHour with Jim Lehrer Transcript; Shreeve (2005), "The Other Stem-Cell Debate", The New York Times Magazine, 2005/04/10.
[54] For background information on Redmond's approach, see Redmond (2002), "Cellular Replacement Therapy for Parkinson's Disease: Where We Are Today?" The Neuroscientist, **8**(5).
[55] See e.g. Bearden (2005b), "Extendend Interview: Irving Weissman", Online NewsHour - A NewsHour with Jim Lehrer Transcript; Shreeve (2005), "The Other Stem-Cell Debate", The New York Times Magazine, 2005/04/10; Traufetter (2005), "Der Mensch im Tier", Der Spiegel, 2005/05/02.
[56] Greene, Schill, et al. (2005), "The Working Group on the Criteria for Cell-Based Therapies, John Hopkins University: Moral Issues of Human-Non-Human Primate Neural Grafting", Science, **309**; Nationaler Ethikrat (2005), "Wortprotokoll - Niederschrift über den öffentlichen Teil der Sitzung am 25. August 2005", p. 7.
[57] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 1.

develops over the years, even more intricate (and less controllable) mixtures are within reach. When alien cells or materials are introduced in a host organism that is not adult and differentiated, but still in early developmental stages itself – e.g. fetal, embryonic, zygote or even gamete –, the integration and influence of alien cells or materials on the novel organism brings pronounced uncertainties. The earlier alien materials are implanted, the bigger and harder to predict the potential consequences for the developing organism.[58] This point is particularly applicable in regard to pluripotent cells (i.e. some types of stem cells) that have the ability to differentiate into basically all kinds of cells.

Experiments where human cells were introduced in animal recipients in the fetal stage include Evan Snyder's 2001 project at Harvard University. Snyder's team implanted human neural stem cells into the brain of fetal bonnet monkeys. The scientists waited until the monkeys' cerebral cortex was developed and then carried out a histological examination of the fetal animals: the human cells had widely migrated, survived and integrated to great extent.[59] This experiment improved the prognosis for success of gene therapy or cell-substitution approaches via neural stem cell transplantation to the brain of large nonhuman primates or – as the ultimate goal – humans.

German stem cell pioneer Oliver Brüstle, working at the MPIbpc's project on differentiation of human embryonic stem cells and xenografts of dopamine-producing precursor cells into marmoset monkeys, and his colleague Ahmed Mansouri, obtained a licence for transplantation of human neural progenitor cells in fetal rat brains in 2003.[60]

In another experiment utilizing fetal chimeras, Esmail Zanjani of the University of Nevada and his research group implanted human hematopoietic stem cells, extracted from bone marrow or cord blood, in fetal sheep, during the stage of development where the immune system of the fetuses had not yet developed. This resulted in adult sheep whose livers contained up to 20% human cells.[61] While Zanjani was initially just interested in gene therapy of genetically defective (human) fetuses, he soon discovered that using animals to

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[58] Greely (2003), "Defining Chimeras…and Chimeric Concerns", American Journal of Bioethics, **3**(3), p. 18.
[59] Ourednik, Ourednik, et al. (2001), "Segregation of human neural stem cells in the developing primate forebrain", Science, **293**; Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 1.
[60] Robert-Koch-Institut (2003), "5. Genehmigung nach dem Stammzellgesetz (erteilt am 27.10.2003)", Register genehmigter Anträge nach §11 Stammzellengesetz; Nationaler Ethikrat (2005), "Wortprotokoll - Niederschrift über den öffentlichen Teil der Sitzung am 25. August 2005", p. 7.
[61] Almeida-Porada, Porada, et al. (2004), "Formation of human hepatocytes by human hematopoietic stem cells in sheep", Blood, **104**(8).

grow human organs or tissues for transplantation might be very promising.[62] Zanjani's group also did similar work on the heart.[63]

Using even less developed recipients, scientists have transplanted human cells into animal embryos. Brüstle, Choudari and Karram, for example, created rats with chimeric brains by transplanting fetal human neural progenitor cells into embryonic rats in 1998.[64] This resulted in extensive integration of the human progenitor cells in the rats' brains, which were killed and examined after one to seven weeks, but not – as opposed to the behavioural transfer in the quail-chick chimeras described on p. 11 – in change of behaviour.[65] For researchers, it is highly interesting to see how human neural cells migrate and develop in a living organ, that is, an animal brain, and how they respond to the multiple developmental cues they are given by the host brain in order to be integrated in the cell structure. In a similar experiment, scientists of the University of Jerusalem implanted human embryonic stem cells in chick embryos in 2002, summing up:

> *"Our results show that human ES cells transplanted in ovo survive, divide, differentiate, and integrate with host tissues and that the host embryonic environment may modulate their differentiation. The chick embryo, therefore, may serve as an accessible and unique experimental system for the study of in vivo development of human ES cells."*[66]

In 2005, Fred H. Gage from the Salk Institute in La Jolla, California and Japanese collaborators injected 100000 human embryonic stem cells into the brain of 14-day-old mouse embryos. These chimeras were brought to term and contamination with genetically human neurons in the brains of the resulting mice amounted to 0.1%. Using patch clamping, it was shown that the human neurons inside the mouse brain were actually firing, which can be regarded as proof for (at least limited) function, rather than mere survival, of the neurons.[67] Apart from hopefully furthering fundamental knowledge of human neural development, the experiments are thought to contribute to the future creation of chimera

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62 Pagán Westphal (2003), "'Humanised' organs can be grown in animals", The New Scientist, 2003/12/17.
63 Airey, Almeida-Porada, et al. (2004), "Human Mesenchymal Stem Cells Form Purkinje Fibers in Fetal Sheep Heart", Circulation, **109**.
64 Brüstle, Choudhary, et al. (1998), "Chimeric brains generated by intraventricular transplantation of fetal human brain cells into embryonic rats", Nature Biotechnology, **16**.
65 Greene, Schill, et al. (2005), "The Working Group on the Criteria for Cell-Based Therapies, John Hopkins University: Moral Issues of Human-Non-Human Primate Neural Grafting", Science, **309**, p. 386.
66 Goldstein, Drukker, et al. (2002), "Integration and differentiation of human embryonic stem cells transplanted to the chick embryo", Developmental Dynamics, **225**.
67 Muotri, Nakashima, et al. (2005), "Development of functional human embryonic stem cell-derived neurons in mouse brain", Proceedings of the National Academy of Sciences, **102**.

models for emulating human neurodegenerative and psychiatric diseases and for assessing the effectiveness of new drugs. Gage's work gained a lot of publicity.[68]

Similarly to Fred Gage, Irving Weissman is a scientist whose actual experiments, as well as possible research scenarios, have stirred up a lot of discussion. Involved in the research of the human lymphoid and hematopoietic system, Weissman helped develop the "SCID-hu mouse" in the 1980s (see p. 5). Experiments that were much more challenging from the bioethicist's standpoint were proposed by Weissman some years ago (but never actually implemented). Because of the apparent ethical import of the experiments he was considering, Weissman contacted Henry Greely of Stanford University Law School in order to find out whether what he was planning could be done ethically. Weissman's scenarios were discussed in 2002 by a working group assembled by Greely, resulting in a report analysing the ethical implications and possible problems of such research. The report remained unpublished, yet Weissman's research plans and the results of the working group were summed up (and updated) in an American Journal of Bioethics target article in 2007.[69] According to this source, Irving Weissman was confronted with the finding of human "brain stem cells" and their successful isolation from human fetuses. At this point, it must have seemed to be a tantalizing prospect to create a mouse model that could accommodate a human neuronal system (or even just some living human neurons): just as the SCID-hu model offers new possibilities of doing research on the immune system, such a "human neuron mouse" would enable research on living, in vivo human neurons that could otherwise not be done. Additionally, in 2003, it had been shown that human brain stem cells can survive, migrate and even connect in the (SCID) mouse brain.[70] So Weissman devised two setups that would go even further. In one scenario, he was planning to use a mouse strain whose cerebellum neurons had the propensity to die off some weeks after birth. The cerebellum is the part of the brain which is otherwise responsible for movement and coordination. Accordingly, the deficient mice show symptoms that closely resemble those of human patients who suffer from Friedrich's Ataxia, i.e. severe motor deficits. Shortly before the expected death of the mouse cerebellum neurons, Weissman would implant human brain stem cells (from aborted human fetuses) into this part of the

[68] Editors of the American Journal Of Bioethics (2005), "Of Mice and Men", Bioethics.net Blog 2005/12/13; Spiegel Online (2005), "Mausgehirn: Menschliche Stammzellen werden zu Neuronen", 2005/12/14; The New York Times (2005), "Trace of Human Stem Cells Put in Unborn Mice Brains", 2005/12/13; Weiss (2005), "Human Brain Cells Are Grown In Mice", Washington Post, 2005/12/13.
[69] Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5).
[70] Tamaki, Eckert, et al. (2002), "Engraftment of sorted/expanded human central nervous system stem cells from fetal brain", Journal of Neuroscience Research, **69**.

mouse brain. By looking at the ensuing cerebellum activity, Weissman would then be able to see whether the implanted (human) cells actually functioned in the mouse brain (in this case, the ataxia symptoms of the mice would disappear or be alleviated). The experiment has not been done yet because the mouse strain proved unfit for this specific use.

A second proposed scenario would have made use of an even more deficient strain of mice, in which all neurons die off already during embryonic development. These missing cells would then be substituted by human neurons from brain stem cells. This model would allow for a functioning formation of human neurons on an animal organism substrate (analogously to the SCID-hu mouse which models the human immune system in a mouse organism). Such a model, Weissman hopes, could not only be used for studying the behaviour of brain stem cells, human neurons in general or human neurodegenerative diseases, but also, in the long run, for drug testing regarding agents' influence on living human neurons in an organism (which can hardly be done today because of ethical boundaries regarding experimentation in humans). This experiment has also not been carried out because, so far, a mouse strain with complete neuronal death could not been found. It remains unclear whether Weissman will return to trying to conduct these experiments in the future.[71] The second setup sounds particularly spectacular, but it would be inaccurate to call the resulting chimera a "mouse with a human brain". This is for two reasons: firstly, the brain does not only consist of neurons, but also of Glia cells, the structural cells of the brain which are a necessary substrate for the neurons. Glia cells would remain murine in Weissman's experiment and constitute up to 50% of the brain mass. Secondly, what makes a brain "human" is not the origin of the neurons in it, but rather the way they are assembled, i.e. their architecture. As long as a brain has a clearly murine architecture, in theory, it is not humanized and human attributes will not emerge. There is some scientific agreement regarding this architecture hypothesis, although it has, as Greely et al. point out, "not been tested."[72] But even if we remain sceptical regarding the attribute "human", it is clearly not true that Weissman's "takeover" mouse would have a "100% human" brain, as Jeremy Rifkin claimed in a 2005 article.[73]

Another chimera experiment involving embryonic animal recipients raised eyebrows in 2006: Ali Brinvalou at New York Rockefeller University implanted human embryonic stem cells into mouse blastocysts (i.e. mouse embryos at a very early stage of development,

[71] Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5), p. 32.
[72] Ibid., p. 35.
[73] Rifkin (2005), "Are you a man or a mouse?" Guardian, 2005/03/15.

before the usual time of implantation). Brinvalou's team then went a step further and proceeded to implant the chimeric human-mouse blastocyst into the uterus of a mouse in order to test the pluripotency of stem cell lines, which is hard to ascertain otherwise (human blastocysts cannot be used for this "test" for ethical reasons). Brinvalou and his colleagues stated that "Embryonic chimeras generated in this way offer the opportunity to study the behavior of specialized human cell types in a nonhuman animal model."[74] Brivanlou's plans for "human-mouse embryos" received attention and criticism even well before they were actually created. The New York Times' Jamie Shreeve pointed out what he called the "gonad quandary". This problem, he mused, could arise when implanting human stem cells at early stages of development and then letting the resulting adult chimeras breed:

> *"If the experiment really works, the human cells should differentiate into all of the embryo's cell lineages, including the one that eventually forms the animal's reproductive cells. If the mouse were male, some of its sperm might thus be human, and if it were female, some of its eggs might be human eggs. If two such creatures were to mate, there would be a chance that a human embryo could be conceived and begin to grow in a mouse uterus – a sort of Stuart Little scenario, but in reverse and not so cute."*[75]

Brinvalou's plans had also met opposition in a 2002 forum of stem cell researchers, not only because of some scepticism concerning the transferability of results gathered in murine blastocysts to human environments, but also because of general concerns about the "ethical complexity" of such experiments. Some of Brinvalou's colleagues feared that the human-murine embryo would "provoke public disquiet, and could galvanize political opposition to all research involving human embryos."[76]

Recent successes in the field of chimera research have fired the imagination of the public. The visions evoked by Gage's, Weissman's, Brivanlou's and others' experiments are hardly ever utopian. Considering the rapid and complex developments of science regarding interspecies mixtures, some believe that scientists will soon be able and willing to create truly "humanized" chimeras. Such creatures could, hypothetically, be produced with similar methods as the "geep", e.g. by fusing a human and a chimpanzee embryo – which could result in "humanzees" or "chumans", chimeric mixtures of human and chimpanzee. The perceived threat of the "humanized chimera" motivated government advisor and biotech

[74] James, Noggle, et al. (2006), "Contribution of human embryonic stem cells to mouse blastocysts", Developmental Biology, **295**.
[75] Shreeve (2005), "The Other Stem-Cell Debate", The New York Times Magazine, 2005/04/10.
[76] DeWitt (2002), "Biologists Divided over Proposals to create human-mouse embryos", Nature, **420**.

critic Jeremy Rifkin and Stuart Newman, a cell biologist, to file two patent applications for "chimeric embryos and animals containing human cells" in 1997.[77] Rifkin and Newman wanted to keep scientists from creating any kind of mammal-human chimera by not giving out any licenses.[78] Both patents, one covering chimeric mixtures with primates, such as the "humanzee", the other regarding mixtures of human material with other animals, such as the alleged "human-brained mice", were turned down in August 2004 – U.S. law forbids the patenting of anything human, and the proposed patents would have resulted in something "too human", in this sense.[79] Though Rifkin hopes that, now that his applications have been turned down, the apparent lack of patentability will keep stem cell researchers from creating human-animal chimeras,[80] current developments seem to prove him wrong. On the other hand, the degree of humanization Rifkin fears[81] as a consequence of chimera research is nowhere near realistic today: there are no "mice who think like human beings", no mice who beget human beings, no "ideal laboratory research animals" in the form of "humanzees". Contrary to Rifkin's assertions, such scenarios still *are* Science Fiction today – albeit fiction that, some argue, has a chance of becoming reality in our lifetime unless we soon take care of installing rigorous regulation preventing such scenarios.

## 5. Animal-to-human chimeras

The novel creatures we have looked at so far were characterized by an animal recipient or host into whom human material was artificially introduced. Scientists have also done the reverse, namely introducing genetically nonhuman material, sometimes whole animal organs, into the human organism.

The prospect of using animal organs for substitution of defective human organs is quite promising, since it could solve (or at least reduce) the problem of organ scarcity and thereby prevent many deaths. Unfortunately, researchers of organ xenotransplantation have encountered severe difficulties in the last century. To begin with, immune rejection, which is the central problem of all transplantation ventures, is much stronger when using organs of alien species. Rejection of interspecies transplants cannot be controlled by the

[77] Newman (2002), "The Human Chimera Patent Initiative", Medical Ethics Newsletter (Lahey Clinic), **9**(4).
[78] Bailey (2003), "Shimmering Chimeras - Moving sheepishly toward the biotech future", Reason Magazine, 2003/12/24.
[79] Kittredge (2005), "A Question of Chimeras", The Scientist, **19**(7); Lamb (2005), "A Mix of Mice and Men", Christian Science Monitor, 2005/03/23.
[80] Kittredge (2005), "A Question of Chimeras", The Scientist, **19**(7).
[81] Rifkin (2005), "Are you a man or a mouse?" Guardian, 2005/03/15.

immunosuppressive means used in (human) allotransplants, but using stronger immunosuppression creates intolerable, fatal complications.[82] Another problem is the differing anatomy, size and functionality of animal organs. Although pigs are somewhat anatomically similar to humans, it is not clear whether organs such as the lung could accommodate to the vertical positioning of their human host over long periods of time; also, porcine tissue may react differently to hormones and other substances within the human body in the long term.

Apart from these problems of compatibility, introducing animal organs or tissues into humans increases the risk of zoonoses, i.e. infectious diseases that are transmitted from animals to humans. Some of the most dangerous diseases in humans result from infectious agents mutating and crossing over the species lines, under circumstances of close contact with infected animals – and introducing animal organs or tissue into immunosuppressed human organisms is probably the closest kind of "contact" imaginable. While most microorganisms can be eradicated from the source pigs, porcine endogenous retroviruses (PERVs) are apparently impossible to completely eliminate so far and could result in tumours and immune deficiency in the human host after transplantation.[83] (The potential risks of xenotransplantation will be further discussed in chapter 2, section C.3 below).

Despite the numerous problems it has to face until today, xenotransplantation has a long (and quite interesting) history – for more than a hundred years, the prospect of using animal material to help diseased humans has fascinated researchers.[84] Solid organ xenotransplantation in modern clinical settings dates back to Princeteau, who transplanted parts of rabbit kidneys in a girl in 1905;[85] and to Ernst Unger, who used a monkey kidney for implantation in 1909.[86] Keith Reemtsma's projects of the 1960s,[87] due to advances in immunosuppression techniques, were the starting point for more promising attempts at xenotransplantation. In 1963, he transplanted chimpanzee kidneys into humans – all but one of the fourteen recipients died within two months, one survived for 9 months. A

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[82] Hammer and Thein (2003),"Xenotransplantation: Medizinische und ethische Fragen", p. 294, in: Oduncu, Schroth, et al. (eds.) Transplantation: Organgewinnung und -allokation.
[83] Denner (2002), "Fortschritte und Risiken bei der Xenotransplantation - Stellungnahme der GfV in Bezug auf Chancen und Risiken der Xenotransplantation."
[84] For introductions to the history of xenotransplantation, see: Reemtsma (1995), "Xenotransplantation: A Historical Perspective", Institute of Laboratory Animal Research Journal **37**(1); Deschamps, FA, et al. (2005), "History of Xenotransplantation", Xenotransplantation, **12**(2).
[85] Princeteau (1905), "Greffe rénale", Journal Medicine de Bordeaux, **26**.
[86] Unger (1910), "Nierentransplantationen", Klinische Wochenschrift, **47**.
[87] Reemtsma, McCracken, et al. (1964), "Heterotransplantation of the kidney: two clinical experiences", Science, **143**; Reemtsma (1969), "Renal heterotransplantation from nonhuman primates to man", Annals of the New York Academy of Sciences, **162**.

human recipient of a chimpanzee heart lived for two hours after transplantation in 1964. In 1984, Bailey succeeded in transplanting a baboon's heart into a newborn ("Baby Fae" lived for three weeks).[88] In 1992, Starzl and colleagues used baboon livers,[89] but the experiments were not very successful, just as Makowka's transplantations of pig liver and heart.[90] Generally speaking, whole organ xenotransplantation, which has been tried over 100 times with diverse organs,[91] has not been successful so far. Because of severe incompatibility problems, whole organ xenotransplantation will probably not catch on until organs can be sufficiently "humanized" via tissue engineering, transgenesis or chimerism.

Transplantation of animal cells and cell clusters (i.e. non-vasculated tissues), on the other hand, has been more successful. Animal (especially frog) skin grafts have been used as temporary adhesive and flexible covering of burn wounds for hundreds of years.[92] Since the 1960s, porcine skin xenografts were a common skin substitute for burn victims.[93] Pig and cow heart valves have been successfully used beginning with Binet's experiments in 1965,[94] resulting in what is today a standard procedure for replacing defective human valves. The animal valves are rendered biologically inert before implantation by a chemical tanning and fixation process and thus do not contain living cells. The same is true for porcine skin xenografts: they are basically dead tissue and are not vasculated during the healing process.[95] Note that therefore, a human being with a bioprosthetic heart valve, just as a burn victim whose wounds are dressed with porcine xenografts, would not qualify as an animal-to-human chimera under definitions of "chimera" that require the use of *live* alien material.

Other methods of xenotransfer did not stand the test of time. In the 1930s, it became therapeutic fashion to introduce live animal cells into the human body in order to generate effects of "revitalisation" – usually understood as pertaining to sexual function. Most famously among these early "endocrinotherapists" became Serge Voronoff, a Russian

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88 Bailey, Nehlsen-Cannarella, et al. (1985), "Baboon-to-human cardiac xenotransplantation in a neonate", Journal of the American Medical Association, **254**.
89 Starzl, Marchioro, et al. (1964), "Renal heterotransplantation from baboon to man: experience with six cases", Transplantation, **2**.
90 Makowka, Cramer, et al. (1995), "The use of a pig liver xenograft for temporary support of a patient with fulminant hepatic failure", Transplantation **59**.
91 Hammer and Thein (2003),"Xenotransplantation: Medizinische und ethische Fragen", p. 300, in: Oduncu, Schroth, et al. (eds.) Transplantation: Organgewinnung und -allokation.
92 Hattermann (2003), "Risikoabschätzung von porzinen Circoviren in Bezug auf die Xenotransplantation", Fachbereich Veterinärmedizin, p. 14.
93 Demling and DeSanti (2005), "Managing the Burn Wound: Use of Skin Substitutes", Managing the Burn Wound.
94 Binet, Duran, et al. (1965), "Heterologous aortic valve transplantation", Lancet, **2**.
95 Demling and DeSanti (2005), "Managing the Burn Wound: Use of Skin Substitutes", Managing the Burn Wound.

working in Paris, who specialized in testicle grafts from chimpanzees and baboons to men, and of ape ovaries to women. He allegedly performed these procedures in 2000 patients.[96] Voronoff's work seems to have brought "relative success" in some patients – apparently the glands did not trigger massive immune reactions. Still, Voronoff lost all scientific and public reputation. The method of a certain Paul Niehans, who worked in Germany until well into the 1950s, was similarly unconventional: he injected crushed animal cells (usually from the thymus glands of lambs) to "rejuvenate" his patients. More than 30 of them died from severe immune reactions instead.[97] "Revitalisation" therapies involving gland xenografts and injection of live animal cells were never scientifically recognized and systematically studied; it remains unclear whether they ever resulted in animal-to-human chimeras with live animal cells integrating into the human organism.

A more modern, scientifically legitimate use of animal cells for therapeutic means is the external use of pig livers as temporary substitute for a failing human organ, i.e. "extracorporeal xenogeneic liver perfusion", which was first introduced in the 1960s. Today, scientists are testing transgenic porcine livers for perfusion applications, which apparently can work as a successful interim solution before allotransplantation.[98] Again, this technique would commonly not be considered to result in "chimerism" because alien material is not introduced into the body itself. The same applies to the extracorporeal use of bioreactors containing pig cells which are connected to patients with liver failure as temporary substitutes ("bioartificial liver devices" or BAL).[99]

There are some instances of successful transplants of animal tissue that actually lead to live animal-to-human chimerism in the patient. To give some examples from the 90s, scientists have used clusters of fetal porcine islet-like cells in diabetes therapy.[100] Pig cells have survived and produced insulin in the human organism for astounding periods of time, in one documented case, for 9.5 years.[101] Injections of fetal pig neural cells have been used to treat neurodegenerative diseases like Parkinson's and Huntington's – though the treatments

[96] Deschamps, FA, et al. (2005), "History of Xenotransplantation", Xenotransplantation, **12**(2), p. 95.
[97] Kempermann (2008), Neue Zellen braucht der Mensch: Die Stammzellforschung und die Revolution der Medizin, p. 37.
[98] Deschamps, FA, et al. (2005), "History of Xenotransplantation", Xenotransplantation, **12**(2), p. 100.
[99] Allen, Hassanein, et al. (2001), "Advances in Bioartificial Liver Devices", Hepatology, **34**(3).
[100] Andersson, Groth, et al. (1992), "Transplantation of porcine fetal islet-like cell clusters to three diabetic patients", Transplantation Proceedings, **24**.
[101] Elliott, Escobar, et al. (2007), "Live encapsulated porcine islets from a type 1 diabetic patient 9.5 yr after xenotransplantation", Xenotransplantation, **14**(157).

have not turned out to be very successful, alien neural cells survived in the host for prolonged periods of time.[102]

As we can see, animal-to-human chimeras are created exclusively in the adult recipient variety – this is because under most legislation, human embryos and fetuses cannot be subject to chimerism-inducing procedures. Induction of animal-to-human chimerism in adults suffering from degenerative diseases is evidently less controversial. This is not only because the introduction of animal material is justified by medical indications (as opposed to mere "experimentation"), but also because integrated xenografts in adult human recipients only affect discrete functions, rather than spreading within the body, which could be the consequence of xenografting during early stages of human development.

Xenotransplantation is currently at a crossroads. Its possibilities have fascinated researchers for almost one hundred years, yet it has never yielded mainstream applications. The use of animal tissues, maybe even whole solid organs, will probably increase and become more common once transgenesis and tissue engineering techniques are fully developed and animal materials can be manipulated in order to better adapt to transplantation purposes. As mentioned on page 16 above, researchers are already trying to grow biologically human organs in (chimeric) animals.[103] This seems like a promising outlook for transplantation medicine – another possible route is genetic manipulation of animal organs. Specialists of the field estimate that 2010 will see the first promising trials of transplantation of transgenic pig hearts into humans in the U.S.[104] "Humanization" of animal organs by means of genetic engineering is another branch of science where the line between human and nonhuman species is crossed by artificial means; I will look at transgenic "humanized" animals in the next section.

## 6. Transgenesis

Advances in genetic engineering have enabled scientists not only to interfere with the genetic information of a given species or individual (by "gene splicing") but also to transfer genetic information from one species to another (transgenesis).

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[102] Deacon, Schumacher, et al. (1997), "Histological evidence of fetal pig neural cell survival after transplantation into a patient with Parkinson's Disease", Nature Medicine, **3**; Jacoby, Lindberg, et al. (1997), "Fetal pig neural cells as a restorative therapy for neurodegenerative disease", Artificial Organs, **21**(11); Fink, Schumacher, et al. (2000), "Porcine xenografts in Parkinson's disease and Huntington's disease patients: preliminary results", Cell Transplant, **9**(2).

[103] Cf. e.g.: Almeida-Porada, Porada, et al. (2004), "Formation of human hepatocytes by human hematopoietic stem cells in sheep", Blood, **104**(8).

[104] Glasmacher (2008), "Wann kann einem Menschen das erste Schweineherz transplantiert werden? Bericht vom 11. Minisymposium Xenotransplantation", idw online, 2008/06/06.

One technique that is commonly used in order to test methods of gene transfer is to introduce certain easily recognizable genes ("reporter genes") into mammals' gene sequences. Gerald Schatten and his team, for example, created the rhesus monkey "ANDi" in 2001.[105] ANDi (the acronym stands for "inserted DNA" read backwards) was manipulated in order to contain the fluorescent protein of a jellyfish (GFP), which results in a green glow of the animal under special lighting. Korean scientists created GFP transgenic pigs in 2006.[106] By using reporter genes like the GFP gene, scientists can make sure the transgenic organism actually expresses the introduced alien information, in preparation for introducing genes that have a more relevant effect (i.e., genes that cause disease). Another possible use of the GFP method could be in stem cell research, because fluorescent stem cells could be much more easily observed and tracked. Transgenesis experimentation is not limited to medical research: in 2000, Chicago artist Eduardo Kac had French scientists manipulate an albino rabbit ("Alba") in order to contain GFP, pronouncing this successful experiment and the ensuing public interest in the animal a "transgenic art project".[107]

*a. Human-to-animal transgenesis*

Transgenesis is also used to create human-animal interspecifics. One example for such transgenic human-animal interspecifics are animals that "model" or emulate specific human diseases. A relatively advanced way of bringing animal organisms to mimic a human disease is that of introducing certain genetic information – e.g., the gene(s) which triggers a certain disease in humans, or the gene(s) which make an organism susceptible to a certain virus – into animals' organisms in order to study the disease more closely and to be able to test possible therapies. Today, thousands of mouse models of human diseases are available – mice which are or become, by genetic disposition, immunodeficient, cancer-infested, above or below average size, naked, obese, sclerotic, diabetic or have chronic hypertension, cystic fibrosis or deficiencies regarding the production of a certain enzyme or hormone.[108] Often, these dispositions have been created by introducing human-typical genes into the mouse

[105] Chan, Chong, et al. (2001), "Transgenic Monkeys Produced by Retroviral Gene Transfer into Mature Oocytes", Science, **291**(5502).
[106] Hogg (2006), "Taiwan breeds green-glowing pigs", BBC News, 2006/01/12.
[107] Kac (2003), "GFP Bunny", Leonardo, **36**(2).
[108] Petters and Sommer (2000), "Transgenic animals as models for human disease", Transgenic Research, **9**(4-5); Herman (2002), "Mouse Models of Human Disease", Institute of Laboratory Animal Research Journal **43**(2).

organism. Usually this is done by using DNA microinjection or homologous recombination in embryonic stem cells.[109]

*b. Animal-to-human transgenesis*

The technology enabling scientists to create transgenic animals could be used to modify the genetic setup of human beings, as well. This is what scientists at Cornell University did in 2007: Zev Rosenwaks and his colleagues introduced GFP marker genes into a human blastocyst in order to find out whether the gene would spread over all the developing cells. And, in fact, all the newly developed cells in the embryo glowed.[110] The experiment was carried out on a non-viable embryo with a severe chromosomal deficiency, which was left to develop for only three days. Still, Rosenwaks' research stirred up controversy and was seen as an attempt to introduce "designer babies".[111] The "species-crossing" quality of his manipulation was apparently not seen as the main problem.

Apart from exceptions like Rosenwaks' experiments, transgenesis in human embryos is not a common field of research for scientists (and illegal in many countries). In an exploratory article, Oxford ethicist Julian Savulescu describes some scenarios in which introduction of animal genetic sequences into human genetic code, in his opinion, might not only be justified, but even advisable:

> *"Imagine that scientists discover that some species are resistant to HIV infection and that resistance is genetically encoded. Imagine that it becomes possible to introduce these gene sequences into the human genome in order to confer resistance to HIV. While this is speculative, it is not absurd."*[112]

Savulescu describes similar scenarios not only aimed at defeating diseases, but also concerning "enhancement" of human properties: e.g. transferring animal genes that lead to a longer life span, improved night vision or even to the emergence of new sensory abilities, such as sonar, in human beings.[113] It is unclear whether any of these scenarios will ever be within the bounds of scientific possibility; apart from this restriction, discussion of the moral advisability and implications of such plans would probably concentrate on the

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[109] Petters and Sommer (2000), "Transgenic animals as models for human disease", Transgenic Research, **9**(4-5), p. 347.
[110] Zaninovica, Haoa, et al. (2007), "Genetic modification of preimplantation embryos and embryonic stem cells (ESC) by recombinant lentiviral vectors: efficient and stable method for creating transgenic embryos and ESC", Fertility and Sterility, **88**(Supplement 1).
[111] Pollack (2008), "Engineering by Scientists on Embryo Stirs Criticism", The New York Times, 2008/05/13.
[112] Savulescu (2003), "Human-Animal Transgenesis and Chimeras Might Be an Expression of Our Humanity", American Journal of Bioethics, **3**(3), p. 22.
[113] Ibid., p. 23.

question under which circumstances enhancement of human beings is morally advisable, and, above all, whether intrusion into the human germ line (which seems, at least under current conditions, to be an irreversible step) is such a good idea, in the first place. Confronted with these issues, the problem of the "species-crossing" quality of transgenic humans would probably take a back seat with bioethicists.

*c. Massive human-animal transgenesis*

Genetic manipulation across species can involve more than single genes – in the human-to-animal direction, for example, mice have been created that contain almost a complete copy of the human chromosome 21.[114] Critics of genetic manipulation fear that a massive introduction of human genes into animals or vice versa could lead to the scenario Sagoff describes in somewhat sensational tones:

> *"(…) a mad geneticist could produce a transgenic embryo, implant it in a surrogate mother, and bring to term a Caliban that is neither clearly animal nor clearly human."*[115]

Though Sagoff vehemently dismisses this as "too incredible for any but the most lurid cinema",[116] it is not an entirely invalid concern. Joshua Lederberg, geneticist and Nobel Prize laureate, noted as early as 1966 that "organisms whose karyotype is augmented by fragments of the human chromosome set", i.e. human-animal transgenic beings, might be more of an issue in future science than human cloning.[117] Lederberg's prognosis of the likely creation of "subhuman", human-animal beings by scientists was never realized, but the problem of "massive humanization" is still recognized as one. A report of the Academy of Medical Sciences in the UK, issued in 2007, pointed out that

> *"(…) it will be necessary to consider the appropriate conceptual and regulatory framework for transgenic and chimeric animals that contain significant amounts of human genetic material."*[118]

The image of a being that is a seamless fusion of human and animal, i.e. in which human and animal components fade into each other so much that one cannot say where one starts

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[114] DeWitt (2007), "Animal-human chimeras: Summary of UK Academy of Medical Sciences Report", Nature Reports Stem Cells, **67**.
[115] Sagoff (2003), "Transgenic Chimeras", American Journal of Bioethics, **3**(3).
[116] Ibid.
[117] Lederberg (1966), "Experimental Genetics and Human Evolution", American Naturalist, **100**, p. 531.
[118] Academy of Medical Sciences (2007), "Inter-species embryos - A report by the Academy of Medical Sciences".

and the other ends, is powerful and iconic; maybe even more potent than that of the characteristically motley chimera found in the art of almost all ages and cultures.

Artist Patricia Piccinini has used such imagery in her work for the Australian pavilion at the Venice Biennale 2002 ("We are Family").[119] Among other exhibits, one especially striking live-sized sculpture titled "The Young Family" depicts a mother-creature – an eerily hyperrealistic mixture of human and pig – which idyllically suckles three demonstrably cute, pinkish human-pig babies (see Picture 4).

*Picture 4: Patricia Piccinini, "The Young Family", sculpture created for Venice Biennale 2003*

Piccinini's sculptures are evidently not realistic portrayals of what is done in today's genetics labs, but they tap deeply into the dream-like images terms like "transgenesis" conjure up in our minds. Current biotechnology has inspired Piccinini since the beginning of the 90s (when she worked on what she called "The Mutant Genome Project"); the catalogue essay accompanying the "human pig family" duly identifies Piccinini's creations as "transgenic".[120]

The ethical implications of "humanizing" animals (or "animalizing" humans) will be discussed later. The degree up to which transgenesis could actually lead to animals exhibiting human properties (or vice versa) remains unknown. Although popular culture sees genetic engineering as a singularly powerful, near-magical device – re-shuffling species seemingly without difficulty, with the help of all-determining, easily transferred genes – the reality of transgenic beings, as exemplified by the scenarios I described above, is considerably less flashy.

[119] Piccinini (2003), "We are Family", Sculpture in The Young Family, Australia Pavilion for Venice Biennale 2003.
[120] Michael (2003), "We Are Family (Catalogue Essay)."

The important point to take from this section is that not only chimerism but also transgenesis can cause creatures to stand between species lines. Transgenic animals like the ones described in this chapter are "interspecific" in the sense that their organisms express not only their own species-typical DNA, but also DNA that is typical for alien species. Mark Sagoff uses the term "chimera" in a somewhat confusing way when calling transgenic mice – such as the "Harvard OncoMouse", a mouse strain that contains a human-typical cancer-gene[121] –"transgenic chimeras" and implying they are "just [mice] with a few human cells."[122] Transgenic animals like the OncoMouse, "ANDi", or "Alba" are not chimeric, that is to say they do not contain "genetically human" cells, at all. Rather, they express one or several human-typical gene sequences in all or some of their cells.

## 7. Human-animal hybrids

We have, so far, looked at interspecifics that are a human-animal mixture on the cellular level (chimeras) and on the genetic level (transgenic organisms). But an interspecific mixture can also take place on a level that is, one could say, relatively "natural": on the level of egg and sperm (gametes).

A mixture of this kind between humans and animals is conceivable – even without highly complex means of contemporary biotech – regarding closely related species, i.e. other primates like chimpanzees, gorillas or orang-utans.

It is a little-known fact that the renowned Russian biologist and artificial insemination specialist Ilya Ivanov tried, with great effort and many supporters, to create human-ape-hybrids in the 1920s.[123] In a mission to Africa, supported by the Russian government, the Academy of Science and the Institut Pasteur in Paris, Ivanov went about this strange project by artificially fertilizing chimpanzee females with human sperm – without success, but this could just as well be due to the fact that the conditions under which the inseminations were carried out were quite adverse and that thus, in effect, no more than three attempts at artificial insemination were undertaken.[124] Back in Russia, Ivanov even tried to realise long-held plans for inseminating woman volunteers with orang-utan sperm

[121] For an example of this effect of transgenesis, see Leder, Kuo, et al. (1990), "v-Ha-ras transgene abrogates the initiation step in mouse skin tumorigenesis: effects of phorbol esters and retinoic acid", Proceedings of the National Academy of Sciences, **97**.
[122] Sagoff (2003), "Transgenic Chimeras", American Journal of Bioethics, **3**(3).
[123] For an extensive discussion of Ivanov's hybridisation experiments and their political, historical and social significance, see Rossiianov (2002), "Beyond Species: Il'ya Ivanov and His Experiments on Cross-Breeding Humans with Anthropoid Apes", Science in Context, **15**(02).
[124] Ibid., p. 297f.

– attempts to inseminate African women (without their knowledge and consent) had, fortunately, not worked out. Since Ivanov fell from grace with the Bolsheviks and ended up in a gulag, such experiments never took place.

Ivanov's curiosity concerning human-ape hybrids was not an isolated case: several biologists of his time wanted to try human-animal hybridization, mainly because of a strong interest in discovering human and other primates' phylogeny. Rossiianov, in his meticulously researched article on Ivanov's crossbreeding experiment, mentions Hermann Moens and Oscar Hermann Rohleder in this context.[125] Others locate the budding scientific interest in human-nonhuman primate hybridization in 19th century France, and cite, among others, Jean-Jacques Rousseau as advocating such experiments.[126] As late as 1971, Charles Remington, a Professor of Biology at Yale University, advocated and predicted human-primate hybridisation experiments, even working out a detailed plan on the raising of a human-chimpanzee hybrid in a primate laboratory,[127] noting dryly that "[t]he experiment's human interest value is too obvious to deserve much justification."[128]

Popular culture, from the 19th century on, seems to be obsessed with the topos of the human-ape hybrid: Gustave Flaubert wrote about Djalioh, product of a slave girl and an orang-utan, in 1837.[129] And fascination with human-ape hybrids remains vivid until today: Wikipedia contributors currently list more than a dozen examples of "human-ape hybrids" in contemporary culture,[130] from "Planet of the Apes" (1968) to Michael Crichton's novel "Next" (2006) – featuring the uncanny human-chimpanzee-hybrid "Dave" who, clean-shaven and well-behaved, certainly has come a long way from Flaubert's infanticidal, rapist Djalioh.

Scientific and popular fascination notwithstanding, the existence of a real human/nonhuman-primate hybrid has never been verified. Although recently, scientists have brought forward the hypothesis that hybridisation between early human and

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125 Moens and Bernelot (1908), Truth: Experimental Researches about the Descent of Man; Rohleder (1918), Künstliche Zeugung und Anthropogenie.
126 Böhme (2002),"Monster im Schatten der Aufklärung", in: Raulff (ed.) Mensch und Tier. Eine paradoxe Beziehung.
127 Remington (1971),"An Experimental Study of Man's Genetic Relationship to Great Apes, By Means of Interspecific Hybridization", in Katz (ed.): Experimentation with Human Beings.
128 Remington apparently did not see any special ethical or legal problems concerning human-chimpanzee hybrids - they are to be treated just like "any other experimental mammals", not ruling out experimentation and "sacrifice for study"; Remington assumes that "contribution of one-half of the genetical material by *Homo*" would not constitute "legal humanness." Ibid., pp. 463-464.
129 Flaubert (1980),"Quidquid volueris (1837)", in: Jugendwerke. Erste Erzählungen. Aus dem Französischen von Trautgott König. For a discussion, see Böhme (2002),"Monster im Schatten der Aufklärung", in: Raulff (ed.): Mensch und Tier. Eine paradoxe Beziehung.
130 Wikipedia contributors (2008b), "Humanzee - Popular Culture", http://en.wikipedia.org/wiki/Humanzee#Popular_culture.

chimpanzee individuals was an important part of the speciesation process of *Homo sapiens*,[131] it remains unclear whether a hybridisation between modern homo-sapiens and other nonhuman primate could ever result in viable offspring.[132]

What about hybridisation of humans with non-primate animals? It is indisputable that such a mixture could not be arrived at by "natural" reproduction or the relatively low-tech means of artificial insemination, i.e. by a simple mixing of human and nonhuman gametes. There is one example that is, so to speak, on the brink of human-non-primate hybridisation: the "Hamster Test", a screening tool in reproductive medicine. In a "Sperm Penetration Assay", (SPA) human sperm fertility is tested on hamster ova.[133] The sperm quality is assumed to be sufficient if the sperm succeeds in permeating the hamster egg. If this does not work, this indicates that the sperm donor might be infertile. The resulting human-hamster hybrid embryo does not proceed beyond the two cell stage,[134] some state that "fertilization" does not even take place.[135]

Generally speaking, the less closely two species are related, the less likely it is that hybridisation between their gametes works. This definitely rules out that "simple" hybrids between humans and non-primates could develop into viable organisms. Additionally, there are no scientific reasons (excluding simple curiosity) that would make generating an (embryonic) hybrid between human and nonhuman appear sensible. This might change, though – as the 2007 report by the UK Academy of Medical Sciences points out, "given the speed of this field of research, the emergence of scientifically valid reasons in the future cannot be ruled out" and further, "the reasons for banning the creation of hybrid embryos for in vitro experimental use (…) are not clear to us (…)."[136] Abstract and tentative interest

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131 Patterson, Richter, et al. (2006), "Genetic evidence for complex speciation of humans and chimpanzees", Nature, **441**.

132 One of the few expert opinions I could find regarding this somewhat unpopular question is by Michael Schwibbe of the German Center for Primate Resesarch, Göttingen, who stated that human-ape hybridisation is "conceivable" - ("Es ist denkbar, dass Mensch und Schimpanse gemeinsame Nachfahren zeugen können", sagt der Wissenschaftler, "denn genetisch gesehen ist die Distanz zwischen Esel und Pferd größer als zwischen Mensch und Großem Menschenaffen." Horaczek (2007), "Ein Affe will Rechte", Die Zeit, 2007/03/01.)

133 Kremer and Jager (1990), "The significance of the zona-free hamster oocyte test for the evaluation of male fertility." Fertility and Sterility, **54**(3).

134 Morriss (1998), "Blurred Boundaries", Inquiry, **40**, p. 259.

135, Petersen, et al. (undated), "Hamster Egg Penetration Test" (Patient Information Leaflet of the Utah Center for Reproductive Medicine). The leaflet states that "The human sperm does not fertilize the hamster eggs."

136 The authors of the AMS Report here point out what they regard as an inconsistency: the creation of other human-animal embryonic mixtures, such as "cybrids", transgenic, and chimeric embryos, is permitted in the UK, while true hybrid embryos are expressly banned. The Academy of Medical Sciences (2007), "Inter-species embryos - A report by the Academy of Medical Sciences", pp. 28, 38.

in human-animal hybrid embryos notwithstanding, the creation of fully grown "humanzees" certainly seems not to be what is at issue at the moment.

## 8. Human-animal cybrids

*a. Technicalities and motives*

Modern biotechnology offers new possibilities, and new motives, for creating human-animal mixtures. Since there is a growing demand for human embryonic stem cells, scientists are trying to find ways of easily obtaining such cells, or cell types with similar properties. An ideal stem cell source would be one that does not rely on human embryos or gametes which are hard to get hold of, and whose use can cause ethical concern. One alternative could be that of "reverting" human cells to embryonic cells by transferring a human cell nucleus to the enucleated egg of an animal. This technique – somatic nuclear transfer – is better known as "cloning": the creators of Dolly the sheep transferred the nucleus of an adult sheep cell into an enucleated sheep ovum which was reimplanted and brought to term. The clone has exactly the same genetic setup as the donor from whom the nucleus has been obtained. The enucleated cell only keeps some of its DNA in its mitochondriae (i.e. organelles that serve as "cellular power plant"). When this method is used on egg and nucleus of differing species, the resulting entity is called "nucleo-cytoplasmic hybrid" or "cybrid", for short.

Even among experts, there are differing views on how "cybrids" should be classified. Although they do not stem from different zygotes, some experts classify them as chimeras because they exhibit a "genetic mix" of differing mitochondrial and nuclear DNA.[137] Journalists often refer to them simply as "hybrid embryos". At the opening conference of CHIMBRIDS (an EU project on chimeras and other interspecifics), one expert declared cybrids "hybrids" while another classified them as "chimeras".[138] Cybrids are certainly not "true" hybrids, since their production does not involve the fusion of gametes of different species – hybrids are usually understood as products of sexual procreation.[139] As a matter of accuracy, cybrids created of human nuclei and animal eggs should be regarded as interspecifics *sui generis*.

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[137] Jens Reich: "Auch das sind Chimären, und zwar, genetisch gesehen, mindestens wegen des Mitochondrienbesatzes. (…) Man beobachtet dabei einen zwischenartlichen Chimärismus." Nationaler Ethikrat (2005), "Wortprotokoll - Niederschrift über den öffentlichen Teil der Sitzung am 25. August 2005", p. 6.

[138] Weschka (2006), "Protocol of the CHIMBRIDS Opening Conference on 11/12 March 2006", p. 2.

[139] Jens Reich: "Der Hybrid ist ein einheitliches Lebewesen und er ist geschlechtlich entstanden, gezeugt worden."- see Nationaler Ethikrat (2005), "Wortprotokoll - Niederschrift über den öffentlichen Teil der Sitzung am 25. August 2005", p. 4.

The history of cybrid creation began in 1996, when Jose Cibelli and colleagues tried to apply the somatic nuclear transfer technique to cow eggs and human nuclei. The team claimed to have created cybrids, but the success of this experiment is doubted.[140] Some years later, a team of Chinese scientists led by Hui Zhen Sheng successfully employed the same approach to fuse human somatic nuclei with enucleated rabbit eggs.[141] As expected, the resulting embryos' DNA is predominantly human; with the exception of DNA which stems from the rabbit egg's mitochondriae. Resulting incompatibilities notably diminish the potential of this cybrid to grow into a viable organism – it remains unclear whether human-animal hybrids could, in theory, ever develop into an adult creature.[142] For the experiments at issue, this question is irrelevant, since the created cells are not expected to survive after the blastocyst stage. At that point, the inner cell mass of the embryo is removed to harvest the resulting nuclear transfer embryonic stem cells, or rather "stem-like" cells which are hoped to have the same (pluripotent) properties as stem cells created without the involvement of somatic cells. The Sheng group showed that the harvested "stem-like" cells are indeed capable of differentiation and self-renewal.[143]

*b. Cybrids in the UK*

From the perspective of bioethics, the question of human-animal cybrids was (alongside with Weissman's proposals) one of the most important condensation seeds of debate. The renewed bioethical interest in cybrids and interspecifics in general was triggered by the plans of several UK researchers to create human-animal cybrids. Lyle Armstrong of Newcastle University wanted to use cow eggs to develop stem cells for the treatment of diabetes and spinal paralysis; Stephen Minger, of King's College London, had plans to use human-cow cybrids to study degenerative neurological diseases, i.e. Parkinson's and Alzheimer's.[144] Chris Shaw of the Institute of Psychiatry, London, said he would need human-animal cybrids to study motor neuron disease. All three applied to the British

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[140] McGee (1998), "Could the embryo be a new species?" Bioethics on MSNBC, 1998/11/13; Wade (1998), "Researchers Claim Embryonic Cell Mix Of Human and Cow", The New York Times, 1998/11/12; Weiss (2003), "Cloning Yields Human-Rabbit Hybrid Embryo", Washington Post, 2003/08/14.

[141] Dennis (2002), "Stem cells rise in the East", Nature, **419**; Chen, He, et al. (2003), "Embryonic stem cells generated by nuclear transfer of human somatic nuclei into rabbit oocytes", Cell Research, **13**(4); Weiss (2003), "Cloning Yields Human-Rabbit Hybrid Embryo", Washington Post, 2003/08/14; Cnn.com (2006), "Scientists seek Rabbit-Human Embryo", 2006/01/13; Highfield (2006), "Stem cell researchers plan to create rabbit-human embryos", news.telegraph.co.uk, 2006/02/13.

[142] For example, András Dinnyés, a Hungarian scientist working on the method of nuclear transfer in animal reproduction, stated that "the basic question whether a rabbit-human nuclear transfer embryo could develop into a human being remains unsolved." Weschka (2006), "Protocol of the CHIMBRIDS Opening Conference on 11/12 March 2006", p. 3.

[143] Chen, He, et al. (2003), "Embryonic stem cells generated by nuclear transfer of human somatic nuclei into rabbit oocytes", Cell Research, **13**(4), p. 263.

[144] Batty (2007), "Hybrid embryos get go-ahead", Guardian, 2007/05/17.

institution responsible for issuing licenses for research involving human embryos, the Human Fertilisation and Embryology Authority (HFEA) in November 2006.

A month later, a government white paper proposal was revealed which stood in clear opposition to the researchers' plans. This draft would have outlawed all kinds of interspecific beings in the UK.[145] Many scientists and patient organisations united in protest against these plans.[146]

The HFEA decided that before granting any licenses, a general licensing policy on creation of human-animal interspecifics should be agreed upon – a three-month process of public consultation followed. It was found that although initially most people were opposed to all interspecific beings, after some information and debate, a considerable majority of participants were in favour of creating cybrids. A quarter of the participants remained opposed to this type of research (scepticism remained much higher regarding chimeric embryos and true hybrids).[147]

A report of the House of Commons Science and Technology Committee opposed general legislative prohibition of cybrids and demanded "a greater role for the regulator within a broad permissive framework set out by the parliament" (Phil Willis, MP). The committee was also in favour of a free vote on the issue of interspecific research regulation.[148]

In a complete reversal from their previous position, the UK government issued a new, permissive draft bill in May 2007. This would allow for transgenesis, the creation of chimeras and cybrids involving human material, as long as the entities created would be destroyed after 14 days, and as long as no true human-animal hybrids were created.[149] Several ministers were opposed to this new bill – they were particularly critical of cybrid creation.[150] In September 2007, the HFEA announced that their consultation had not found fundamental arguments against cybrid experiments, and that specific committees would now look at the three license applications. Public reaction was immediate, worldwide, and mostly negative: e.g. several German church officials and politicians denounced the UK cybrid plans.[151]

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[145] Department of Health (2006), "Review of the Human Fertilisation and Embryology Act: proposals for revised legislation (including establishment of the Regulatory Authority for Tissue and Embryos)".
[146] Janositz and Lüdemann (2007), "Britische Chimären", Tagesspiegel, 2007/09/06.
[147] HFEA (2007), "Hybrids and Chimeras - A report on the findings of the consultation."
[148] Kahn (2007), "Leave UK hybrid embryo decisions to experts: panel", reuters.com, 2007/07/31.
[149] Department of Health (2007), "Human Tissues and Embryo (Draft) Bill."
[150] Hinsliff (2008), "Brown faces deepening revolt over embryo bill", The Observer, 2008/03/23.
[151] Die Welt (2007), "Die Mensch-Tier-Embryonen bleiben umstritten", 2007/09/07.

In January 2008, Lyle Armstrong of Newcastle University and Stephen Minger from King's College were granted HFEA licenses for the creation of cybrids, even before the House of Commons had decided on the government's proposal. [152] The Newcastle team announced the successful creation of human-cow cybrids in April 2008.[153]

In May 2008, a strong majority of the House of Commons, in a free vote, decided in favour of the new permissive embryo bill, against criticism from several ministers and the Catholic Church.[154]

At the time of writing (July 2008), the HFEA has granted another one year license to scientists at Warwick Medical School who plan to create human-pig cybrid embryos in order to obtain stem cells which are then supposed to be differentiated into heart cells if the experiment works out as planned. To improve the cybrid procedure, the researchers around Justin St. John are planning to destroy all remaining (mitrochondrial) pig DNA in the cybrids: the resulting cells are supposed to be "the world's first human stem cells from embryos that are part human and part animal."[155] Removal of the mitochondrial pig DNA is supposed to improve the functions of the resulting cells. The ultimate goal is to create a human stem cell line with which to study cardiomyopathy (heart muscle disease).

What is particularly remarkable about the cybrid debate is that these entities seem extremely hard to grasp for laymen and even scientists. As we have seen, cytoplasmic hybrids defy old-fashioned modes of classification as "chimera" or "hybrid", but also unambiguous categorization as "human" or "nonhuman". They are also hard to grasp in a simpler sense: the entities involved are not accessible and well-known objects like human or animal bodies, but rather elusive, tiny microscopic cells. As John Burn, the head of the human genetics institute at Newcastle University put it, "We're talking about something that looks like sago under the microscope."[156] Maybe this elusiveness made the debate around cybrids so fervent and fruitful: as objects that are not easily imaginable, cybrids are the perfect blank screen on which intuitions about "human-animal mixing" in general can be projected. And so, one side comes up with comparisons like "sago" – implying that the mere idea of restricting such research could only have roots in silly, unjustified superstitions and myths – while the other side imagines something rather like Patricia Piccinini's human-animal abominations, or Frankensteinian procedures carried out on

[152] HFEA (2008), "HFEA Statement on licensing of applications to carry out research using human-animal cytoplasmic hybrid embryos."
[153] Spiegel Online (2008), "Forscher schaffen Hybrid-Embryo aus Mensch und Kuh", 2008/04/02.
[154] Koydl (2008), "Alles bleibt möglich", Süddeutsche Zeitung, 2008/05/21.
[155] Sample (2008), "Hybrid embryos: UK team plans stem cell first", Guardian, 2008/07/01.
[156] Batty (2007), "Hybrid embryos get go-ahead", Guardian, 2007/05/17.

babies, and is understandably up in arms. The intuitions of both sides clash violently and lead to the impression that compromise is impossible. After some consideration it seems that neither of these projections does justice to what is actually happening when cybrids are created. What we can learn from the debate around cybrids in the UK is that stepping back from knee-jerk reactions and analysing what, exactly, it is that makes us oppose (or welcome) the creation of interspecific beings is a necessary step when trying to find consensus on future policies regarding their creation: regarding interspecific beings, things are often not what they seem at first glance.

To come back to the original intent of this chapter, let us once more look at the precise definition of "chimeras" and other interspecific beings, which is the first stepping stone for any serious debate.

## C. Definitions

As we have seen, the concept of "chimera" in biology is a plurivalent and complex one. There is no one authoritative definition of what "chimera" means in biology or bioethics. Let us, therefore, have a look at several approaches at defining chimeras before deciding on how to proceed.

Aiming at an all-encompassing taxonomy of chimeras, Henry Greely offers an extremely wide definition of chimeras. Under his definition, a chimera is "a single biological entity that is composed of a mixing of materials from two or more different organisms."[157] This is a suitable formulation for Greely's purpose (namely, giving a very wide taxonomy of interspecifics), but for a fixation of the meaning of "chimera" in bioethics, it seems too wide: after all, any animal (or human) that is a product of sexual reproduction would have to count as a chimera in that sense.

Jens Reich, in an introductory presentation on the subject of chimeras to the "Nationaler Ethikrat", gives a more restricted definition of chimeras as organisms that consist of genetically differing parts.[158] This would rule out organisms which consist of genetically identical parts (i.e. of cells which carry the same genetic fingerprint), and thereby not count usual outcomes of sexual reproduction. Reich's classical definition highlights the puzzle-like

[157] Greely (2003), "Defining Chimeras…and Chimeric Concerns", American Journal of Bioethics, **3**(3).
[158] Nationaler Ethikrat (2005), "Wortprotokoll - Niederschrift über den öffentlichen Teil der Sitzung am 25. August 2005", p. 3. In German, this passage reads: "Die biologische Definition von Chimäre besagt, dass es sich dabei um einen Organismus handelt, der aus unterschiedlichen Zellen oder Geweben oder Organen zusammengesetzt ist, unterschiedlich vor allen Dingen in ihrer genetischen Zusammensetzung."

quality of chimeric organisms on cell-level. Reich adds that chimeric organisms somehow stem from two source organisms, specifically, that chimeric organisms are "tetragametic": their DNA stems from four gametes, i.e. from two zygotes (fertilized eggs). Thus, a standard, general definition of chimera can be given as: "Animal that has two or more different populations of genetically distinct cells that originated in different zygotes."[159]

Some further qualifications or refinements seem advisable when defining "chimera". Firstly, as we have seen above, the hosts used for chimera research are not necessarily complete organisms. It seems advisable to describe the objects involved as "organisms and biological entities", since chimera production starts at the point of fused zygotes or other pre-organismal entities (e.g. cybrids).

Secondly, it might be advisable to restrict the definition of "chimera" to organisms which consist of genetically differing material which is alive. Greely mentions the example of the "man with the wooden leg".[160] When human beings with heart-valve implants of bovine or porcine origin are described as "chimeras", this is misleading: heart-valve implants are biologically dead, and their hosts are not animal-to-human chimeras, just as a man with a wooden prosthesis is not an oak-to-human chimera.

In a similar vein, it is questionable whether the use of extracorporeal bioreactors filled with porcine cells or extracorporeal xenoperfusion with animal organs (see p. 24) constitute instances of animal-to-human chimerism. A key factor of chimerism seems to be the mutual contact and influence of differing sets of cells. Extracorporeal bioprosthetics' mutual contact with the human organism and resulting feedback effects are very limited. In order not to blur the concept of chimera, it seems suitable to exclude extracorporeal and dead material that is brought in contact with the host from constituting chimerism.

Another problematic point that I already mentioned above is that of "transgenic chimerism". I would not find it advisable to subsume transgenic organisms under the concept of "chimera", even if they express DNA that is usually found in other species: such organisms do not exhibit the puzzle-like quality that is typical for chimeras, but are homogenous. The term "chimeric DNA", on the other hand, may be useful for describing genetic material that consists of sequences taken from different organisms.[161]

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[159] Wikipedia contributors (2008a), "Chimera (genetics)", http://en.wikipedia.org/wiki/Chimera_(genetics).
[160] Greely (2003), "Defining Chimeras…and Chimeric Concerns", American Journal of Bioethics, **3**(3), p. 19.
[161] Karpowicz, Cohen, et al. (2004), "It is ethical to transplant human stem cells into nonhuman embryos", Nature Medicine, **10**(4), p. 331.

For the same reason, I think it would not be prudent to describe nucleo-cytoplasmic hybrids ("cybrids", see p. 32) as "chimeras" – if they would develop further, the resulting organisms would not consist of genetically differing sets of cells, but rather of homogenous cells whose origin from differing organisms and even species would only be evident on the inner-cell level.

Many contributors to the bioethical debate tend to restrict their discussion of ethical issues concerning chimeras to human-to-animal embryonic chimeras.[162] It is probably true that these particular creations raise more, and probably also more complex, ethical questions than, e.g., animal-to-animal adult chimeras. However, I will not employ this restricted use of "chimera", because I believe that it implies that chimeras, as such, are ethically problematic. Equalising "chimera" with "organism whose creation is ethically problematic and whose existence poses ethical problems or confusion" is not advisable because it might lead to ethically problematical non-chimeras being overlooked while ethically unproblematic creatures or experiments are scrutinized just because they involve chimerism. While it is unproblematic to limit discussion within a publication to human-to-animal embryonic chimeras and to call them "chimeras" for brevity's sake, it seems not advisable to extend this limited use of the term "chimera" to general discourse. "Chimera", therefore, should not be equated with "ethically problematic artificial being".

Concerning the definition of "chimera", another approach might be not to settle on one authoritative formula, but rather to point out that several definitions are in use. These definitions may differ, depending on the circumstances they are used in. A single, absolute definition seems not advisable to some: firstly, new types of organisms are created over the years. When sticking to traditional definitions of "chimera", one will have a hard time accommodating new types of beings like cybrids, fused embryos or transgenic beings. Secondly, different fields of expertise have differing requirements regarding the concept of "chimera". Karpowicz, Cohen and van der Kooy, commenting on the meaning of "chimera" and "hybrid" in the context of experimental biology, note that

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[162] Cf. Bailey (2003), "Shimmering Chimeras - Moving sheepishly toward the biotech future", Reason Magazine, 2003/12/24; Karpowicz (2003), "In Defense of Stem Cell Chimeras: A Response to 'Crossing Species Boundaries'", American Journal of Bioethics, **3**(3); Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3); Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2), p. 110; Max-Planck-Institut für biophysikalische Chemie (2005), "Richtigstellung und Stellungnahme - Informationen zum SPIEGEL-Artikel 'Der Mensch im Tier' und zur dpa-Meldung 'Nationaler Ethikrat will sich mit Chimären-Experimenten befassen'"; Sherringham (2008), "Mice, Men, and Monsters: Opposition To Chimera Research And The Scope Of Federal Regulation", California Law Review, **96**(765).

> *"For molecular biologists, chimeric DNA refers to sequences derived from two sources and combined into one; for cell biologists, there are nucleocytoplasmic hybrids involving somatic cell nuclear transfers (cloning) within or between species; for embryonologists, chimeras are prenatal combinations of cells derived from different zygotes, either intraspecies or interspecies; for geneticists, there are interspecies genetic hybrids such as the mule; and finally, there are interspecies xenografts of tissue into postnatal hosts."*[163]

We can see that the terms "chimera", "chimeric" and "hybrid" are sometimes used to denote not only creatures that are literal "chimeras", corresponding to the textbook definition given above, but to all kinds of biological entities that are a "mix" in the widest sense. When I use the term chimera, this will be in the – quite restrictive and biologically exact – meaning:

> ***Chimera*** *(Def.): Biological entity composed of genetically distinct living cellular material stemming from two or more different zygotes.*

This definition does not imply the artificiality of chimeras – it includes not only man-made novel creatures, but also natural occurrences like microchimerism. The definition also includes non-organisms (such as fused zygotes). It excludes some artificial interspecifics, such as cybrids and natural non-chimeric mixtures, such as hybrids, as well as creatures with transgenic ("chimeric") DNA.

Even if we have not yet discussed the specific ethical concerns regarding (some) chimeras and other novel creatures, it already seems quite clear that being a chimera as such does not make any ethical difference whatsoever. As Henry Greely puts it:

> *"As an ethical concern, chimerism per se might itself be 'an unfounded conception.' The fact that something is or isn't a chimera does not in itself raise ethical concerns. A new type of organism might raise concerns (…) whether or not it meets anyone's definition of chimera."*[164]

As I have mentioned above, many types of chimeras are plainly uninteresting for ethicists – take the odd bovine twin chimera or human microchimerism. On the other hand, and this is what Greely hints at, many non-chimeric interspecifics seem to be highly controversial – out of the same or very similar reasons that make some chimeras controversial.

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163 Karpowicz, Cohen, et al. (2004), "It is ethical to transplant human stem cells into nonhuman embryos", Nature Medicine, **10**(4).
164 Greely (2003), "Defining Chimeras…and Chimeric Concerns", American Journal of Bioethics, **3**(3), pp. 19,20.

My further discussion will, therefore, usually not focus on "chimeras" or other tightly defined types of interspecies mixtures such as cybrids or transgenic beings, but rather refer to "interspecifics", defined as follows:

> ***Interspecific*** *(Def.): any organism or living biological entity which is the product of mixing of species, including but not limited to products of inter-species chimerism (as a result of embryonic injection, mixing, xenografting or xenotransplantation), products of inter-species transgenesis, products of inter-species hybridisation (sexual procreation between animals of different species), and inter-species nucleo-cytoplasmic hybrids ("cybrids").*

Usually, the interspecifics at issue in the bioethical context will be between human and nonhuman species (i.e. human-animal interspecifics). Similarly inclusive concepts are used, e.g., by David Castle, who also employs the term "human-nonhuman interspecifics (HNHIs)"[165] and by Jason Scott Robert, who refers to "part-human entities".[166]

In chapter 2 below I will spell out what types of ethical concerns are or could be caused by the creation or existence of chimeras and other interspecifics. At this point, it should become much clearer what kinds of interspecifics could be ethically problematic, in what sense, and why. Before this discussion of ethical implications, let me give a very short overview of the legal situation of chimera and other interspecific research involving human material.

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[165] Castle (2003), "Hopes against Hopeful Monsters", American Journal of Bioethics, **3**(3).
[166] Robert (2006), "The science and ethics of making part-human chimeras in stem cell biology", Journal of the Federation of American Societies for Experimental Biology, **20** p. 839.

## D. Excursus: Legal situation of human-animal interspecific research

A short overview of the regulatory situation regarding research with human-animal chimeras and other mixtures seems to be advisable for two reasons: firstly, the regulatory conditions surrounding this research influence what happens in research labs, determine where interspecific research will flourish or deteriorate, and what conditions researchers face concerning funding, licensing procedures and legal risks, and thereby helps us to gain deeper understanding of the situation of chimeric/interspecific research around the world which I presented in the previous sections. Secondly, an overview of the regulatory background and political positions on the subject indicates commonly held public or political attitudes towards interspecific research, which will be interesting in respect to chapter 2 below.

The legal and regulatory situation of human-animal interspecific research is closely tied to that of research with human stem cells, particularly human embryonic stem cells (hESC), since most chimeric/hybrid/cybrid research today involves the use of such materials – many instances of modern human-animal chimera research can be regarded as special cases of stem cell research. The status of hESC research is unclear in most countries: an international legislation database of the International Society for Stem Cell Research (ISSCR) lists policies, legislation and pending legislation regarding hESC research around the world, and shows that most countries do not have any explicit legislation of such research (much less on chimeras or cybrids produced involving hESC or other stem cells), be it restrictive or liberal.[167] There are also frequent changes in stem cell policies at the moment. The regulations that are in place on the national level regarding hESC research and chimeras vary wildly.

This underregulation, frequent change, and underlying discord about stem cell policies explains why there is no international legislation on this topic and much less on that of chimeras: international treaties claim a general "right to life" (e.g. The Universal Declaration of Human Rights, Art. 3), but it remains unclear from what point on human embryos are granted this right. Direct or uncontroversial conclusions in regard to interspecific human-nonhuman experimentation do not follow from a "right to life". Disagreement about the ethical permissibility of hESC (and chimera/cybrid) research is also common within the European Union and its member states. For example, the

[167] ISSCR (2007), "International Legislation on Human Embryonic Stem Cell Research."

European Parliament planned legislation on "Advanced Therapies" in 2007 which was meant to regulate and simplify the central licensing of medication and new therapies, among them hESC and chimera/cybrid-based methods. In the end, controversy concerning questions of authority and discord about ethical considerations led to an exclusion of all embryo related research (i.e. chimera and cybrid research, as well) from this EU regulation.[168] The European Union decided in 2006 to offer funding for stem cell research[169] (contrary to a German initiative for an EU-wide ban on stem cell research). Yet, definitive European legislation on permissibility of hESC research or chimera research seems unlikely to come to pass in the near future, because opinions are divided internationally and even within political camps.

Regarding regulations below the legislative level, there are international guidelines concerning hESC research, issued by the ISSCR (International Society for Stem Cell Research) in 2006.[170] These largely procedural guidelines recommend that "review, approval and ongoing monitoring by a special oversight mechanism" (SCRO – Stem Cell Research Oversight) should be maintained whenever "human totipotent or pluripotent cells" are incorporated into animal chimeras (8.1), and that in this process, "ethical permissibility and justification" should be factored in. At least some adult chimerism experiments would be exempt from this full-scale process (category 1 of the ISSCR guidelines entails "routine and standard research practice" such as assays of human tumour formation in SCID mice, 10.1), while embryonic chimeras would fall under full SCRO procedure (amount, point of introduction of cells, species, and affected organ would have to be considered here). Research that "should not be pursued" under ISSCR guidelines includes the cultivation of manipulated human embryos, or part-human structures with "human organismal potential" past 14 days or until formation of the primitive streak;[171] implantation of animal-human chimeras into an uterus; and breeding of human germline chimeras. The ISSCR guidelines are supposed to be incorporated by journal editors, who should prevent the publication of research that does not meet ISSCR standards. The ISSCR committee forum has also issued a report on "Ethical Standards for Human-to-Animal Chimera Experiments in Stem Cell

[168] Biotechnologie.de (2007), "EU-Parlament: Weg frei für die zentrale Zulassung neuartiger Therapien", 2007/05/22.
[169] Council of the European Union (2006), "Press Release: 2747th Council Meeting Competitiveness - (Internal Market, Industry and Research) - 11554/06 (Presse 215)", p. 7.
[170] ISSCR (2006), "Guidelines for the Conduct of Human Embryonic Stem Cell Research."
[171] This development marks the change from blastocyst stage to gastrulation, where the germ layers are established and the basic building plan of the organism is laid out.

research" which proposes more detailed standards for SCRO committees.[172] It is unclear to what extent scientists do actually follow these non-binding international guidelines or the ethical standards proposed.

Regarding regulation on the national level, in the U.S.A., the potential problematicity of human-animal interspecific research was already addressed by President Bill Clinton, who referred the "troubling" matter of "mingling of human and nonhuman species" to the National Bioethics Advisory Council in 1984.[173] No legislative action was undertaken back then. The U.S. National Academies of Sciences (NAS) issued guidelines for conducting human embryonic stem cell research in 2005,[174] which also include guidance for interspecific research: an additional SCRO review process is required for research involving introduction of hESC into animals. Also, patterns of integration into the animal organism should be closely watched – special attention should be paid to neural chimeras. NAS Guidelines prohibit the introduction of hESC into nonhuman primate blastocysts,[175] the introduction of human and nonhuman hESC into human blastocysts, breeding with human-to-animal chimeras and, finally, the cultivation of human-animal products of hESC research past 14 days/formation of the primitive streak. Although stem cell researchers claim to abide to the NAS guidelines, evidence for this claim is hard to come by.[176] State regulations in the U.S. concerning hESC and chimeric/cybrid research vary. California, for example, has adopted the NAS guidelines as state law. On the federal level, there is hardly any legislation regarding hESC research, although federal funding by the National Institutes of Health is limited to certain types of hESC research – expressly excluding at least some kinds of interspecific research.[177] A federal legislative initiative by four conservative U.S. senators, led by Sam Brownback, was started in 2005 to ban "human chimeras" altogether

[172] Hyun, Taylor, et al. (2007), "ISSCR: Committee Forum - Ethical Standards for Human-to-Animal Chimera Experiments in Stem Cell Research", Cell Stem Cell, **1**(2).
[173] National Bioethics Advisory Council (1998), "Discussion Transcript: President Clinton's Request Re:Embryonic Stem Cells ."
[174] Committee on Guidelines for Human Embryonic Stem Cell Research (2005), "Guidelines for Human Embryonic Stem Cell Research", National Research Council.
[175] Francoise Baylis discusses this specific policy in Baylis and Fenton (2007), "Chimera Research and Stem Cell Therapies for Human Neurodegenerative Disorders", Cambridge Quarterly of Healthcare Ethics, **16**(2).
[176] Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5), p. 30.
[177] National Institutes of Health (2000), "National Institutes of Health Guidelines for Research Using Human Pluripotent Stem Cells", Federal Register, **65**(166), p. 51981. Research that is ineligible for NIH funding includes creation of human-animal hybrids and experiments involving cybrids (III D., E.) as well as " Research in which human pluripotent stem cells are combined with an animal embryo" (III F..), i.e. embryonic chimera creation.

("Human Chimera Prohibition Act").[178] The (unsuccessful) initiative was supported by President Bush, who openly criticized the creation of "animal-human hybrids" in his 2006 State of The Union Address as one of the "most egregious abuses of medical research."[179] A new, similar bill to "prohibit human-animal hybrids" was introduced in November 2007 by Brownback and 13 supporters, among them Republican presidential candidate John McCain.[180] The misleadingly named bill would apparently not only outlaw the creation of human-animal hybrids, but also the creation of cybrids and at least some human-animal chimeras: germline chimeras, nonhumans "with human brains" and, somewhat vaguely, "human embryo[s] into which a non-human cell or cells (or the component parts thereof) have been introduced to render the embryo's membership in the species *Homo sapiens* uncertain."[181]

In other leading research countries, the status of chimera research is under similar public and political scrutiny – in Great Britain, the possible ethical import of human-animal hybridisation was first mentioned in a 1984 report of the committee of Enquiry into Human Fertilisation and Embryology ("Warnock Report"), in the context of the "hamster egg test" mentioned in section B.7 above.[182] HESC research, in general, is allowed in the United Kingdom under quite liberal conditions (i.e. even creation of hESC for research purposes is allowed). As noted above, the Human Fertilisation and Embryology Authority, which is concerned with issuing the necessary licenses for such research, held a public consultation on human-animal chimeras and cybrids in 2007. The consultation's report came to the conclusion that cybrid experimentation could in principle be licensed in cases approved by the HFEA.[183] Three projects involving cybrids by UK researchers have been approved in November 2007, January 2008, and July 2008 respectively.[184] The legislation introduced in May 2008 is quite permissive, allowing for the creation of chimeras, cybrids,

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[178] Congress of the United States of America (2005), "Human Chimera Prohibition Act (S. 659)", Introduced by Sam Brownback; Sherringham (2008), "Mice, Men, and Monsters: Opposition To Chimera Research And The Scope Of Federal Regulation", California Law Review, **96**(765), p. 13ff.

[179] "Tonight I ask you to pass legislation to prohibit the most egregious abuses of medical research: human cloning in all its forms, creating or implanting embryos for experiments, creating human-animal hybrids, and buying, selling, or patenting human embryos. Human life is a gift from our Creator – and that gift should never be discarded, devalued or put up for sale." Bush (2006), "State Of The Union Address By The President."

[180] Congress of the United States of America (2007), "Human-Animal Hybrid Prohibition Act of 2007 (S. 2358)", Introduced by Sam Brownback.

[181] §1131 (1), Ibid.

[182] Warnock (1985), A Question of Life: The Warnock Report, pp. 70,71.

[183] HFEA (2007), "Hybrids and Chimeras - A report on the findings of the consultation."

[184] HFEA (2008), "HFEA Statement on licensing of applications to carry out research using human-animal cytoplasmic hybrid embryos"; Sample (2008), "Hybrid embryos: UK team plans stem cell first", Guardian, 2008/07/01.

and transgenesis using human embryos.[185] What the new UK embryo bill prohibits are true human-animal hybrids and, similarly to NAS guidelines, implantation of manipulated embryos as well as cultivation for longer than a fortnight. All in all, Great Britain seems to remain on a relatively liberal course regarding interspecific research.

This is in contrast to the situation in Germany, where hESC research in general is handled rather restrictively. The Stammzellengesetz of 2002 used the cut-off date of January 1st, 2002 to determine which imported stem cell lines may be used; this legislation was reviewed in 2008, and the cut-off date was moved to May 1st, 2007. The parliamentary debates revealed deeply divided opinions on hESC research, ranging from demands to lift import restrictions to requests that hESC research should be stopped altogether. Accordingly, the future situation regarding chimeric research involving hESC remains quite unclear. The German licensing authority (Zentrale Ethikkommission für Stammzellenforschung, ZES) has, in fact, granted chimera experimentation with non-embryonic human stem cells in the past.[186] German law, while it may be hard on hESC researchers, does not prohibit the creation of embryonic chimeras – as long as the research does not involve the use of a human embryo, or totipotent parts of it, but disparate pluripotent embryonic cells.[187] German law does also, in principle, allow the creation of human-animal cybrids, experts on medical law confirm.[188] The legislative situation in Germany regarding interspecific research can currently be described as open-ended; hESC research as such is the problem dominating public and political discourse. Germany shows remarkably restrictive tendencies in this context compared, e.g., to the U.S. or UK. This indicates that extensive legislative restriction of chimera/cybrid research might be an issue in the future.

Apart from the U.S., the UK and Germany (which I have picked out as examples, since they are especially important research nations), the legislative/regulatory stances countries take regarding hESC and chimera research vary wildly. Some nations have decided to take a

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185 Department of Health (2007), "Human Tissues and Embryo (Draft) Bill."
186 Zentrale Ethikkommission für Stammzellenforschung (2005), "Stellungnahme zur öffentlichen Debatte über die Chimären-Problematik."
187 The German licensing autority ZES has composed an explanatory interpretation of the Embryonenschutzgesetz specifically in regard to stem cell research - see Zentrale Ethikkommission für Stammzellenforschung (2007), "Stellungnahme der Zentralen Ethikkommission zur Stammzellenforschung: Die einfachgesetzliche Lage: Das Embryonenschutzgesetz."
188 Jochen Taupitz on the lawfulness of cybrid creation: "Derartige Experimente seien sogar in Deutschland möglich. Denn das Embryonenschutzgesetz sei in dieser Hinsicht lückenhaft. Es verbiete zwar die Schaffung von Schimären [sic] unter Verwendung von Embryonen unterschiedlicher Arten. Taupitz: 'In diesem Fall handelt es sich aber nicht um Embryonen, sondern um eine Körper- und eine Eizelle.'" Brüning (2007), "Eine Frage der Mischung", Berliner Zeitung, 2007/09/07.

restrictive position regarding the creation of human-animal interspecifics. For example, Australia, which is permissive regarding hESC research, adopted the "Prohibition of Human Cloning for Reproduction and the Regulation of Human Embryo Research Amendment Act" in 2006, which prohibits creating human-nonhuman chimeric and cybrid and hybrid embryos (except for human fertility testing, which can be carried out with a license under strict regulations).[189] The creation of cybrids and chimeric embryos involving human material is also forbidden in Canada, through the Assisted Human Reproduction Act of 2004 and regulations for state funding (which cover all research facilities since there are no private laboratories involved in chimera research in Canada).[190]

Other countries are particularly permissive of stem cell (and interspecific) research: at the forefront of this is China, which allows all kinds of chimera creation and even the introduction of human genetic material into nonhuman embryos.[191] Likewise, South Korea, Japan, and Singapore are relatively supportive of chimera/cybrid creation.[192]

Xenotransplantation, as we have seen, is another possible source of human-animal chimeras. The technique is closely regulated in many countries; the rare clinical trials that take place will usually have to be approved by oversight committees. Since the main problems associated with xenotransplantation are nowadays in the area of medical risk, i.e. tumorigenicity and virus transfer (rather than in the ethical problematicity of "species-crossing"), and also because xenotransplantation is currently not in the focus of research, I will not discuss these regulations in detail here.[193]

Summing up the legal and regulatory situation of chimera and other interspecific research, it has become clear that regulations vary wildly, and that the legal situation is unclear and/or currently changing in many regions. Additionally, as I pointed out, the legal and regulatory situation of *some* chimeric and interspecific research is complicated by their dependence on human embryonic stem cells, whose use in research is subject of public controversy around the world. Irrespective of these varying views on interspecific research

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[189] Government of Australia (2006), "Prohibition of Human Cloning for Reproduction and the Regulation of Human Embryo Research Amendment Act 2006."
[190] Cf. Appendix C 2.4 in HFEA (2007), "Hybrids and Chimeras - A report on the findings of the consultation."
[191] See ISSCR report on legal situations regarding hESC research, http://www.isscr.org/public/regions/country.cfm?CountryID=52.
[192] For an overview of "legislation of countries with a permissive policy towards human embryo research" in regard to chimera and esp. cybrid creation ,see Appendix C 4 in HFEA (2007), "Hybrids and Chimeras - A report on the findings of the consultation."
[193] For an overview of xenotransplant regulation, see "Appendix: International Approaches to Xenotransplantation Regulation" in Toi Te Taiao (2005), " The Cultural, Spiritual and Ethical Aspects of Xenotransplantation: Animal-to-Human Transplantation", pp. 42-44.

and the overlapping controversies of chimeras/cybrids and hESC use, we can conclude from our look at the legal situation that some kinds of interspecific research are more likely to be forbidden than others.

Research that is most likely to raise controversy, and therefore to be regarded or declared as illegal in many countries, includes:

- Creation of *human-animal hybrids* (through fertilisation of human eggs with animal sperm, or animal eggs with human sperm). Human-animal hybridisation is a punishable offense in many legal systems and discouraged by both NAS and ISSCR research guidelines. Objections regarding the creation of "true hybrids" sometimes, but not always, extend to human-animal cybrids.
- Use of *whole human embryos as hosts* for chimera-creation is penalised by several laws, e.g. German Embryonenschutzgesetz, and restrictive U.S. draft bills. Using disparate hESCs in chimera creation is usually regarded as less problematic,
- *Use of hESC* for transfer into animals (while use of adult or somatic stem cells, or non-stem cells, is usually not regarded as extremely problematic)
- *Early transfer*, and
- *Transfer into especially relevant systems*, such as the neural system or gonads, is met with suspicion (cf. NAS guidelines).
- *Transfer into nonhuman primates* is regarded with more scepticism than transfer into not closely related animals, e.g. in the NAS guidelines.
- *Cultivation past two weeks* of cybrids, hybrids or chimerically manipulated human-animal embryos is often prohibited.
- *Implantation* into an animal or human uterus or otherwise *bringing to term* of human-animal interspecifics is regarded as problematic, and forbidden under many legislations/guidelines.
- *Breeding* with human-to-animal interspecific organisms is perceived as problematic.

These gradations in the legal/regulatory judgement of interspecific research should become much clearer once we look at the underlying ethical considerations concerning interspecific research. In the next part, we will therefore analyse the moral reasons and justifications brought forward for prohibition or strong(er) regulation of chimera/cybrid research. As

reflected by legal and other restrictions, many people think that creation of human-animal interspecifics is wrong – but why, exactly?

# Chapter 2: Arguments Against Creating Interspecifics

So far, I have presented the natural occurrence and the artificial creation of chimeras and other interspecifics in a largely descriptive manner, and given a short overview of the legal situation of human-animal interspecific research. In the following sections, I will address the moral arguments that have been brought up regarding the creation of interspecifics, particularly human-animal interspecifics.

I will first give an introduction to the participants of the current debate around chimeras and other interspecifics, i.e. my main sources, in section A below. In the following sections, B, C, and D, I will present several types of arguments that experiments involving or resulting in chimeras and other interspecifics have given or could reasonably give rise to. This part will offer detailed descriptions of arguments against the creation of interspecifics, and a systematic classification of such arguments into different types. This taxonomy will be useful in making the terrain of argumentation against interspecific creation accessible for further analysis. That will be the task of chapter 4, where I will address the question central to this dissertation: Is there an argument that persuasively supports the general position that creating interspecifics (specifically: human-animal-interspecifics) is wrong and should be prohibited?

Before this concluding analysis, chapter 3 will offer an excursus to a closely related area, introducing the concept of "moral status" and discussing the question of the moral relevance of species membership ("Speciesism"); questions which will be relevant for the final analysis and conclusion in chapter 4.

## A. An introduction to the debate: Sources

Who has contributed to the discussion of the ethical problems of creating chimeras, particularly human-animal chimeras or interspecifics, so far?

Many aspects and arguments discussed in chapter 2 of my dissertation are originally based on the American Journal of Bioethics' 2003 Target Article Collection "Crossing Species

Boundaries".[194] Numerous philosophers, bioethicists and scientists responded to Jason Scott Robert's and Francoise Baylis' assessment of the moral quandaries connected with the creation of human-to-animal interspecifics (specifically, human-to-animal embryonic chimeras). "Never", AJOB editor-in-chief Glenn McGee recalls, "has a Target Article collection published in *The American Journal of Bioethics* occasioned as much interest as 'Crossing Species Boundaries.' (…) Dozens more than we were able to publish wrote to suggest articles."[195] This might be because the AJOB chimera issue is one of the first instances of assessing the problem of human-nonhuman interspecifics – subjects that have gone more or less untouched, so far, invite discussion.[196] Secondly, this might be because the subject is deeply interesting and highlights aspects that are crucial for other ethical problems as well. Another selection of articles, this time on a specific form of animal-human chimeras (Weissman's "human neuron mouse" scenario) appeared in 2007, also in the AJOB.[197]

German and other Continental European philosophers have not extensively contributed to the chimera debate so far. There are some exceptions to this rule: Christoph Vallant's "Hybride, Klone und Chimären" (2008) is based on actual new developments regarding the creation of interspecific and other artificial beings, but does not strive for precision regarding biological terminology. Vallant aims for a sweeping analysis of big idea-historical connections rather than the analytical applied ethics approach I follow here. Irrgang, and Orland et al., in their 2005 discussion of posthuman perspectives, focus on and cyborgs or "enhanced" humans and mention the related, in some respects overlapping, field of interspecific beings or "chimeras" only in passing.[198] Eminent moral philosophers Robert

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194 Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3).
195 McGee (2003b), "The Wisdom of Leon The Professional [Ethicist]", American Journal of Bioethics, **3**(3), p. vii.
196 Note that Peter Morriss offered an extensive and in-depth discussion of the human-animal interspecific (or "hybrid") problem already in 1998. The article did not stir much immediate reaction, the time for a "chimera debate" had apparently not yet come. Morriss (1998), "Blurred Boundaries", Inquiry, **40**.
197 Baylis and Robert (2007), "Part-Human Chimeras: Worrying the Facts, Probing the Ethics", American Journal of Bioethics, **7**(5); Cheshire (2007), "The Moral Musings of a Murine Chimera", American Journal of Bioethics, **7**(5); Cohen (2007), "Beyond the Human Neuron Mouse to the NAS Guideline", American Journal of Bioethics, **7**(5); Eberl (2007), "Creating Non-Human Persons: Might It Be Worth the Risk?" American Journal of Bioethics, **7**(5); Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5); Greely, Cho, et al. (2007a), "Response to Open Peer Commentaries on 'Thinking about the Human Neuron Mouse'", American Journal of Bioethics, **7**(5); Lavieri (2007), "The Ethical Mouse: Be Not Like Icarus", American Journal of Bioethics, **7**(5); Rollin (2007), "Of Mice and Men", American Journal of Bioethics, **7**(5); Sagoff (2007), "Further Thoughts About the Human Neuron Mouse", American Journal of Bioethics, **7**(5).
198 Irrgang (2005), Posthumanes Menschsein? Künstliche Intelligenz, Cyberspace, Roboter, Cyborgs und Designer-Menschen - Anthropologie des künstlichen Menschen im 21. Jahrhundert; Orland, Ed. (2005), Artifizielle Körper - Lebendige Technik. Technische Modellierungen des Körpers in historischer Perspektive; Vallant (2008), Hybride, Klone und Chimären. Zur Transzendierung der Körper-, Art- und Gattungsgrenzen.

Spaemann and Julian Nida-Rümelin commented on the UK cybrid decision of 2008. Both apparently think that something is seriously wrong with creating human-animal interspecifics – Nida-Rümelin finds cybrids tolerable when they are just used as substitutes for human eggs, while he declares that the "'production' of human-animal-chimeras" would be a "crime against humanity" [transl. CH].[199] Spaemann speaks of "horrific visions of half-human chimeras" and notes that their creation is "one of the biggest crimes humans can commit, an opting out of Tao which denotes the immemorial frame of humanity" [transl. CH].[200] Apart from these passing remarks, Spaemann's and Nida-Rümelin's discussion of cybrids focuses on the general issue of using human embryos in stem cell research rather than on the specific aspect of mixing of human and nonhuman material.

An Ravelingien's thesis "Pig Tales, Human Chimeras and Man-Made Public Health Hazards" (2006) offers one of the few extensive philosophical academic discussions of the topic of mixing human and nonhuman.[201] While Ravelingien concentrates on the topic of xenotransplantation, some parts of her analysis overlap with the topic of this dissertation – particularly her chapter on human dignity argumentation.[202]

Journalists in the U.S., Great Britain, and Germany have extensively commented and reported on the subject of "interspecifics" in science – another important source for my typology of arguments. Irving Weissman's research plans spurned a first wave of debate around 2005, and the UK cybrid debate triggered an avalanche of journalistic commentary in 2007-2008.

Institutions responsible for bioethical counselling and research are discovering the subject all over the world: Germany's "Nationaler Ethikrat" was given a talk by its member, bioethicist and politician Jens Reich on "the question of cultivation of chimeras" in 2005.[203] Its institutional successor, the "Deutscher Ethikrat", discussed human-animal interspecifics in February 2008.[204] From 2005-2007, the EU funded an international project on "Chimeras and Hybrids in Comparative European and International Research" (CHIMBRIDS) at the Institute for Medical Law in Mannheim. As an interdisciplinary

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[199] Nida-Rümelin (2008), "Neue Sachlichkeit - Über das Ende der Ideologie in der Stammzelldebatte", Cicero, Juli 2008.
[200] Spaemann (2008), "Jedes nach seiner Art", Cicero, (Mai 2008).
[201] Ravelingien (2006), "Pig Tales, Human Chimeras and Man-Made Public Health Hazards. An Ethical Analysis of Xenotransplant Benefits and Risks", Ghent University Faculty of Arts and Philosophy.
[202] See also Ravelingien, Braeckman, et al. (2006), "On the moral status of humanized chimeras and the concept of human dignity", Between the Species, **VI**.
[203] Nationaler Ethikrat (2005), "Wortprotokoll - Niederschrift über den öffentlichen Teil der Sitzung am 25. August 2005."
[204] Florian (2008), "Deutscher Ethikrat tagte erstmals öffentlich", Informationsdienst Wissenschaft, 2008/06/27.

project, one of the aims of CHIMBRIDS was to "enable a close, lasting and sustainable interrelation between the rapid progress in scientific research and basic ethical, philosophical and legal principles."[205] The final report had not been published at the time of writing (October 2008).[206]

The UK entered the debate about questions of interspecific research much earlier with the Warnock Report of 1984; more recently, the Embryology Authority HFEA carried out a public consultation on chimeras/cybrids and connected ethical questions,[207] which was extensively covered by the UK press. The topic of chimeras has probably received most attention in the U.S., culminating in the 2005 NAS guidelines and current legislative initiatives to regulate human chimera/interspecific research, which are backed by presidents and presidential candidates.

Human-animal interspecifics have become a mainstream subject of bioethics debate and public policy both in the U.S. and in Europe. The cultivation of human-animal embryonic chimeras and cybrids has triggered this discussion, but the arguments brought forward, as we will see, are rarely limited to these two particular kinds of interspecifics. Apart from some, very rare, exceptions,[208] commentators argue *against* chimera creation rather than defending it. Below, I have divided up possible objections into three types:[209] firstly, in section B, that of the intrinsic, "bioconservative" type; in section C, we will assess objections based on a fear of possible consequences of chimera production, and thirdly, in section D, indirect consequence-based objections based on the threat of "confusion" which is allegedly the consequence of creating interspecifics.

## B. Intrinsic objections

Intrinsic arguments against creating chimeras are characterized by the implicit or explicit assumption that creating chimeras is wrong *as such*. Arguments of this type will not be brought forward by a consequentialist (i.e. someone who thinks that what makes an action wrong or right is its consequences), but rather by someone who believes in ethical

[205] www.chimbrids.org - Project Summary.
[206] Taupitz and Weschka, Eds. (forthcoming), CHIMBRIDS: Chimeras and hybrids in comparative European and international research – scientific, ethical, philosophical and legal aspects.
[207] HFEA (2007), "Hybrids and Chimeras - A report on the findings of the consultation."
[208] For authors that are not per se opposed to creation of interspecifics, even human-animal interspecifics, see: Morriss (1998), "Blurred Boundaries", Inquiry, **40**; Savulescu (2003), "Human-Animal Transgenesis and Chimeras Might Be an Expression of Our Humanity", American Journal of Bioethics, **3**(3).
[209] My distinction between "intrinsic" objections and objections concerning (bad) consequences is based on Bernard Rollin's typology of concern regarding genetic engineering and biotechnology, see Rollin (2003), "Ethics and Species Integrity", American Journal of Bioethics, **3**(3).

principles as guiding fundamental assumptions for his actions. The adherence or disobedience to the principle determines whether a certain action is morally right or wrong. For understanding and evaluating this kind of argument, we must find out what principles are brought forward against the creation of chimeras and whether they hold up under scrutiny (i.e. whether they are or will be violated by the creation of chimeras, and whether they are consistent).

Intrinsic arguments are, one might think in the first place, absolute arguments: once you have accepted such an objection, you are not going to change your mind just because (empirical) conditions in the world change. To take the example of chimera research: even if it turned out that, by means of painless experimentation on human-animal chimeras, scientists had found a way to cure cancer, a person who has intrinsic arguments against creating chimeras would still be opposed to such experimentation. Likewise, if it turned out that following his principle led to very adverse effects, this could not – in theory – lead to the intrinsic objector changing his mind on the matter. His objection against creating chimeras is not based on expected adverse consequences and he is therefore not fazed by a change in expectation (or actual outcome) regarding the action at hand.

This absolute view of intrinsic objections is doubted by Gregory Kaebnick: an intrinsic claim, he says, is not absolute and unchallengeable by changed expectations or outcomes. Rather than answering ethical questions once and for all from a standpoint that is independent of the world as it is, intrinsic arguments, specifically in bioethics, invoke a kind of "precautionary principle" and move us to adopt a "preservationist attitude".[210] Intrinsic and consequentialist arguments are not as intransigent or unconnected as it seems in the first place. Mary Midgley points out that the two are linked at a crucial point:

> *"Acts that are wrong in themselves can be expected to have bad effects of a particular kind that is not just accidental. Their badness follows from what is wrong in the act itself, so that there is a rational, conceptual link between them and their results."*[211]

Additionally, it can be noted that outlooks are imaginable where both intrinsic and consequentialistic aspects are considered and, only when taken together and balanced against each other, result in a position on a certain subject.

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[210] Kaebnick (2000), "On the Sanctity of Nature", Hastings Center Report, **30**(5), p. 22. I will discuss the idea of a "precautionary principle" in regard to dealing with risk in chapter 2, section C.4 below.
[211] Midgley (2000), "Biotechnology and Monstrosity - Why We Should Pay Attention to the 'Yuk Factor'", Hastings Center Report, **30**(5).

I see a meaningful difference between intrinsic and consequentialistic argumentation mainly in their proponents' different argumentative focus or emphasis. Intrinsic arguments are open appeals to basic values or principles of the opponent or combatant. The empirical questions at hand are, in this type of argumentation, often taken for granted or not too closely considered. Consequentialistic arguments, on the other hand, give more attention to empirical questions (i.e.: "What will the consequences of the action really be?"). Yet, they also rely on basic principles – often in the form of a utilitarian approach – which are usually not discussed. Intrinsic and consequentialist argumentation overlap and, ultimately, can complement each other.

I do not want to give a general assessment of different types of ethical arguments or metaethical positions in this thesis. A question that should interest us more is: how convincing are the intrinsic arguments that are used to prove the wrongness of creating interspecifics? I have identified four approaches to why creating interspecifics could be intrinsically wrong. Some apply only to the mixing of human and animal, be it in the form of chimerism or hybridisation; others might, in theory, be applied to all kinds of artificial chimeras (even in plants). Firstly, let us have a look at arguments from "repugnance" or, more general, arguments from an intuitively negative emotional reaction to interspecifics.

## 1. Repugnance, the "Yuk Factor", and arguments from emotion

*a. Leon Kass' "Wisdom of Repugnance"*

The first kind of intrinsic argument that has attracted the interest of bioethicists is the so-called "Wisdom of Repugnance" argument. Leon Kass, a former chairman on President G.W. Bush's Council of Bioethics, developed this point in 1997,[212] noting that, though disgust is not an argument, as such, "in crucial cases (…) repugnance is the emotional expression of deep wisdom, beyond reason's power fully to articulate it." This alleged wisdom is there to "protect the central core of humanity". In his praise of "repugnance", Kass states:

> *"Indeed, in this age in which everything is held to be permissible so long as it is freely done, in which our given human nature no longer commands respect, in which our bodies are regarded as mere instruments of our autonomous rational wills, repugnance may be the only voice left that speaks up to defend the central*

[212] Kass (1997),"The Wisdom Of Repugnance", in: Kass and Wilson (eds.) The Ethics of Human Cloning; Kass and Wilson (1998), The Ethics of Human Cloning.

> *core of our humanity. Shallow are the souls that have forgotten how to shudder."*[213]

In 1997, this statement was meant as a response to the cloning of Dolly the sheep and the prospect of human cloning, but "repugnance" has since been used or at least alluded to in many areas of bioethics.

Some bioethicists answer Kass' argument with outright refusal or even ridicule. It is noted that intuitions or "knee-jerk reactions" have, in the past, been used to argue against morally neutral actions (e.g. interracial marriage, homosexuality), without any justification.[214] There are, arguably, some reactions based on repugnance that should have no moral consequences and which ought to be ignored or suppressed. Feelings of violent repugnance towards a very sick or disfigured person, a burn victim or a person suffering from a skin condition are common. How are we to tell that this repugnance caused by disease or unusual genetic variation in another person is not a "sign of wisdom" and that we should shun, avoid or punish all that are affected by such atypicalities? What is it that repugnance is telling us, if it tells us anything at all? David Castle notes that the type of argument Kass praises "is a viciously poor guide for channelling one's uneasy responses to people with severe disabilities or injuries."[215] Another problem that arises when trying to use the "repugnance" objection to the creation of chimeras is that, clearly, not all chimeras or even human-animal interspecifics look "yucky". Thus, the argument could probably not be used against not obviously suspicious cases like mice with a few human cells or genes, or against cybrids in early stages, or against human beings with (not directly visible) animal transplants. These are all quite pragmatic objections to or restrictions of the repugnance argument. Others attack Kass' type of argument from repugnance on much deeper grounds, stating that it lacks philosophical content, altogether. Science journalist Chris Mooney, in a critical assessment of Kass' career in US bioethics, ridicules his source of inspiration, Hans Jonas (whom he deems a "rather obscure German philosopher") and his "heuristics of fear"[216] as demagoguery, then accuses Kass of fear-mongering, and both of an utter lack of convincing ethical argument.[217] Glenn McGee (editor of the *American Journal of Bioethics*), in a similarly acidic tone, notes that the "rules for avoiding 'yuk'" are

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213 Kass (1997),"The Wisdom Of Repugnance", in: Kass and Wilson (eds.) The Ethics of Human Cloning.
214 Cf. Karpowicz, Cohen, et al. (2004), "It is ethical to transplant human stem cells into nonhuman embryos", Nature Medicine, **10**(4).
215 Castle (2003), "Hopes against Hopeful Monsters", American Journal of Bioethics, **3**(3), p. 29.
216 Jonas' "heuristics of fear" can also be understood as a variation of the "precautionary principle", which, some argue, should guide our way of dealing with risk or at least certain types of risks. This type of argument will be discussed in chapter 2, section C.4 below.
217 Mooney (2001), "Irrationalist in Chief", The American Prospect, **12**(17), 2001/08/10.

completely arbitrary and that reference to "shared feelings of yuk" are just political tactics and part of a "flimsy new kind of neoconservative natural law theory."[218] Here, most of the objections to Kass are based on criticism of his role in (conservative) politics, rather than the philosophical content of his argument.

The most substantial objection to Kass-style arguments is that any moral intuition or emotion must be justified and defended as valid – intuition must be "legitimate". David Castle thinks that the Kass-style arguments mentioned by Robert and Baylis are

> *"so weak they can be toppled with pea shooters. Kass' 'wisdom of repugnance,' perhaps the most pernicious of the lot, puts typological reasoning to poor ends by backstopping claims about the legitimacy of moral intuitions."*[219]

It seems quite clear at this point that Kass' argument does not have many followers – particularly few, it seems, in contemporary U.S. bioethics – and does certainly not succeed in persuading adversaries.

*b. Sub-argumentative references to emotion and intuition*

Still, "repugnance" has been used by many objectors to creating chimeras – not necessarily as a free-standing argument, but in the description of typical "knee-jerk"-reactions to (human-animal) chimeras or other interspecifics. Most authors would not go as far as declaring their or the "typical" intuition regarding chimeras a fact that is directly morally relevant or decisive. Still, no author would go to great lengths at describing his or others' intuitive reaction to a phenomenon if he or she thought these reactions were entirely irrelevant.

Let us look at some examples of philosophers referring to or even elaborating on emotional reactions regarding chimeras or other interspecifics. Jeffrey Stout uses the example of a (hoax) cat/rabbit interspecific ("Cabbit"), shown on TV, for comments on the attribute "abominable". [220] He notes: "I have no objection in principle to cabbits. Yet the sight of a living cabbit did affect me. I found it revolting."[221] Seyfer, elsewhere raising religious concerns against creating chimeras (see section B.2 below), notes in the last sentence of his article that mixing humans and animals, (among other points) "(…) evokes a certain repugnance. Perhaps this repugnance is a sign of wisdom" – a direct reference to

[218] McGee (2003b), "The Wisdom of Leon The Professional [Ethicist]", American Journal of Bioethics, **3**(3).
[219] Castle (2003), "Hopes against Hopeful Monsters", American Journal of Bioethics, **3**(3), p. 29.
[220] Stout (1988), Ethics After Babel - The Language of Morals And Their Discontents, pp. 147.
[221] Stout (1988), Ethics after Babel – The Language of Morals And Their Discontents, Ch.7

Kass' Argument.[222] Mary Midgley defends a soft argument from revulsion concerning the advances of biotechnology: she thinks that there is a widespread feeling of revulsion regarding (trans-species) genetically manipulated plants and animals which should not be ridiculed but "spelled out" in the form of an argument.[223] Midgley's approach could just as well be applied to the question of artificial production of human-animal interspecifics – we will assess it more closely below. Physician, biologist and bioethicist William Hurlbut, interviewed by the New York Times' Jamie Shreeve, notes that "When we start to blend the edges of things, we're uneasy.(…) That's why chimeric creatures are monsters in mythology in the first place." He even offers an evolutionary explanation for this feeling of uneasiness, giving it the "justification" of being natural and useful: "Our minds have evolved to be hypersensitive to the borders between species, just as we see a rainbow as composed of six or seven distinct colors when it is really a continuum of wavelengths of light."[224] Morriss (who ultimately does not subscribe to an argument from revulsion) describes the typical reaction to human-animal hybrids like this: "We react with fright, with horror. This is not just the horror of ordinary physical fear, it is an existential horror – a metaphysical one. This sort of existential angst is a very powerful feeling (…)."[225] In the political sphere, U.S. President Clinton, according to a 1998 request regarding the bioethical assessment of the production of human-bovine cybrids to the National Bioethics Advisory Council, noted that he felt "(…) deeply troubled by this news of experiments involving the mingling of human and nonhuman species (…)."[226] In general, newspaper or magazine articles about interspecific research appeal to emotions of fear or horror in their titles with astonishing regularity.[227]

There are also more indirect forms of evocation of disagreeable feelings regarding interspecifics. The connection of interspecifics with the category of "monsters" is rooted in their name's ambiguity. As mentioned earlier, "Chimera" also denotes a monster of Ancient Greek mythology that is a composite of several animals (see picture 1, p. 4). This mythical connotation survives until today: Bruce Lehman, the U.S. commissioner of patents, calls

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[222] Seyfer (2004), "The Ethics of Chimeras and Hybrids", Ethics and Medics, **29**(8).
[223] Midgley (2000), "Biotechnology and Monstrosity - Why We Should Pay Attention to the 'Yuk Factor'", Hastings Center Report, **30**(5).
[224] Shreeve (2005), "The Other Stem-Cell Debate", The New York Times Magazine, 2005/04/10.
[225] Morriss (1998), "Blurred Boundaries", Inquiry, **40**, p. 273.
[226] National Bioethics Advisory Council (1998), "Discussion Transcript: President Clinton's Request Re: Embryonic Stem Cells ."
[227] To give but some examples: Kastilan (2005), "Die Angst vor der Chimäre", Die Welt, 2005/05/02; Illinger (2006), "Die Angst vor der Chimäre", Süddeutsche Zeitung, 2006/11/08; Müller-Lissner (2007), "Angst vor der Chimäre", Tagesspiegel, 2007/09/10.

human-animal chimeras "monsters", outright.[228] So do others (not necessarily intrinsic objectors to creating chimeras): Bernard Rollin entitles one category of possible (consequentialist) objections "rampaging monsters",[229] Mark Sagoff mentions a "Caliban" (i.e. a villain) as one possible type of interspecifics one could create. Depiction of chimeras and other interspecifics, especially of the human-animal kind, as "monsters" is quite common, and undoubtedly this denotation provokes fear and disgust towards and exclusion of the creature referred to – it also to a certain degree predetermines the evaluative stance one will have towards creating such a being.

*c. Can there be an "Argument from Emotion"?*

We have seen that emotions of disgust, revulsion and repugnance play a role, be it a direct or an indirect one, in the debate around interspecifics. This type of objection – depending perhaps on the sensitivity of the person who uses it – can be directed against the creation of different kinds of interspecifics. Some apparently already feel revulsion when thinking about transgenic plants or animals, others deem an animal-to-animal chimera like the "geep" disgusting, less sensitive subjects feel revulsion only when considering "funny looking" chimeras, and for others, the line is crossed only if human material is involved.

There have not been many polls or similar inquiries into whether human-animal chimeras (and which kinds of them) do really stir the negative affective reactions cited by the bioethicists who make use of arguments from revulsion, although the HFEA report of 2007, which concluded a three-month public consultation process in the UK, notes:

> *"Certainly at the outset of the deliberative work, many of the participants expressed an initial repugnance in reaction to the suggestion of mixing human and animal material. Associations were drawn with incidents such as the Northwick Park drug trials, myths and legends, and the elephant man. However, when further factual information was provided and further discussion took place, the majority of participants became more at ease with the idea, although as one participant observed, 'The gut reaction is hard to overcome.'"*[230]

This gut reaction might not be as fixed and hard-wired as it seems, though. Morris points out that societies can be very different regarding their view of the inherent value of human-nonhuman boundaries, and that the portion of people who react with disaffection could be

[228] Dowie (2004), "Gods And Monsters", Mother Jones, (January/February 2004).
[229] Rollin (2003), "Ethics and Species Integrity", American Journal of Bioethics, **3**(3).
[230] HFEA (2007) "Hybrids and Chimeras - A report on the findings of the consultation", section 5.8.

"narrower than the human race".[231] It is very well imaginable, for example, that other cultures produce less horrendous, or even positive emotional reactions to mixed beings – analogously, intersexual persons evoke vastly different reactions in different cultures, ranging from disgust in (traditional, but also modern) western societies to spiritual worship: many non-western religions know intersexual – and interspecific – deities. The connotations of chimeric beings also seem to have changed within Europe's own cultural development. Ancient Greece, apart from frightening monsters like the Chimera and the Minotaur, also knew neutral or even "good" hybrid or chimeric creatures, such as the Centaurs (human-horse mixtures), Satyrs (often described as donkey- or goat-men), and Pegasus (a winged horse which helped slay the monstrous Chimera).

Apart from the varying prevalence of negative feelings raised by (human-animal) interspecifics, and apart from the question whether there are such feelings in all or the majority of the population: can direct or indirect reference to "emotions" be used as an argument in ethics, at all*?* Many have noted that emotion or intuition by themselves are not arguments: "If claims about repugnance are to have any moral force, the intuitions captured by the 'yuk' response must be clarified", Robert and Baylis state.[232] Much of the criticism Kass' and Kass-like arguments are met with is based on this point, and many philosophers forbid the use of "yuk factor" arguments because they are nothing more than thoughtstoppers.

But let us not prematurely discard this type of argument: what defences are there for the moral relevance of "repugnance"?

*d. Defences of the "Yuk Factor"*

Not all ethicists concerned with arguments of this kind immediately reject them as useless. Let us take an exemplary look at two defences of the "Yuk Factor", especially its use as an argument against biotechnological advances: Mary Midgley's (who is concerned with the progress of bio-engineering in general) and Robert Streiffer's (who specifically addresses the problem of human-animal chimeras).

In an article tellingly entitled "Biotechnology and Monstrosity – Why We Should Pay Attention to the 'Yuk Factor'"*,*[233] Midgley discusses arguments involving the "yuk factor" in a broader context, namely that of bioengineering in general. Aside from

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[231] Morriss (1998), "Blurred Boundaries", Inquiry, **40**, p. 276.
[232] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 7.
[233] Midgley (2000), "Biotechnology and Monstrosity - Why We Should Pay Attention to the 'Yuk Factor'", Hastings Center Report, **30**(5).

xenotransplantation and cross-species transgenesis, she mentions human enhancement and GM crops, and, generally, biotechnology that takes species not as fixed entities but as objects of our technical improvement or engineering. Undoubtedly, her reasoning could and would also be applied to the production of all kinds of artificial interspecifics. Midgley wants to make two points: she argues that we should take emotional objections seriously and try to understand or spell out what is behind them, because then we will see that they are not as "irrational and negative" as we took them to be. Secondly, we should recognize that pro-bioengineering positions are not as rational as they purport to be, but really the upshot of "algenic manifestos" and a general new "agenda" of biotechnology their supporters (unconsciously or consciously) subscribe to. I will not elaborate further on the second point here for it is a political or polemic one which does not really help us with the question whether emotional reactions can make (or at least support) valid arguments, in general. Let us focus on Midgley's first point instead: we should, in a nutshell, pay attention to the "yuk factor" because there *might be* a rationale behind the simple utterance of an adverse emotional impulse. Midgley goes further: in her opinion, in regard to bioengineering, there *is* such a rationale behind the "yuk". It is our responsibility to spell out and understand properly what an objector to bioengineering is actually saying behind his façade of seemingly "inarticulate disgust". And he or she is, in Midgleys words, really "objecting to the attacks on the concept of species". In Midgley's view, "there is good reason for that objection."[234] At this point, she goes on to spell out the rationale behind arguments that deem "unnatural" actions morally wrong. Is this a defence of the "yuk factor" or of an argument from repugnance? I think not, although Midgley tries hard to construct it as one. If an objector to bioengineering states that the mere thought of GM crops or animals fills him with disgust and revulsion, and that therefore one should forbid such advances of bioengineering, even with the most charitable interpretation, his or her statement cannot be understood as an argument drawing from the value of integrity of the species concept. It is true that "yuk factor" approaches can be beefed up and made persuasive by explaining what concepts or values are behind the emotional reaction reported, and that, in this context, the report and assessment of intuitions and knee-jerk reactions is helpful; but it remains true that the pure reference to the "yuk factor" is argumentatively void. It turns out that despite her express intentions, Midgley's argument is not one from the "yuk factor" but one from a quasi-religious view of species boundaries as

[234] Ibid., p. 9.

morally relevant. I will therefore assess Midgley's argument under the heading of "Religious and quasi-religious objections", below.

Robert Streiffer defends the view that the "yuk factor" could be used as a valid argument for objecting to the creation of human-animal chimeras. While he admits that such an action is not necessarily morally wrong just because it is "unnatural", and that the notion of moral wrongness qua "unnaturalness" is problematic, he notes that "proponents of the unnaturalness objection can insist that (…) they still know that crossing species boundaries is wrong."[235] (Karpowicz et al. (2005) do not defend, yet reconstruct a similar argument, referring to incest and cannibalism as abominations that might be comparable. They call this the "moral taboo argument".)[236] To support this, Streiffer identifies analogous cases in which moral wrongness cannot be further explained, but where we "know by just looking" that they are wrong: "Bestiality and pedophilia are wrong even when they cause no physical or psychological harm" and therefore: "Robert and Baylis' epistemological claim that intuitions must be justified if they are to 'have any moral force' is mistaken."[237] Thus, the "yuk factor" *could*, after all, be an argument against creating chimeras – though Streiffer does not decide on whether it is valid, he wants to hold on to the possibility of using arguments of this type. One could argue against Streiffer by doubting that his examples are convincing: for one, one could state that there is no "pedophilia" without harm done to the child (or rather, that mere "pedophilia" is not the problem – pedosexuality is, even if the two are often confused). One could also make the point that "bestiality" is not morally wrong in itself (as Peter Singer did, quite persuasively, in his review of Midas Dekker's book "Dearest Pet").[238] Some argue against the use of the "yuk factor" by pointing out that arguments of this kind have been used to support anti-miscegenation policies or other systems and structures now considered morally wrong. For the field of bioethics, note that blood transfusions and organ transplantation were, not too long ago, considered "abhorrent", and arguments were made against these new techniques based on these emotional or "taboo" responses.[239] Streiffer counters this somewhat weak objection by noting that, as with other types of arguments, it may be wrong for some, but right for other

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[235] Streiffer (2003), "In Defense of the Moral Relevance of Species Boundaries", American Journal of Bioethics, **3**(3), p. 38.
[236] Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2), p. 110ff.
[237] Streiffer (2003), "In Defense of the Moral Relevance of Species Boundaries", American Journal of Bioethics, **3**(3).
[238] Singer (2001), "Heavy Petting", nerve, 2001/01/03.
[239] Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2), p. 112.

cases (his example are paternalistic arguments, which are today considered a mistaken approach when used concerning women, but appropriate when used concerning children). Yet finally, Streiffers' concluding remark regarding the repugnance argument shows the crucial problem of this kind of reasoning:

> *"Should the repugnance some feel at the crossing of species boundaries be dismissed (as the reaction of a racist should be), or does it constitute yet another intuition in a long line of intuitions where our difficulties in providing satisfactory theoretical explanations merely indicate theoretical inadequacy? Given the poor state of the arguments on both sides of the debate, it is too early to tell."*[240]

What Streiffer says is: we will know whether our argument from repugnance was right once we have worked out whether there are actual reasons that support it. The "argument", after all, is based on emotion and, as such, it is hugely influenced by our socialisation and cultural surroundings, and – most importantly – it cannot be used to convince other people who have different emotive responses. Therefore, it is useless in any ethical debate where there are conflicting emotive responses. Basically, Kass and Streiffer use emotions in a supporting role – as stand-ins for when they have run out of arguments. This does, in my opinion, not make their position more convincing. Karpowicz et al. (2005) offer a similar interpretation of what they call "taboo arguments":

> *"What makes such outrage justifiable, however, is not the emotion in itself, but the reasons why one responds with this emotion. We would be reluctant to accept ethical judgments based solely on emotions (…) for these can occur by chance and may be misplaced."*[241]

The authors extend this critique to arguments from "intuition" (as distinct from emotion) – though intuitions, in their view, "establish a prima facie case", they can still be conflicting and fallible, and "need to have the support of some form of reasoning that is intersubjectively available and can be followed by others."[242]

To sum up, the feelings or intuitions people have when confronted with novel beings such as chimeras are a valid object of research regarding their roots and the concepts behind them. They are useless as an argument and – at least this is true for emotions –, in my

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[240] Streiffer (2003), "In Defense of the Moral Relevance of Species Boundaries", American Journal of Bioethics, **3**(3), p. 38.
[241] Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2), p. 111.
[242] Ibid.

opinion, they should not even count as a vague indicator that "something is wrong". Karpowicz et al. arrive at a similar conclusion, finding that "taboo arguments" do "not provide an adequate basis for rejecting studies using human-nonhuman chimeras (…)." [243]

After this examination of the "yuk factor" or arguments from repugnance, let us look at other, more promising types of argument. As I mentioned above, it proves to be hard to draw lines between different types of intrinsic arguments, and also between intrinsic and consequentialist arguments; keeping a crude typology, however, seems advisable for the sake of a clear synopsis. The following two types of intrinsic argument are often constructed as explanations for (or reasons behind) the "yuk factor". Creating chimeras is deemed offensive and repugnant because it means "challenging God's existence".[244] Another type of argument highlights "boundaries" between species that are considered sacred or, as Robert and Baylis write, "inappropriate objects of human transgression". Transgression of such a boundary leads to the violation of a taboo which causes "instinctive and intense revulsion".[245] Are these objections to creating chimeras more convincing than the repugnance argument, or do they substantially improve its persuasiveness?

## 2. Religious and quasi-religious objections

It is not uncommon to explain revulsion or similar aversion to interspecifics by religious reasons. I will not dwell on this kind of argument for too long, but still mention some typical concerns. I will also have a look at what I call "quasi-religious" concerns: objections on the grounds of beliefs that are not necessarily religious in the traditional sense, but based on the belief in a higher order of some kind (e.g. the teleological belief that there is a sense or direction in nature which we should obey, or a sanctity that does not derive from specifically religious beliefs). These "quasi-religious" concerns are probably even more influential nowadays than religious concerns proper.

*a. Christian attitudes towards the creation of interspecifics*

Objections against the creation of chimeras, especially human-animal chimeras, can apparently be derived in a relatively direct fashion from the scripture: "bestiality", i.e. sexual

[243] Ibid., p. 113.
[244] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 7. Robert and Baylis reconstruct but do not support this argument.
[245] Ibid., p. 2.

intercourse between human and nonhuman beings, is expressly forbidden.[246] Some infer from this that technically assisted "mixing" of humans and animals – especially in the quasi-sexual way of merging human and animal embryos or embryonic cells – would be highly problematic.[247]

A somewhat more abstract argument states that mixing one species with another species can be seen as meddling with the types of beings God has given us. Morriss reconstructs (but does not share) a view that sees the world as "complete" and any creation of novel creatures therefore necessarily as an insult to God.[248] In the same vein, a 1987 synod of the Evangelische Kirche Deutschland concerning genetic engineering and reproductive medicine referred to the "predetermined shape of creation", which would be "violated" by creation of chimeras and hybrids [transl. CH].[249] Mixing human with nonhuman beings would be regarded as an even graver offense, since humans are seen as a kind of being that has a special and unique connection with God. Human beings, according to Christian doctrine, belong to an altogether different category than nonhuman animals; God has created them in his image and correspondingly they carry an inherent value. Seyfer notes that, from the Christian viewpoint,

> *"Jesus Christ did not come as an animal, but specifically as a human being, in a human body. This bespeaks the dignity which God accords human beings and their bodies and how specially He views the human race. It thus seems to lead towards the blasphemous to purposefully combine the genetic or bodily material of a human being and an animal in a way that changes either of their identities. To mix the imago Dei with non-imago-Dei seems a violation, and evokes a certain repugnance. Perhaps this repugnance is a sign of wisdom."*[250]

Aside from this reference to Kass' argument from repugnance, the main part of the argument rests on the religiously grounded dignity of human beings and thereby the offensiveness of mixing human with nonhuman (for further discussion of "human dignity" in this context, see section B.4 below).

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[246] See Leviticus 18:23: "And you shall not lie with any beast and defile yourself with it, neither shall any woman give herself to a beast to lie with it: it is a perversion." and Lev 20:15-16: "If a man lies with a beast, he shall be put to death; and you shall kill the beast. If a woman approaches any beast and lies with it, you shall kill the woman and the beast; they shall be put to death, their blood is upon them."

[247] Robert and Baylis (2003), p. 7, (though they find this reasoning mistaken), mention that: "Sexual intimacy between human and nonhuman animals typically is prohibited in law and custom, and some, no doubt, reason from the prohibition on the erotic mixing of human and nonhuman animals to a prohibition on the biotechnological mixing of human and nonhuman cellular or genetic material."

[248] Morriss (1998), "Blurred Boundaries", Inquiry, **40**, p. 279.

[249] Evangelische Kirche Deutschland (1987), "Zur Achtung vor dem Leben - Maßstäbe für Gentechnik und Fortpflanzungsmedizin. Kundgebung der Synode der EKD, 1987, Berlin."

[250] Seyfer (2004), "The Ethics of Chimeras and Hybrids", Ethics and Medics, **29**(8).

The overriding principle of Catholic Christian opinions regarding the creation of human-animal interspecifics is the priority of the doctrine of sanctity of human life from conception on. This results in staunch opposition to any research that involves the use of human embryos – including many types of interspecific research. The priority of the sanctity of life principle can lead to results that seem counterintuitive at first glance. Roman catholic bishops suggested in 2008 that, should human-animal embryonic chimeras be created (which they consider to be morally wrong), then there should be no legislation preventing the embryo from being implanted in the womb of the woman who donated the egg:

> *"Such a woman is the genetic mother, or partial mother, of the embryo; should she have a change of heart and wish to carry her child to term, she should not be prevented from doing so"*[251]

Sanctity of life considerations, in this point of view, clearly overrule other arguments that would make the bringing to term of such a hybrid being morally wrong.

Although the standard Christian reaction to hybridisation, chimerisation and transgenesis is negative, some argue that Christian viewpoints do not necessarily result in a firm opposition to the creation of interspecifics (even human-nonhuman mixtures). Theologian Daniel McGee points out that human life, though it has a supreme position in the hierarchy of Christian values, is not granted "absolute value or sacred status" in the Judeo-Christian tradition. Regarding chimeras, McGee reminds of Karl Rahner, who, in the 1960s, warned fellow Catholics not to absolutely dismiss new technologies for human manipulation: "He noted that Christians must recognise that such self-manipulation will contain the potential for both good and evil", McGee resumes, and that (even for faithful Christians) there is no one answer to the new complexities brought about by new developments of biotechnology such as chimera creation.[252] Robert and Baylis point out that

> *"Some would argue further that not only is it* not *wrong to play God, but rather this is exactly what God enjoins us to do. Proponents of this view maintain that God 'left the world in a state of imperfection so that we become His partners' – his co-creators."*[253]

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[251] Gledhill (2007), "Human-animal hybrid embryos should be legal says Catholic Church ", Times Online, 2007/05/27.
[252] McGee (2003a), "Moral Ambiguity? Yes. Moral Confusion? No", American Journal of Bioethics, **3**(3).
[253] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3). Citing Breitowitz (2002), "What's so bad about human cloning?" Kennedy Institute of Ethics Journal, **12**.

Let me close this incomplete and very tentative look at Christian views of chimera creation with the somewhat surprising result that the ethical classification of human-animal chimerism research is not a univocal one even within the bounds of Christian interpretation, at least not on the level of intrinsic objections.

*b. A quasi-religious objection: Hubris*

In the bulk of adverse reactions to biotechnology, there is one very common type of objection or concern which I would not call "religious" although it sometimes uses religious terminology. It is expressed in the formula that biotechnology, and particularly chimera creation, constitutes "Playing God" or "Meddling with Nature" and is, therefore, morally reprehensible or at least suspect.

In a 2005 interview with the Christian Science Monitor, Jason Scott Robert stated that "he's been struck by how 'even secular people, people who aren't of faith, nonetheless see the wisdom of the ›playing God‹ objection' to creating chimeras."[254] Robert Streiffer cites the U.S. Office of Technology Assessment's report on public perceptions of biotechnology as stating that concerns "about playing God and tampering with Nature" are quite prevalent in the (American) public.[255] Chakrabarty reports that "crossing the so-called evolutionary barrier through scientific interventions does not resonate well with most people; it is considered an overreach for scientists to play God."[256] Jeremy Rifkin, in an assessment of human-mouse xenograft experiments, states that such research will "stretch the limits of human tinkering with nature to the realm of the pathological" and he fears a "journey into a brave new world in which all of nature can be ruthlessly manipulated."[257]

I understand both the (non-religious) "Playing God" and the "Meddling With Nature" concerns to have one common root: the accusation of hubris. Stemming from Ancient Greek culture, this today denotes a combination of ignorance, arrogance and exaggerated pride of an agent which is typically followed by punishment by fate or higher powers. A typical kind of modern hubris view assumes that there are actions, or types of action, that are reserved for higher beings (God or Nature), and areas of life and nature which are inappropriate for human beings to interfere with. Robert Spaemann's reference to "opting

[254] Lamb (2005), "A Mix of Mice and Men", Christian Science Monitor, 2005/03/23.
[255] Streiffer (2003), "In Defense of the Moral Relevance of Species Boundaries", American Journal of Bioethics, **3**(3), p. 37.
[256] Chakrabarty (2003), "Crossing Species Boundaries and Making Human-Nonhuman Hybrids: Moral and Legal Ramifications", American Journal of Bioethics, **3**(3), p. 20.
[257] Rifkin (2005), "Are you a man or a mouse?" Guardian, 2005/03/15.

out of Tao" seems to fit this pattern;[258] others directly refer to the dangers of hubris concerning interspecific research.[259] Concerns of this type are not limited to the creation of human-animal interspecifics, they can be directed against the artificial creation of life, in general (e.g. in vitro fertilization), against the creation of manipulated life (manipulation of the genome, cloning, hybridisation), against the ending of life by man (suicide, assisted suicide, death penalty), against the undue prolonging of life by medical means, or even against contraception. Since it is assumed that a supernatural being (or "Nature") is in charge of creating categories of creatures, of giving life, creating life and taking it away as it sees fit, human interference with these responsibilities is seen as insolent and morally wrong.

Mary Midgley, whose "Biotechnology and Monstrosity" I introduced above as trying to defend "yuk factor" arguments, is one of the few to spell out this type of intrinsic objection. While her article addresses all kinds of manipulative biotechnologies, the paragraph entitled "How solid are Species?" focuses on beings that stand "between species" (she speaks of hybrids and, in her examples, of "novelties and monsters, chimeras and winged horses and three-headed dogs").[260] Can an argument be made from the statement that such beings are "unnatural" to the moral view that we shouldn't make them? Putting aside the assumption that everything that straddles species lines is somehow dangerous, Midgley admits that modern biology has uncovered that "species are not timeless essences – that they can be formed and can change and decay – and also that a few species hybridize and mingle at their borders."[261] Still, she indicates that, in modern (evolutionary) biology, the "evolutionary niche" has taken the place of the "species essence" – it is today what is believed to give "sharp edges" to the kinds of beings that can exist: "(…) actually very few evolutionary niches are available at any given time, and (…) these are normally far apart, accommodating only the rather widely varied creatures that now occupy them." Between the niches, nature is "inhabitable", Midgley states, and utterly inhospitable to beings like "mice with ears on their backs" or lion-tiger hybrids – "they could not survive in the wild." Midgley concludes: "Evolution (…) knows what it is about when it puts together the repertoire of characteristics that marks a species." I understand Midgley, from this analysis of the current state of nature, to conclude that "Nature Knows Best", and that creating beings that have no place in it is therefore demonstrably morally wrong. Species, then,

[258] Spaemann (2008), "Jedes nach seiner Art", Cicero, (Mai 2008).
[259] Wenzel (2007), "Rache der Chimären", Neue Zürcher Zeitung, 2007/09/06.
[260] Midgley (2000), "Biotechnology and Monstrosity - Why We Should Pay Attention to the 'Yuk Factor'", Hastings Center Report, **30**(5), p. 10.
[261] Ibid.

must be "taken seriously", because there is a principle telling us that (at least some) species characteristics "should not be moved".

Contrary to Midgley, I do not think that making use of modern evolutionary biology is of much help when defending the point that "Nature Knows Best". Firstly, I am troubled by Midgley's definition of "evolutionary niche". An evolutionary niche does not have to be in the wild. The niche concept can, more plausibly, be understood as meaning that all beings which are alive have, by virtue of being alive, and retaining the possibility of procreation, found their "evolutionary niche". This includes wild animals, but also pets which – from Chihuahua to Koi fish – could not survive in the wild (it also most likely includes a lot of human beings, e.g. short-sighted and/or weakish persons, like the majority of professional philosophers). This means that chimeras and other interspecifics, contrary to Midgley's assessment, *do* have an "evolutionary niche", even though they are not running wild in the woods like other participants in the competition of evolution: their niche is in labs and cages and in the willingness of humans to create and feed them. We can grant Midgley the point that interspecific chimeras do not live in the wild and do not occur without human intervention, yet the step from this assertion to the moral problematicity of their creation is hard to make. They are "unnatural" – probably yes, depending on your definition of "natural". But why this is an argument against their creation is not made clear by Midgley's argumentation. How can we make sense of her statements?

Midgley uses a telling metaphor when saying that "Evolution, in fact, knows what it is about (…)." In modern evolutionary biology, which Midgley stresses as her starting point in this paragraph, there is no way of saying that evolution "knows", "does", or "has in mind" anything at all. Behind this manner of speaking, there seems to be a view of Nature not as a random process, but as an almost personal being or "incorporated principle" that has aims and – most importantly – whose aims or intentions are morally relevant, *right* for us. I call this a "quasi-religious" view because Nature, crudely speaking, seems to take the place God occupies in other worldviews. It is this teleological view of nature which is the foundation for arguing against the creation of "unnatural" beings (i.e. beings that are openly at odds with the principle). Karpowicz et al. offer a similar interpretation of quasi-religious arguments (in their terminology: "The 'unnaturalness' argument"):

> *"This argument maintains that the operations of nature are to be understood and valued in terms of their purposes. It is indebted to Aristotelian thought, which asserts that every living thing has an inner tendency to reach its appropriate end or goal (telos) by exercising certain characteristic biological*

> *functions. According to traditional natural law theorists, the very fact that a living entity pursues a particular kind of life through certain biological processes is its own justification."*[262]

Once we assume such a teleological view of nature, it is possible that a promising intrinsic argument against the creation of chimeras could be made. In this sense, the "unnaturalness" argument need not immediately fail – natural features could then be regarded as having direct moral importance. Karpowicz et al. point out that the teleological kind of argument is far from helpful, though, mainly because we have no criterion for finding out when intervention is allowed and when it is against nature's aims, or which natural features or "aims" are morally relevant and which are not. Modern human life is basically identical with "intervening with nature"– it cannot be true, and it is probably not the claim proponents of this argument have in mind, that *all* interventions are wrong in themselves. The teleological route does not equip us with tools with which to find out which of them are. In any case, the road Midgley takes (i.e. via a teleological analysis of evolutionary biology) does not seem viable.

Another possibility for intrinsic objections to chimera creation, as we will see in the next section, is in a certain understanding of species boundaries.

## 3. The boundary between humans and nonhumans

The concept of a boundary between humans and nonhumans – and of the problematicity of crossing it by creating human-animal chimeras – is widespread in the discussion of interspecifics. Further analysis of this argument-type reveals that it would have to jump three hurdles by demonstrating that:

(I) There is a boundary between humans and nonhumans

(II) The boundary is morally relevant, i.e. there is a fundamental/categorical moral division between human and nonhuman beings

(III) Creating human-animal chimeras (or other interspecifics) constitutes a "crossing" or "violation" of the boundary

From these premises it would follow that creating human-animal chimeras or other interspecifics is morally wrong.

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[262] Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2), p. 113.

What is intrinsic about this type of argument is the assumption of a morally relevant boundary between humans and nonhumans – crossing the line, according to this approach, is wrong because of the innate sacredness of this boundary, not because of detrimental consequences its crossing might have. One can ask several central questions in this context:

Ad (I) What constitutes the "boundary" between humans and nonhumans? Is it genetic, or metaphysical (e.g. in the sense of humans and nonhumans belonging to different natural kinds)?

Ad (II) What confers moral relevance to the "boundary"? Why should there be a fundamental moral difference between humans and nonhumans?

Ad (III) In what way, at what point, is the boundary violated when someone creates an interspecific entity?

The first concept that comes to mind when thinking about what could constitute a proper "boundary" is that of (biological) species. Human beings, in contrast to other living beings, belong to the species *Homo sapiens*. To give a short glimpse of considerations to come: we will see below that the concept of species is today understood in a way that makes it difficult to accept it as the fundament of given, natural boundaries between kinds of beings (see chapter 3, section B.3.a below). But even if we did not have these problems with species concepts (which, for the sake of analysing this type of argument, I will assume for the duration of this chapter), we would need a good argument to explain why this biological categorisation should be deemed morally relevant for the question of chimera production, at all.

In their analysis of boundary arguments, Robert and Baylis refer to the notion of "fixed species boundaries" which are "inappropriate objects of human transgression".[263] They note that, far from concerning each and every biological species, only one particular species boundary is affected by this notion, namely that between human and nonhuman beings. Besides, the crossing of species lines cannot be immoral, as such, since it happens in nature (e.g. hybridisation of horse and donkey).[264] Robert and Baylis diligently consider the question of what could possibly fuel the moral power of this special boundary – and conclude that, in their opinion, there is no actual "human essence" or "species essence" that could be considered the root of a fixed boundary. Species boundaries are a "moral

[263] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 2.
[264] Ibid.

construct",[265] and they reveal that worry about species boundaries is, in fact, a concern about something else. The human-animal boundary is a typical "taboo", they say – a social and moral shield held up against ambiguous things, because uncategorizable objects pose a danger to moral decision-making. Ultimately, Robert and Baylis find it unhelpful and mistaken to use the concept of "fixed boundaries" to argue against the creation of human-animal chimeras. The concern with human-animal chimeras, they say, is not really about a fixed boundary (because such a thing cannot be identified), but rather about "moral confusion" – i.e. an alleged consequence of chimera creation that will be discussed in detail in section D.3 below. Regarding my three-step analysis of boundary arguments, one could say that Robert and Baylis abandon this approach already at step (I): they believe that realism concerning the boundary is mistaken (because they think that boundary realism relies on species essentialism which they declare obsolete) – they also argue that, concerning step (III), it cannot be inherently wrong to "cross species boundaries" by, e.g., moving genes from one species to another, since such things also happen in nature. As we will see in more detail in chapter 2, section D below, Robert and Baylis are not prima facie disinclined to arguments belonging in the realm of step (II) (i.e. speciesism). Robert's and Baylis' influential discussion of the boundary argument was, as we have seen, not favourable.

On the other hand, there are several defenders of the view that there is a boundary between species (especially that between humans and animals) which is also a morally relevant border line. Mary Midgley, e.g., supports a kind of species realism which sees as the defining and determining element of species not a "hard essence", but rather the adaptedness of species to an evolutionary niche (Step I). Midgley does not explicitly state why violating the boundary would be morally problematic, but can be understood as using a teleological view of Nature (or "Evolution") to do so (Step II). I have made clear above that Midgley's route is not promising: because Midgley's account of evolutionary niches is mistaken, it fails to explain why chimeras violate the alleged boundaries between species (Step III), at all.

Robert Streiffer, to give another example, defends the moral relevance of species boundaries as at least possible. Regarding the question whether there is such a thing as "species boundaries", he states that just because there's disagreement about the boundary (i.e. the species concept), the concept isn't necessarily superfluous. He also doubts Robert's and Baylis' assumption that "crossing species boundaries" cannot be immoral as such since

[265] Ibid., p. 6.

it happens naturally: "(…) it can be natural for bacteria to move genes across species boundaries without it being natural for human beings to do so."[266] Streiffer does give some support to the concept of "species boundaries" – it might be useful and not necessarily superfluous for ethical debate. Still, his considerations do not, in my opinion, offer the "*Defense* of the Moral Relevance of Species Boundaries" the title promises, mainly because Streiffer's defence is grounded in a repugnance argument I do not find convincing (see chapter 2, section B.1.d above).

Louis Charland defends the species concept as such – claiming species can be understood as natural kinds – but he acknowledges that this doesn't do anything for explaining or erecting a morally relevant boundary (i.e., Step II): "None of this settles the question whether and how moral categories crosscut natural ones", he admits.[267] Charland does not address the questions subsumed under (II) or (III).

Cynthia Cohen[268] states that a species concept is *necessary* for keeping up the assertions Robert and Baylis make – we must first "understand which properties, features, characteristics and functions are distinctively and importantly human." – then we can decide in how far the created chimeras "have become human", i.e. "where the conceptual boundary between human beings and animals lies and when it has been crossed." In the following, she implies (or assumes) that "turning animals into human beings" is morally wrong, but gives no reason why it should be. Therefore, regarding step (III), Cohen's approach would supposedly be that creating chimeras is a transgression of the boundary if and in as far as it "turns animals into human beings." Similarly to Streiffer and Charland, Cohen defends the species concept in answering question (I), but shies away from giving answers to question (II) (i.e. the reasons for moral relevance of such a concept).

Like the commentators before him, Leo Zwanziger[269] defends the idea behind the species concept, stating that there is "significant and real, if not immutable, stability in Homo sapiens." Again, there is no mentioning of the question of moral relevance identified here as question (II).

At this point, we are confronted with commentators generally defending the usefulness of a concept of species boundaries or a firm boundary between human and nonhuman as such

[266] Streiffer (2003), "In Defense of the Moral Relevance of Species Boundaries", American Journal of Bioethics, **3**(3), p. 37.
[267] Charland (2003), "Are There Answers?" American Journal of Bioethics, **3**(3).
[268] Cohen (2003), "Creating Human-Nonhuman Chimeras: Of Mice and Men" American Journal of Bioethics, **3**(3).
[269] Zwanziger (2003), "Crossing Perspectival Chasms about Species", American Journal of Bioethics, **3**(3).

but shying away from the question whether and why it should be morally relevant, let alone the third step of formulating why and in what cases, exactly, creating human-animal mixtures constitutes a violation of the boundary defined. What could a successful boundary argument against the creation of human-animal interspecifics, specifically chimeras, look like?

Let me, again, resort to the crude outline of possible arguments described on p. 69-70. On the level of (I) – regarding the existence of a boundary – there are two roads one can take. One is an antirealist approach: "species", and, more specifically, the species boundary between humans and nonhumans, is understood as a mere "social construct" that has a value in as far as it prevents the occurrence of bad consequences. This is the road Robert and Baylis take in their article and which I will follow in section D. Such an approach would, however, leave the realm of intrinsic arguments that are the subject matter of this section. The other possible approach regarding question (I) is that of realism concerning species (at least in the sense of sticking to a classification into "human" or "nonhuman"). This is, basically, what defenders of the species concept like Charland and Zwanziger do. (We will see in chapter 3 that the problematicity of constructing an appropriate species concept, and more specifically, essentialism, are not only relevant for a discussion of human-animal chimeras, but also situated at the very centre of the speciesism debate).

Only at this point are we beginning to touch upon questions of morality, i.e. on questions of step (II). Why should species membership or, as it were, membership in a "natural kind", have moral relevance? One possibility here would be to assume that being a member of the natural kind "human being" confers the property of personhood or, more generally speaking, high moral status. The natural kind of "beings belonging to the species *Homo sapiens*" would be assumed to be coextensive with the natural kind of "beings deserving special moral consideration". This assumption is made by some who defend the moral privileges of members of our species as an ethical principle (i.e. by proponents of "Speciesism", see chapter 3, section B below). This should certainly be included in a typology of intrinsic arguments regarding chimeras, since it seems, at least prima facie, to do a satisfying job of connecting the realm of facts (existence of species) with that of morals (moral relevance of being a member of a species).

But does taking this route really help someone who intrinsically objects to the creation of (human-animal) chimeras? Let us recapitulate the course of the argument so far: the objector has stated that boundaries between species (especially between humans and nonhumans) do exist in reality/nature. Further, he has stated that these natural kinds are

relevant in a moral sense: beings which belong to the natural kind of "*Homo sapiens*" do also belong to the natural kind of "person". But there is a third hurdle to take. The objector must argue for the proposition that making a (human-animal) chimera constitutes a "violation" of the boundary he has identified.

Here, at step (III), my reconstruction encounters two problems: firstly, I cannot fathom how an objector to creating human-animal chimeras can take offense with mixing humans and animals, at all. A mixture in the sense of tainting the human essence with nonhuman parts (or vice versa) seems unimaginable in the conceptual framework presented. The natural kinds of "human/person" and "nonhuman/nonperson" must be mutually exclusive – otherwise, there would not be a clear boundary between them in the first place. Interspecifics in the sense we are discussing here – i.e. beings that are neither of the kind human/person nor of the kind nonhuman/nonperson (or part of both)[270] – seem conceptually impossible in such a view. Is that an argument against creating them – or rather, one against taking the route of declaring humans a natural kind?

Is there another rationale for declaring chimera creation a violation of boundaries? Putting aside the problematicity of natural kinds, one could, from the speciesist argument above, argue that crossing the human-animal boundary by "making an animal out of a human" (e.g. by injecting a huge amount of nonhuman stem cells in a human embryo) must be seen as morally wrong, since it destroys a person. This would not constitute a valid intrinsic argument against the creation of (human-animal) chimeras, though. For one, it would do nothing to explain why the opposite – namely, turning animals into human beings – should be deemed morally wrong (as is implied by, e.g., Cohen).[271] Considering that experiments done today are usually human-to-animal and not vice versa, this to me seems to be the bigger threat that is posed by chimerism experiments. With the suggested approach, such experiments might even be considered morally favourable – what, after all, could be wrong with creating a being that has the highest moral status (even if it is created from an animal)? This "uplift" scenario will be discussed further in section C.2.2 below.

Ultimately, it remains unclear what ethical principle an intrinsic boundary argument would be based on. What exactly is it that would make introducing living animal parts into human bodies (as in the case of chimeras), or alien genes (as in the case of transgenics) intrinsically

[270] This view, in an analogy to the doctrine of the two natures of Christ, is defended by DiSilvestro (2004), "A Neglected Solution To The Problem Of The Metaphysical And Moral Status Of The Human-Animal Chimera", Ethics and Medicine (Summer 2004).
[271] Cohen (2003), "Creating Human-Nonhuman Chimeras: Of Mice and Men", American Journal of Bioethics, **3**(3), p. W5.

wrong, while living together with nonhuman animals as pets, touching them, or even eating them, would *not* constitute such an intrinsically wrong "boundary crossing"?

## 4. Human dignity arguments

Several bioethicists analyse the creation of human-animal chimeras in relation to the notion of human dignity. Human dignity concerns are intrinsic concerns – they do not refer to specific interests of humans or animals or animal-human mixtures which are supposedly violated as a consequence of creating interspecifics, but to the general and abstract concept of "dignity" which makes, some argue, creation of interspecifics wrong in principle.

The most extensive discussions of dignity approaches are given by Johnston and Eliot (2003), Karpowicz, Cohen and Van der Kooy (2005), and Ravelingien, Braeckman, et al. (2006).[272] Others argue that "human dignity" is a nebulous and vague term, that there is no agreement on how it should be understood exactly, and that it adds nothing to the host of concerns for the wellbeing of humans which are brought forward without referring to the notion of "dignity", at all. Robert and Baylis,[273] for example, and with them the majority of authors in both the AJOB 2003 and 2007 issues concerned with chimeras, leave "human dignity" out of their analysis of chimera creation altogether; likewise, the CHIMBRIDS project opening discussion was highly sceptical of "human dignity" approaches.[274]

Nevertheless I think that the human dignity concept adds a perspective to the discussion that differs considerably from just stating that human beings might be treated inadequately. "Simple" concerns for the wellbeing of humans, as described in section C.2.b below, are based on the assumption that chimera creation might violate the interests or the rights of humans (or part-humans). Claiming that human dignity is being violated is a much stronger, and structurally different, claim – in particular because a genuine violation of human dignity is not justifiable by means of a cost-benefit analysis, which means that an

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[272] Johnston and Eliot (2003), "Chimeras and "Human Dignity"", American Journal of Bioethics, **3**(3); Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2); Ravelingien, Braeckman, et al. (2006), "On the moral status of humanized chimeras and the concept of human dignity", Between the Species, **VI**.

[273] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3); Robert (2006), "The science and ethics of making part-human chimeras in stem cell biology", Journal of the Federation of American Societies for Experimental Biology, **20** ; Baylis and Robert (2007), "Part-Human Chimeras: Worrying the Facts, Probing the Ethics", American Journal of Bioethics, **7**(5).

[274] "The whole discussion reflected the general difficulty that even outside the ethical debate on chimeras and hybrids no consistent definition of human dignity has been found so far and that a consequent use of one specific concept of human dignity, which is convincing for one certain situation, might lead to unwanted conclusions in a different context." Weschka (2006), "Protocol of the CHIMBRIDS Opening Conference on 11/12 March 2006", p. 7.

argument from this approach would be much stronger than the consequence-based arguments discussed below. The statement that human dignity is "inviolable", in this sense, is a prescriptive one which means that violations of dignity cannot be justified or balanced out with other values (e.g. wellbeing).

Apart from concerns about outright violation of dignity, there are also concerns that chimera creation might lead to constrictions or limitations of human dignity. Such constrictions or limitations – "threats to human dignity" – might be somewhat more easily justifiable – they fuel consequence-based rather than intrinsic concerns. As Resnik puts it, "it is not reasonable to prevent all possible threats to human dignity, because this strategy would require societies to forego important opportunities or violate basic rights."[275] But still, such threats could be the basis for viable arguments against human-animal chimera creation: especially in the form of slippery slope arguments, they are influential in many bioethical debates. A variant of such concerns for a (indirect) threat to human dignity will be discussed in section D.3 below.

In the typical phrasing of "human dignity" approaches, human beings' *special characteristics* demand that they be treated as means, not only as ends. These characteristic(s) are defined in varying ways – as the ability to act in order to fulfil purposes (cf. Alan Gewirth),[276] as being created in the image of God (imago dei) (cf. Christian approaches), as a bundle or family of valuable capacities (cf. Karpowicz, Cohen, Van der Kooy),[277] or they can be found in the role of humans as moral subjects (cf. Kant).[278] Ravelingien's adaptionist approach to human dignity tries to identify uniquely human characteristics that are responsible for "human dignity" as "those adaptations that arose in response to the particular adaptive problems not shared by the ancestors of other species."[279]

Different interpretations of the "special characteristic" notwithstanding – what should be central to our analysis of human dignity concerns is the question of what, exactly, the violation, constriction or endangerment of human dignity consists in in the case of creation

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[275] Resnik (2003), "Patents on Human-Animal Chimeras and Threats to Human Dignity", American Journal of Bioethics, **3**(3), p. 35.
[276] Gewirth (1992),"Human Dignity as the Basis of Rights", in: Meyer and Parent (eds.) The Constitution of Rights: Human Dignity and American Values.
[277] Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2), p. 118 ff.
[278] "Allein der Mensch, als Person betrachtet, d. i. als Subject einer moralisch=praktischen Vernunft, ist über allen Preis erhaben; denn als ein solcher(…) ist er nicht blos als Mittel (…) sondern als Zweck an sich selbst zu schätzen d. i. er besitzt eine Würde (einen absoluten innern Werth) (…)", see Kant (1797/1968), Die Metaphysik der Sitten, pp. §11, 434-435.
[279] Ravelingien, Braeckman, et al. (2006), "On the moral status of humanized chimeras and the concept of human dignity", Between the Species, **VI**.

of human-animal chimeras or other interspecifics. Since not all types of interspecific-creation raise these issues (xenotransplantation of insulin-producing porcine cells, for example, is rarely mentioned in respect to dignity violations), there must be something about specific types of interspecific-creation which makes them problematic in this regard.

According to Karpowicz et al. (2005), there are different ways of violating human dignity:

(a) Human dignity is violated when individuals with valuable capacities are kept from exercising them. Examples for this are slavery or any kind of forcible coercion, which keeps humans from acting freely and deciding for themselves, which in turn makes their role as moral agents dubitable.

(b) Human dignity is even more severely violated when human beings which are in possession of valuable capacities are wilfully robbed of them. Murdering a human being is the worst possible case of this type, since it means denying a human all capacities; mutilation, in as far as it leads to a permanent diminishment of valuable capacities, is also regarded as an especially reprehensible violation of human dignity in this sense.

What, then, does the dignity violation consist of in the case of creation of human-animal interspecifics? The identification of a violation would presuppose that special characteristics/valuable capacities are affected – it is not conceivable, e.g., how the transfer of human muscle or renal cells into an animal could count as a violation of human dignity in these senses. Accordingly, Karpowicz et al. assume a transfer of those physical components that are necessary for "valuable capacities" from a human being to an animal host.

Let us look first for dignity violations of type (a), i.e. cases where beings are kept from exercising valuable capacities. One would find them in the (hypothetical) case of chimeras which do have valuable capacities, but which are prevented from exercising them because of the lab setting they are kept in. This is not a direct argument against the creation of human-animal-chimeras, but rather, parallel to inadequate treatment arguments (section C.2.c below), an indirect one. Assuming that the physical components transferred to the animal do *not* induce the development of valuable capacities, the chimera is not kept from exercising the latter and human dignity is not violated (at least not in the sense of type (a)).

For the sake of argument, Karpowicz et al. discuss the case of a whole-brain transfer from human to animal host and state:

> *"The development of such a chimera arbitrarily would limit the ways in which certain human characteristics and capacities associated with human dignity could be exercised in a nonhuman setting and therefore would contravene human dignity."*[280]

The situation of a whole-brain transfer into an animal seems, in this respect, to be similar to cases in which a human individual's body is mutilated or otherwise constricted (i.e. by drugging) in order not to exercise "valuable capacities". Accordingly, this would be a quite straightforward dignity violation of type (a). Such a procedure is wholly hypothetical, though, and certainly not what is currently understood by human-animal chimera creation.

As for dignity violations of type (b), it is doubtful here who is robbed of valuable capacities when physical components which are necessary for the former are removed and transferred to an animal host. The animal host organism cannot be the subject at issue, since it does not have valuable capacities before the transfer. If we, to follow Karpowicz et al., assume the transfer of big, undissociated portions of neuronal cells taken from an aborted fetus, we could prima facie understand this as "robbing" the fetus of something. But this approach raises several questions. Firstly, how could the fetus be robbed of valuable capacities it does not have (such as reason, being a moral agent, consciousness, etc.)? This could maybe be remedied with an argument from potential (although I am sceptical of such approaches). Secondly, and more importantly, it is to be assumed that *if* a human dignity violation takes place in the course of chimera creation with material taken from aborted fetuses, at all, it should be interpreted to take place in the act of abortion (or, in other scenarios, killing of the embryo which is created specifically for experimentation). This is the point at which the fetus can sensibly be regarded as being "robbed" of something. How its tissues are used afterwards, and, particularly, whether they are implanted into alien bodies, seems completely irrelevant regarding the primary violation that has already taken place. Finally, whether human tissue is transferred into a nonhuman body in this process, i.e. the "chimera creation" itself, does not play any role in whether we regard this as "dignity violation" regarding the embryo. Accordingly, I find it hard to identify a "dignity violation" in human-to-animal embryonic chimera creation itself – be it in sense (a) or in sense (b). If at all, this construction seems to work against all embryo-destructive research (and abortions), but is not conducive to arguing against chimera creation, in particular. Baylis, in her analysis of the prohibition of human-nonhuman primate blastocyst grafts, has similar

[280] Karpowicz, Cohen, et al. (2005), "Developing human-nonhuman chimeras in human stem cell research: Ethical issues and boundaries", Kennedy Institute of Ethics Journal, **15**(2), p. 123.

difficulties finding the point of violation of human dignity in such scenarios.[281] This critique does not rule out that a point of "dignity violation" could be identified in certain scenarios of human-animal interspecific creation in the future, but this point seems to require more clarification. Our difficulties in finding what the specific conditions of a dignity violation would be are similar to problems in the context of "boundary" arguments, where a specific, consistent principle stating what makes some kinds of species-crossing morally reprehensible while other types are neutral could not be given (see section B.3 above).

Additionally, the question may crop up whether human dignity talk is helpful, at all, when discussing human-animal chimera creation. What is so special about "human dignity"? The concept brings with it three characteristics that, I believe, are indispensable if one wants to take it seriously, at all:

(1) Firstly, human dignity is understood as something a subject either partakes in or does not partake in, i.e. an absolute value that is not doled out in degrees. Partakers in human dignity are not only different, but of a wholly different category than other beings.

(2) Secondly, a basic idea behind human dignity is the view that it does not depend on certain characteristics of the individual. The human individual does not have to jump any hurdles in order to gain this status – he or she has it, uncontestedly, in virtue of being human. Höffe, in his discussion of the concept, calls this aspect "Mitgiftwürde" (human dignity as an unmerited "dowry"), and observes that the contrasting aspect of "Leistungswürde" (human dignity as accomplishment) is, rather than being a precondition, just an appendix to this central characteristic.[282]

(3) Thirdly, human dignity approaches assume or imply speciesism, i.e. the position that human beings are fundamentally morally superior to nonhuman beings.

In addition to the assumed "inviolability" of human dignity mentioned at the beginning of this section, these three characteristics – being *absolute*, being *unconditional,* and *only applying to human beings* – are what distinguishes human dignity from other values, and therefore what distinguishes human dignity arguments from more straightforward or simple arguments that claim a plain violation of interests of living beings (i.e. arguments of the type spelled out in section C.2 below). I deem these characteristics to be indispensable, essential parts of the concept of human dignity. Yet, these very characteristics are also what could make

[281] Baylis and Robert (2007), "Part-Human Chimeras: Worrying the Facts, Probing the Ethics", American Journal of Bioethics, **7**(5), p. 202.
[282] Höffe (2002),"Menschenwürde als ethisches Prinzip", p. 132, in: Höffe, Honnefelder, et al. (eds.) Gentechnik und Menschenwürde - An den Grenzen von Ethik und Recht.

human dignity arguments problematic in the context of assessing the moral relevance of creating human-animal chimeras.

This is, firstly, because under some circumstances it might be hard to determine whether a being is human or nonhuman (think, e.g. about the humanness of the hypothetical case of a human-chimpanzee hybrid, or about the humanness of rabbit-human cybrids). Using species-membership as the determining factor for moral status, under these circumstances, might not be advisable. The assumption that every being falls clearly either into the "human" or the "nonhuman" category, and that this classification is central for the question of whether a being is accorded human dignity, is problematic. The part of "special characteristics" as preconditions for dignity, at this point, seems to be reduced to a mere appendix of the human dignity concept: If a being is human, it is accorded human dignity no questions asked, i.e. even if it does not exhibit any of the "special characteristics", or only exhibits them to a small degree. The most striking problem of using human dignity argumentation in the discussion of human-animal chimeras, then, is its inherent speciesism: Human dignity approaches assume fundamental human superiority. In the context of the animal rights debate, the assumption of "human dignity" (as opposed to any other kind of ethical value beings can have) is begging the question. The very term "*human* dignity" assumes and implies speciesism, i.e. a fundamental difference between humans and nonhumans. Baylis and Fenton identify the tension resulting from this connection in Karpowicz, Cohen et al. 2005, who work with the concept of "human dignity" and, according to their critics,

> *"want to both (a) value certain human functions and capacities for their own sake and not because they are human and (b) value certain human functions and capacities because they are human and not for their own sake. At the same time, both of these points in tension rely on an implicit appeal to a principle conferring intrinsic moral value on x if x belongs to a class A that contains members who manifest certain cognitive or emotional capacities, even if x herself does not. X is thus valued, or possesses moral significance, because x is a member of class A. In this case, the class is all humans."*[283]

That this connection between "human dignity" and "speciesism" is a necessary one is disputed by, e.g., Otfried Höffe, who states:

> *"Should there be beings with a similar capacity for reason on other planets of the universe, though, then these beings would deserve the same dignity. Arguing*

[283] Baylis and Fenton (2007), "Chimera Research and Stem Cell Therapies for Human Neurodegenerative Disorders", Cambridge Quarterly of Healthcare Ethics, **16**(2), p. 201.

> *against Peter Singer, therefore, this is not a case of morally disputable kind-egotism ('speciesism')."* [transl. CH][284]

This saving of human dignity approaches from the accusation of Speciesism does not work, in my opinion, because Höffe does not address Singer's (and other Anti-Speciesists') undoubtedly strongest argument, i.e. the Argument from Marginal Cases. A central characteristic of human dignity, for Höffe, is that it is accorded to all human beings, independently of merits or achievements. Human dignity is unconditional, innate, an unmerited "dowry" (Mitgiftwürde), and its sphere includes beings which cannot "answer for their own dignity" [transl. CH], such as babies, the mentally ill and slaves.[285] Nonhuman beings, on the other hand, are *excluded* from this sphere of beings that are accorded dignity although they also cannot "answer for their own dignity". This is because they do not belong to the biological species "human" which, according to Höffe, is not necessary but (in the case of beings who "cannot answer for their own dignity") *sufficient* for belonging to the sphere of carriers of dignity. Accordingly, human and nonhuman beings are measured by fundamentally different standards – if you are human, you are accorded dignity no matter what, if you are nonhuman, you must jump hurdles. So human dignity approaches *do* bring about speciesism. Whether that position is in fact "morally questionable", though, is a distinct issue that shall be discussed in chapter 3, section B below. Note that the success of dignity approaches, at this point, seems to crucially depend on whether Speciesism is defensible.

Let me conclude this discussion with a roundup: it appears that, if at all, only the creation of those human-animal interspecifics that are "humanized" (in the sense of having "valuable capacities" that yield superior moral importance) could be countered by human dignity arguments. However, even in these cases I found it difficult to pin down what exactly the violation of human dignity would consist in, a point that would need more elaboration by supporters of "human dignity" arguments. One argument one could make would be that *any* use of embryos for research (and abortion) is unjustifiable under all circumstances, since human embryos have valuable capacities (or at least potential valuable capacities), and destroying them robs them of the latter and thereby constitutes a violation

[284]"Sollten sich allerdings auf anderen Planeten des Universums ebenso vernunftbegabte Wesen finden, so gebührt ihnen dieselbe Würde, weshalb – gegen Peter Singer gesagt – kein moralisch fragwürdiger Gattungsegoismus ("speciesism") vorliegt.". Höffe (2002),"Menschenwürde als ethisches Prinzip", p. 119f., in: Höffe, Honnefelder, et al. (eds.) Gentechnik und Menschenwürde - An den Grenzen von Ethik und Recht.
[285] Ibid., p. 122 - "Wesen (…) die für ihre Würde nicht aufkommen können".

of human dignity. Additionally, the success of human dignity arguments depends on whether the Speciesist assumption they presuppose is defensible in some way.

As mentioned at the beginning of this section, some arguments from human dignity do not assume a *direct* violation of dignity by creation of human-animal chimeras, rather, they suspect that allowing the creation of human-animal chimeras could ignite a process which would, in final consequence, lead to dangers for human dignity. Via a slippery slope from seemingly marginal encroachment on human dignity, the collective worth of humanity could be seriously endangered (leading, in turn, to dangers for individual humans, and inadequate treatment). Arguments of the slippery slope type, which state that interspecific creation could have indirect disadvantages for human dignity, will be discussed in chapter 2, section D below, as they are consequence-based rather than intrinsic arguments.

## 5. Intrinsic arguments: Conclusion

I hope that I have made sufficiently clear in this section that intrinsic arguments might not be the best route to take when trying to argue against experiments that involve the creation of human-animal interspecifics. Arguments of the "repugnance" type and "quasi-religious" arguments are powerful and popular in the chimera debate, but they are not accessible to anyone who is not repugned by the idea of such creatures or who is not religious or believes in nature as a quasi-god, posing a teleological principle that should govern our actions. Arguments of the boundary type appear to be more promising and more accessible to debate. Still, my analysis reveals that there are several hurdles to take. Firstly, a convincing argument for (human) species realism must be made; secondly, the view that this boundary is morally relevant must be defended; and thirdly, it must be explained in how far the creation of human-animal interspecifics does violate the boundary while other kinds of mixing with nonhuman animals do not. This leaves open the questions of "species realism" or essentialism, which touches in turn on the defensibleness of some kinds of speciesism (I will come back to further discussion of this point in chapter 3 below). Thus, even boundary arguments – a type of intrinsic argument that is commonly brought forward and intuitively appealing even to non-religious people – have proven to be hard, if not impossible, to spell out in a coherent way. Dignity arguments fail for a very similar reason: it remains hard to phrase a consistent ethical principle which spells out why, and in what way exactly, the creation of human-animal interspecifics constitutes a violation of human dignity, while other kinds of "mixing" of human with animal are supposedly unproblematic.

Additionally, the concept of human dignity presupposes speciesist assumptions which, as we will see in chapter 3, section 3 below, are highly problematic.

## C. Direct consequence-based objections

Not all objectors to interspecific experimentation rely on intrinsic arguments, and indeed, powerful resistance to such research is possible without resorting to such types of objection. Let us have a look at the more tangible type of argument which refers to the possibility of disadvantageous consequences (costs) of such research. Looking at the debate around interspecific experiments from this angle, we are presented with a wide array of objections, ranging from very direct concerns (e.g. for animal welfare) to quite indirect or abstract ones. First, let us have a (relatively short) look at possible benefits of interspecific research.

### 1. The benefit side

Discussing chimerism research in a consequentialist framework would not make much sense if one would take the side of possible benefits of this research out of the equation. I will not extensively comment on the benefit side of this analysis, though, but rather give some introductory remarks in this regard.

The potential or actual benefit of experiments involving interspecific entities varies greatly – which is true for any basic, not yet directly therapeutically applicable research. Looking at Irving Weissman's (proposed) work, for example, I find it to be quite plausible that the development of disease models like the "human neuron mouse" could offer many advantages regarding the improvement of our knowledge of how brain stem cells work to advances as tangible as screening of psychiatric drugs in a environment similar to a human brain. Greely's working group comes to a similar result when assessing potential benefits of Weissman's experiments.[286]

On the other hand, there are chimerism experiments that seem to have no benefit apart from satisfying the curiosity of the researcher. Andrzej Tarkowski, a Polish embryologist and pioneer of mouse chimera research,[287] notes in his recollections regarding interspecific (animal to animal) chimera experiments:

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[286] Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5), p. 32.
[287] Tarkowski (1961), "Mouse chimaeras developed from fused eggs", Nature, **190**.

> *"For those who love experimenting in general, and in whom the childish curiosity and fantasy have not been yet completely ousted by logic and coolness of a respectful adult scientist, this is a wonderful experiment to do, but…(see below). (…) Although creation of interspecific mammalian chimaeras is indeed a spectacular experiment, in the author's opinion its contribution to embryology and genetics of mammals has been rather limited and disappointing."*[288]

The creation of interspecific (nonhuman) chimeras has turned out to be of almost no use for the embryologist, apparently. I say "turned out" since, as in all areas of research that are still in their infancy, it is impossible to predict what kinds of benefits one might one day reap from them. An area of research that seems highly promising today might turn out to be a dead end in the future, as cross-species chimerism research apparently has for embryology. Also, it is imaginable that research results that might today seem only accessible via chimerism research might, at some point in the future, turn out to be researchable by other means – chimerism experimentation might turn out to be a detour in retrospect.

A prognosis of the future successes of basic research notoriously carries pronounced uncertainties. It seems extremely hard to make any useful statement on whether interspecifics research as such, or certain areas of it, e.g. human-animal chimera or cybrid research, will reap benefits. Even regarding specific experiments, it might prove to be impossible to sensibly predict whether they will, in retrospect, turn out to have promoted scientific success in a meaningful way. This uncertainty runs deep in the character of basic research.

I will assume here that the odds are somewhat skewed towards the point of view that the bulk of research done, in the long run, is reasonable or justified in some way. The reasons for this assumption pertain not to special moral qualities or benign intentions of scientists, but to pure mechanics of the research industry. Scientists, who are confronted with a situation of scarcity – funding for basic research is hard to access – are generally not interested in wasting money and time on unjustified or unreasonable experimentation, because this would hardly further their own long-term financial and status-related interests. These advantageous mechanics, evidently, can get skewed over short periods of time or in some areas of research. For example, the crude and dangerous "revitalisation" therapies of the 1930s (see p. 23) probably do not jump the hurdle of reason; neither does Ivanov's

[288] Tarkowski (1998), "Mouse chimaeras revisited: recollections and reflections", International Journal of Developmental Biology, **42**.

work regarding the hybridisation of human and ape (p. 30).[289] The benefits of these (ultimately botched) ventures were not immediately tangible even at the time they were tried. I deem these cases to be rare exceptions from the rule that researchers usually, on average, have good reasons to believe that what they do will probably result in concrete scientific or medical benefits (this does not imply that I believe they necessarily *will* result in such benefits in all cases).

My assumption of overall reasonableness may sound trivial, yet I believe that stating it openly is important. Some popular objections to the creation of interspecifics (including the "hubris" concerns of section B.2.b above) work with or even crucially rely on the topos of the "mad scientist" who is completely cut off from common sense and allegedly does everything he does "simply because it can be done".

My analysis of consequentialist concerns will, from now on, concentrate on the cost side of the calculation, as this is what the debate focuses on. What bad consequences does (or could) interspecifics research lead to?

## 2. Bad consequences for the entities created

Many objectors to interspecific experimentation have concerns for the beings that are used in, or result from, inter-species experiments. There are arguments that work independently of the question of whether the beings qualify as "humans", but also arguments that only apply once the interspecific is identified as human or "part-human". I will begin with arguments of the former type, concerned with the protection of living beings in general (see section a below), and proceed to arguments of the latter type, concerned with the protection of human beings, or human materials/structures that qualify for special protection (see section b below). I will then discuss objections that focus on the undetermined, undeterminable or at least preliminarily unclear moral status of interspecific novel beings, which some think puts them in an especially dangerous position for exploitation and abuse (see section c below). The final part of this section will be concerned with the moral relevance of intentionally "shifting" the moral status of living beings (see section d below).

[289] Rossiianov (2002), "Beyond Species: Il'ya Ivanov and His Experiments on Cross-Breeding Humans with Anthropoid Apes", Science in Context, **15**(02).

*a. Animal welfare concerns*

Opponents to experimentation on animals in general will also come to doubt whether experimentation of the type we see in interspecific research is justified or justifiable. All types of objection given in this section presuppose a (minimum) concern for animal interests, i.e. they would not be supported by someone who thinks that animals do not feel pain, do not have "interests" in the widest sense, or that their pain or distress is not morally relevant at all.[290] Such concern usually is more pronounced concerning higher-developed animals – most prominently primates,[291] but also other mammals like rats, mice, etc. – while few would see pronounced ethical problems concerning experimentation in jellyfish or molluscs (aside from holists who, in extreme cases, assume that even natural phenomena, like rivers or forests, have "interests"). This kind of (pathocentric) argument is not limited to human-animal interspecifics, but to basically all kinds of chimeric, hybrid or transgenic novel beings.

In regard to concerns about animal welfare, the killing of research animals – which is regularly and systematically carried out in succession to completed experimental series – can be seen as a moral problem, even when it is done painlessly. This concern is, in many regards, distinct from the question whether harming animals or cruelty towards them is morally problematic. It is conceivable for someone to consistently allow for the painless killing of animals while objecting to causing animals pain in almost all circumstances (e.g. by stating that animals are not "harmed" by death because they have no continuing self-awareness), just as it is a consistent moral position to object to killing animals, in principle, while assuming that the causation of pain can be justified quite easily (e.g. because pain is reversible while death is permanent).[292]

Putting aside the question of whether painless killing of animals is problematic, the classic objection to animal experimentation, and therefore also to chimera research, is that many experiments cause notable or even extreme amounts of distress or pain in animals, and that this is not, or cannot be justified by benefits for human beings. Argumentation of this type

[290] Alternatively, indirect objections to cruelty to animals could be offered, e.g. a Kantian formulation that believes that cruelty should be avoided since it is detrimental to human character.

[291] For example, an asssessment of human-nonhuman primate neural grafting of the Working Group on the Criteria for Cell-Based Therapies at John Hopkins University states that "Some group members have serious ethical concerns over *any* use of nonhuman primates in invasive research. However, we set aside broader controversies to focus on ethical challenges specific to human-to-nonhuman primate (…) neural grafting." Greene, Schill, et al. (2005), "The Working Group on the Criteria for Cell-Based Therapies, John Hopkins University: Moral Issues of Human-Non-Human Primate Neural Grafting", Science, **309**.

[292] On the general question of animal killing, see: Singer (1979), "Killing Humans and Killing Animals", Inquiry, **22**(Summer 1979); Jamieson (1983),"Killing Persons and Other Beings", in: Miller and Williams (eds.) Ethics and Animals; Young (1984), "The Morality of Killing Animals: Four Arguments", Ethics and Animals, **5**(4).

will focus on the amount of pain or distress inflicted upon the experimentation subjects, thereby declaring such experimentation morally unjustifiable. Arguments mentioning the aspects of chimera and other interspecific research that are detrimental to animal welfare are brought forward by Rollin[293] and (more indirectly) by Urie, Stanley and Friedman.[294] The latter call for a standard in scientific and medical experimentation that requires "full disclosure and informed consent (…) regardless of species", which would most probably rule out any use of animals in science, not only in the field of chimera or interspecific research.

The general discussion of animal use in science aside, let us have a look at one animal welfare aspect that is specific for research involving the creation of chimeras: interspecific chimeric animals (be it human-to-nonhuman or animal-to-animal) are especially prone to developing severe and debilitating or fatal medical problems. Interspecies chimerism experiments produce adult animals in only a small minority of cases: the bigger the "genetic gap" between the species involved, the bigger the risk of severe malformation – most interspecific chimeras, therefore, die off before birth. Bernard Rollin hints at a similar problem with regard to transgenic beings when asking: "[M]ight hybrids be harmed or diseased in some way simply because they are transgenic?"[295]

Rollin also mentions other fears concerning what he calls the "plight of the creature" – he speaks of "harming animals for human benefit, as in genetically engineering suffering animals as models for human disease", and asks:

> *"Would we enslave them (as when rumors were rife about genetically engineering human traits into chimps so that they could perform tasks that human beings abhor)? Would we create them as cannon fodder?"*[296]

This is not a direct argument against chimera creation; we could treat the newly created beings appropriately, after all. In contrast to concerns I will address in section c below, Rollin is not up in arms against such enterprises because he thinks animals infused with human genetic material deserve, as such, special protection that would not be granted in animal testing labs: using "normal" animals as "cannon fodder" would, in principle, be just as problematic for Rollin, who embraces a non-speciesist, pathocentric perspective.

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[293] Rollin (2003), "Ethics and Species Integrity", American Journal of Bioethics, **3**(3).
[294] Urie, Stanley, et al. (2003), "The Humane Imperative: A Moral Opportunity", American Journal of Bioethics, **3**(3).
[295] Rollin uses "hybrid" and "transgenic" in a very wide sense here, probably denoting all kinds of "altered" beings - Rollin (2003), "Ethics and Species Integrity", American Journal of Bioethics, **3**(3).
[296] Ibid., p. 17.

*b. Concerns for human embryos, gametes, and genes*

In chapter 1, section B.4 above,, we saw that, in many cases, research resulting in human-animal interspecifics of diverse kinds uses human embryonic cellular material. Human-to-animal chimeras are typically made by introducing human embryonic stem cells, or cells derived from hESC lines, into animal organisms. Ebryonic stem cells are obtained from embryos in an early stage of development, and are especially useful for research because of their pluripotency.

It is argued that any research that destroys human embryos warrants very careful ethical consideration and justification, or even that such research is not justifiable, at all; because human embryos have a special moral status – be it because they belong to the species *Homo sapiens* (argument from species membership), because of the moral continuum from conception to birth (argument from continuity), because they are identical with the "fully human" being they will be later on (argument from identity), or because they have the potential to become such a "full" human being (potentiality argument).[297] The protection of the human embryo can be limited, or it can be seen as growing continually along a developmental scale, but it can also amount to the view that the human embryo deserves the same full amount of protection any adult human warrants from conception on. Some have argued that every type of experimentation with human embryos should be completely banned;[298] this demand would certainly also extend to all kinds of human-animal chimeric experimentation which involves the use of human embryos. Many, if not most, of these arguments for the special protection of human embryos are grounded in Speciesist assumptions (see chapter 3, section B below).

Human fetal tissue used in interspecific research is usually obtained from intentionally aborted fetuses because this source has numerous advantages to using spontaneously aborted or stillbirthed fetuses (i.e. cells are fresher and in better condition, usually not tainted with pathogens or carriers of genetic disorders). Especially in the U.S., where abortion remains a controversial topic, there has been an ongoing debate since the 1980s about the propriety of using human fetal tissue from fetuses that have been intentionally aborted.[299] "Pro-life" positions aside, even many "pro-choice" advocates would probably not support research that relies on fetuses that would otherwise not have been aborted.

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[297] For a comprehensive overview, see Damschen and Schönecker, Eds. (2003), Der moralische Status menschlicher Embryonen.

[298] See e.g. Annas, Andrews, et al. (2002), "Protecting the Endangered Human: Toward an International Treaty Prohibiting Cloning and Inheritable Alterations", American Journal of Law & Medicine, **28**.

[299] Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5), p. 33.

Intentional abortion – or even abortion forced on unwilling or persuaded and pressured women – in order to obtain fetal material is a scenario that makes a vivid argument against the use of fetal tissues. Use of fetal tissue from intentionally aborted fetuses does not necessarily lead to a rise in abortion numbers or to pressuring women into abortion, though (although the possibility that individual womens' choices are skewed towards abortion as soon as they know that "it might do some good" probably cannot be completely ruled out). The topic of abortion and the closely connected fetal tissue research debate cannot be discussed here in detail. Many or even most of the experiments discussed in chapter 1 would be exposed to arguments against research using human embryonic stem cells and fetal tissues, as mentioned in my excursus on the legal situation of chimera research (chapter 2, section D above*).* Chimera creation which makes use of *adult* stem cells or precursor cells would avoid the discussion around embryonic stem cell use, on the other hand.

It is controversial whether the creation of nucleo-cytoplasmic hybrids (cybrids, see p. 32) can be said to constitute a "use of human embryos" – after all, what would purportedly be used is only a human cell nucleus implanted into an enucleated animal egg. Views which assign full moral status to human beings after the fusion of egg and sperm do not, prima facie, understand cybrids as human embryos, since no egg and sperm are involved and fusion in the traditional sense does not take place. It would also be quite difficult to construe identity, potentiality, species membership or continuity arguments for cybrids: they will not and, it is said, cannot possibly develop into adult beings, so they are not identical with humans, there are no potential humans, nor do cybrids slide on a "normal process"-continuum towards humanness. As is plausibly argued, the cybridic being could be considered a "human embryo" in a wider sense (being used as source of human embryonic stem cell lines and having just a very small part of nonhuman DNA in its mitrochondiae). The ethical characterisation of the cybrid should take these factors into account. In this sense, at least an argument from species membership could probably be construed in the favour of outstanding moral status in human-animal cybrids and therefore, indirectly, against cybrid experimentation which ends in destruction of the cybrid. Again, such an argument would depend on the defensibility of Speciesist assumptions which will be discussed in chapter 3, section B below..

Some see the human gamete (egg or sperm) as precursor of human life that requires special protection. The circumstances of the harvestation of these materials are regulated in most countries, and so is their use (some legislations, e.g., forbid the sale of human eggs and/or

sperm). It is therefore easy to infer that creation of human-animal hybrids by fusion of gametes would cause many ethical concerns just in regards to the protection of human gametes (apart from the numerous other ethical concerns such an undertaking would give rise to).

Due to considerations similar to those concerning gametes, human-typical genetic sequences ("human genes") are, by some, regarded as deserving special safeguarding against commodification and utilisation – this concern would affect the creation of transgenic beings which are manipulated to contain sequences of human genome.

Finally, Hank Greely's 2007 working group résumé points out that human tissue also warrants respectful, especially careful handling (derived from special treatment that is usually reserved for human bodies). Different cultures might have very different views on what kind of behaviour is appropriate concerning human tissue – some organs might have special symbolic value, e.g. the heart and especially the brain which is today, by many, seen as the "seat of consciousness". Human-animal interspecific chimera bodies which contain human tissue should, according to these considerations, be treated as medical waste that is properly disposed of; the consumption of human-animal chimeras by other animals should be avoided.[300]

While the human embryo is, by many, seen as having a "value in itself", concerns for the proper handling of gametes, genetic material and tissue do not rely on such an inherent value, but rather see the careful handling and non-commodification of these as indirectly conducive to other goods, e.g. "human dignity".

Let me recapitulate the main types of concern regarding human precursors or, more generally, human biological materials human-animal interspecific experimentation can lead to:

- The concern of unjustified or unjustifiable use of *human embryos* (via hESC use, applies to many human-animal chimeras and maybe also to cybrids)
- The concern of unjustified or unjustifiable use of *human gametes* (applies to all human-animal hybrids)
- The concern of unjustified or unjustifiable use of *human-typical genetic material* (be it from transplanting a whole nucleus – applies to cybrids – or genome sequences – applies to human-animal transgenesis)

[300] Ibid., pp. 34-35.

- The concern of inadequate use or treatment of dead or live *human tissue* (applies to all kinds of human-animal interspecifics).

These types of concern have not yet been extensively addressed in bioethical discussions of chimera experimentation (apart from Greely, Cho, et al.).[301] This is because they are seen as belonging to or stemming from different kinds of bioethical debates (i.e. the stem cell debate, the abortion debate, the debate around patentability of human genes, the debate around the proper handling of human gametes e.g. regarding contraception, and the questions surrounding proper treatment of medical waste, which are discussed in medical ethics). Still, these aspects are important to mention as potential costs of chimera, hybrid or cybrid experimentation involving human material.

*c. Concerns for novel interspecific beings: Inadequate treatment*

Both the concern for animal welfare and the concern for human embryos and proper treatment of human material have their source in the idea that nonhuman beings – or human embryos – could, as a result of chimera or other interspecific experimentation, be treated in a way that is not in accordance with their moral status. Going further, some claim that what is at issue is the proper treatment not of nonhuman beings (cf. animal welfare) or all-human beings (cf. embryo protection), but the treatment of "part-human" beings. In contrast to Rollin, they say that creation of human-animal chimeras is despicable precisely and particularly because it puts *part-human* beings in a bad situation.

Chakrabarty, for example, fears that in a not-so-distant future human-animal hybrids could be created for "organ harvesting, for use as subhuman species to perform hard manual labors, or simply for curiosity's sake."[302] He points out that this would be legally problematic since it is conceivable that such a hybrid could fall under the protection of the Thirteenth Amendment (which forbids slavery and ownership of human beings). The real question behind this is a moral, not just a legal one: shouldn't a "part-human" at some point be granted human rights? If yes, this could mean that the exploitation of such beings should be tightly controlled and in parts restricted – because we are morally bound not to treat part-humans the way we treat "normal" lab animals, livestock, or pets.

One common concern for the "part-human" novel being is that it is wronged because the circumstances it is born into allow it – it is to be used as a subject of experimentation. As I noted in my discussion of Rollin's objections, this is not a direct argument against the

[301] Ibid.
[302] Chakrabarty (2003), "Crossing Species Boundaries and Making Human-Nonhuman Hybrids: Moral and Legal Ramifications", American Journal of Bioethics, **3**(3), p. 21.

creation of chimeras – after all, one could create them and then treat them royally – however, it seems to be a valid objection, since hardly anybody would have an interest in creating disease-models or research subjects that are then not to be touched. Streiffer (2005) points out:

> *"So long as experiments that involve the xenotransplantation of human stem cells into animals are overseen by animal research oversight committees (…), the wrong, or an incomplete, set of moral protections is likely to be afforded to status enhanced chimeric research subjects."*[303]

Streiffer adds that researchers could guarantee "adequate protections" for humanized research subjects, but that then, the main objective of chimera creation would be void: most research could not be performed on subjects who are granted the same protections as human beings, and even if they could, why then not simply do them on human beings, which would be even better models? The danger of inadequate treatment seems to constitute a catch-22 of human-animal interspecific research. As we have seen, this type of research is based on the assumption that human-animal chimeras have the "advantage" that they can be treated like animals – should their moral status be elevated to that of human beings, their creation would become useless. At the same time, the scientific justification for creating chimeras usually depends on the claim that they are demonstrably humanized (i.e. exhibit human-typical properties that are relevant for research).[304]

When the Working Group on the Criteria for Cell-Based Therapies at John Hopkins University considered the scenario of human-to-nonhuman primate neural transfer, it identified several issues as potentially morally problematic – most prominently, the development of "humanlike cognitive capacities relevant to moral status" in the altered primate.[305] Humanization of the primate, in this relevant sense, cannot be ruled out according to Greene, Schill et al., and it can be seen as a "risk to avoid", since it could lead to beings that are not treated according to their moral status, and to "greater capacity for suffering that would add to existing concerns about the harms caused by inadequate

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[303] Streiffer (2006), "At the Edge of Humanity: Human Stem Cells, Chimeras, and Moral Status", The Kennedy Institute of Ethics Journal, **15**(4), p. 362.

[304] Robert acknowledges an analogous dilemma in regard to "human dignity" concerns, noting that "those studies that are least scientifically contestable (…) are those that are apparently most morally controversial in terms of human dignity, while those studies that are most scientifically problematic (…) are those that are apparently least morally controversial in terms of human dignity." Robert (2006), "The science and ethics of making part-human chimeras in stem cell biology", Journal of the Federation of American Societies for Experimental Biology, **20** p. 843.

[305] Greene, Schill, et al. (2005), "The Working Group on the Criteria for Cell-Based Therapies, John Hopkins University: Moral Issues of Human-Non-Human Primate Neural Grafting", Science, **309**.

conditions for [nonhuman primates] in research."[306] In their 2007 résumé on Weissman's human neuron mouse scenario, the Greely Working Group comes to the similar conclusion that "human consciousness trapped in a mouse's body would truly be cruel treatment" although it "seems extremely unlikely."[307]

Johnston and Eliot's critical assessment of the consequences of chimerism experiments between humans and animals states that:

> *"Intentionally creating compromised human beings or part-human beings is cruel to the creature created (it is, for example, a laboratory subject created for the purposes of experimentation, able to exercise only compromised human facilities, likely to be kept in a cage, and perhaps not able to fend for itself.)"*[308]

Clearly, the concern for inadequate treatment of human-animal chimeras is closely connected with concerns that the moral status of the latter is hard to determine or even altogether indeterminable. This point – which I call "moral confusion" – will be dealt with in chapter 2, section D below.

*d. Concerns for novel interspecifics: Shifting moral status*

Another possible concern could be based on the view that shifting the moral status of a being *as such* could be morally problematic – that is, independently of the danger of inadequate treatment described above. Some of the concerns cited above seem to point in this direction, namely the notion of the "compromised human being" employed by Johnston and Eliot,[309] – which evokes the picture of a human being that has been violated in some way – and the fears that human consciousness could be "trapped" in a mouse's body used by Greely et al.[310] *Apart* from jeopardizing human-animal chimeras by putting them in environments that are not in accord with their demands and thereby violate their moral status, could it simply be wrong to transfer an individual from one level of moral status to a considerably higher or lower level? Could it be wrong to "shift" the moral status of a being? Could the subject of such a "shift" be violated by it?

We might approach this question by first asking who would possibly be the subject of the moral status shift. Assume, for simplicity's sake, that there is a status-unambiguous or at

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306 Ibid.
307 Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5), p. 34.
308 Johnston and Eliot (2003), "Chimeras and "Human Dignity"", American Journal of Bioethics, **3**(3), p. W7.
309 Ibid.
310 Greely, Cho, et al. (2007b), "Thinking About the Human Neuron Mouse", American Journal of Bioethics, **7**(5).

least relatively status-fixed being to begin with. In this context, it is useful to distinguish between two different types of scenarios: "Downshift" and "Uplift".

Let us first have a look at an example of "downshift". In a scenario, for example, where a human embryo is subject to neural xenografts with animal neurons which render its brain cognitively inferior to typical human brains or which let its brain develop into an organ that is below the functional standard it would have reached without intervention, we can sensibly understand this subject as being "compromised" or violated. A being that would otherwise have developed into something with exceptional cognitive capacities would have been harmed by chimerizing it; for some, its moral status would (at least prima facie) "shift down" since it could not fulfil criteria like self-awareness or consciousness anymore. Similarly, it would seem abhorrent to subject a human being to a xenografting procedure that would make it *look* like a nonhuman animal – for many, human appearance signals or even constitutes a criterion for high moral status, which in turn, a human with a nonhuman face, furry skin or an animal body would be denied. Chimerisation of humans would be comparable to other cases where human beings are intentionally violated or deprived of necessities and thereby lose important cognitive capacities (or other morally relevant properties), e.g. by mutilation, drugging, or other medical intervention that renders the victim incapable of higher "typically human" capacities. It seems indisputable that such actions would be morally wrong.

Fortunately, chimeric and other interspecific manipulation is usually not done on human embryos – among other reasons, certainly because it is widely recognized that shifting down the moral status of a human embryo or adult by massive chimeric/transgenic introductions would be morally reprehensive and constitute a massive violation.[311] Xenografts into adult humans (e.g. in Parkinson's stem cell therapy trials) are not substantial enough to influence the brain's functioning or lead to "downshift", though they apparently can infer damage on the brain by leading to tumours. Other xenografts, such as small graft transplants of skin and tissues, have even less influence on the human organism (and on morally relevant properties). Downshifting the moral status of human beings by chimerizing them, then, is not what is at issue when pointing out that "shifting" moral status could be problematic.

[311] The experiments of Rosenwaks – see p. 26 – are a rare exception; even in their case, it is hard to argue that the human embryos which were transgenically manipulated were "compromised" – Rosenwaks used embryos with a chromosomal defect, which had no potential to grow into full embryos, much less adults. See Zaninovica, Haoa, et al. (2007), "Genetic modification of preimplantation embryos and embryonic stem cells (ESC) by recombinant lentiviral vectors: efficient and stable method for creating transgenic embryos and ESC", Fertility and Sterility, **88**(Supplement 1).

What, on the other hand, about the second possibility mentioned above - "uplift" scenarios? How should we regard the possibility that the moral status of animals could – hypothetically – be shifted upwards by the introduction of human material? Could this be understood as constituting a "compromising" of animals, or how else should it be interpreted?

The improvement or "humanization" of (usually: mental) capacities of animals by technical means has been a subject of fiction since at least 1896, when H.G. Wells published "The Island of Dr. Moreau".[312] Wells was deeply influenced by the public debate of vivisection in his time. In Wells' haunting novel, a misguided physiologist tries to transform animals into humans by means of painful surgical procedures. These procedures give the animals involved an appearance bordering on humanness, but also apparently greatly improves their mental capacities – they begin to master language and even show interest in moral rules. Dr. Moreau, who has no justification for his experiments but pure curiosity, is ultimately killed by one of his wayward creations, a "humanized" puma. The scenario of "biological uplift" of animals has inspired dozens of books and movies since Wells' time. What makes these stories special is the wide chasm between two possible points of view. Uplift-negative approaches, such as Wells', assume that using technology to alter animals in order to make them more human is evidently wrong. Moreau's creatures, for example, are portrayed as deeply conflicted and ultimately unable to retain control over their horrifying, ugly and violent "animal side" (here, Wells may be telling us more about the Victorian idea of man than about the dangers of vivisection). The narrator's attitude is not one of compassion or pity towards the botched "Beast Folk", but rather one of intrinsic, intuitive rejection of and disgust at the mixed beings living on Moreau's island. Uplift is portrayed as wrong because it is predetermined to result in preternaturally evil or at least dangerous creatures. Contemporary works of fiction have a very different attitude towards "uplift", describing it as ambiguous, neutral or even positive.[313]

Since the recent progress of interspecific research, the idea of an – intentional or unintentional – "uplift" of nonhuman creatures, i.e. their endowment with properties or capacities that are seen as essentially human (and relevant for human moral status), is not limited to Science Fiction anymore. Bioethicists' considerations usually focus on the improvement or change of mental capacities, such as intelligence and self-awareness. To

[312] Wells (2005/1896), The Island of Doctor Moreau.
[313] The most prominent example of uplift-positive works of fiction is David Brin's "Uplift Universe," series of Science Fiction novels, starting with Brin (1980), Sundiver.

give but two examples of reputable institutions analysing the ethical import of such scenarios, as mentioned above, the 2005 John Hopkins Working Group concerned with the introduction of human neural cells into primate brains considered the possible "humanization" of the nonhuman-primate.[314] Similarly, the 2007 guidelines of the ISSCR committee forum for chimera research involving human material explicitly consider "research with the known, intended, or wellgrounded significant potential to create humanized cognition, awareness, or other mental attributes."[315]

Just as in the fictional examples we looked at, bioethicists' reactions to "uplift" scenarios are deeply divided: some regard this possible consequence of interspecies mingling as evidently morally wrong, while others have a prima facie neutral or even positive approach.

Commentators that are prima facie uplift-negative include Ramaswamy, who states that

> *"If a human-animal chimera (such as a monkey with a human-like brain) comes to possess any of these qualities [i.e. the capacities for language, consciousness, or rationality], then it would be morally objectionable to create that organism. (…) In cases where there is a reasonable possibility of transferring quintessentially human capacities to a chimera, scientists must stop short of actually creating it."*[316]

Similarly critical of uplift scenarios is Cynthia Cohen, who is afraid that chimerism experiments could "turn animals into humans" (which, she implies, would be a very bad thing and should definitely be avoided).[317] Note that these objections centre on the mere fact of "uplift", rather than on the danger of inadequate treatment that could be the consequence of uplift.

Uplift-negative views are seldom argued for and more often simply taken as granted. Criticizing this tendency, Baylis and Fenton remark that the view that "enhancing the psychological and cognitive capacities of nonhumans is a priori a bad thing" is in urgent need of "critical examination".[318] Baylis and Fenton are not the only ones to have recognized this need: the John Hopkins Working Group on Human-nonhuman primate neural grafting mentions as an aside that a "humanization" of the nonhuman primate could

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[314] Greene, Schill, et al. (2005), "The Working Group on the Criteria for Cell-Based Therapies, John Hopkins University: Moral Issues of Human-Non-Human Primate Neural Grafting", Science, **309**.
[315] Hyun, Taylor, et al. (2007), "ISSCR: Committee Forum - Ethical Standards for Human-to-Animal Chimera Experiments in Stem Cell Research", Cell Stem Cell, **1**(2), p. 162.
[316] Ramaswamy (2007), "The Chimera Question", The Boston Globe, 2007/07/16.
[317] Cohen (2003), "Creating Human-Nonhuman Chimeras: Of Mice and Men", American Journal of Bioethics, **3**(3).
[318] Baylis and Fenton (2007), "Chimera Research and Stem Cell Therapies for Human Neurodegenerative Disorders", Cambridge Quarterly of Healthcare Ethics, **16**(2), p. 205.

also be seen as a "potential benefit to the engrafted animal, insofar as the changes are viewed as enhancements of the sort we value for ourselves."[319] Robert Streiffer, too, points out that moral status enhancement – apart from problems of inadequate treatment – is "prima facie good" for the research subject.[320]

Apparently, an argument from moral status shift is not viable *against*, but maybe can be used *in favour* of the creation of certain types of human-animal chimeras. It seems highly unlikely that this position will ever be used in a serious manner to justify human-animal chimerism experimentation – the interests of research into interspecifics are tightly bound to possible human benefits, not to "making humans out of animals".

But still, I find the question of how to react to the slightest evidence of the development of human-like cognitive capacities in chimeric research subjects hard to answer exactly because of this puzzling aspect of "humanization". The termination of experiments struck by such developments seems unavoidable (and is advocated, e.g., by the John Hopkins Working Group and Robert Streiffer), but how does one justify the killing of an experimental subject on the grounds that it "became too human"? After all, beings that are in the delicate process of developing into a creature that has the full array of human-typical features are seen as morally valuable and worthy of protection in many ethical approaches exactly *because* they are just undergoing this process. This is known as the "argument from continuum" in the discussion of the moral status of the human embryo – wouldn't supporters of such arguments have to fend for the not-yet-wholly-human chimera or cybrid, too? If the creation of a human life, or life that displays typically human capacities, is seen as a prima facie positive thing, would that not also include the creation of human life via "making animals human"? I haven't spotted arguments of this orientation in secular bioethics, but one point of view that points in this direction is maybe found in Roman Catholic Bishops' view that the carrying to term of chimeric or hybrid human-animal embryos, once they exist, should be allowed (although the Catholic Church is distinctly against the creation of such chimeric embryos).[321]

Apart from these – highly speculative – remarks, let us note that we have found status shift, as such, not to be a problem in current or likely future chimera research. Experimentation would, if at all, lead to upshift of animal xenograft hosts rather that downshift of human

[319] Greene, Schill, et al. (2005), "The Working Group on the Criteria for Cell-Based Therapies, John Hopkins University: Moral Issues of Human-Non-Human Primate Neural Grafting", Science, **309**, p. 386.
[320] Streiffer (2006), "At the Edge of Humanity: Human Stem Cells, Chimeras, and Moral Status", The Kennedy Institute of Ethics Journal, **15**(4), p. 348.
[321] Gledhill (2007), "Human-animal hybrid embryos should be legal says Catholic Church ", Times Online, 2007/05/27.

subjects. Downshift seems to be clearly morally wrong, just like other kinds of mutilation or detrimental manipulation of human beings.

The question of whether the "enhancement" of nonhuman beings in order to outfit them with characteristics we find desirable in humans is advisable or even obligatory will not be discussed here. Although the enhancement question is highly interesting,[322] I believe it does not play a big role in what human-animal interspecific research is currently concerned with.

All this does not affect our result from c above, i.e. that inadequate treatment of human-animal (and other) chimeras because of undetermined or even indeterminable moral status could present us with a considerable problem.

## 3. Bad consequences for human populations: Health risks

Objections to chimera experimentation are not only based on consideration for chimeras or other interspecifics, i.e. the novel beings created. There are also direct concerns for the security and health of already existing beings – especially human beings. The most concrete concern of this type is the thought that experiments that involve cross-species grafts could lead to or heighten the risk of diseases.

In this respect, xenotransplantation/xenografting is associated with two types of health risk: risks that only concern the host individual, and risks that also concern others.

Several types of risk are considered that are limited to the recipient of nonhuman material: *Immunoresponse*, i.e. the risk that the recipient has an immediate adverse reaction to animal material; *Tumorigenicity*, the risk that the recipient has long-term adverse reactions to the animal material, and *Zoonosis*, the risk of contracting a disease via transferred animal material. A connected third-party risk that would also affect non-recipients is seen in the scenario of an epidemic or even *pandemic* spread of zoogenic pathogens.

My introduction to xenotransplantation (chapter 1, section B.5 above) already explained that immunoresponse was, and still is, a serious problem for transplantation from animal to human recipient, especially when whole organ transplants are considered. Immunoresponse in xenotransplantation is much stronger than in allotransplantation. Additionally, with the porcine material that is commonly used, this risk is even more pronounced than it would

[322] The question of "enhancement" is, today, predominantly discussed in regard to humans; though, e.g. Hughes explicitly mentions as a future challenge to politics "The intellectual enhancement of animals, forcing a clarification of the citizenship status of intelligent non-humans."Hughes (2006),"Human Enhancement and the Emergent Technopolitics of the 21st Century", in: Roco and Bainsbridge (eds.) Managing Nano-Bio-Info-Cogno Innovations: Converging Technologies in Society.

be with material from more closely related species (i.e. nonhuman primates). Immunoresponse is usually the most massive problem preventing or complicating xenotransplantation.

Tumorigenicity, on the other hand – i.e. the disposition of certain material to lead to the formation of tumours in the recipient – is a problem for embryonic stem-cell-based therapies. Stem cells have the advantage of being able to "morph" into several types of cells, but also the disadvantage of sometimes morphing into a teratoma, a certain type of tumour. This risk is also present in interspecific grafts,[323] and thus must be considered in cases where animal embryonic stem cells are xenografted into human hosts. Immunoresponse and tumorigenicity are risks that are not specific to xenograft/-transplantation but also known from allotransplantation.

Things are even more complicated concerning the risk of pathogen transfer. A disease that is subject to trans-species transmission from animal to human is commonly called zoonosis. The danger of zoonoses has been discussed and recognized as a severe problem in the context of xenotransplantation. Here, apart from the danger of an infection of the individual recipient, there is a much bigger danger: that of a xenogenic epidemic or even pandemic which could potentially kill thousands or even millions of people.

For understanding this risk, it is important to realize that the precursors of many or even most of the most dangerous and ravaging diseases throughout human history – bubonic plague, typhus, measles, smallpox, influenza, HIV, and many others – were originally transmitted from animals to humans. The "jump" of a pathogen from one species to another, i.e. a shift of the disease host, brings the risk of a pandemic – this is what happened when the SARS virus "jumped" from civet cats to humans, and this is what scientists fear is about to happen in the case of porcine influenza (swine flu) and/or avian influenza (bird flu). The transmission of such viruses to humans and the associated pandemic risk is a constant matter of concern for epidemiologists.

In the case of xenotransplantation, there is a quite specific zoonosis concern: it is feared that a cross-species jump of porcine endogenous retroviruses (PERVs) could produce a virus that recombines with human DNA and results in a highly pathogenic, fatal virus aimed at human hosts (such as the HI virus, which probably originates from a retrovirus in chimpanzees, SIV). If there is a danger of "species jump" and pandemic, transplanting

[323] E.g. in a case were a cell line derived from pig embryonic stem cells was transferred to diabetic mice – see Fujikawa, Oh, et al. (2005), "Teratoma Formation Leads to Failure of Treatment for Type I Diabetes Using Embryonic Stem Cell-Derived Insulin-Producing Cells", American Journal of Pathology, **166**(6).

living body parts of one species into another seems to be a surefire way of increasing this risk, since live xenografts make it hard to eliminate eventual pathogens. Additionally, xenografting eliminates virtually every barrier viruses usually face when crossing from one species to another – keeping in mind that strict immunosuppression is necessary in the host. Previous zoonoses have emerged because of close contact with animals or their excrements, or because of consumption of animal products – in comparison, the introduction of live material into the (immunosuppressed) host organism itself seems to be an even closer kind of contact between species, and to open the door to species jumps. Normal pathogens, in this context, do not constitute such a big danger of xenozoonosis, since they can be eliminated before introduction of animal material into the human organism, by keeping the animals under "specific pathogen free" (i.e. partly sterile) conditions, vaccination, and by breeding selection for uncontaminated animals. Endogenous retroviruses are characteristically wired into the DNA of animals, though – they are integrated into the genome of their host organism, not acquired by infection, and cannot be removed from the tissue nor can one selectively breed uncontaminated animals. All vertebrates have such endogenous retroviruses that do not figure as pathogens in the original species, but which have pathogen potential when transferred to other species, leading to immunosuppression or tumours in the host, and possibly to a disease that can also be transmitted to other humans (or other species). The question of whether being subject to porcine (or other) xenotransplantation leads to a high risk of PERV (or other, especially primate, ERV) zoonosis is a highly complex one which cannot be discussed in depth here – it seems that studies have come to the conclusion that, though PERVs can transfer to human material in test-tube settings,[324] transmission in subjects of pig-human xenograft of living material is not easily established.[325] An EU study done in 2003 comes to the conclusion that nonhuman primate material should not be used for xenotransplantation because of xenozoonosis risk of easily transmittable primate endogenous retroviruses, while pig material can be used as long as certain safety measures are in place.[326] The moratorium on clinical xenotransplantation that was demanded in the 1990s[327] and which

[324] Patience, Takeuchi, et al. (1998), "Infection of human cells by an endogenous retrovirus of pigs", Nature Medicine, **3**.
[325] E.g. a search for transmission of PERVs to 160 human subjects 12 years after they had been treated with living pig tissue was unsuccessful, see Paradis, Lanford, et al. (1999), "Search for Cross-Species Transmission of Porcine Endogenous Retrovirus in Patients Treated with Living Pig Tissue", Science, **185**(5431).
[326] Working Party on Xenotransplantation (CDBI/CDSP-XENO) (2003), "Report on the State Of The Art in the Field of Xenotransplantation ."
[327] E.g. Bach and Fineberg (1998), "Call for moratorium on xenotransplants", Nature, **391**(6665); Butler (1998), "Last chance to stop and think on risks of xenotransplants", Nature, **391**(6665).

was, de facto, in place in many countries at the end of the century has today in most nations been replaced by more stringent control and regulation.[328]

What about the risk of zoonosis in other types of interspecifics? The Scottish Council on Human Bioethics regards zoonoses as a risk to be considered when thinking about "human-animal mixtures" (of chimeric and transgenic origin – i.e. not only products of "classic" whole organ xenotransplantation). The council concludes that

> *"This infectious danger is therefore sufficiently serious to induce physicians and biologists to publicly raise the question of whether it is ethical to allow humankind to run the risk of devastating and uncontrollable pandemics since animal-human mixtures will never concern more than a limited group of procedures."*[329]

In the case of transgenesis and (micro)-chimerism, the risk of epidemics is crucially lower than in the case of xenotransplantation. This is simply because the (animal) host does not or at least need not necessarily come into contact with humans which would allow contamination with potentially dangerous new pathogens. Unlike in organ xenotransplantation, the danger of zoonosis can be limited to the animal host which can easily be subject to stringent control (as compared to free-roaming human transplant recipients).

The scenario of a zoonotic infection and resulting epidemic is even more unlikely in the case of cybrids – the UK Academy of Medical Sciences report of 2007 judged this risk to be "not greater than" in normal (non-interspecific) cell cultures.[330]

## 4. Risk, uncertainty, and precaution

In regard to assessing the risk potential of new technologies, especially biotechnology, some argue that the standard approach of Risk-Cost-Benefit-Analysis (RCBA), which tries to take into account all kinds of foreseeable health risks, is not sufficient and even inapplicable and misleading.

For example, Hans Jonas, in his influential 1979 book "Prinzip Verantwortung" ("The Imperative of Responsibility") argued that, as modern technologies' consequences are

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[328] Ravelingien (2006), "Pig Tales, Human Chimeras and Man-Made Public Health Hazards. An Ethical Analysis of Xenotransplant Benefits and Risks", Ghent University Faculty of Arts and Philosophy, p. 100.
[329] Scottish Council on Human Bioethics (2006), "Ethics of animal-human mixtures. Embryonic, Fetal and Postnatal Animal-Human Mixtures: An ethical discussion. "
[330] Academy of Medical Sciences (2007), "Inter-species embryos - A report by the Academy of Medical Sciences", www.acmedsci.ac.uk.

becoming harder and harder to predict, and, more importantly, as we are presented with technology risks which could wipe out humanity, one should apply a "heuristics of fear", a pessimistic outlook that assumes that negative scenarios will indeed take place (even though they may seem extremely unlikely).[331] Normal Risk-Cost-Benefit-Analysis, Jonas argued, is prone to neglect highly unlikely scenarios, even if they have full catastrophic scale, and is therefore not the appropriate means of devising how to handle powerful tools like nuclear power or advanced biotechnology. In a similar approach, Gregory E. Kaebnick mentions a "precautionary principle" that can be distilled from intrinsic arguments and argues that we should adopt a "preservationist attitude" in regard to biotechnology.[332]

Can we make sense of a precautionary principle outside of intrinsic concerns discussed in section B above? Could such an argument for precaution be used against the creation of human-animal interspecifics?

The problems of standard RCBA are comprehensively outlined by Timothy Lewens:[333] comparing the consequences of different scenarios poses one evident problem, another is the fact that RCBA which makes use of economic methods does not offer an objective assessment of values, but rather tells us how average persons would allocate resources. RCBA also does not deal with distributional issues: who is at risk and who, on the other hand, reaps the benefits of the risk taken is by many considered to be relevant for moral consideration, but this aspect is not captured in RCBA. These points make it clear that RCBA approaches are not about replacing ethical analysis with juggling numbers, but that RCBA must necessarily be preceded or complemented by decisions about ethical values.

Precautionary principles are at the basis of many regulatory policies regarding risk management – they "dominate most European regulatory policy",[334] and are e.g. expressed in the 15th principle of the 1992 Rio Declaration on Environment and Development,[335] feature in professional medical ethics codes like the Hippocratic oath and the related *primum non nocere,* and are also captured in proverbs like "better safe than sorry". The de facto moratorium on xenotransplantation that was in place in many countries at the end of the last century was based on such precautionary principles.[336]

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331 Jonas (1979), Das Prinzip Verantwortung. Versuch einer Ethik für die technologische Zivilisation.
332 Kaebnick (2000), "On the Sanctity of Nature", Hastings Center Report, **30**(5), p. 22.
333 Lewens (2007),"Risk and philosophy", in: Lewens (ed.) Risk: Philosophical Perspectives.
334 Ibid.
335 Cf. Sandin (2007),"Common-Sense Precaution and Varieties of the Precautionary Principle", p. 99, in: Lewens (ed.) Risk: Philosophical Perspectives.
336 Cf. Ravelingien (2006), "Pig Tales, Human Chimeras and Man-Made Public Health Hazards. An Ethical Analysis of Xenotransplant Benefits and Risks", Ghent University Faculty of Arts and Philosophy, p. 100.

The adoption of a "precautionary" approach is typically advised when we are confronted with ignorance regarding the potential consequences of an action – RCBA can only usefully be applied to situations in which we have a basis of past experience or data points to draw on and extrapolate from. In cases where probability distributions of consequences are unknown or potential consequences are unclear because we have no previous similar cases to compare the new scenario with, it is argued that following a precautionary principle would be advisable.

Is the creation of interspecific (particularly human-nonhuman) beings a case where a principle of precaution should be applied? And if yes, what would such a principle tell us?

As mentioned above, precautionary principles typically come into play when we are confronted with ignorance concerning the potential outcomes of an action. This would be the case in regard to genuinely novel types of actions, which have not been done before, or which are sufficiently different from types of actions done before that extrapolation is impossible. Is the creation of interspecific beings or entities novel in this sense? Do we have any data to draw on when thinking about the risks of mixing interspecies animal or even human and nonhuman material?

Prima facie, mixing species, particularly human and nonhuman species, seems to be a drastic, absolutely novel thing to do. Yet, we have seen, there are interspecific hybrids between closely related species in nature. Also, there are intraspecific cases of chimerism in nature and also in humans (e.g. microchimerism in twins). Regarding human-animal mixtures, it could be argued that very close, even symbiotic connections between human and nonhuman animals have existed for millions of years. We coexist with wild animals, livestock, pets and vermin. Parasites live on and enter into most human bodies and, more enjoyably, most of us voluntarily introduce animal materials into our own bodies by the very common habit of consuming animal products. From all these data points, it seems that we actually do have vast experience concerning the mixing of different species, and even "mixing" animal and human material. Some of these past experiences have led us to believe that certain types of mixing might be dangerous: we know that, for example, xenotransplantation could result in dangerous new pathogens. We certainly do not operate in an area of total ignorance when assessing the risks of creating interspecifics.

Still, there are areas which are not easily covered or mapped by such extrapolation from our experiences with "mixing". One of these scenarios would be that of chimeric, hybridic, or transgenic beings released (accidentally or on purpose) in populations of non-

interspecific animals. How would populations, or whole ecosystems, react to such intrusions? Could recombination of genes from different species lead to the emergence of dangerous properties in the transgenic being? These scenarios may sound familiar from the area of genetically manipulated plants. Other areas in which it seems very hard to give useful prognoses include the aspect of Robert's and Baylis' Argument from Moral Confusion, which I will discuss in section D.3 below, and, in general, the aspect of emerging consciousness or other valuable mental properties in interspecifically manipulated animals (see sections 2.c and 2.d(ii) above).

Concerning these areas of the unknown or unforeseeable, would precaution be a sensible argument? Should we avoid creating interspecifics even in cases where specific problems cannot (yet) be pointed out, or seem very vague, but should still be considered in our analysis?

It seems advisable here to step back and ask what a principle of precaution can sensibly mean. In a very weak sense, precaution could mean that we should not assume something has no risk just because there is no scientific proof for that risk – we should not argue from ignorance, or as Sunstein puts it, "a lack of decisive evidence of harm should not be a ground for refusing to regulate."[337] Another interpretation states that precaution means shifting of the burden of proof: the party which plans an action would have to prove that it is not dangerous, rather than burdening the party affected with possible consequences with proving that they could be harmed – this would introduce distributional issues into the analysis. These interpretations of a precautionary principle, however, seem merely complementary to standard RCBA. They add ethical and other considerations to the assessment rather than overriding this method's general outcome or applicability. Precaution, in these senses, constitutes procedural minimum requirements that should be fulfilled in our RCBA process, and/or ethical/distributional considerations that should complement RCBA.

But could a principle of precaution be understood in a way that tells us to avoid an action *even if* a RCBA carried out fulfilling all these minimum requirements tells us that we are justified to carry out the action? Are there cases where RCBA is the wrong approach, as such?

As mentioned above, RCBA is appropriate for cases where the probability distribution of outcomes is known or can be extrapolated, but not for cases which are actually not about

[337] Sunstein (2002), "The Paralyzing Principle", Regulation, **Winter 2002-2003**, p. 33.

risk but rather about deep uncertainty. The distinction between risk and uncertainty, as described by Knight,[338] is a crucial analytic step at this point: "risk" proper is described as "measurable uncertainty" (i.e. we do not know whether scenario x will take place, but we think it will take place with a probability of y), while "uncertainty" describes cases where we have no access to probability distributions of the scenario at issue. The potential detrimental consequences of the creation of novel interspecific beings, in some aspects, fall into the realm of risk (example: risk of transfer of known types of pathogens to xenotransplant recipients). In other aspects, potential detrimental consequences fall squarely into the field of uncertainty (example: unforeseeable detrimental consequences in case of release of transgenic beings to ecosystems).

What if we accept that RCBA does not cover all possible risks and potentially understates catastrophic scenarios? Does precaution offer a sensible alternative? In a very general sense, the precautionary principle could be understood as stating that we should be especially or extremely risk-averse, simply because RCBA does not "give us the whole picture".

As Sunstein[339] points out, this is not a sensible alternative: being risk-averse is not a principle that can tell us what to do (or not to do). In the case of interspecific creation, it might be advisable not to create interspecific beings in the light of precaution in order to avoid detrimental consequences like rampaging interspecific monsters destroying the world. On the other hand, it could be seen as the risk-averse path of action to invest in research (and interspecific-creation) in order to have the best chance to find out about therapies for all kinds of diseases. Thus, we could avoid the detrimental consequence of us or future generations dying of diabetes, Parkinson's, stroke, or even diseases that do not exist yet but may threaten humanity in the future. Precaution, unfortunately, does nothing to tell us *which* detrimental consequence to avoid. It does not even tell us not to act, at all (in the literary sense of a "paralyzing principle"): difficulties of distinguishing actions from non-actions aside, acting is often as or even more precautionary as not acting.

Also, it remains unclear which areas of action precaution should apply to: in fact, every action in the real world has potential unforeseeable consequences which are not covered or would not be taken into account by a standard RCBA (rare examples are something like throwing dice or roulette, where the probability distribution is known beforehand).

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[338] Knight (1957/2006), Risk, Uncertainty and Profit.
[339] Sunstein (2002), "The Paralyzing Principle", Regulation, **Winter 2002-2003**.

Following a precautionary principle in all situations where uncertainty is at play would make us incapable of decision.

Precaution, then, must be understood as complementing or stating minimum requirements to standard risk analysis, not as an alternative to this approach. It is true that risk analysis does no good job of covering scenarios of uncertainties – but unfortunately, precautionary principles do an even worse job of helping us deal with these unquantifiable risks by creating the impression that they can be avoided by simply abstaining from action or risk-taking.

## D. Confusion: Indirect consequence-based objections

The consequence-based arguments presented so far rely on relatively direct consequences of the creation of interspecifics, like possible problems for animal welfare, the destruction of human embryos, and health concerns. Other concerns are more indirect and subtle: it is claimed that the creation of interspecifics, particularly of human-animal interspecifics, leads to confusion, which is understood as a detrimental consequence. This confusion can be understood in different ways. Three types of confusion which could be the consequence of the creation of interspecifics will be presented in this chapter.

When confronted with human-animal interspecifics, there are two primary ways of understanding "confusion": one is stating that the moral status of chimeric subjects (and thereby our obligations towards them) is *hard to determine* due to the conditions of interspecific creation – this will be discussed in section 1 below. The second way of understanding "confusion" in the context of human-animal chimeras is more absolute: the moral status of human-nonhuman interspecifics could become altogether *indeterminable* (see section 2 below). A third type of "confusion" argument is based on the concern that the uncertain moral status of some human-animal interspecifics could, in turn, lead to society questioning its' criteria of moral status assignment and, in the process, give up the assumption of human beings' superior moral status (see section 3 below).

### 1. Confusion as complicated determinability

Let us look at the first aspect of the confusion problem, which I will call the problem of complicated determinability. Note, in the first place, that determining the moral status of a being is rarely easy or undisputed. As we will see in our excursus on moral status, there are many problems lurking in the question of which capacities or properties of creatures are

morally relevant, i.e. which qualities have an influence on the moral status of the being. Candidates for such properties or characteristics include language capacity, rationality, free agency, species membership, natural kind membership, and many others. Defining such concepts and justifying their moral relevance is fraught with problems. In addition, we face epistemological hurdles when trying to pin down criteria for when a being (be it human, animal, or chimera of both) does *exhibit* these properties – how, to give but one example, are we to find out whether a monkey does or doesn't have consciousness or self-awareness?[340]

The problem of determinability is even graver in the case of artificial interspecifics discussed in chapter 1, section B above, simply because they are *novel* beings. When assessing the various capabilities and properties of a common rat, we have a huge body of empirical data to fall back on, namely all kinds of research that have been done with other typical rats. For determining the moral status of the individual "new" rat, we can make use of general knowledge about rats: the rat (assuming it is not a wildly atypical mutation) will not be able to use language, no matter how hard we try to teach it, it will be able to solve mazes up to a certain degree of difficulty, it will feel pain, etc. Regarding novel interspecifics like embryonic chimeras or transgenic beings, there is, at least from a certain point of humanization on, no such extensive empirical data to extrapolate from. This would similarly be true for other novel beings (which have been altered in morally relevant characteristics), e.g. (if this were possible) animals that are outfitted with enhanced cognitive capacities via genetic manipulation, but also Artificial Intelligence and extraterrestrial beings. In all these cases, we would have the epistemological problem of finding out what properties these entities have without having access to comparable precedents.

This problem does not make moral status indeterminable as such. In moral systems that discriminate between different moral status levels there are certain *criteria* for determining whether a property (like having the capacity for language, being rational, etc.) is present in a being. If moral status classification is the aim, stating morally relevant properties must mean stating the criteria for determining whether they are present. The being's moral status will be derived accordingly (for a further explanation of moral status assignment, see chapter 3, section A below). Such a process will take place for all kinds of beings: humans, nonhumans and human-nonhuman chimeras alike. This analogy in process between moral

[340]For an excellent introduction to the problems of "animal minds", see: Perler and Wild (2005),"Der Geist der Tiere - eine Einführung", in: Perler and Wild (eds.) Der Geist der Tiere.

status classification of chimeras and "normal" cases is also pointed out by Andrew Siegel, who comes to the conclusion that classifying chimeras is not especially problematic in many moral systems ("For both [Kantianism and utilitarianism] there is no conceptual obstacle to understanding the moral status of chimeras.").[341] There will – as I pointed out – be cases where categorisation will be especially difficult. We need not resort to Science Fiction in order to come up with examples for this: all kinds of atypical beings will do. The classification of a human embryo in its early stage is problematic, because it does not exhibit most of the typical characteristics of humans that are candidates for morally relevant properties. Similarly, the classification of nonhuman primates is vexing, since many of them exhibit astonishing feats of language use and problem solving. Even more so is the positioning of human (or nonhuman) *individuals* that are atypical: take the brain-damaged adult or the anencephalic infant, or flatland gorilla Koko who has, over decades, learnt hundreds of words in sign language and who has complex relationships with animals and humans alike.[342]

It could be interjected here that it might be morally wrong, in general, to create beings whose moral status we do not know in advance. I do not think that is a useful point, simply because every living being that is born is novel in the sense that we do not know for sure which capacities it will develop, especially since many capacities – like language, complex problem solving, etc. – only unveil after extensive training and stimulation. There is also the possibility of genetic mutation that brings about atypical individuals in every species, be it human or non–human. If we were limited to creating beings whose future moral status we can determine beforehand, having children (at least having children "the natural way", without genetic screening) would have to be regarded as morally reprehensible.[343]

The fact that this complication is not unique to interspecifics does not render void arguing against their creation by pointing out the problem of complicated determinability. Because such beings are novel and, in particular cases, without precedent, determining their moral status could be so costly as to render moot or outbalance the possibly beneficial effects of interspecific research. This added cost would then be a valid argument against chimera creation from complicated determinability – a point David Castle also touches on when stating:

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[341] Siegel (2003), "The Moral Insignificance of Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 34.
[342] Patterson and Linden (1981), The Education of Koko.
[343] This argument is limited to positions which assume that moral status is influenced by certain characteristics, rather than being exclusively determined by membership in the species *Homo sapiens* (for a critique of such "Strong Speciesism" views, see chapter 3, section B).

> *"What is ethically worrying (…) is if [Human-Animal Interspecifics] are viable creatures that add an extra dimension of complexity to borderline moral reflection and decision making. Deciding these cases could be highly unsettling and does not seem likely to be worth whatever benefits the biotechnology might bring."*[344]

Note that this problem of complicated determinability (which is not an absolute argument, but needs to be included in a cost-benefit-analysis) would also apply to nonhuman interspecifics. One need not go as far as Castle, who hypothesizes:

> *"(…) were it possible, crossing lobsters with cows to make the ultimate surf-and-turf organism might raise eyebrows at first (…), but then issues of how to humanely cultivate, transport, and slaughter the organism would float to the surface."*[345]

Slightly more realistic (though still speculative) cases are conceivable: if we acknowledge that primates deserve a treatment different from that of dogs (as is recognized e.g. in the higher standards of animal welfare concerns regarding research in primates vs. other mammals), we would encounter a problem when trying to devise ethical standards for the treatment of dog-primate interspecifics that show a high rate of mixing or "primate behaviour".

To sum up, firstly, every moral status classification brings with it profound epistemological and ethical problems or questions – this is not a problem limited to novel interspecifics. Secondly, there are atypical beings – among them individuals that do not exhibit species-typical characteristics because of being in a certain developmental stage, because they are diseased, have been subject to especially beneficial or harmful environments, training, or stimulation, because of genetic mutation or because they are chimeric or other interspecific beings. In the latter cases, moral status classification is particularly difficult, but not categorically more so – except if we make species membership the determinant of moral status, i.e. embrace Strong Speciesism. Thirdly, it cannot be stated in general that creating beings whose moral status we do not know beforehand is wrong as such. If we do not assume Speciesism, human-animal chimeras are not categorically more morally confusing than other beings. Nor is their creation wrong due to the fact that we cannot anticipate their moral status. A point against interspecific creation that is independent of Speciesist

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[344] Castle deems human-nonhuman interspecifics not to be morally confusing, but just "worrying." This is a matter of nomenclature which corresponds to my distinguishing absolute, total or conceptual confusion from "normal" or "relative confusion." Castle (2003), "Hopes against Hopeful Monsters", American Journal of Bioethics, **3**(3), p. 29.
[345] Ibid.

assumptions can be made by including costs for moral status determination in a cost-benefit analysis. These points are, to a lesser degree, also valid for animal-animal interspecifics.

## 2. Absolute confusion

Given some moral axioms or rather presuppositions regarding moral status, interspecifics – human-nonhuman interspecifics, in particular – can evoke "absolute" confusion that goes far beyond the mainly epistemological problems, or problems of uncertainty, I described above. There is one specific position which is a candidate for evoking absolute confusion: the conviction that human beings, and only human beings, have, in virtue of being a member of the species *Homo sapiens*, a moral status that is superior to that of nonhuman beings (Strong Speciesism).

When one uses such a Strong Speciesist framework in order to assign human and nonhuman beings moral status, one will have a hard time when confronted with beings that are, in some sense, between being human and being nonhuman. It can be doubted at this point that any of the human-animal chimeras presented in chapter 1, secion B.4 above fulfil the condition of being ambiguous in this sense. Are they not just clearly nonhuman animals that have some, often very few, human cells in their body? Ambiguity in the sense of not clearly being a member of one or the other species might be more apparent in hybrids or cybrids: a "humanzee" (a hybrid of human and chimpanzee), if there were such a being, could not easily be characterized as human or nonhuman. Cybrids – which consist of an enucleated animal egg into which a human nucleus is introduced – also fulfil the condition of ambiguity. What else is considered ambiguous in the field of interspecifics depends on the conditions one assumes for belonging to the human species (i.e. one's definition of species membership). There are, as I will show below, numerous definitions for biological species, and numerous concurring ways of understanding "human being" (in the biological and in other ways), and therefore numerous ways in which a being can be "species-ambiguous".

Robert and Baylis, in their seminal 2003 article,[346] make clear that no matter what species concept one entertains, unambiguous classification of all beings as either human or nonhuman is not possible. There is, so they claim, no "human essence", and this is why arguments that are based on the sacredness of a "boundary" between the human and other

[346] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3).

species do not work. Yet, Robert and Baylis try to construct an argument against the creation of chimeras that does not depend on "boundary" concepts (though they, as they made clear in a 2007 article, do not endorse this construction themselves). Their argument from "moral confusion" is based on the notorious moral ambiguity of human-animal chimeras. Ambiguity is problematic, for once, because we do not know what kind of obligations we would have towards part-humans – this founds the concerns regarding inadequate treatment of chimeras discussed in section C.2.c above. Secondly, thinking about what properties human (and, possibly, nonhuman) beings have that are morally relevant would, as Robert and Baylis put it, endanger the "clear but fragile moral demarcation line"[347] between human and nonhuman animals.

There are two branches of argument here: on one of them, classification in human or nonhuman is indeed impossible. This could be the case when confronted with human-animal hybrids or cybrids, or chimeras with a very high rate of mixing. One could argue that creation of such novel beings would be wrong because we have no ethical tool at hand with which we could ascertain their moral status and thereby make sure they are treated properly – inadequate treatment, the concern voiced in chapter 2, section C.2.c above, would be the consequence. Robert and Baylis contentrate on another, second branch of argument.

## 3. Robert's and Baylis' argument from moral confusion

Robert and Baylis are concerned with a more indirect issue. Short of absolute confusion, the candidate criterion employed to single out beings which should be accorded high and direct moral status might, in the process of classification of novel beings, become more and more dubious. Newly developed criteria, on the other hand, could lead to unwanted consequences regarding the moral status classification of human and nonhuman beings. Once they are applied not only to novel, but also to "conventional" beings, they might call into question the traditional consensus on moral status assignment, and, in turn, our treatment of humans and nonhumans. Robert and Baylis put it this way:

> *"Asking – let alone answering – a question about the moral status of part-human interspecies hybrids and chimeras threatens the social fabric in untold*

[347] Ibid., p. 9.

> *ways; countless social institutions, structures, and practices depend upon the moral distinction drawn between human and nonhuman animals."*[348]

The "moral distinction" mentioned here is easily identified as Speciesism: it is assumed that nonhuman beings are subject to a moral framework that is fundamentally different from (and incommensurable to) that applied to humans. While the latter enjoy "categorical" moral status, the status of the former is "contingent on the will of regnant human beings".[349]

But where exactly are the threats for our "social fabric"? Let us assume that the starting point is a Strong Speciesism which assumes that "being human" is defined in terms such as "organism with human DNA". Confronted with ambiguous beings "between" human and animal, a Strong Speciesist can, on one hand, change his definition of "being human" in order to accommodate beings that are deemed morally superior to "normal" animals. He could, for example, state that beings which show typical human behaviour like language use, problem solving, or human-like appearance, should "count" as full human beings. Alternatively, the Strong Speciesist could give up Strong Speciesism and admit beings that are not human according to his standards into the circle of beings with high moral status (as soon as they fulfil certain criteria). This would result in a position where "being human" in the biological sense (i.e. species membership) would not be a necessary condition for high moral status anymore. This, in turn, would call into question many of our current practices regarding nonhuman beings, such as hunting for sport, animal testing, etc., since the exculpatory remark "It's just animals" would not be persuasive anymore. (This is not to say many of our exploitative practices regarding animals could not be justified otherwise, but justification would have to consist in more than the simple declaration that "they're not human, after all.").

This perceived threat goes in the opposite direction, too. If species membership were, in this way, driven from the throne of morally relevant properties, other candidate properties would be put forward, such as rationality, language, free will, etc. Strong Speciesism could be substituted by Qualified Speciesism, i.e. the view that only some beings are, in virtue of having properties like rationality, capacity for moral agency, or self-awareness, morally superior, while, in general only human beings fulfil these conditions (and, possibly, some lucky human-nonhuman interspecifics). When trying to construct a consistent view of Qualified Speciesism, it is remarkably hard not to end up with a position that states that

[348] Ibid., p. 10.
[349] Ibid., p. 9.

human species membership is not only not necessary, but also *not sufficient* for high moral status – we will encounter this problem in the form of the Marginal Cases Problem in chapter 3, secion B.2 below. This is, I think, another danger Robert and Baylis see embedded in the debate around chimeras: it could surface that being human in the biological sense (species membership) would not be a *sufficient* condition for high moral status anymore; which would, in turn, challenge the categorical, high moral status of human beings that do *not* exhibit the properties one has worked out as morally relevant. Atypical human beings like embryos, infants, comatose and severely mentally handicapped individuals would then lose the prima facie privileged status they enjoy in Strong Speciesist accounts in virtue of their species membership. Asking the question of how human-animal chimeras should be classified morally could trigger a landslide that ends not only with questioning our treatment of nonhuman animals, but also challenges the high moral status we, as a matter of course, assign all human beings no matter their properties and capacities aside from "being human" in the biological sense. This looming danger could ultimately be used as an argument for strict regulation or even prohibition of human-animal interspecific creation.

Whether one finds this kind of argument persuasive (and many, including Robert and Baylis themselves, do not) crucially depends on the importance one assigns to keeping up a fundamental moral difference between human and nonhuman beings. For someone who does not assume such a fundamental difference (i.e. a non-speciesist), Robert's and Baylis' confusion argument will not be very compelling. To give three examples of its failure to persuade non-speciesists, Hilary Bok states that "Chimeras do not introduce confusion into our moral views. They reveal ways in which those views are inadequate and make us think about how we might improve them."[350] In a similar vein, David Castle thinks chimeras are "no more ambiguous then any other living thing."[351] He points out that chimeras must not be seen as made up of parts ("fallacy of composition"), but as organisms in their own right, and that "they will get whatever moral consideration they deserve on the same grounds that apply to any other organism, including human beings."[352] Julian Savulescu goes even further when, in turn, attacking the conservative speciesist impetus the confusion argument is based on:

[350] Bok (2003), "What's wrong with confusion?" American Journal of Bioethics, **3**(3), p. 25.
[351] Castle (2003), "Hopes against Hopeful Monsters", American Journal of Bioethics, **3**(3), p. 28.
[352] Ibid., p. 29.

> *"The social costs of acceding to irrational confusion are, at least historically, much greater than the costs of clearing it up and reforming society. (…) Our job is to clear this up (…), not to perpetuate it or allow it to persist or base social policy on it."*[353]

At this point we can see how Robert's and Baylis' confusion argument can be turned around in order to make speciesism (Strong Speciesism in particular) dubious, rather than defending or supporting it – a fact that will be important to our further discussion of the chimera debates' possible influence on questions of animal versus human moral status.

Robert's and Baylis' confusion argument, like many arguments in this debate, hinges on the question whether speciesist attitudes are defensible. I have already explained that speciesism is a position which claims that the moral status of human beings (however defined) is fundamentally different from that of nonhuman beings. In order to understand and put in context this type of view – and, consequently, decide whether it should play a role in arguing against the creation of human-animal interspecifics – it is necessary that we understand what exactly speciesism is and what its problems are. To do this, I will in the next chapter include an excursus on the concept of moral status, which is crucial for Speciesism approaches as presented here. Building on this, I will elaborate on the problems of finding a suitable ethical principle of Speciesism. I will come back to an in-depth, concluding analysis of concerns against creating interspecifics in the last chapter 4.

[353] Savulescu (2003), "Human-Animal Transgenesis and Chimeras Might Be an Expression of Our Humanity", American Journal of Bioethics, **3**(3), p. 25.

# Chapter 3: Excursus on Moral Status and Speciesism

Several of the threads of argumentation presented above rely on the concept of "moral status". For example, I discussed the implications of what I called "moral status shifts" in chapter 2, section C.2.d above, and I assumed that some properties of human and nonhuman beings could be somehow relevant for this moral status, while others were irrelevant in this respect (see my discussion of "violation of human dignity" in chapter 2, section B.4 above). Also, I have already mentioned that Speciesism builds on this concept, and can be characterized as stating that humans have a fundamentally different (higher) moral status than nonhumans.

This chapter will be concerned with the concept of "moral status" (in section A) and, consequently, with the ethical principle of Speciesism (in section B). I will present a detailed concept of "moral status" and describe how the latter is assigned to entities by moral agents, present this concept's advantages and disadvantages, and discuss whether it is appropriate for the task at hand. I will then describe differing types of Speciesism and give a cursory outline of their main problems.

## A. The concept of moral status: General considerations

### 1. Defining moral status

"Status" refers to the state, i.e. the mode or condition of being, of an entity; or its position in a complex system or hierarchy. *Moral status* refers to the position of an entity in the hierarchy or system of entities that come into question when gauging the scope (and intensity) of moral consideration. Moral status – like legal or social status – is ascribed to entities by the moral community and individual moral agents. Status, in the case of legal, social, but also of moral status, is based on norms – beings which are accorded status are treated according to certain rules (e.g. the legal status of citizens is determined by the rules of law).[354] When saying an entity has moral status, this can be understood as saying that the entity is in the category of beings that are to be considered morally (i.e. that there are rules

[354] Vossenkuhl (2002),"Der ethische Status von Embryonen", p. 166, in: Oduncu, Schroth, et al. (eds.) Stammzellenforschung und therapeutisches Klonen.

according to which it demands to be treated). Warren, e.g., understands "having moral status" to mean "being worthy of moral consideration".[355]

In a wider sense, which I use here, moral status is open to the question whether a being or thing is, in fact, directly morally considerable. Just as the question for "marital status" can be answered by "single", the question for "moral status" can be answered by "does not deserve/is not accorded any moral consideration". For example, in most moral systems, stones are not considered morally, so their moral status is "not to be considered (directly)"; in my interpretation of the term, stones do have a moral status, though (i.e. the status of not being morally considerable).

From this it follows that the concept of moral status is not necessarily directly concerned with the question of whether the entities that are to be classified are addressees (subjects) of moral rules or obligations – having a "moral status" does not mean, as such, that the entity is subject to moral norms. This question can still play an indirect role, as in some approaches (e.g. Kant's) a being can only reach full moral status if he or she is also a moral agent and thereby subject to morality. In fact, many aspects of the superior moral status that is commonly accorded to human beings or persons do crucially depend on the ability of the carrier of status to act and make autonomous decisions.[356]

The moral status of beings can be understood in a prescriptive way (i.e. "status" tells us how a being ought to be treated) or as descriptive (i.e. "status" tells us how a being or type of being is actually treated). In my own discussion, I will commonly use moral status in a descriptive sense. Moral status will be seen as prescriptive within the specific moral framework it relates to; the moral status of a being can vary wildly depending on what ethical framework the assigner subscribes to.

A simple model of moral status assignment could consist of a process involving three steps. When confronted with an entity and the question how to behave towards it, one first takes note of its *properties* (observed, relatively simple, properties, like "interacts with environment" or "is able to move" or "uttering sounds", but also derived properties, like "being alive", "possessing faculty of speech", "being a person", or "being human"). Employing the moral theory (or axioms) one subscribes to, one then assigns the being a *moral status*. In a common approach to moral status, there are three rough possibilities of classification here:

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[355] Warren (1997), Moral Status - Obligations to Persons and Other Living Things.
[356] Vossenkuhl (2002),"Der ethische Status von Embryonen", p. 163, in Oduncu, Schroth, et al. (eds.): Stammzellenforschung und therapeutisches Klonen.

The lowest possible status ("not to be considered") is usually applied to inanimate objects. An intermediate status is usually ascribed to nonhuman animals (and sometimes, plants). Carriers of this status are to be considered indirectly, on certain conditions, i.e. when a certain value is ascribed to them.[357] Indirect consideration is also imaginable regarding wholly inanimate objects: e.g., the lifeless body of a human being, in many moral (and legal) systems, demands respectful treatment, and it does so indirectly because certain values are ascribed to it. Finally, there is, in many moral approaches, a superior, overriding, or "full" moral status. This is usually assigned to human beings, or persons. Often, this ascription is regarded as a *direct* one, meaning that it takes place not because of a value that is ascribed to the carrier entity, but solely by virtue of the entity being human. The superior moral status of human beings can also be justified *indirectly*, by stating that humans possess certain characteristics that are valuable (consciousness, moral agency, free will, personhood, etc.); i.e. by the same process of value ascription that takes place in assessing nonhuman entities. This, in turn, leads to the problem of how to correctly determine the moral status of human beings who do not exhibit the valuable characteristics. This problem of human "marginal cases", as we will see, is crucial for the discussion of human vs. nonhuman moral status.

After this assignment of moral status one derives (again, with the help of the moral system one subscribes to) the proper way one should treat, or rather, consider the entity – moral norms come into play. A rights theorist might, at this point, decide that the being has, because of its moral status, a certain right, and that we should act accordingly; a utilitarian decides now whether the entity should be counted in the felicific calculus.[358]

The aim of this process, i.e. of determining the moral status of beings or groups of beings is described by Mary Ann Warren as a twofold one: "to specify minimum standards of acceptable behaviour towards entities of a given sort", and "to establish moral ideals".[359] Accordingly, we should keep in mind that the moral status concept is not, prima facie, geared towards making moral decisions under specific circumstances (i.e. whether one

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[357] Ibid., p. 164.

[358] Lori Gruen, in a similar approach, understands the moral status concept as involving two distinct steps, one of basic recognization and one of actual assessment. In her discussion of the moral status of animals, she distinguishes between "moral considerability" of a being, which she likens to "showing up on a moral radar screen" and "moral significance", which tells us "how strong the signal is or where it is located on the screen." Cf. Gruen (2003), "The Moral Status of Animals", The Stanford Encyclopedia of Philosophy (Fall 2003 Edition).

[359] Warren (1997), Moral Status - Obligations to Persons and Other Living Things, p. 13. For another proponent of this two-step approach, see Pluhar (1995), Beyond Prejudice: The Moral Significance of Human and Nonhuman Animals, p. 1.

should or should not create chimeras), but rather towards discussing, on an abstract level, values and value ascriptions to certain classes of entities.

## 2. Advantages of the moral status concept

The central issue in the context of moral status is the special, superior moral status of human beings. Often, this status is contrasted or compared to that of nonhuman animals or other nonhuman entities. In this context, I could also have used concepts like "rights", "dignity", or of "welfare" or "interest". Up to now I avoided these terms because they would have led to the implicit assumption of deontological or instrumental (consequentialistic) theories of rights (or, rather, to a commitment to rights-based or non-rights-based approaches). The possibility of avoiding premature commitment in these respects is a central advantage of the moral status concept.

Using the moral status concept also enables us to compare moral systems whose distinctness regarding vocabulary or moral axioms usually make comparisons difficult. Picking out this very abstract aspect, we can, e.g., compare Kant's position on animals (in his approach, they are not to be considered directly, while indirect consideration is regarded as advisable) to that of someone like Peter Singer (here, all sentient animals are to be considered directly). Asking whether there are "animal rights" in Kant's or Singer's approaches, respectively, would not really give us anything to work with, since it would presuppose extensive analysis of the concepts of "rights" Singer and Kant use. Most likely, this would result in the answer that their concepts are not measurable by a common standard. "Moral status", on the other hand, offers such a common standard.

Another advantage of using the moral status concept at this point is that this term makes it easier to avoid an explicit commitment to (or rejection of) of speciesism. Concepts like "human rights" or "human dignity" allow only humans into their scope, assuming as a given that there is a fundamental moral difference between human and nonhuman beings. I spelled out this problem in my discussion of human dignity arguments against interspecific production (see p. 81), the same consideration applies to the term "human rights". The notion of "rights", as such, may not be inherently speciesist (after all, there are many who claim animal rights), yet often, it invokes the prima facie objection that only beings which also have obligations can have rights, at all. While this is not a necessary corollary of the term "rights", I still find it to introduce a certain tendency into the debate that is not intended and unnecessary at this point.

Putting aside the problem of speciesist tendencies, does it make a difference, at all, whether one speaks of "rights" that are accorded to beings or whether one prefers to refer to "high moral status" that is assigned? Are these concepts interchangeable? I think that, on a very basic level, they are not. This is because a being which "has a right" (as opposed to a being which "is to be morally considered") may not be violated in the respect the right protects, even if such a violation or disregard might be indicated by utilitarian reasons. This is true at least for some basic or absolute rights. Not all, but some rights are inviolable entitlements, at least in approaches which think that there are "real" rights (i.e. deontological approaches; cf. footnote 362 below). This implication of inviolability or absoluteness is the basic difference between using rights vocabulary and more restrained and neutral "moral status" vocabulary.

When using the term "moral status" I do not mean to imply or point towards a *status concept of rights*. In such a theory, beings are identified as right-holders because they have certain attributes.[360] "Status", in these deontological approaches, is a precondition or indicator for rights. This is contrasted to what Leif Wenar, in his introduction to the concept of "rights", calls instrumental or consequentialist approaches, where rights are only doled out to subjects if and in so far as the assigned rights further welfare or other aims.[361]

So status is the basis of rights in (deontological) "status approaches". A more basic notion of moral status, though, is also crucial for the classification of objects of morality within approaches that work without "real" rights (without a strong reading of the rights concept), i.e. consequentialist/instrumentalist approaches. After all, one needs to decide whose interests count, and whose count more than others, and whose welfare is included in the maximization process (this discussion starts with the question which entities can be ascribed such a thing as welfare or interests, at all). Utilitarian approaches, depending on their respective answers to these questions, can be about furthering human welfare, about the welfare of some human and some nonhuman beings who share "typically human" traits, or about welfare of all sentient beings (such an approach would be called sentientism or pathocentrism). Utilitarians could even reach out to more holistic views, including the interests of plants, species or even inanimate objects. This question of very basic

[360] Wenar (2007), "Rights", The Stanford Encyclopedia of Philosophy, Fall 2007 Edition.
[361] If one understands being unconditional on other circumstances to be an essential characteristic of moral rights, it seems that such instrumental or consequentialist approaches make use of rights in name only – "real" rights carry attributes like "natural", "inviolable" or "unconditional", and are scorned by consequentialists, e.g. utilitarian Bentham, who famously called the strong reading of the rights concept as "Natural Rights" "simple nonsense: natural and imprescriptible rights, rhetorical nonscnse, -- nonsense upon stilts." Bentham (1843),"Anarchical Fallacies", in: Bowring (ed.) Works of Jeremy Bentham..

classification is distinct from the question whether one later takes the line of "real" rights or whether one uses them only as instruments to further other aims. Consequently, the question of moral status is distinct from whether one prefers a "real" (deontological) rights approach or whether one is of a more consequentialistic bent.

To sum up, the abstractness of moral status vocabulary is advantageous. One need not commit to big ethical systems or axioms in order to talk about moral status, and it therefore makes different approaches comparable; likewise, it is neutral regarding the question of speciesism.

## 3. Groups, members, and the kind paradigm

A tendency one frequently encounters in the context of of moral status is the preference to direct this concept towards groups, or individuals qua members of a group, rather than individuals as such. Warren states that moral status is "usually ascribed to members of a group, rather than merely to specific individuals", on "basis of some property or properties that are thought to be possessed by all or most group members."[362] Indeed, moral status statements are usually (though not necessarily) about groups, referring to their members only by proxy. Exemplary statements are "All human beings have superior moral status" or "Inanimate objects have the lowest moral status; i.e. not to be considered." But this is not necessarily so – moral status statements about individuals without references to a group are possible, too, e.g. "This individual human being has superior moral status." The observance that moral status statements are often, yet not necessarily, about groups is not Warren's point, though. What Warren alludes to is the common paradigm that group-members are accorded/possess a certain moral status in virtue of their *belonging to the group* or of being of a kind that typically has certain traits. I will call this approach the "kind paradigm", since it assumes that belonging to a certain kind is crucial for moral status. An example of a moral status statement that conforms with this paradigm would be "Human embryos have superior moral status in virtue of belonging to the species *Homo sapiens* whose members typically have the characteristic of being moral agents." This position is distinct from that expressed in "Human embryos have superior moral status in virtue of being live human beings." Here, what is crucial are the actual characteristics of the embryo, i.e. its being alive and human, while its membership in the group of "alive and human beings" is secondary. To give an actual example of an approach that subscribes to the kind paradigm in regard to the moral status classification of humans, consider the statement:

[362] Warren (1997), Moral Status - Obligations to Persons and Other Living Things, p. 9f.

> *"As opposed to inanimate objects, persons have their ethical status immediately/directly as members of humanity."* [transl. CH][363]

Here, being of a kind (of the human kind) is crucial for moral status ascription.

Summing up, moral status statements are often about groups, or about individuals qua members of groups of entities. Yet, there is a difference between moral status approaches which subscribe to the kind paradigm – i.e. which assume that belonging to a kind is crucial for moral status – and those which do not, i.e. which assume that actual properties or characteristics determine an entity's moral status.

In this context, a distinction should also be made between the practice of classification and theoretical considerations. Regarding classification, group-membership can be regarded as an indicator for moral status (e.g. "Belonging to the species *Homo sapiens* indicates high moral status, other things being equal").[364] This indicator function of group membership can mean that in some cases – i.e. when we know nothing but species membership of the creatures involved – the fact that one is human and the other is not will be decisive regarding our moral consideration towards it. This practical point is distinct from and does not imply the assumption that group-membership determines moral status – we will see later on that this distinction is crucial for understanding different types of speciesist attitudes.

## 4. Variations of approaches to moral status

As I pointed out in section 1 above, there is a standard or consensus view regarding the moral status of certain groups of entities. In this consensus view, human beings, or persons (these terms are often used equivalently or at least seen as intrinsically connected) are assigned the highest moral status – they are to be fully, and sometimes overridingly, considered. Inanimate objects have the lowest status, i.e. they are not to be considered directly. There are also views which differ from this standard. Some – like Jain Philosophy or Deep Environmentalism – assign higher moral status to what is usually regarded as inanimate entities. Others, like Racism and Sexism, deny some human beings highest moral status while granting it to others, and segment human beings into a hierarchy of moral

363 "Im Unterschied zu Sachen haben Personen ihren ethischen Status unmittelbar als Angehörige der Menschheit." Vossenkuhl (2002),"Der ethische Status von Embryonen", in Oduncu, Schroth, et al. (eds.): Stammzellenforschung und therapeutisches Klonen, p. 164.

364 In a slightly different context, cf. Warren: "Genetic Humanity (…) is at best an indicator, not an independently valid criterion, of moral status." Warren (1997), Moral Status - Obligations to Persons and Other Living Things, p. 19.

status where non-white or female humans are typically set below white and male human beings. Even inside the consensus view, there is a wide margin for dissent. Widely differing characteristics or criteria are brought forward to make moral status classifications, resulting in similarly diverse views on the moral status differences between entities or groups of entities. In preparation for the following sections, which will deal with the debate around the moral relevance of species membership, I will give a coarse taxonomy of differing views on moral status distribution which is primarily based on the distinction between speciesist and species-neutral or non-speciesist views.

Speciesist views of moral status are either characterized as Strong Speciesism – such a view would assume that "being human" is the single criterion which can mark an entity for entry into the highest rank of moral status. On the other hand, there are Qualified Speciesism views: they assume that there is one, or that there are several, criteria, which make a being eligible for this highest rank; yet this criterion/bundle of criteria is distinct from "being human". Qualifying criteria which could be used by a Qualified Speciesist include sentience, personhood, reason, moral agency, the ability to enter into contracts, and many others. It is essential for Qualified Speciesism that these characteristics are thought to exclusively occur in human beings.

Non-speciesist views of moral status, on the other hand, can assume that the very same criteria or criterion (such as sentience or personhood) are decisive, but deem them not to be (necessarily or contingently) exclusive characteristics of human beings. Some non-speciesists argue that the characteristic(s) occur in nonhuman beings, as well. Other non-speciesists deny that criteria like "being human" are morally relevant, as such (i.e. they deny Strong Speciesism). As a third possibility, non-speciesists explicitly lower the hurdle for entrance into the category of entities with highest or high moral status, denying that, e.g. characteristics like "being a moral agent" or "faculty of speech", or even sentience, are morally relevant – for example when assuming that "being alive" is the decisive criterion ("Reverence for Life").

Apart from the speciesist/non-speciesist distinction concerning theories about moral status distribution, there is another aspect such theories can vary in: the structure of the hierarchy they describe. One can, for example, assume that there is such a thing as "absolutely superior" or "overriding" moral status, a kind of trump that is usually ascribed to human beings (in analogy to Dworkin's metaphor of rights as trumps).[365] This assumption of a

[365] Dworkin (1984),"Rights as Trumps", in: Waldron (ed.) Theories of Rights.

trump is not necessary in order to state that the moral statuses of entities differ, since such a difference can be marked on a relative scale, as well. Likewise, it is not necessary to entertain a trump assumption in order to defend speciesism – relative and continuous varieties of speciesism are imaginable. Accordingly, the question of whether some entities demand absolutely superior, overriding moral consideration takes place on a more abstract level and is, in this respect, analogous to that of whether there is an "ace of rights", i.e. a right that "has priority to absolutely all other normative considerations", as Wenar puts it.[366] Relative superiority of some entities' moral status over others', on the other hand, seems an indispensable assumption in order for moral status talk to make sense, at all.

This superiority will also have to be pronounced enough to ultimately warrant real, noticeable differences between the consideration of human vs. nonhuman beings. How these differences play out in the end (i.e. in what way they influence actual treatment) is not only determined by moral status, as we will see in the next section.

## 5. Moral status assignment: Caveat

Up until now, I presented the moral status concept as a viable means of discussing different approaches regarding the ethical consideration of entities of all kinds (especially human vs. nonhuman beings). Yet there are some caveats or limitations one should keep in mind when dealing with this concept.

One central limitation of the moral status concept is that it is quite a blunt tool. On one hand, this means that moral status statements do not delineate all moral obligations we might have towards a being: obligations that are justified in an indirect way are not covered by moral status concerns. Indirect consideration can lead to a final result that is very different from what initial statements about status might have implied. Therefore, we have to keep in mind that the decision for or against a certain general stance on the level of moral status consideration does not necessarily determine the actual overall normative outcome of an ethical theory. To illustrate this, imagine a theory in which nonhuman animals are assigned the moral status of non-consideration, but where at the same time cruel behaviour towards all kinds of beings is considered highly reprehensible, in principle (e.g. because it is thought to compromise human character, and thereby lead to cruelty towards human beings). Experimenting on animals, in this theory, could be extremely hard to justify. At the same time, a theory that accords all sentient beings basically the same

[366] Wenar (2007), "Rights", The Stanford Encyclopedia of Philosophy, Fall 2007 Edition.

moral status may come to the conclusion that animal experimentation is easily justifiable as long as the benefits it produces outweighs the harm it does. So, surprisingly, a theory that at the first glance entirely devalues nonhuman beings may, on another level, grant them vigorous protection; while a theory that seems clearly "pro-animal", at a second glance puts animals in a quite precarious position.[367] It is a somewhat counterintuitive result of these considerations that – although that is the usual paradigm – speciesism is not necessarily associated with the sanctioned maltreatment of animals, and that non-speciesism does not necessarily result in a very strong protection of nonhumans. While this is not a shortcoming of the moral status concept, it should be kept in mind that the informative value of general moral status assertions is limited by further moral considerations on more indirect levels.

Adding to the bluntness of moral status statements is the fact that they, as I pointed out above, usually refer to groups of beings (such as "nonhuman animals", "sentient beings", "human beings") rather than individual entities. One central problem at this point is that the delineation of the groups that are picked out may be blurred or continuous. At what point, for example, do human sperm and egg, or human embryo, become a human being? Or, to remind of the subject of this dissertation which is an exemplary case of blurred boundaries, when do animal-human interspecifics? At what point does a being become sentient, or alive, or self-aware? One could, as a general point of criticism, note that the simple structuring into what is a limited number of levels of moral status is much too coarse to capture the continuous, vague reality of status distribution. Accordingly, one could also assume a "sliding scale" of moral status, where entities are assigned continuous variable moral consideration according to what actual properties or characteristics they have, taking into account that they may be inferior in one respect while they are equal in another. An approach that sees moral status as an infinitely graded continuum of different status levels of individuals is also imaginable, but would be beside the point here – this is because we will discuss moral status primarily within a moral framework of the ethical principle of Speciesism, which would not go along with particularism regarding moral status assignment.

The bluntness of the tool of moral status makes it unlikely that particular cases, such as the question of how to treat one specific human-animal chimera, can be coped with in its

[367] The same is true for a speciesist theory which assumes a prima facie priority of human interests, but makes exceptions from this rule if petty interests are staked against vital ones. Here, the human "interest in meat eating" might lose out against a non-human "interest in surviving." Non-speciesist theories,on the other hand, can allow for meat consumption.

entirety by referring to moral status considerations. This, again, is not to say that such considerations are superfluous, but that their informative value is limited because results depend enormously on the specifications for terms such as "being human", "being sentient", etc.: two theories may both state that sentience is the single criterion for moral considerability, and yet come to extremely differing results. For an illustration of this principle, compare Carruthers' extreme pro-animal-testing stance to Singer's (albeit not absolute) condemnation of such practices – both regard sentience as the decisive criterion for moral status, but Carruthers believes that animals do not meet this criterion, and that they therefore do not qualify for high moral status.[368] Again, decisions made on other levels (in this case, assumptions made in philosophy of mind regarding the presuppositions of phenomenological consciousness, which Carruthers deems to be dependent on a "theory of mind") lead to the result that isolated statements about moral status and its criteria have limited informative value.

The possible variations – and limitations – of moral status assignments notwithstanding, note that, on a very basic level, the assessment of moral status can have extremely significant consequences. Moral status questions are not just relevant for seemingly exotic questions like the status of animals (or even chimeras). The inclusion in or exclusion from the realm of morally considerable, or "fully" considerable, beings is one of the most basic decisions of any moral system. Though consideration or non-consideration can be shaped in ways that differ widely regarding actual treatment, moral status assignment is probably the most powerful weapon in moral discourse: extremely morally reprehensible practices were and are often justified not by "fine-tuning" of normative rules (such as "murder is allowed, if you have good reasons" or "torture is ok for the greater good"). Rather, the construction used was, and is, typically one of explicit exclusion of certain subjects out of the moral realm (i.e. negative moral status assignment). Africans were simply not included in the realm of persons in times of slave trade, Jews did not "count" as to-be-considered subjects by the perpetrators of the holocaust, communist regimes styled the ostracising of non-compliant individuals not along the lines of "x does not follow moral rules and must be punished", rather, certain individuals were declared "class enemies", which were then fundamentally excluded from the realm of subjects to be considered morally (allegedly, moral philosophy books in the cold war Eastern Bloc stated as an example of an ethical principle with an admissible perception the phrase "Killing your mother is always wrong,

[368] Cf.: Singer (1976), Animal Liberation - A New Ethics for Or Treatment of Animals; Carruthers (1992), The Animals Issue: Moral Theory In Practice.

except if she is a class enemy.") So note that even if moral status assignment is a blunt instrument, it has, on the other hand, also the potential to be used as a drastic, incisive tool, with far-reaching consequences.

## 6. General critique – and reality – of status assignment

A very general criticism of the moral status framework claims that status classification of groups or types of beings according to certain criteria is a mistaken approach, as such, because status assignment, as a construct, has no leg to stand on, and is a fundamentally wrong approach to distribution of moral consideration.

Wilhelm Vossenkuhl, sceptical of any general value ascription to entities in nature (which I understand to be analogous in many respects to what I here describe as "status assignment") notes that in this context "No hierarchy is without problems." [transl. CH][369] His critique is not only aimed at holistic approaches which ascribe value according to function in the world's ecosystem or similar criteria, but also to pathocentric approaches. Any value ascription (or status assignment) is necessarily an anthropocentric one, Vossenkuhl states: it is always done by humans, out of a human mindset, and cannot take into account interests of nonhuman entities, since the latter are not accessible to us. Furthermore, while criteria like sentience are hard to ascertain, criteria like "utility within an ecosystem" are possibly even harder to establish, and, ultimately, have no moral relevance, Vossenkuhl argues. Consequently, value ascription systems and hierarchies are on a fundamentally wrong track, and should be given up altogether.

In fact, many types of status hierarchy take into account criteria which I personally would not regard as morally relevant (be it "utility in ecosystem", "membership in a race", or "rationality"). These are valid points of concern, yet, rather than presenting this as a general critique, I would suggest a type of status assignment that makes use of criteria that are more to my taste and reflect my respective value assumptions. Still, I acknowledge that status assignment processes are always highly problematic no matter what criteria are employed. Each such process depends on countless potentially problematic empirical assumptions (e.g. about the physical structure and needs of other beings), inductive steps or hypotheses (e.g. about preferences or interests of fellow beings, be they human or nonhuman), and all status assignments are tainted by our human and our personal perspective, which, in certain respects, we cannot leave behind.

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[369] Vossenkuhl (1993), "Ökologische Ethik - Über den moralischen Charakter der Natur", Information Philosophie, **1**, p. 8.

Yet, I believe that the model of status assignment describes quite well how moral consideration of types of entities does in fact happen in the real world. Robin Attfield's notorious statement that a human life is worth as much as one million trees is tacitly dismissed by Vossenkuhl, probably as indecent, morally reprehensible or at least demonstrably ridiculous.[370] In fact, many such calculations are carried out implicitly in today's societies and by ourselves, maybe not with the same numerical result, but with the same variables being weighted against each other. Our governments do not spend all taxes on emergency healthcare or foreign aid (to save human lives), but use a sizeable proportion on the protection of animals (or even trees). Most governments or voters would hesitate to publicly make the calculation that "One life is worth n trees", yet these calculations are implicit in spending and other decisions. Regarding the value of human lives, government policy implicitly counts the lives and interests of natives far above the welfare and even lives of foreigners. Laws ensure that such hierarchical status assignments do have real world consequences, and they do not elicit much protest in public – as long as the status assignment is not made explicit.[371] This is also true for individuals: every time you spend one Euro on free-range eggs rather than battery-hatched ones (out of animal welfare rather than culinary reasons), you make an implicit decision that ranks the interests of chickens above your own interest in buying something else with this amount of money. You weight chicken-welfare against human welfare, and have implicit assumptions about status hierarchies in this context (e.g. there is probably a quite low monetary limit above which you would not go in order to further chickens' interests).

Granted, there rarely is explicit status assignment in these processes – but this does not mean that there is *none*. We can detect a de facto, real-world status hierarchy in the consideration given to certain groups of people (or types of beings or entities) by society, and by individuals – even if the very same societies and individuals would find making such status hierarchies explicit mistaken and wrong. Status assignment to groups or types of beings may ultimately not be the perfect approach to moral consideration, but moral status assignment, resulting in (relatively) clear hierarchies and discriminatory practices, is what we as individuals, our governments and societies actually engage in on a large scale. It is also a cornerstone of speciesist approaches, the subject matter of the next section.

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[370] For Attfield's hierarchical and strictly consequentialistic view of value distribution in nature, see Attfield (1987), A Theory of Value and Obligation.

[371] An exception to this tendency is found in the U.S., where new regulation routinely undergoes cost benefit analyis which then takes into account measures like the value of a statistical life, expressed in U.S. Dollars.

## B. Speciesism

In chapter 2 above, I concluded that the success of several typical arguments against the creation of human-animal interspecifics depends on what I called speciesist positions. Arguments that presuppose speciesism or are based on the intention to preserve it include those from human dignity (see chapter 2, section B.4 above), some kinds of boundary arguments – i.e. those which claim that the boundary between humans and nonhumans is an inherently special or sacred boundary (see chapter 2, section B.3 above) – arguments that claim human-animal interspecifics could lead to the detrimental consequence of "absolute confusion" about their moral status (see chapter 2, section D.3 above), and the confusion argument reconstructed by Robert and Baylis,[372] which states that human-animal interspecifics could wrongfully endanger speciesist attitudes and thereby put society's current values at risk (see chapter 2, section D.3 above). Arguments that are based on the belief in a particularly high moral status of human beings also include most concerns for the proper use of human material like gametes, DNA, and tissues, and the influential concern regarding the misuse and destruction of human embryos (see chapter 2, section C.2.b above). Since the validity of speciesist positions is a complex issue, and also because human-animal interspecifics emphasize interesting aspects of the speciesism question, I want to discuss speciesist approaches in this separate section.

"Speciesism" stands for diverse types of opinions and positions – their common denominator is the belief that nonhuman animals deserve less consideration than humans.

Speciesism can present itself as a simple pragmatic rule of discriminatory decision-making. Such a rule of thumb could, e.g. say that you should favour humans over mosquitoes. This discriminatory approach to insects could, for example, be based on the assumption that, statistically speaking, it is highly likely that a human being is self-aware and conscious, while it is extremely improbable that an insect has these traits. Such a speciesist pragmatic rule allowing the swatting of annoying mosquitoes while forbidding the squashing of annoying humans could be based on pathocentric (i.e. non-speciesist) ethical principles. In my discussion of the process of assignment of moral status, I explained this effect with the "indicator function" of membership in certain groups (see p.121).

In other cases, speciesist pragmatic rules concerning the treatment of humans and nonhumans will be based on general assumptions regarding the moral status of humans vs.

[372] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 9f.

nonhumans. These are the positions I am concerned with in this chapter – I will call them "Speciesism" (with capital S) or "Speciesist ethical principles".

Speciesist ethical principles come in different types. One possible way to classify them is according to the reason they offer for assigning humans higher moral status than nonhumans. One type of Speciesism states that human beings have high moral status because "being human" is valuable in itself (Strong or Simple Speciesism). More complex types of (Qualified) Speciesism state that humans have high moral status because of certain characteristics that are particularly valuable (such as self-awareness, language, consciousness, etc.).

A second taxonomy could ask what classification system Speciesists use for distinguishing between human and nonhuman beings, in the first place. Very often, "human" is understood in the sense of biological taxonomy as "member of the species *Homo sapiens*". Others prefer a non-definitional approach – saying that we do not need to define "human" or even that it would be wrong and mistaken to reduce "being human" to a fixed list or bundle of necessary and sufficient properties. This table shows a matrix of Speciesist approaches along the lines of these two taxonomies:

| Classification method: / Reason for high moral status assignment | Biological Taxonomy | "Non-Definitional" | |
|---|---|---|---|
| Valuable in itself (Strong Speciesism) | "Being a member of the species *Homo sapiens* confers high moral status to members of human species." | "Being human, which cannot be reduced to natural properties, confers high moral status." | → moral relevance problem, see 1. |
| Valuable because of associated characteristics (Qualified Speciesism) | "Members of the species *Homo sapiens* have characteristics which justify their high moral status." | "Human beings have characteristics which justify their high moral status." | → marginal cases problem, see 2. |
| | →classification problem, see 3. | →universalizability problem, see 4. | |

As this table illustrates, all four main angles of Speciesist approaches bring with them a specific problem. Some of these problems are further emphasized by human-animal interspecifics – this, in turn, should influence our final judgment of Speciesism.

The four problems of Speciesist approaches will be the subject matter of the following sections.

## 1. The moral relevance problem

This problem affects all Speciesist approaches which claim or assume that "being human" or "being a member of the species *Homo sapiens*" is valuable in itself and gives its carrier superior moral status (i.e. Strong Speciesism). Why, one could ask, should being human be relevant for moral status?

The problem of moral relevance can be illustrated by an analogy of Speciesism to racism or sexism (the term "speciesism" originally alluded to this analogy, though it is understood by many, including myself, as a neutral term today). The racism/sexism analogy stems from

Peter Singer's seminal anti-speciesist work "Animal Liberation".[373] Singer argued that, just like women are no doubt different from men, and white people demonstrably different from black people, animals are different from human beings. However, factual inequality of the sexes (or races) does nothing to *justify* sexism or racism, and, in the same way, factual differences between human and nonhuman beings do not justify discriminating against nonhumans. Singer argued that the "principle of equality", which demands equal consideration *in spite* of factual inequality, should be extended to nonhuman animals. In the light of Singer's analogy, Speciesism, as a moral position, is not just abstractly mistaken. It is untenable in the very same way, to the same degree, and for the very same reasons sexism or racism are, i.e. it is deemed systematically wrong. Speciesism, Singer says, must be condemned "in analogy with racism", and he finds it "obvious that the fundamental objections made to racism and sexism […] apply equally to speciesism", which he regards, just like other "-isms" as a "prejudice of attitude of bias in favor of the interests of members of one's own species and against those of members of other species."[374]

Is the analogy between speciesism and sexism or racism persuasive as an argument against speciesism? Is speciesism "like racism" or "like sexism", and, if yes, in what regard? And does that mean speciesism is untenable?

What Singer stresses in regard to both sexism/racism and speciesism is the fact that they base their moral distinction between man and woman (or white and non-white, or human and nonhuman) on qualities that are *morally irrelevant*. Singer's objection can be used to counter Strong Speciesism, which holds that species membership determines superior moral status. Why should the mere fact that a being belongs in a different biological species justify its having a different moral status, i.e., ultimately, ought to be treated differently? This seems like a naturalistic fallacy (drawing ethical conclusions from natural facts), and conspicuously similar to racist or sexist ideologies, which also claim that a biological disposition, like belonging to a race, or that of having or not having a Y chromosome, determines moral status. "Belonging to a nonhuman species", from this standpoint, appears to be a characteristic that is just as obviously morally irrelevant as "having dark skin" or "being female". Singer's analogy between speciesism and racism/sexism boils down to one basic accusation: it is claimed that speciesists, just like racists and sexists, base their discrimination between human and nonhuman animals on morally irrelevant characteristics.

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[373] Singer (1976), Animal Liberation.
[374] Singer (1976/1990), Animal Liberation, p. 6.

This does not rule out Speciesism, once and for all. It could be the case that there is indeed one, or several, morally relevant characteristic(s) that all human (but no nonhuman) beings share – this leads towards the Qualified type of speciesism described above. Whether this route is a promising one will be discussed in the following section.

In defence of Speciesism, one could also remark that the problem of moral relevance is not unique to Speciesism, but applies to *any* ethical system which discriminates between entities regarding moral status. Each of these systems has to own up to justifying its discrimination criteria. Although a discrimination criterion like sentience seems somewhat less in need of justification than one like genetic disposition, rarely do pathocentrists give an overt justification of why they deem sentience, or phenomenal experiences, to be more valuable than non-sentience, or absence of phenomenal experiences. These value statements seem self-evident to many, but they may not be evident to all. In turn, the moral relevance of species membership may be regarded as defensible or even evident by some.

The question of Speciesism or Non-Speciesism, accordingly, is not settled once and for all with the assertion that speciesism is "like racism or sexism". It seems clear though that if species-membership itself is flaunted as "morally relevant characteristic", this approach will be quite hard to defend, or at least much harder to defend than non-speciesist accounts which use criteria like sentience or self-awareness.

## 2. The marginal cases problem

Qualified Speciesists, who justify the superior moral status of humans by pointing out that members of the species *Homo sapiens* have particularly valuable properties such as consciousness, self-awareness, intelligence, capacity to form complex social relationships, and so on, can avoid the problem of moral relevance or at least keep it to a minimum by referring to those typical human properties that seem evidently relevant for moral status. In turn, Qualified Speciesism is faced with another problem: biologically human beings who do not exhibit these properties. In the speciesism debate, such cases are called "marginal humans". This somewhat clumsy but by now customary term means to imply that those cases are on the borders of what is considered "typical" for a human being (rather than implying that they are "not really human").[375]

What counts as a marginal human can vary wildly. It depends on which properties the Speciesist account in question uses: the more demanding the approach is, the more

[375] Cf. Pluhar (1995), Beyond Prejudice: The Moral Significance of Human and Nonhuman Animals, p. 63.

biologically human beings will qualify as marginal. E.g. if rationality or even capacity for moral agency is declared to be the relevant property, children and mentally handicapped persons will not make this hurdle. Ultimately, even for the lowest of hurdles (e.g. sentience) there are biologically human beings which cannot jump it (e.g. anencephalic infants).

Marginal cases are imaginable on both sides of the human-nonhuman divide. When Speciesism assumes a lower hurdle, stating that, e.g., "capacity to form social relationships" is the property which determines moral status, one will have to deal with the claim that there are nonhuman beings which also have this capacity. The scenario of animals that are somehow subject to a moral upshift by introduction of human material would constitute a paradigmatic case of a "marginal animal". The occurrence of mice or nonhuman primates which suddenly speak up, laugh, become self-aware etc. is, as we have seen above, a commonly discussed scenario in the interspecific debate – even if it is strictly hypothetical today, as human-animal interspecifics have not shown any kind of humanization in this sense. Still, marginal animals are a thought experiment which effectively highlights an actual problem of Speciesist approaches.

The Qualified Speciesism account, facing marginal cases, ends up with two questions: Why should marginal humans be accorded high moral status, although they do not exhibit the properties allegedly responsible for this high moral status? And secondly, why should nonhumans which exhibit these properties not be accorded high moral status?

A solution to this problem would be, first of all, in finding a property that all humans and no nonhumans have (as a second step, one would have to argue for its moral relevance). The search for such a property often leads Speciesists to scientific species classification concepts. Zoological taxonomy is assumed to deliver the desired mode of unambiguous distinction between human and nonhuman, the desired property that "all, and only, humans have". But does it?

## 3. The classification problem

Speciesism approaches which rely on biological taxonomy assume that members of the species *Homo sapiens* have a superior moral status in comparison to non-members of this species. Aside from justifications for this position, in order for this ethical principle to make sense, the Speciesist should be able to tell us (at least in theory) which entities are human in this sense, and which entities are not – otherwise, the principle could not offer any guidance in decisions about a general course of action concerning the treatment of

differing entities, which I deem to be a minimum requirement for ethical principles. So, what Speciesists try to derive from biological classification is an unambiguous, consistent way of carving up nature into different species or, rather, into humans and nonhumans. They assume an essentialist concept of species: for every species, they believe, there is a set of characteristics or properties all of which any member of that species must possess. At least, they believe that this is true for the *human* species. Does the concept of "species" in biology accommodate for such "essences"?

*a. Searching for a human species essence in biology*

There is a stunning variety of concepts of "species" and criteria for "species membership" in biology, far too many to describe them here. The classical species concept is the typological species, which goes along the lines of differing phenotypes; other species concepts (e.g. biological species) rely on the (actual or possible) reproduction of fertile offspring between species members; phylogenetic species describe one "branch" in the evolutionary tree. There is no generally predominant or most appropriate species concept in biology.

We can look at the question of whether there is such a thing as "species essences" from a very general point of view, though. Modern biology assumes that all living beings are products of evolution. Spontaneous mutation is the motor of this process. And evolutionary theory states that, in principle, all characteristics of individuals can be subject to spontaneous mutation in the next generation. This means that over time, there is no room for something like an unchanging "species essence" that members of a species necessarily share. Ereshefsky concludes: "From a biological perspective, species essentialism is no longer a plausible position."[376]

The lack of "species essences" goes counter folk taxonomy and confuses us. Essentialist perceptions in this field are still common standard. Today, they often come in the guise of a very modern concept: that of the gene, the basic transmission unit of biological heredity, which is included in the genome, the whole of hereditary information of an organism. In folk genetics, the genome has retained the reputation of determining, unambiguously, the species membership of an individual. Genetic sequences, accordingly, are referred to in species terms: there are "jellyfish genes",[377] "human genes",[378] and so on. Additionally,

[376] Ereshefsky (2002), "Species", The Stanford Encyclopedia of Philosophy (Fall 2002 Edition).
[377] A German journalists refers to the "Quallengen" (jellyfish gene) inserted into transgenic monkey ANDi, see Schuh (2001), "Affen-Flop Transgene Primaten", Die Zeit, 2001/01/25.
[378] nano (2007), "Menschliches Gen lässt Mäuse die Welt in Farbe sehen", 3sat online, 2007/03/23.

genes are ascribed a quasi-magical deterministic power: they are the "blueprints" of organisms, from which the developing cells slavishly take orders concerning the setup of their surroundings. From this vantage point, it seems that species essentialism is still intact: members of the species *Homo sapiens*, in this view, can be distinguished from non-members by their bodies' content of "human genes". Any organism that contains such human genes, in turn, is a member of the species *Homo sapiens*, and accordingly has high moral status.

There is no such thing as a "genetic essence", though. The "humanness" of a DNA set, for example, can only be assured by relational comparison to other DNA sets. There are no uniquely human DNA sequences which are common to all, and only, humans. Robert and Baylis put it this way:

> *"(…) it is not the case that there is a certain part of an individual's genome that is 99.9% identical with every other human's genome. Although human beings might share 99.9% commonality at the genetic level, there is nothing as yet identifiable as absolutely common to all human beings. According to current biology, there is no genetic lowest common denominator, no genetic essence, 'no single, standard, normal DNA sequence that we all share.'"*[379]

The simple explanation for this fact is, again, that evolution is crucially dependent on variability of traits. Spontaneous mutation is based on the variability of DNA microstructure. In order to make adaption to the environment, the enabler of evolution, possible, each and every DNA sequence in an individual's genome is up for variation. The mechanism of evolution is not compatible with the development of a "genetic essence".

Additionally – and this is crucial for the context of interspecies beings – the layman idea that genes are the ultimate determinator of living beings, functioning as "control centres" which effortlessly steer the development of organisms into every imaginable direction (i.e. the direction that is typical for "their" species), is mistaken. As the ISSCR Committee Forum points out:

> *"(…) what does 'animal or human gene' or 'animal or human cell' actually mean? In the light of the evolutionary conservation of many signalling pathways, 'human or animal genes or cells' can refer only to the fact that these units have a human or animal origin. But from this it does not follow that an animal gene or cell, once put into a human, behaves as an independent unit of 'animal agency' or vice versa."*[380]

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[379] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3), p. 4.
[380] Hyun, Taylor, et al. (2007), "ISSCR: Committee Forum - Ethical Standards for Human-to-Animal Chimera Experiments in Stem Cell Research", Cell Stem Cell, **1**(2), p. 160.

In the last decades, research on posttranslational and epigenetic processes has revealed the limitations of genetic determination. So, not only is there no such thing as a "species essence" to be found in genes. Genes are also not the single magic ingredient that determines living beings' properties, but rather, one puzzle piece in a complex, interacting system of numerous parts that are bound into feedback loops. The belief in genes understood as all-determining "blueprint" of organisms has, in fact, decreased so far over the last years that researchers have now declared the "post-genomic era", where the focus is less on deciphering DNA and, more holistically, in finding out "how novel functions and properties emerge from the dynamic web of interactions and feedbacks brought about by the molecules of a living organism."[381]

This all does not mean that species or genes are irrelevant or non-existent. It only means that the term species, as Darwin himself stated, is: "one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other."[382] Dunbar repeats this conventionalist interpretation:

> *"Species, as we describe them, are matters of convenience rather than biological reality. The real world consists only of individuals who are more or less closely related to each other by virtue of descent from one or more common ancestors."*[383]

*b. Consequences for Speciesism based on biological taxonomy or genetic disposition*

What does this mean for Speciesism? For views which claim that membership in the species *Homo sapiens* determines moral status, the moral relevance problem is emphasized by this discovery. "Species" are not a given category of nature, but rather a human convention. And as we know, the grouping of species is done for the sake of biological research, not for the sake of singling out morally superior beings. Why there should be a connection between these two realms stays unclear. Graft concludes:

> *"The term species may have a meaning in the context of our everyday discourse or in the context of practical taxonomy, but those contexts are not coherent for use in the context of morality."*[384]

For views which claim that human species membership confers moral status because the human species has certain particularly valuable properties, a similar problem emerges: if

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381 Falaschi (2002), "Living in the Post-genomic Era", UN Chronicle (3).
382 Chapter II, "Doubtful Species", in Darwin (1872), On The Origin of Species.
383 Dunbar (1993),"What's in a classification?" in: Singer and Cavalieri (eds.) The Great Ape Project.
384 Graft (1997), "Against Strong Speciesism", Journal of Applied Philosophy, **14**(2).

"human genes" are not the lone determinators of the characteristics of an organism, their existence in an organism loses at least some of its relevance.

What is more, both strong and qualified speciesism views face a classification problem that is emphasized by interspecific beings. With a non-essentialist view of species, the species membership of a being is not necessarily ascertainable anymore: It is unclear whether the DNA of a (hypothetical) human-animal hybrid, e.g. between human and chimpanzee, would count as "human", and, in turn, whether such a being would have to be considered "human" or not. When a human-to-animal embryonic chimera contains human-typical DNA, this does not necessarily mean that the organism is a member of the species *Homo sapiens*. Other mixed entities, like human-animal cybrids, are similarly problematic: they contain human-typical DNA, but in an environment which is most likely not conducive to its development into a human organism. Are these entities "human"? A Speciesist view which tries to take refuge in biological classification methods will not be able to answer these questions, and, in turn, will not be able to ascertain the moral status of such entities.

## 4. The universalizability problem

This whole complex of problems is apparently bypassed by Speciesist approaches which avoid the classification question and state that "being human" cannot be reduced to a fixed list or bundle of natural properties and that the whole step of defining "human" is unnecessary or even mistaken.

In this vein, one could state that "being human" just means that a being is assigned high moral status by the moral community. In this view, everything that the speaker(s) wants to be treated according to a superior status would be called "human". Declaring something "human" would simply be identical with assigning this specific being superior moral status (rather than referring to biological taxonomy).

It seems in fact plausible to me that the way we use the term "human", especially in the moral context, is strongly influenced by our normative assumptions about what *should* be treated as human, e.g. which entities should be assigned high moral status. This is where our strong intuitions about what is human and what not come from, rather than, so to speak, from an internalized but inaccessible list of "essentially human" properties: human is whatever we want to be treated humanely. This understanding of "human" and "nonhuman" would make it easy to circumnavigate the problems described so far: the moral relevance of "being human" would be ascertained by the view that calling something

"human" is simply identical with assigning it moral status. Marginal cases of atypical humans could be called "human" and assigned high moral status without running into inconsistencies. Classification would be avoided as a whole.

This strategy fails, though, because the result would not be an ethical principle of Speciesism, but rather a reduction to ethical particularism concerning status assignment. Such an outcome would go counter the whole concept of Speciesism as a guiding principle in assigning moral status. Universalizability is a minimum requirement of an ethical principle: it should be transferrable and applicable to similar particular cases. A rule of moral status assignment which does not offer any criteria for future classification would not meet this requirement.

Differing varieties of Speciesism as an ethical principle are, as we have seen, riddled with severe problems: one is that the moral relevance of "being human" is hard to establish once we understand "being human" as membership in the species *Homo sapiens*. Another problem is that, once the superior moral status of human beings is somehow tied to their having particularly valuable properties, the occurrence of humans which lack these properties is hard to deal with. Interspecific "Marginal Animals" in the form of nonhuman beings to which valuable human properties have been transferred are a thought experiment that further emphasizes this problem of moral relevance. A third complex of problems is found in the concept of species, in general: its conventionality makes the case of moral relevance even harder to argue for; additionally, the reduced deterministic power of genes destroys the idea that species membership is essentially linked to certain characteristics like "having human genes". Additionally, novel human-animal interspecific mixtures show that classification into human and nonhuman can pose insurmountable problems for species concepts, which, in turn, would make the assignment of moral status impossible for Speciesist approaches. Finally, we have seen that Speciesism needs to rely on some kind of classification in order to constitute a generalizable ethical principle. Speciesist ethical principles, in the light of human-animal interspecific beings, but also independently of them, seem extremely hard to defend.

# Chapter 4: Should We Prohibit Interspecific Creation?

Our overview of possible arguments against the creation of interspecifics, in chapter 2, covered a wide array of possible concerns, ranging from very practical worries like the threat of zoonoses to highly theoretical remarks, e.g. on moral boundaries between species, human dignity concerns or different types of moral confusion. The excursus of chapter 3 revealed that Speciesism, a position that some or even most of the arguments discussed rely on, is hard to defend and should, consequently, at least not be the main supporting beam of argumentation against the creation of interspecifics.

After this comprehensive presentation, I will analyse the argument-types in order to answer the central question posed above: is there a persuasive argument for the general position that creating interspecifics (specifically: human-animal interspecifics) is wrong and should be prohibited?

In answering this question, I will assume that, were creating interspecifics arguably morally wrong, governmental or other institutional prohibition of their creation would be advisable. Although usually the question of moral wrongness of an action and the admissibility of its prohibition are better treated separately, I will conflate the two here for simplicity's sake. In the case of high-profile, often governmentally funded research, which typically already is subject to heavy regulatory intervention, it seems that prohibition of certain actions seems to be an appropriate and also effective intervention – were these actions found to be morally wrong. What types of regulation or prohibition seem advisable in the light of my analysis will be discussed in section B below.

## A. Concise analysis of arguments

To answer the question whether the creation of interspecifics is morally wrong, I will now give a distilled overview of the most important arguments presented above and focus on three aspects in each case:

- *Originality*: Is the argument presented new and specific to the chimera debate, or where does it originate?

- *Applicability*: What types of interspecific beings would the argument apply to?

- *Persuasiveness*: Does the argument convincingly state that creating interspecifics, or specific types of interspecifics, is morally wrong?

Let us look once more at the argument types introduced previously.

The type of arguments discussed under the catch phrase "Yuk Factor" is not unique to the chimera debate, rather, they stem from other areas of concern – Leon Kass' "Wisdom of Repugnance"[385] was originally directed against cloning. The idea that mixtures as such are in some way repugnant or bewildering is found in many other areas as well (e.g. in the common reaction to transgendered persons). It is unclear what kinds of interspecific beings arguments from repugnance would refer to, exactly. Essentially, they could be directed against all kinds of mixed beings – including artificial interspecifics, but also "natural" animal-animal hybrids or transgenic plants. In all these cases, it could be argued that "the mere idea" of an animal-animal or human-animal mixture is revolting. The beings that are apparently most likely to create direct reactions of "yuk" are those that have human-typical features or parts. Vacanti's earmouse (see p. 12) would be one example which often has this effect on people – interestingly, tissue engineering can produce such "yucky" creatures without even mixing human and nonhuman material (Vacanti's mouse's ear was made of bovine cells, it could also be created from exclusively murine material). Most creatures or entities created in current interspecific research, on the other hand, would probably not evoke an intuitive "yuk" response: they seem inconspicuous and not monstrous at all, or, in the case of manipulated microscopic entities, much too unfamiliar to the layman to generate any direct emotional response. Thus, the specific direction of yuk-factor arguments remains unclear. Repugnance or "yuk factor" objections, I conclude, are not philosophically persuasive. Even after several rescue attempts and with a lot of charitable interpretation, they remain in the realm of appeals. Additionally, invoking "repugnance" or "yuk" is not helpful for the debate since these reactions vary greatly and cannot, as it were, be reasoned into people who do not feel them. However, an assessement of intuitive or emotional reactions to confrontation with the idea of chimerism can be helpful in finding out where the real arguments against chimera creation lie. To give but one example, the theory that the human face is an important signifier for high moral status can explain why many find the thought of creating animals with human features especially revolting.

[385] Kass (1997),"The Wisdom Of Repugnance", in Kass and Wilson (eds.): The Ethics of Human Cloning.

The second type of arguments we looked at in chapter 2, section B.2 above were religious and quasi-religious arguments. Christian religious objections against the creation of interspecifics can be derived directly from the scripture (i.e. from the explicit prohibition of sex with animals), and are, in this sense, based on a very well-known moral taboo that exists in many cultures and religions. More indirect Christian arguments against human-animal interspecifics can be derived from the concept of human dignity which will be discussed below. Religious or quasi-religious concerns stating that interspecific creation constitutes "Meddling with Nature" or "Playing God", i.e. hubris arguments, have been, analogously, aimed at new biotechnologies like genetic engineering or cloning. They are not new or specific to the chimera debate. Christian arguments against the creation of interspecifics often focus on the fundamental distinctiveness of humanity from other living beings – in this case, they are only applicable to human-animal interspecifics. More general religious arguments (i.e. from the "completeness of creation"), just as quasi-religious/hubris concerns, can potentially be used not only against the creation of human-animal chimeras, but also against the creation of interspecific animal-animal chimeras and transgenic animals and plants. Religious objections and what I called quasi-religious concerns (see chapter 2, section B.2) have the obvious disadvantage of being not persuasive to non-religious persons or persons who do not believe in a natural teleology. The mythical idea of hubris, today, is hard to defend in an intellectual argument, though it seems to have extensive influence on public debate.

The third type of intrinsic argument I introduced above rely on the moral relevance of the boundary between species, especially between human and nonhuman species. These arguments are new and specific to the debate around chimeras, though one could argue that part of this argument already can be found in (rarely explicitly discussed) arguments against sexual contact with animals. Boundary arguments certainly become clearer, and much more intense, in the context of human-animal interspecific creation, though. Boundary arguments would, at first glance, apply to all kinds of novel, artificial interspecific beings and maybe even to "natural" animal-animal hybrids. What specific actions these arguments are directed against, however, depends on what exactly is identified as the "violation" of species boundaries. Since this is rarely discussed, the specific direction of boundary arguments remains unclear. Boundary arguments depend, firstly, on the assumption that there is a clear, hard boundary between species – an assumption that is not at all easy to make, as we have seen in chapter 2, section B.3 above. Explaining why biological disposition should be morally relevant presents another challenge for boundary

arguments. Even if these difficulties were overcome, I still see a problem in the most basic question concerning boundary arguments, i.e. the question in what way, or at what point, mixing constitutes a violation of boundaries (and what kinds of mixing are considered boundary-crossings). Accordingly, I do not think that boundary arguments show much promise as arguments against the creation of chimeras, even against human-nonhuman chimeras.

Concerns for violations of human dignity (see chapter 2, secion B.4 above) are well known from many fields of bioethical discourse. In the specific case of human-animal interspecific creation, it is not clear what exactly the violation of human dignity – i.e. a transgression that exceeds a simple violation of interests – would consist in. It remains unclear which cases of interspecific research such arguments could apply to. I find the view that creating human-animal interspecifics constitutes a violation of human dignity to be mistaken, since I could not identify which subject is robbed of valuable capacities or kept from exercising them as a result of creation of chimeric, hybridic or transgenic beings. There is, of course, the much more general objection that human embryonic stem cells or human embryos should not be used for research, at all, because this constitutes a violation of human dignity. This far-reaching argument does not help to express the view that interspecies creation is *especially* violating to human dignity (much more than simply destroying an embryo e.g. in an abortive procedure), a view that objectors to chimera creation on grounds of human dignity seem to hold. Apart from these problems, using the language of "human dignity" is not very helpful in the area of moral classification of human-animal chimeras or other interspecifics, since it presupposes or at least hints at an assumption that, in my opinion, is questioned by the very idea of humanized chimeras (namely, that we can always determine who is and what isn't in the group of "humans"). Human dignity approaches, as I explained above, are based on the questionable doctrine of Speciesism. To sum up, human dignity concerns do not seem persuasive as arguments against the creation of interspecifics because the exact point at which interspecific creation, as such, results in a violation of dignity, remains unclear. But even indirect approaches (i.e. stating that all embryo use violates human dignity or that keeping part-humans in lab settings might) are dubitable since the concept of human dignity begs the question of what is relevant for moral status by assuming Speciesism.

What about consequence-based arguments against creating interspecifics? The first aspect covered in our discussion were "classic" animal welfare concerns. The issue of animal welfare in medical or other experimentation settings is vigorously discussed not only in

cases of interspecific research. Maybe less obviously, the creation of beings that are designed with tacit acceptance or deliberate causation of sub-par quality of life is not limited to interspecific research. Concerns about the cruelty inherent in creating suffering animals also apply to animal models which are bred to model human diseases, but which are not necessarily a product of transgenesis or chimerism. The general concern for beings that are created in order to exhibit detrimental characteristics actually even predates modern engineering technologies: traditional animal husbandry often leads to pets and livestock with diminished quality of life. Animal welfare concerns can presumably pertain to all kinds of interspecific research. Often, the problem is not only in the experiment per se, but in detrimental keeping of animals (i.e. lack of proper habitat conditions, lack of social contact, etc.). Even research done in vitro (e.g. human-animal cybrid research) might be susceptible to concerns for animal welfare, because it makes use of animal material (e.g. cow or rabbit eggs) which might be obtained under morally despicable conditions. In effect, in vivo research involving adult nonhuman primates is most likely to raise animal welfare concerns; in vitro research, on the other hand, will probably raise the least concerns. The creation of interspecifics, as such, is no more objectionable than other kinds of research involving animals. In this sense, animal welfare seems not to be a powerful argument against interspecific research creation per se. Chimerisation is not outstandingly cruel, as such, and the same is true for hybridisation, transgenesis, and cybridisation. Fears of creating a "human trapped in an animal body" may be eerily intimidating, but seem extremely speculative and implausible; full-brain transplants are not planned, and: human characteristics develop according to the possibilities and stimulation that is provided. Even if a "human" brain would develop in a lab animal (e.g. a monkey or ape), it is doubtful whether this scenario would lead to a fully conscious and desperate being that, e.g., would not be able to make itself heard because of a larynx that cannot produce speech sounds. Rather, it would probably lead to a primate with slightly atypical behaviour. Animal welfare concerns can definitely be valid in certain cases of interspecific creation, just as in other kinds of research involving animals. Regulation and control of interspecific research with respect to animal welfare is necessary, but this does not translate to a need for prohibition of interspecific research. Animal welfare, if understood in a sense that is consistent with commonly used, moderate concepts practiced in the research context, does not work as a persuasive argument against creation of interspecific entities. In the light of chapter 3, section B above, it is not enough to justify animal experimentation by pointing out the differing moral status of human versus nonhuman beings. Justification of the use of

animals in research in a non-speciesist approach should be supported by more appropriate criteria – this could be, for example, the capacity (or lacking capacity) to feel pain, or have close and complex social relationships. Making use of these criteria as decisive instead of species membership/"being human" could lead to severe problems when trying to justify experimentation on nonhuman animals which exhibit these properties to some degree – especially nonhuman primates, maybe also mammals like rats. Giving up Speciesist justifications would not necessarily mean that research using nonhuman animals would not be justifiable, though. Also, it would not mean that research on marginal humans would become acceptable.

Other consequence-based arguments (discussed in chapter 2, section C.2.b above) that refer to concerns for the proper treatment of human embryos, gametes, genes, and tissues in research are well-known from the stem cell or the abortion debate or addressed in ethical regulations for the therapeutic or scientific use of human tissues. Arguments of this type would pertain to all cases where such material is used, i.e. human-animal chimeric embryos (which often require the use of human embryonic stem cells), human-animal transgenic beings (which require the use of human-typical genes), human-to-animal chimeras (which require human tissue), and human-animal hybrids (which would require the use of human gametes). It is unclear whether these concerns would also pertain to cybrids: firstly, can the use of single human cell nuclei for injection still be regarded as a case of "human tissue" use? Secondly, and more important, do human-animal cybrids count as human embryos? Scientists assume that they do not and that consequently, arguments for human embryo protection do not apply to cybrids. Whether one shares this view depends on one's definition of "human embryo". Concerns for the proper treatment of cells, gametes and genes are not stronger in the case of chimerism than in all other areas where human material is used, still, they must be considered. Yet I think it is unlikely that such concerns in themselves will offer a strong argument against the creation of human-animal chimeras. Exceptions from this rule are positions that demand absolute protection of human embryos from conception on. If the use of human embryos and pre-embryos cannot be morally justified, this would warrant the prohibition of all human-to-animal chimera creation which requires human embryonic stem cells or cells derived from hESCs. Many areas of interspecific research would not be affected by this argument, though: e.g. xenografts of stem cells that are not derived from human embryos, xenotransplantation, transgenesis, (hypothetical) human-animal hybridisation and probably also human-animal cybrids. An argument against the creation of human-animal interspecifics that is rooted in

absolute protection for human embryos seems, to me, more persuasive than many other approaches in the field, but it would only warrant the prohibition of some areas of interspecific creation, and not a general prohibition of human-animal interspecific research. It should be noted that many, if not all, arguments for the stringent protection of human embryos and pre-embryos are based on dubitable Speciesist premises; the problems of Speciesism outlined in chapter 3 therefore also apply to these views.

The related, but distinct concern for inadequate treatment (see chapter 2, section C.2.c above) is not necessarily a consequence of research involving interspecific beings – as mentioned above, all animal experimentation is subject to allegations of "inadequate treatment" of animals. Yet, as I spelled out, chimeras and other artificial interspecifics are at a particularly high risk of inadequate treatment – this is because, firstly, there are no precedents (this is a property they share with other novel beings) and, secondly, because some ethical systems have fundamental difficulties with determining their moral status. So – and this is the fundamental difference to other occurrences of animal experimentation – even if the researcher is willing to do all he can to acknowledge the moral status of the being he creates, and assuming for the sake of the argument he even knows the right morally relevant properties to look out for, he might still have difficulties to find out or decide how to properly treat the research subject. Inadequate treatment becomes a particularly challenging and genuinely new threat when the chimeric research subjects are characterized as "part-humans". None of the human-animal chimeras or interspecifics created today are sufficiently "humanized" in this sense as to justify concerns of inadequate treatment, but this could be a real problem in the future, and is already treated as such by ethics committees and authorities. In this context, interspecific research has to confront what I called a "catch 22": most types of interspecific research relies on the "humanization" of human-animal interspecifics, as this is what makes them interesting as assay systems or disease models in the first place. In some areas, e.g. emulation of the human brain in animal models, properties that are interesting for research could coincide with the properties relevant for moral status (e.g. higher brain function, which might lead to an emergence of consciousness). In these (limited) areas, the catch 22 of inadequate treatment poses a severe problem, which is already recognized by ethics committees.

Inadequate treatment concerns offer a persuasive argument against research that would lead to human-animal interspecifics which exhibit especially morally valuable properties. It is an indirect argument, because it would not directly justify the prohibition of the creation of such "humanized" human-animal interspecifics, but rather, their use in laboratory

research contexts – still, it can be quite persuasive, specifically against interspecific research which meets the criteria of "catch 22" (e.g. where scientifically interesting properties brought about by humanization coincide with morally relevant properties). Concerns for inadequate treatment can, but need not necessarily be based on Speciesist premises: they can be applied only in regard to beings which "become human" or "are part-human", but also to beings which exhibit special, valued capacities (which may be human-typical or not).

What about the concern that status shifting in itself could be a disadvantageous consequence of interspecific creation (see chapter 2, section C.2.d above)? Status shifts seem, at first view, quite extraordinary – as Streiffer notes, the moral evaluation of research "normally presupposes a fixed moral status for the subject."[386] This is only literally true, though, in ethical systems that assume, prima facie, that a being's moral status is determined by its being or not being human. If we assume an ethical system that uses other criteria for determining moral status, human beings' moral status changes over time. For example, fetal and adult phases, or demented/comatose and mentally healthy phases of the same human being result, at least prima facie, in the assignment of different moral statuses in approaches where self-awareness or consciousness are deemed morally relevant properties. In the same way, animals' moral status could be said to change (even without xenografts): it could be stated that animals are made more human-like by stimuli and a special environment. As the Working Group at John Hopkins points out, "Human-Nonhuman primate neural grafting may not be unique in having the potential to alter the capacities of nonhuman primates. Chimps reared with humans behave in a more humanlike way than chimps reared by chimps."[387] Such human-like behaviour, at some point, could lead to an upwards shift in moral status (the process is sometimes called "cultural uplift"). So could, to give more speculative examples, genetic manipulation of individuals or treatment with substances that influence morally relevant factors like consciousness, intelligence, etc ("biological uplift"). Advanced computational models of neural processes ("Artificial Intelligence") could, in the future, present us with a similar case of status shift, resulting in a piece of software that shows human-typical response patterns. Let us therefore keep in mind that moral status shifts are only unique for chimeras once we assume a speciesist background – in non-speciesist ethical frameworks, moral status shifts are not uncommon and, in a way, to be expected as morally relevant properties in

[386] Streiffer (2005), "At the Edge of Humanity: Human Stem Cells, Chimeras, and Moral Status", The Kennedy Institute of Ethics Journal, **15**(4), p. 348.
[387] Greene, Schill, et al. (2005), "The Working Group on the Criteria for Cell-Based Therapies, John Hopkins University: Moral Issues of Human-Non-Human Primate Neural Grafting", Science, **309**.

individuals change over time, due to "natural" development of the being/entity or due to environmental influences of diverse kinds. The allegation of intentional "status shift" does not apply to the human-animal interspecifics created today, since none of them exhibit human-typical valuable properties to an increased degree. It is imaginable that e.g. the massive introduction of human stem cells into developing animal organisms of nonhuman-primate origin could lead to the emergence of human-like cognitive properties in a "human neuron chimpanzee". Likewise, the scenario of "downshift" is not applicable to any of the human-animal interspecific experimentation done today. That the possible consequence of "status shifts" might be morally problematic seems not persuasive in the case of upshift. Downshifts, on the other hand, would evidently be morally problematic, but they are neither planned nor would they offer advantages for research. "Subhuman" creation by "dumbing down" human beings would clearly constitute a morally reprehensive practice, but this is not due to chimerisation but due to violation and harm done to a human being, in general. Shifting moral status as such is not disadvantageous and does not offer an argument against chimera creation.

The most direct, palpable risk discussed in chapter 2, section C.III – the direct danger to human populations by increasing the risk of zoonoses and "species jumps" of pathogens that could lead to pandemics of highly lethal diseases – is not unique to interspecific experimentation. Animal-to-human transfer of pathogens, in general, is a well known health risk in other contexts that do not involve human-animal chimerisation or hybridisation (cf. bird and swine flu, HIV, SARS). Certain factors increase this risk in the case of human-animal xenografts. The threat of zoonotic pandemic originates in animal-to-human xenotransplantation. In vivo or in vitro laboratory research involving human-to-animal chimeric creatures poses this risk to a much lesser degree. The zoonosis transfer risk is negligible in regard to human-animal cybrid research. Concerns for the development of zoonoses and zoonotic pandemics are valid and need to be considered, yet they do not seem to suffice as persuasive arguments against the creation of human-animal chimeras or other interspecifics in general. Zoonosis concerns are persuasive in a limited area, i.e. in justifying the close control and regulation of xenotransplantation that is already in place in most legislations.

The argument that Risk-Cost-Benefit-Analysis is somehow not applicable to the scenario of interspecific creation since it misrepresents uncertain outcomes which cannot be quantified was discussed under the keyword of "precaution" (in chapter 2, section C.4 above). The idea that precautionary principles should be applied in risk assessment is well

known from many areas (e.g. environmental regulation, medical decision-making). It would be applicable specifically to those scenarios of interspecific creation where there is a great degree of uncertainty concerning potential outcomes – e.g. the creation of human-to-animal chimeras with humanized brains, regarding the concern of emergence of human-typical capacities; or the release of transgenetically manipulated animals into the wild, regarding risks for the equilibrium of ecosystems. The persuasiveness of precautionary arguments is severely limited though because their direction is unclear. A preference for risk-aversion does not tell us how to act or not to act. "Precaution" can only be understood in this context as a minimum requirement of risk assessment methods; in this sense, it does not offer an argument against creating interspecific beings by itself.

The last three types of arguments I assessed were under the label of "moral confusion" (chapter 2, section D above). Non-speciesist and qualified speciesist accounts will have a problem with assigning chimeras moral status. This is due to the fact that artificial chimeras are novel beings without precedents, and it is unclear at first what properties, capacities, and needs they have or could potentially develop. Consequently, "relative confusion" is not a problem that is unique to chimeras. Other novel beings or entities, and, in fact, all kinds of "atypical" individuals, give rise to similar complicated determinability, as I called this problem above. The problem of complicated determinability can not only apply to human-animal, but potentially all kinds of interspecific beings. It would probably be most pressing in cases where the original species involved have very different capacities, needs, and moral status levels (e.g. human/mouse). The interspecific beings created today are not affected by these considerations. The argument of complicated determinability is convincing, and also works against the creation of all kinds of novel beings. Finding out the moral status of a new being has costs which must be considered in a cost-benefit analysis. These costs can, ultimately, be so high that the creation of the being is not advisable anymore. This is not a direct argument for prohibiting interspecific creation, but it may be used as an argument against the creation of beings (interspecific or not) whose moral status is not easily determinable. This type of argument does not depend on Speciesist assumptions.

The second type of "moral confusion" I looked at was construed differently: Strong Speciesists, who believe that moral status is derived directly from (human) species membership, will face a unique problem when confronted with species-ambiguous human-animal chimeric and other interspecific beings ("absolute confusion", see chapter 2, section D.2 above). Some use this as an argument against creating human-animal beings. This argument is genuinely unique to the debate around artificial interspecifics, since human-

animal interspecifics do not appear naturally. What kinds of interspecifics trigger "total confusion" depends on the particular design of the moral background (namely on convictions regarding species membership) – hybrids and cybrids seem to be especially difficult and "ambiguous" in this regard. Whether one finds this argument persuasive depends on whether one supports speciesism. If, as I have done here, one rejects Speciesist ethical principles, the argument from "absolute confusion" does not work; on the contrary, the confusion described can be turned around and used as an argument against Speciesism itself.

The last type of argument discussed was one reconstructed by Robert and Baylis in their 2003 article "Crossing Species Boundaries"[388] (see chapter 2, section D.3 above). Having to deal with human-animal interspecifics could lead to the point where both the assumption that human species membership is necessary for high moral status and that it is sufficient are questioned and thrown overboard, and social practices that depend on these assumptions are no longer defensible. General threats to unique human status are not new: from Freud's classic three offenses to mankind (Galileo, Darwin, and his own discoveries) to contemporary findings of allegedly "unique" capacities in nonhuman animals, the anthropocentric paradigm has had many attackers. More specifically, the deconstruction or questioning of (Qualified) Speciesism need not necessarily rely on the example of human-animal chimeras or interspecifics. All kinds of "marginal" or atypical cases (both on the human and the nonhuman side) make it hard to defend Speciesism. What is unique about interspecifics is that some kinds of artificial human-animal interspecifics, namely hybrids and cybrids, whose species membership is unclear, make Strong Speciesism conceptually untenable – this problem is described elsewhere as "absolute confusion" about the moral status of novel beings. The second case of human-animal interspecifics that could be problematic in this sense would be the (hypothetical) case of interspecifics that exhibit human-typical properties, such as language capacity, or consciousness, but which are not evidently human. In these two senses, the threat of moral confusion is unique to human-animal interspecifics. Which interspecifics would be dangerous in this regard depends on what properties one wishes to regard as "quintessentially human". Presumably, adult human-to-animal chimeras with emerging cognitive capacities would be one case, human-animal hybrids (if at all possible) another. Cybridic entities seem less obviously threatening here. According to Robert and Baylis' reconstruction of an "argument from moral confusion", confrontation with chimeras could lead to cognitive dissonance and, as the

[388] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3).

final result, to giving up the assumption that all and only human beings have superior moral status. In analogy to the second argument from confusion, the persuasiveness of this argument depends on the question of whether one finds Speciesism attractive. Additionally, it also depends on whether one agrees with the prognosis that thinking about Strong Speciesism and discovering inconsistencies will lead to people giving up this view, which is not self-evident, in my view.

## B. Conclusions and recommendations

From my analysis of the legal situation in chapter 1, section D above, one could argue that in Germany, the question of regulation of chimeric and other interspecific research is not a pressing issue at the moment: interspecific research is already strictly limited by the restrictive regulation of the use of human embryonic stem cells. Still, interspecific research involving human embryonic stem cells and their derivatives is carried out in many countries, most prominently the U.S.A., South Korea, the United Kingdom, and Israel. A future review of German laws on the use of human embryonic stem cells cannot be ruled out, especially if stem cell cures should become successful in the therapeutic context – this would necessitate the use of chimeric animals as assay systems. It is also possible that "reprogramming" of adult cells to pluripotency could become accessible in the long term, thereby allowing chimeric research without having to face the moral problems (and legal restrictions) surrounding human embryonic stem cells.

What kind of policies would be advisable in regard to interspecific research? What are the results of my work in this respect? Are there good arguments for prohibiting human-animal interspecific creation and research (aside from the problematicity of human Embryonic Stem Cell use)? If prohibition is not advisable, how should interspecific research be regulated? How should public discussion of this subject move forward in order to reach a satisfying consensus or compromise?

One pragmatically relevant result of my analysis is that although interspecific beings elicit an exorbitantly vehement emotive response in many people, these "yuk" responses are usually vague and can be mitigated by information and discussion. This does not mean that "yuk factor" objections should be disregarded – rather, they should be understood as an indicator of a lack of information regarding what is going on in research labs, which needs to be addressed and remedied. The same is true for allegations of hubris of researchers: these should be understood not as philosophical arguments for the moral wrongness of interspecific creation, but as implicit calls for explanation, justification and clarification of the procedures carried out by scientists. It is crucial in this respect to understand that if such information is withheld or not spelled out in a manner that is understandable for non-experts, this will probably lead to an indiscriminate overall rejection of all types of interspecific research. Other analysts also support this point – as Nature's editorial put it in 2007,

> *"Scientists should identify the various research protocols defining interspecies research involving human cells and embryos, and the associated risks, ethical issues and benefits of each. They should put forward clear and comprehensive recommendations to the public and to regulatory bodies. If they don't, they risk having regulation and funding restrictions imposed on their research that are out of proportion to the ethical or safety risks involved. Even worse, they could face prohibitions that lump together research with vast disparities in intent and in the balance of risk and benefit — ultimately penalizing those who stand to gain from the therapies that might emerge."*[389]

Robert makes a similar point when stating that

> *"Judging from the negative public response to proposals to create part-human animals (…) stem cell researchers will have a difficult task in disabusing the image of mad scientists run amok. Well-articulated scientific justifications may help to dispel the appearance of hubris and irresponsibility."*[390]

Another practically relevant result of my analysis is that certain concepts – specifically that of a boundary between human and nonhuman, but also that of human dignity – are not conducive to a clarification of the ethical problems of interspecific research. Instead, these concepts lead to further obfuscation of problems and to talking at cross purposes, and should be avoided in discussion. Other argument types were similarly vague and unhelpful: namely, the idea that risk-cost-benefit-analysis is not suitable for such complex cases as interspecific creation and that we should follow a "precautionary principle", instead. Vague concerns, which offer no clear analysis of what exactly is problematic about the creation of human-animal interspecifics, should be subject to objective scrutiny and not accepted as general arguments for a prohibition of chimera or other interspecific creation.

My negative results concerning Speciesist approaches may seem far-reaching, but they actually have only limited practical relevance: most importantly, a rejection of Speciesism will mean that justification for experimentation on nonhuman animals will have to be more elaborate. Stating that the research subjects are "not human" is not a satisfying justification for sacrificing animals in research. Considering the advanced capacities of nonhuman primates, it will be particularly difficult to justify their use in research once we give up Speciesist argumentation. Rejection of Speciesist argumentation will also mean that the high moral status of human embryos and atypical ("marginal") human beings will be harder to defend. This, again, need not mean that preferential treatment of biologically human

[389] Nature Editorial (2007), "Avoiding a chimaera quagmire", Nature, **445**(7123).
[390] Robert (2006), "The science and ethics of making part-human chimeras in stem cell biology", Journal of the Federation of American Societies for Experimental Biology, **20** p. 844.

beings cannot be justified; only that its justification will be considerably more difficult, and cannot be established as a prima facie ethical principle.

All in all, concerns about the inadequate treatment of interspecifics seem to be the strongest arguments for a strict regulation of the creation of human-animal interspecifics. This is because such concerns can be made independently of Speciesist assumptions. Additionally, they are sometimes hard to avoid because of the "catch 22" of interspecific research: humanization is needed as *scientific* justification, but some types of "humanization" can, at the same time, mean that scientific use of the humanized subject is not *morally* justifiable. Inadequate treatment concerns are a strong argument, but are they strong enough to justify the prohibition of human-nonhuman interspecifics? I believe that this is not the case because the "catch 22" problem only arises in an extremely limited area of interspecific research, namely, in those cases where the aspects of "humanization" in the research subject concern morally relevant properties like consciousness or self-awareness, which would clash with a use of the research subject in experiments. This applies only to a very limited amount of cases. Regulation, e.g. in the form of oversight committees, should make sure that this aspect is kept in mind, but a complete prohibition of human-animal interspecific creation would be exaggerated and unnecessary.

A procedural approach to regulation is reflected in the idea of a state licence, which is already a requirement in many countries regarding hESC research, such as in Germany (ZES) and in the UK (HFEA). Another task of oversight committees will be to assess the health risks of interspecific experimentation where this is necessary – this practice is already well established (and well justified) in the area of animal-to-human xenotransplantation. Newer forms of interspecific research, like the creation of human-animal cybrids and transgenetically manipulated animals, justify similar, but not categorically more stringent regulation – creating an interspecific entity is not particularly dangerous, as such.

There are, however, certain scenarios of human-animal interspecific creation which clash so violently with public perceptions of what is morally justifiable in research that prohibition is justified.

Three extreme scenarios, in my view, qualify for absolute prohibition:

1. Bringing to term or long cultivation (i.e. longer than a fortnight) of massively chimerically manipulated human embryos,

2. Bringing to term or long cultivation of human-animal true hybrid embryos; and the

3. Bringing to term or long cultivation of transgenetically manipulated human embryos.

These three scenarios, in my opinion, would also be perceived as not justifiable by non-speciesist consequentialist approaches when taking into account the interests of the creatures involved (and the dim potential benefits of such experiments, on the other hand).

Notably, all these scenarios *are already prohibited* under German law (and in many other countries). Although it is unclear whether anyone would be actually interested in performing such experiments, i.e. whether there are potential perpetrators, at all, a prohibition of these scenarios works as an important symbolic stop-point. Explicit prohibition of these extreme scenarios can ease public concerns regarding interspecific research, in general, by serving as a visible statement that the proverbial slope of research is only as slippery as we allow it to be.

My selection of scenarios that warrant prohibition is a very limited one – which suggests the conclusion that some of the prohibitions that are currently in place, or are suggested in Germany and other countries, are not justified in my view. This includes the prohibition of the creation of true hybrids between human and nonhuman gametes – if the cultivation period is limited to a fortnight, this scenario seems well justifiable, in my view. The same is true for transgenesis experimentation and chimeric manipulation in human pre-embryos, as long as the cultivation period is strictly limited. In these cases, a general prohibition is not consistent with other policies concerning protection of human embryos, not necessary, and not justified, in my view.

Today, the "artificial interspecific" scenarios described in chapter 1 are largely unfamiliar to most laymen; just as the naturally occurrence of mixed beings. The details of research involving human-nonhuman interspecifics are unclear, and rarely cleared up by reporting and interest groups, which often prefer sensationalist tones. Most scientists, on the other hand, try to keep a low profile and stay out of the focus of public opinion, taking a defensive approach to publicity and information. In order to reach the point where an informed and sensible debate is possible, bioethicists and other commentators now have the important task to make the practices of interspecific research accessible and understandable, and to point out the actual ethical issues as well as unfounded or exaggerated concerns. An exemplary instance of public discussion in this regard is the German stem cell debate, where wide parts of the public have reached detailed knowledge about biological circumstances and are therefore well equipped to discuss ethical implications of dealing with hESC research (a fact that is even recognized by experts of

stem cell science). The "chimera debate", which actually concerns various types of interspecifics – chimeras, hybrids, cybrids and transgenic beings – should follow this example.

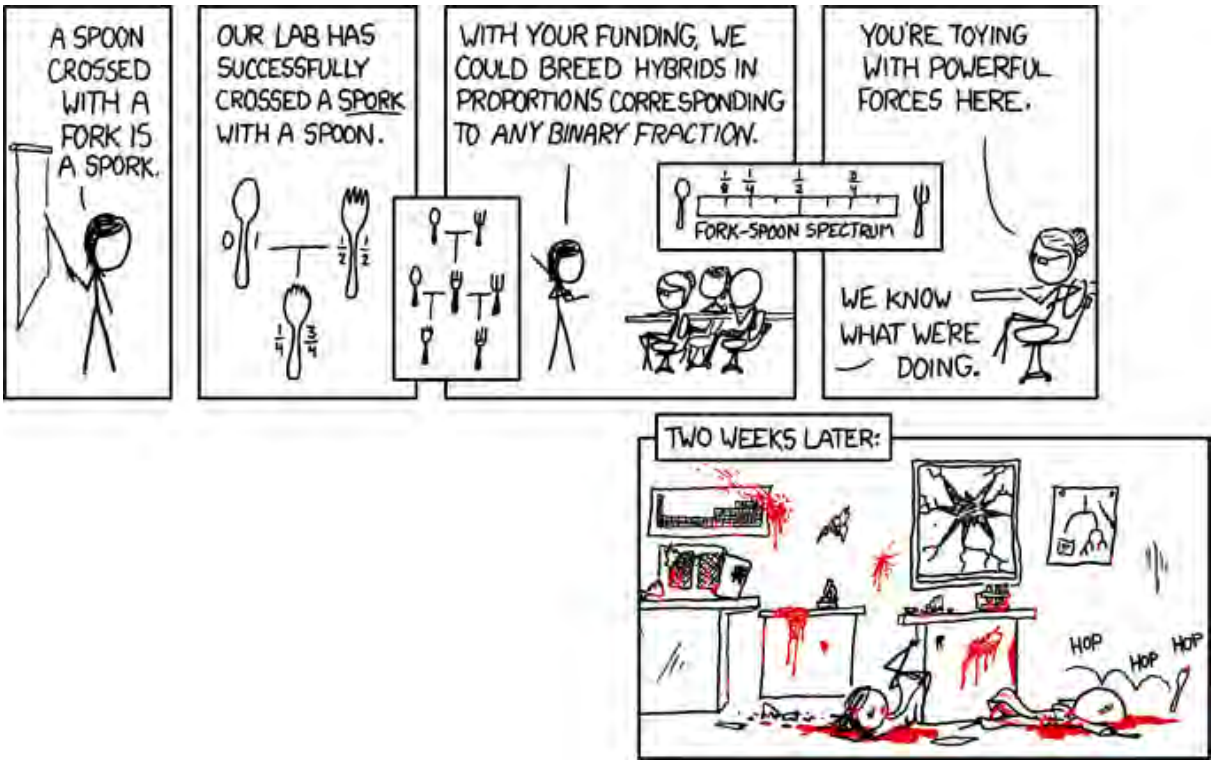
The chimera debate has distinctive features which make it more than a subset of the stem cell discussion and which bring with it genuinely new ethical problems. As I hope to have shown, human-animal interspecifics reveal the problematicity of concepts like human dignity, the idea of fixed species boundaries, and of Speciesism as an ethical principle. Approaching the ethical issues around human-animal interspecifics requires an approach which can accommodate new scientific possibilities of mixing (human and nonhuman) species, an approach that does not crucially rely on classification into human/nonhuman categories.

Jens Reich concluded his presentation before the Nationaler Ethikrat with this warning – or promise? – concerning research on interspecific beings:

> *"With these developments on the horizon, we can expect surprising, adventurous, amazing, and alarming advances from experimental developmental biology; on a grand scale and with surprising twists, in the face of which our present concepts will be of no avail."* [transl. CH][391]

[391]"Nach allem, wie die Enwicklung sich abzeichnet, können wir damit rechnen, dass überraschende, abenteuerliche, tolle, beängstigende Entwicklungen von der experimentellen Enwicklungsbiologie zu erwarten sind, im großen Stil mit überraschenden Wendungen, angesichts derer wir mit den bisherigen Begriffen nackt dastehen werden." Nationaler Ethikrat (2005), "Wortprotokoll - Niederschrift über den öffentlichen Teil der Sitzung am 25. August 2005", p. 15.

# Epilogue


A SPOON CROSSED WITH A FORK IS A SPORK.
OUR LAB HAS SUCCESSFULLY CROSSED A SPORK WITH A SPOON.
WITH YOUR FUNDING, WE COULD BREED HYBRIDS IN PROPORTIONS CORRESPONDING TO ANY BINARY FRACTION.
FORK-SPOON SPECTRUM
YOU'RE TOYING WITH POWERFUL FORCES HERE.
WE KNOW WHAT WE'RE DOING.
TWO WEEKS LATER:
HOP
HOP
HOP

# Photography and Illustration Credits

Picture 1 (p. 4): Chimera, Etruscan Bronze, Archaeological Museum, Florence (Mode 1974, p. 166).

Picture 2 (p. 11): Sheep goat chimera, Anderson, Dr. Gary B./Wikimedia Commons. Retrieved from http://en.wikipedia.org/wiki/Image:Sheep_goat_chimera.jpg

Picture 3 (p. 12): Vacanti Mouse (Cao, Vacanti et al. 1997).

Picture 4 (p. 30): Piccinini, Patricia, "The Young Family", sculpture from the exhibition "We are Family" at Venice Biennale 2003. Photo retrieved from http://www.patriciapiccinini.net/wearefamily/index.php?sec=yf&pg=01

Epilogue (p. 165): "Forks and Spoons", xkcd, retrieved from http://xkcd.com/419/

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# Zusammenfassung in deutscher Sprache

Im Zentrum dieser Arbeit steht die ethische Debatte um Chimären, die sich in den vergangenen Jahren vor allem im englischsprachigen Raum abgespielt hat, und hierbei vor allem die Frage, ob es ein schlüssiges, überzeugendes Argument gegen die Herstellung von Mensch-Tier-Mischwesen gibt.

Voraussetzung für eine sinnvolle Auseinandersetzung mit dieser Frage ist zunächst einmal eine Untersuchung darüber, was der Begriff "Chimären" in dieser Debatte eigentlich bezeichnet. Sieht man sich den Begriff der Chimäre in der Biologie an, so bemerkt man, dass es neben den heute heiß diskutierten, neuartigen Chimären das Phänomen des Chimerismus in der Natur schon immer gab. Chimären sind grob gesprochen Organismen, deren Zellen aus zwei oder mehr unterschiedlichen Zygoten stammen. In der Natur tauschen der Organismus der Mutter und der des ungeborenen Kindes, aber auch zweieiige Zwillingsembryonen mitunter Zellen aus, was zum Vorhandensein "genetisch fremder" Zellen im erwachsenen Organismus von Mensch und Tier führt. Empfänger von Allotransplantaten lassen sich übrigens ebenfalls als Chimären charakterisieren. Neben diesen eigentlichen Chimären finden wir in der Natur auch noch andere Mischungen, auch zwischen verschiedenen Arten: so gibt es bekanntermaßen Hybridformen oder "Kreuzungen" zwischen verschiedenen (nahe verwandten) Tierarten, die manchmal auch ihrerseits fruchtbar sind. Solche Hybride enthalten – im Gegensatz zu Chimären – in jeder Zelle ihres Körpers die gleiche Erbinformation; bei ihnen findet die Durchmischung auf Ebene der DNA und nicht auf Zellebene statt.

Die neuartigen, künstlichen Mischwesen, die die Chimärendebatte angestoßen haben, überschreiten nun interessanterweise nicht nur die Grenzen zwischen den Tierarten, sondern mitunter auch die zwischen Tier und Mensch. Die Herstellung von Mensch-Tier-Chimären war und ist für die Forschung aus ganz unterschiedlichen Gründen interessant: zum einen lassen sich dadurch, dass man menschliche Zellen in Tiere einbringt, "Tiermodelle" herstellen, d.h. menschliche Krankheiten im tierischen Organismus simulieren und erforschen. Zweitens will man erkunden, wie sich menschliche Zellen eigentlich genau in einem lebenden Organismus ausdifferenzieren und entwickeln und will dafür aus naheliegenden Gründen einen Tier- statt einen Menschenorganismus verwenden. Drittens erscheint es verlockend, irgendwann im tierischen Organismus Zellen oder gar Organe züchten zu können, die sich für die Transplantation eignen. Dies waren die

Hauptmotive dafür, sogenannte Mensch-Tier-Chimären herzustellen. Im Standardfall handelt es sich dabei um Tiere, in die menschliche Zellen so eingebracht werden, dass sie "weiterleben" und funktionsfähig bleiben. Diese Übertragung von Fremdzellen kann bei adulten Tieren, aber auch in embryonalen Stadien geschehen, übertragen werden dabei üblicherweise Stammzellen, die noch ein gewisses Differenzierungspotential haben, darunter auch (aber nicht notwendigerweise) embryonale Stammzellen. Wir kennen aber auch den umgekehrten Weg, nämlich die Übertragung tierischen Materials in (adulte) Menschen: so etwa bei der klassischen Xenotransplantation von Tierorganen und bei neueren Methoden, wo nur einzelne Zellen (tierische Stamm- oder Vorläuferzellen) übertragen werden, um abgestorbene Zellen, etwa bei Diabetes oder neurodegenerativen Erkrankungen, zu ersetzen.

Neben diesen Chimären im engeren Sinne dreht sich die "Chimärendebatte" aber auch um andere, nicht chimärenartige, artifizielle Mischwesen zwischen Mensch und Tier. Dazu gehören zunächst transgene Tiere, also solche, in deren Genom man nicht-arttypische DNA eingeschleust hat – hier käme die Einschleusung typisch menschlicher DNA in Tiere in Frage, etwa um Krankheiten in Tiermodellen zu simulieren oder schlicht um die Wirkung und Interaktion bestimmter originär menschlicher Gensequenzen zu erforschen. In der Diskussion tauchen manchmal auch "Mensch-Tier-Hybriden" auf. Im Sinne einer schlichten Kreuzung zwischen Mensch und Tier sind solche Wesen nur schwer vorstellbar; jedoch gab es tatsächlich über lange Zeit Forschungen zur Hybridisierung von Mensch und Menschenaffe und es ist nicht vollständig klar, ob eine solche Kreuzung wirklich unmöglich wäre. Als "Mensch-Tier-Hybriden" werden seit neuestem aber auch sogenannte Nukleo-Zytoplasma-Hybriden (Cybrids) bezeichnet – entkernte menschliche Eizellen, denen ein tierischer Zellkern eingepflanzt wurde und die zur Gewinnung von Stammzelllinien dienen sollen. In Großbritannien gab es eine große Debatte um diesen Anwendungsfall.

Bei näherer Betrachtung stellt sich also heraus, dass das, was als "Chimärendebatte" bezeichnet wird, sich nicht auf alle Chimären und nicht allein auf Chimären bezieht: in der Natur vorkommende Chimären und auch viele künstliche Chimären (wie etwa Empfänger von Allotransplantaten) scheinen ethisch nicht besonders problematisch oder aufsehenerregend zu sein. Andererseits sehen wir, dass es neben den eigentlichen Chimären noch ganz andere Arten von Mischwesen gibt, die oft in ähnlicher oder gleicher Art und Weise Probleme aufwerfen wie die als ethisch problematisch empfundenen Mensch-Tier-Chimären.

Eine genaue Betrachtung der biologischen Grundlagen zeigt uns hier also, dass die Chimären-Debatte sich eigentlich ganz allgemein um Mensch-Tier-Mischwesen ("Human-Animal Interspecifics") dreht, dass aber von diesen anscheinend wiederum nur bestimmte Typen als ethisch problematisch empfunden werden.

Welche das sind, hängt nun davon ab, mit welcher Art von Argument man gegen die Herstellung solcher Lebewesen oder Entitäten vorgeht. Die Argumente gegen die Herstellung von Mischwesen lassen sich zunächst grob in intrinsische und konsequenzbasierte Einwände einteilen.

Als Vertreter der intrinsischen Argumente findet sich hier zunächst das "Ekel-Argument" (Argument from Repugnance), das nur selten direkt vorgebracht, aber sehr oft implizit angedeutet wird: die verbreitete Reaktion von Abscheu oder Angst, die (insbesondere Mensch-Tier-)Mischwesen hervorrufen, so wird argumentiert, sei ein deutliches Zeichen dafür, dass ihre Herstellung moralisch falsch sei. Von Vertretern religiöser Strömungen wird mitunter vertreten, die Vermischung von Tierarten, insbesondere aber von Mensch und Tier, sei aus religiösen Gründen abzulehnen. Auch quasi-religiöse Argumente appellieren (ohne dabei Heilige Schrift oder Konzepte wie Gottesebenbildlichkeit ins Spiel zu bringen) an das Konzept der Hybris oder Anmaßung: die Vorwürfe des "Gott Spielens" und "der Natur ins Handwerk Pfuschens" sind typisch für diesen Argumenttyp. Spezifisch für die Chimärendebatte ist der Hinweis auf die inhärente Schutzwürdigkeit von Artgrenzen (insbesondere der Grenze zwischen Mensch und Tier), die – so wird argumentiert – eine Überschreitung dieser Grenzen an sich schon moralisch falsch macht. Analog wird behauptet, die Herstellung von Mischwesen verletze die Menschenwürde und sei daher nicht rechtfertigbar.

Aber auch konsequenzbasierte Argumente gegen die Herstellung von Mischwesen sind zahlreich: zunächst stellt sich die Frage, inwiefern man aus der Herstellung solcher Chimären, Hybride oder transgener Wesen wissenschaftlichen Nutzen ziehen kann. Schwerpunktmäßig muss dann analysiert werden, welche Kosten die Mischwesenherstellung mit sich bringen könnte: zunächst spielen hier schlichte Tierschutzaspekte eine Rolle, dann aber auch die Sorge um die richtige Behandlung bzw. Verwendung menschlicher Materialien und an vorderster Stelle die Sorge um das Wohl ungeborenen menschlichen Lebens. Auch die neu erschaffenen Lebewesen könnten Leiden ausgesetzt sein – so etwa durch eine Behandlung bzw. Haltung, die ihrem moralischen Status nicht angemessen ist. Problematisch könnte dann auch noch sein, dass der moralische Status von Lebewesen, die einer Einmischung artfremder Materialen

unterzogen werden, sich ändern könnte, was manche schon unabhängig von etwaiger unangemessener Behandlung als problematisch ansehen. Etwas greifbarer sind die Gesundheitsrisiken, die von der Herstellung von Mischwesen (hier insbesondere von der Xenotransplantation) anerkanntermaßen ausgehen: man befürchtet eine xenogene Pandemie durch Übertragung von Krankheitserregern auf den Menschen. Fraglich ist hier noch, ob der Apparat der Kosten-Nutzen-Analyse dem Umgang mit Risiken solcher Art überhaupt angemessen ist oder ob man sich hier lieber auf ein Vorsichtsprinzip ("Precautionary Principle") berufen sollte.

Konsequenzbasierte Einwände können auch indirekter gestaltet werden, so etwa beim Argument, Mensch-Tier-Mischwesen könnten auf verschiedene Arten und Weisen moralische Verwirrung stiften: einmal dadurch, dass ihr moralischer Status aus epistemischen Gründen schlecht bzw. nur unter hohen Kosten zu ermitteln ist. Dann dadurch, dass ihnen in gewissen ethischen Entwürfen gar kein moralischer Status zugewiesen werden kann, weil sie keine Menschen, keine Tiere, sondern "weder noch" sind. Schließlich droht durch die Existenz von Mensch-Tier-Mischwesen der überragende moralische Status von Menschen in Frage gestellt zu werden, wie Robert und Baylis es in ihrem vieldiskutierten Artikel[392] beschreiben.

In der Diskussion der Einwände stoßen wir auf zwei zusammenhängende Konzepte, die in einem Exkurs noch näher beleuchtet werden, um die Argumente abschließend zu bewerten – nämlich einmal den Begriff des "Moralischen Status" und außerdem den des "Speziesismus." Es stellt sich bald heraus, dass Speziesismus – d.i. das moralische Prinzip, nach dem das "Mensch-Sein" bzw. "Nicht-Mensch-Sein" entscheidend ist für den moralischen Status einer Entität – aus mehreren Gründen nur schwer zu vertreten ist; wobei Mensch-Tier-Mischwesen seine Vertretbarkeit sogar noch schmälern. Das heißt wiederum, dass in der Argumentation gegen die Herstellung von Mensch-Tier-Mischwesen auf Einwände verzichtet werden sollte, die nur unter Bezugnahme auf speziesistische Annahmen funktionieren.

In der abschließenden Analyse der Argumente gegen die Herstellung von Mischwesen stehen drei Fragen im Vordergrund: Handelt es sich um ein genuin neues, für diese Debatte spezifisches Argument, oder kennen wir es bereits aus anderen Gebieten? Auf welche Arten von Mischwesen bezieht es sich? Und natürlich: überzeugt es? In dieser Analyse wird deutlich, dass intrinsische Argumente – also Abscheu-Argumente, Hybris-

[392] Robert and Baylis (2003), "Crossing Species Boundaries", American Journal of Bioethics, **3**(3).

Argumente, Argumente, die auf die moralische Relevanz von Artgrenzen abstellen sowie Menschenwürde-Argumente nicht besonders schlagkräftig sind, da sie zu vage und unspezifisch bleiben und zudem üblicherweise auf Speziesismus aufbauen. Konsequenzbasierte Argumente scheinen überzeugender, wobei hier besonders stichhaltig das Argument der unangemessenen Behandlung wäre, das allerdings wieder nur auf eine stark begrenzten Bereich von Mischwesen (und auf keine der aktuell hergestellten Mischwesen) zutrifft. Ähnlich ist es bei der recht greifbaren Bedrohung durch Zoonosen: dies wäre tatsächlich ein gutes Argument gegen die Herstellung von Mensch-Tier-Mischwesen, doch ein solches Risiko scheint nur von ganz bestimmten Anwendungsfällen (insbesondere in der Xenotransplantation) auszugehen und bietet kein umfassendes, allgemeines Argument gegen die Forschung mit Mischwesen. Die "moralische Konfusion", die Mensch-Tier-Mischwesen auslösen können, kann tatsächlich auch als Argument gegen ihre Herstellung verstanden werden – allerdings, wie die Analyse klar macht, nur in einem ganz eng begrenzten Sinne, der sich wiederum nur auf ganz bestimmte Fälle bezieht.

Zusammenfassend ist zunächst zu bemerken, dass das Problem der Mensch-Tier-Mischwesen momentan in Deutschland nicht besonders im Vordergrund steht, da es von der Stammzellendebatte sozusagen verdeckt wird. Dies ist allerdings nicht überall so, und wird sich voraussichtlich auch in Deutschland in Zukunft ändern.

An für die Chimärendebatte pragmatisch relevanten Ergebnissen kann festgehalten werden, dass Mischwesen oft vehemente, emotionale Reaktionen hervorrufen, die allerdings durch Information erheblich gemildert werden können. Skandalisierende Parolen und entrüstete Aufschreie in dieser Debatte sollten keinesfalls ignoriert, auf der anderen Seite aber auch nicht als philosophische Argumente missverstanden werden: sie sind implizite Aufrufe zur Aufklärung, Information und Rechtfertigung, denen Forscher sachlich nachkommen sollten. Andernfalls drohen alle Experimente, die Mischwesen verwenden – unabhängig von Details und tatsächlicher ethischer Relevanz – in einen Topf geworfen und verdammt zu werden. Es stellte sich des Weiteren heraus, dass bestimmte Konzepte in der Chimärendebatte nicht hilfreich, ja sogar schädlich sind. Dazu gehören unter anderem ein moralisch aufgeladener Bergriff der "Artgrenze" sowie der Begriff der "Menschenwürde."

Ein generelles Verbot der Herstellung von Mischwesen oder Mensch-Tier-Mischwesen scheint nach meiner Analyse nicht gerechtfertigt. Nur ganz extreme Szenarien – etwa die Kultivation massiv chimerisch manipulierter menschlicher Embryonen, echter Mensch-Tier-Hybriden oder transgenetisch manipulierter menschlicher Embryonen über einen eng begrenzten Zeitrahmen hinaus – rechtfertigen ein Verbot. Diese Szenarien sind in

Deutschland, und in vielen anderen Ländern, bereits zu Recht verboten. Einige der in Deutschland bestehenden Verbote betreffend Mensch-Tier-Mischwesen hingegen scheinen nicht nötig und auch nicht konsistent – nämlich das Hybridisierungsverbot und das Verbot chimerischer und transgenetischer Manipulation von menschlichen Embryonen (wohlgemerkt nur dann, solange es um einen sehr eng begrenzten Zeitraum bis zur Gastrulation geht). Forschung, die keine der oben genannten "extremen" Szenarien anstrebt, sollte erlaubt sein – dies allerdings unter strenger externer Aufsicht und Regulation, die nicht nur medizinische, sondern auch ethische Probleme berücksichtigt.

Es wird Aufgabe der Bioethik sein, die Öffentlichkeit über die Details und die spezifischen ethischen Probleme der Forschung mit Chimären und anderen Mischwesen zu informieren. Dabei kann man sich z.B. an der sinnvoll und auf recht hohem Niveau verlaufenden Stammzelldebatte orientieren, muss aber die Spezifika, die Mensch-Tier-Mischwesen mit sich bringen, beachten. Insbesondere werden Entwürfe, die moralischen Status untrennbar mit der Klassifikation in "menschlich" und "nicht-menschlich" verbinden, dieser Aufgabe ab einem gewissen Punkt nicht mehr gewachsen sein. Eine gründliche Vorbereitung auf die ethischen Probleme, die Mensch-Tier-Mischwesen in Zukunft mit sich bringen könnten, ist also vonnöten – auch wenn die Mischungen aus Mensch und Tier, die es heute gibt, noch relativ unproblematisch erscheinen.

# Lebenslauf

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