Reframing the Ethical Issues in Part-Human Animal Research: The Unbearable Ontology of Inexorable Moral Confusion

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Abstract. Research that involves the creation of animals with human-derived parts opens the door to potentially valuable scientific and therapeutic advances, yet invokes unsettling moral questions. Critics and champions alike stand to gain from clear identification and careful consideration of the strongest ethical objections to this research. A prevailing objection argues that crossing the human/nonhuman species boundary introduces inexorable moral confusion (IMC) that warrants a restriction to this research on precautionary grounds. Though this objection may capture the intuitions of many who find this research unsettling, it relies on mistaken views of both biology and moral standing, ultimately distorting the morally relevant facts. We critically examine IMC, identify mistaken essentialist assumptions, and reframe ethical concerns. The upshot is a stronger line of objection that encourages a more inclusive and productive ethical discourse.

Keywords: Part-Human; Chimera; Research Ethics; Species; Bioethics; Stem Cell Ethics.

1. Introduction

Research that involves the creation of non-human animals with human-derived parts opens the door to valuable scientific and therapeutic advances, yet invokes unsettling moral questions. A prevailing objection cautions against creating these individuals due to worries of the "inexorable moral confusion" (IMC) that may arise over their moral status (Robert and Baylis 2003). This objection frames the ethical issues as stemming from crossing species boundaries, notably the human/nonhuman divide. This framing, though, is more likely to obscure, rather

than enlighten, the ethical discourse. Crossing or blurring species boundaries, in and of itself, is not a compelling source of ethical concern. Biological facts and theory fail to support the idea that species boundaries are fixed or carry any moral relevance (Karpowicz et al. 2004; Robert and Baylis 2003). Here we seek to reframe the ethical discourse along more productive lines.

We begin by recounting the structure of IMC arguments and articulating the subsequent motivations for adopting a precautionary attitude about human-to-nonhuman cross-species research. We argue that IMC arguments are undermined by core commitments to *naïve developmental essentialism* and to an incommensurable moral divide between humans and nonhumans, which distort the morally relevant facts. We unpack these claims by considering what we call the *two-essence problem*, demonstrating that the motivating confusion is a product of the core IMC commitments. This stands in contrast to what is generally taken to be the source of confusion: the (actual or potential) crossing of species boundaries.

The payoff is a re-evaluation of the ethics of human-to-nonhuman interspecies research. We suggest a way to reframe objections to the creation of animals with human-derived parts that avoid the troubling assumptions of IMC arguments while at the same time capturing the motivating intuitions. The moral force of these objections turn on *uncertainty* about the moral status of the resulting creatures (reminiscent of Streiffer 2005), rather than *confusion* about species identity. Disagreement over whether these uncertainties are severe

enough to trigger a prohibition on precautionary grounds may remain, but we suggest this is just the sort of disagreement worth having. Moral disagreements, after all, may be fruitful even when consensus is absent and uncertainty remains.

A word about terminology: although there are important distinctions to be drawn between chimeras, transgenic animals, hybrids, and other cross-species mixes (see Robert 2006), the ultimate target of IMC arguments may be any creature that results from novel combinations of human and nonhuman biological material in human-to-nonhuman interspecies research. Different technologies imply different possibilities for combination, and what type of creature may result. However, these finer distinctions may be shelved for now. We will adopt what we hope is a neutral terminology, referring directly to the creature or individual. When a predicate is needed, we will use 'animal with human-derived parts', 'human/non-human' or 'part-human'. We acknowledge each is imperfect. The first should be understood as referring to non-human animals, though, of course, that's part of what is at stake. Still, we think it reflects good recent practice, e.g., the "human neuron mouse" (Greely et al. 2007) would be described as a 'mouse with human-derived neural tissue', as opposed to a 'mouse with human neurons' (n.b. Academy of Medical Sciences 2011 and Benham and Haber 2008). 'Part-human' is particularly loaded and ambiguous. Usage will be restricted to cases where (a) we wish to draw attention to the inherent tensions loaded into such terms; (b) using *animal with human-derived parts* would render a clause grammatically unwieldy; or (c) a precise meaning has been specified. We think

these terms capture the general objects of concern in arguments from IMC, and avoid question begging unsettled biological and conceptual facts. Indeed, it is the status of these facts that are themselves centrally morally relevant.

Sound moral reasoning relies on considerations grounded in well-formulated concerns that adequately identify the morally relevant facts at hand. Our re-framing of concerns regarding human-to-nonhuman interspecies research and therapy present stronger candidate lines of moral objection to that research. However, this identification of candidate objections should not be confused for endorsement—instead we offer a fruitful re-examination of the ethical landscape involved in interspecies research.

2. Inexorable Moral Confusion

Robert and Baylis (2003) sought to helpfully frame discussions on the ethics of human-to-nonhuman interspecies research. Their aim was to capture what critics found morally troubling, and to identity the strongest objections to that research. Their articulation has been deeply influential, and continues to be cited as a proxy for critics of interspecies research (see Bhan et al 2010, Chan 2009, Cohen and Majumder 2009, Coors et al. 2010, Grunwell 2009, Hug 2009, Hyun et al. 2007, among others). They proposed that the strongest objection stems from what they label “the argument from inexorable moral confusion” (IMC). Namely, the crossing of species boundaries threatens established and important moral categories, producing such unavoidable and irresolvable moral confusion

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that a precautionary attitude is warranted, justifying a halt to (or at least major restrictions on) such research (p. 9):

> All things considered, the engineering of creatures that are part human and part nonhuman animal is objectionable because the existence of such beings would introduce inexorable moral confusion in our existing relationships with nonhuman animals and in our future relationships with part-human hybrids and chimeras.

Robert and Baylis do not endorse this argument, and go so far as to actively deny its efficacy (see also Baylis and Robert 2007; Baylis 2008). Yet they recommend further discussion of the concerns raised, noting that worries over transgressing the human/nonhuman species boundaries underwrites these and many other concerns. Given IMC's status as a prevailing critical view, a response is warranted.

Though Robert and Baylis develop a number of ideas encapsulated in the argument from IMC, here we focus on two key claims: the *generation* of moral confusion, and *consequences* of that confusion. Mixing biological material from human and nonhuman animals to produce novel creatures, it is said, generates a troubling moral confusion—a confusion that is inexorable, i.e., unavoidable and irresolvable. In particular, this research involves crossing fundamental species boundaries, mixing categorically distinct species, thus producing an irresolvable confusion about what species the resulting creature belongs to. This is particularly troubling due to a presumption of IMC arguments that belonging to *Homo sapiens* is a necessary condition for full moral standing. In contrast, the moral status of a nonhuman animal is presumed to depend, primarily, on features

other than species identity, e.g., its value to humans. On the argument from IMC, these two moral frameworks are incommensurable and introduce an irresolvable confusion: if creatures are made that contain a combination of human and nonhuman biological material, the means by which we determine the moral status of the resulting creature is fundamentally unsettled. Thus, "It follows that hybrids and chimeras made from human materials are threatening insofar as there is no clear way of understanding (or even imagining) our moral obligations to these beings" (Robert and Baylis 2003, 9).

On IMC arguments, the consequences of this moral confusion are profound: undermining the categorical divide between human and nonhuman animals challenges the very nature of moral justification. To challenge this divide is to threaten the claim that "humanness is a necessary (if not sufficient) condition for full moral standing" (Robert and Baylis 2003, p. 2). The threat, in a very real sense, is existential. The divide maintains, and perhaps even establishes, human biological and moral identity. Thus, proponents of IMC arguments adopt a precautionary stance: until the moral confusion is resolved, the potential consequences justify preventing (or severely restricting) human-to-nonhuman interspecies research. However, on the assumption that the confusion is inexorable, a resolution is unlikely and the precautionary approach demands an on-going prohibition.

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3. Sources of Confusion

For IMC arguments to be effective they must correctly identify the source of moral confusion and the consequences that justify prohibition. IMC arguments fail on both counts. Let's first consider the purported source of moral confusion. For crossing species boundaries to generate an inexorable moral confusion, moral categories must closely track biological ones. Otherwise the putative threat dissipates and the worry about moral confusion falls flat. However, this connection between moral and biological status is problematic (to say the least), involving essentialist thinking about biological species (and subsequent effect on moral status) that is not simply unsupported, but undermined, by empirical facts (n.b., Hull 1986). This is widely recognized, and even Robert and Baylis (2003) note that this essentialism is not well founded. Yet, in order to explicate the argument from IMC, they adopt a folk essentialism about species and moral status—more precisely, they adopt *naïve developmental essentialism* (Benham and Haber 2008). We are under no such obligation, and hold that essentialism, even a folk variety, is caustic to understanding the ethics of human-to-nonhuman interspecies research. Indeed, it is *this commitment* to naïve developmental essentialism that is a major source of moral confusion in arguments from IMC, not the crossing of species boundaries.

Benham and Haber (2008, 43) describe naïve developmental essentialism as locating the "essence of an entity in its developmental material." As in other forms of essentialism, the essence of an entity is what makes it the kind of thing

it is and is found in all and only that kind of entity; being a kind of thing is defined by possession of an essence. Naïve developmental essentialism is analogous to genetic essentialism, though rather than locating the essence in genetic material or information, it is located in what for convenience we call 'developmental apparatus'. An organism's (or organ's, or cell's, etc.) developmental apparatus includes the characteristic species-specific developmental plan, or program, or pathway that an organism (organ, cell, etc.) undertakes to become that type of organism (organ, cell, etc.). This may include genetic pathways, cell signalling, chemical gradients, etc. On developmental essentialism, then, if some transfer of biological material across species includes the relevant developmental apparatus, a species-specific essence is transferred as well. On this view, human brain stem cells inserted into fetal mice (Greely, et al. 2007) may carry with them not just the proteins and cytoplasm characteristic of human neurons, but also the characteristically human developmental apparatus. The resultant neurons, then, would be considered fundamentally human regardless of how they develop in the context of the mouse embryo. That is, the essential identity of those cells is identified with their (context-free) development. Developmental essentialism thus entails that because these human brain stem cells contain a human developmental apparatus, they will produce *human* neurons, *human* networks of neurons, or, potentially, a functional *human* brain or network—regardless of what features those neurons or brains exhibit! The identity of the cells remains essentially human. Add to this the presumption of determination of moral status

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described above, and the upshot is that for the naïve developmental essentialist, the moral identity of an entity is strongly tied to its developmental apparatus. Insofar as we mix the developmental apparatus of human and nonhuman animals, we risk mixing the moral identity of the resulting creature. In effect, on this view, there is one body but two essences—each assessed by incommensurable moral frameworks. We call this the *two-essence problem*.

The two-essence problem, however, is poorly motivated, as it relies on the presumption of naïve developmental essentialism. As with other kinds of species essentialism, the lack of empirical or theoretical support for such a stance poses a serious problem. For example, there simply are not good data supporting any facts of development that are exclusively and universally shared among *H. sapiens* that might function as an essence, and prospects appear slim. Indeed, developmental suites are famously widespread across taxa, and redundant within them (Carroll 2000).[1] The onus is on the essentialist even in case a unique and universal developmental apparatus were found in humans, as it is unlikely to be necessary to either our moral status or biological identity. Variation in that developmental apparatus would likely be biologically tolerated, e.g., non-lethal mutations or developmental plasticity (West-Eberhard 2003) are typically treated as sources of variation, not a threat to moral or biological identity. This suggests that the universality of that apparatus was accidental, and as irrelevant as the universality of a non-coding stretch of DNA that might be found among all and only humans (Hull 1986).

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A second problem with naïve developmental essentialism is that it ignores the context in which a cell (or other biological material) develops. This is a function of the commitment to naïve developmental essentialism, and further undermines the two-essence problem. Placing a human-derived cell into mouse tissue does not, by necessity, result in that cell developing in the same way as if it were in human tissue. Cells respond to signals from the environment, adapting or altering their development to the context in which they develop. What is characteristic in the development of a cell in one environment may not be characteristic of that same cell in a different environment. Thus it is deeply misleading to refer to a cell as 'human' (or even 'part-human') when it is developing in a non-human context; to identify it as such threatens to conflate origin or derivation with characteristic development in the original context. In effect, this treats development as context-free, while encouraging a conflation of 'human' as a species and 'human' as a moral category when pressed into service of the two-essence problem.[2]

Furthermore, given that many cell functions and processes, including many developmental apparatus, are already shared across species, it is no surprise to see that cells or tissues transferred from one species to another will develop in a fairly predictable fashion. But this is a far cry from the fact that a naïve developmental essentialist needs to refer to in support of the moral status or biological identity of the resulting organism. The fact that cells develop similarly across contexts is evidence for evolutionary relationships, not

essentialism. The essentialist gets this backwards. Evolutionary developmental biology explanations of the conservation and convergence of development, for example, rely on facts of evolutionary relationships and ontogeny (Brakefield 2006; Shubin, Tabin and Carroll 2009). Naïve developmental essentialism is a competing explanation that ignores, and conflicts with, these facts.

The focus on developmental apparatus in IMC arguments is not surprising. After all, how an organism develops is clearly central to that organism's identity. However, in cross-species mixes, it is a distraction to focus solely on the developmental apparatus in consideration of that organism's identity and moral status. The precise role played by development in determining which species an organism belongs to, let alone its moral status, is complicated and, arguably, cannot be separated from reproduction (Griesemer 2000). There are unlikely to be clear, uncontroversial answers, and any such discussion will have to draw on biological and moral theories. Thus, by focusing exclusively on the developmental apparatus, naïve developmental essentialism is too simplistic, and ignores how those competing theoretical frameworks might impact our conclusions about the biological identity and moral status of animals with human-derived parts. The details of development matter, as do the details of the developmental and moral theories adopted to assess these facts. These details go a long way towards determining the contours of the ethical landscape of interspecies research.

To recap, on IMC arguments, human-to-nonhuman interspecies research produces creatures with one body but two essences. This creates a conflict between the moral frameworks (human and nonhuman) used to determine moral status, i.e., the two-essence problem. On arguments from IMC, the moral divide central to the nature of moral justification has been breached, producing inexorable moral confusion. But the move to inexorable moral confusion here is too fast, as it presumes naïve developmental essentialism. Even if we accept the general precautionary framework of IMC arguments, rejecting naïve developmental essentialism undermines the claim that mixing biological materials from human and nonhuman animals results in the two-essence problem and, thus, an inexorable moral confusion. After all, if no essences are being transferred along with biological material, then the two-essence problem simply fails to materialize. This is not to say the moral status of these creatures will be obvious—many questions certainly remain. Our point is that the presumption of essentialism obscures, rather than clarifies, how to pursue answers to those questions. There may be *uncertainty* about the biological and moral identity of the resulting creature, but uncertainty is not the same as confusion. Confusion, in this context, involves a conceptual incommensurability that does not promise resolution. This reflects the flawed conceptual categorization implicit in naïve developmental essentialism. Uncertainty here reflects something else, i.e., our epistemic state regarding facts of the matter, and *how* to apply conceptual apparatus. Disagreement may persist, and consensus hard to come by (or even

absent), yet this need not be inexorably confusing and may even prove fruitful and enlightening. Recognizing this, and rejecting naïve developmental essentialism, paves the way to reframing the ethics of cross-species research in a more productive way.

4. Reframing the Ethical Analysis

Prevailing objections to human-to-nonhuman interspecies research stem from IMC arguments. On these objections, the inexorable moral confusion that would result would be so undesirable and constitute such an existential threat as to warrant a prohibition (either in part or wholly) against such research. Above we described one motivating presumption of this objection, the *two-essence problem*: animals with human-derived parts would contain two essences in a single body. These essences derive from developmental apparatus, and are determinant of moral status. The moral status of these creatures will be indeterminate and/or self-conflicting, and the resultant inexorable moral confusion would constitute a precautionary justification against this type of research.

The presumption of naïve developmental essentialism obscures the morally relevant facts and creates confusion, to be certain. This confusion is the result of a flawed ontology that conflates the central biological and moral facts of the matter. Rejecting naïve developmental essentialism avoids the two-essence problem, but leaves open the central motivating question: *how are we to evaluate the moral status of animals with human-derived parts*? We think the answer

turns on what morally relevant features are (or may be) possessed by these individuals, not on species identity, and expect that existing ethical frameworks will accommodate ethical questions raised by this research.[3] What the morally relevant features will be will depend, in large part, on what moral theory is adopted.[4] Disagreements or uncertainties about moral status may still arise, but these can be illuminating, even if no clear resolution or consensus emerges. More to the point, the disagreements need not be confusing (inexorably or otherwise) in the sense presumed by IMC arguments.

Rather than focus on naïve developmental essentialism, we might instead ask after the presumed moral divide between human and nonhuman animals. Robert and Baylis identify preservation of this divide as a core motivation in arguments from IMC (2003, 2):

> … we explore the strong interest in avoiding any practice that would lead us to doubt the claim that humanness is a necessary (if not sufficient) condition for full moral standing.

Call this the *necessity condition*. We contend it is flawed in at least two ways: (1) it is too strong, ultimately weakening the objection; and (2) the concept of *humanness* is ambiguous, and conflating competing senses fatally obscure the morally relevant facts. Addressing these flaws produces our positive contribution: a reframing of the ethical discourse.

First, the necessity condition is unnecessarily strong. *Humanness* could be weakened to a sufficient condition for full moral consideration without much loss. In this case, all humans will, of necessity, be due this consideration, yet not

all those due full moral consideration need be, by necessity, humans. The intuition that all humans, by virtue of being human, warrant full moral consideration is retained; yet other creatures may also warrant full moral consideration (even if not by sufficiency) and have moral standing. This expands the potential pool of those who may qualify for full moral standing, and invites discussion of the moral status of both humans and nonhumans. Admittedly, some critics may balk at this, preferring the original formulation that extends a *privileged* moral status to humans in terms of an *exclusive* claim to full moral standing. We think this is too narrow a view, as it rejects by definition the possibility of non-human claims to full moral standing. There may turn out to be good reasons to exclude non-humans, but that position ought to be defended rather than stipulated.[5] We think this position would also ultimately undermine possible objections to human/nonhuman interspecies research, e.g., it may be unpalatable to those who would otherwise be sympathetic, such as some animal rights defenders. Given the project of identifying the strongest objection to this research, we caution against this narrow stance.

Second, the necessity condition, ostensibly, is about species identity and humanness. However, *humanness* is ambiguous; consider three possible senses:[6]

(1) The essence of being human;

(2) Being human-like; or

(3) Belonging to the species *Homo sapiens*.

Working through this ambiguity helps identify how critics of interspecies research might reframe their objections.

The first sense listed above is a non-starter. There is simply no empirical support for this brand of essentialism, and the conceptual case for species essentialism is weak at best. The core problem with essentialism in this arena is that it typically demands categorization by similarity, whereas evolutionary groups must account for variation and dissimilarity[7] (Ereshefsky 2001; Hull 1986; Robert and Baylis 2003). If arguments from IMC rely on this sense, and are the strongest candidate objections to human/nonhuman interspecies research, then critics of such research are on tenuous grounds at best.

If we take *humanness* to mean 'being human-like', or 'exhibits similarity to (other) humans', then what species (if any) an organism belongs to is less important than what features that organism possesses. What those features might be, of course, is a question of which features one takes to be morally relevant and will be sensitive to the moral framework being pressed into service; for example, a utilitarian may look at an organism's capacity for suffering, whereas others may consider degree of autonomy, etc. We remain neutral on which moral framework to adopt.[8] Regardless, a solution the two-essence problem now presents itself: the moral divide between human and nonhuman animals is no longer over *what* criteria are used to assess moral status, but *how* relevant criteria are expressed or met—there is no incommensurable moral divide to generate inexorable moral confusion. If *humanness* is taken to mean

relevantly similar to humans than species membership is a red herring; what matters is whether an organism possesses the morally relevant features conferring relevant similarity to humans.[9] This relocates the moral force of the argument from '*what species does this organism belong to?*' to '*is this organism relevantly similar to humans?*', where what counts as *relevantly similar* will be specified and justified by appeal to moral theory. An advantage of this approach is that it is easy to see how biological facts and moral theory correspond. The normative force will track the relevant biological features of an organism, rather than rely on poorly supported categorical notions of species membership (see Greene et al. 2005 for an application of this approach).

Alternatively, we might read *humanness* to mean 'belongs to the species *H. sapiens*.' This is a question about lineages and species identity. To belong to a species is to be an organism in a particular lineage (Ghiselin 1974; Hull 1976). For most animal species, the edges and boundaries of lineages are poorly resolved; they blend into one another and overlap, and introgression between closely related species is common. In other words, lineages tend to be leaky, rather than impermeable. Species concepts reflect this fact, e.g., the Biological Species Concept tolerates low levels of hybridization between species (Coyne and Orr 2004).

H. sapiens is unusual in its distinctiveness from other lineages. There simply are no closely related lineages with which we hybridize.[10] The worry, though, is that successful creation of, say, human/nonhuman chimeras will

constitute a novel means of creating overlaps between *H. sapiens* and other lineages. In much the same way that a hybrid duck belongs to both and neither of its parents' species, the concern is that animals with human-derived parts will have a similarly indeterminate identity. In evolutionary biology, this indeterminacy may be resolved by appeal to competing species concepts (i.e., the infamous 'species debates'; Ereshefsky 1992), or simply recognized as a fact and consequence of biology. This works fine for evolutionary studies. However, where biological identity is a driver of moral status, as in IMC arguments, this indeterminacy poses a foundational threat to moral reasoning (or categorization). More specifically, if the bright line separating humans biologically from other species may be breached, then so too, perhaps, may that moral divide. Should we be concerned?

Let's take stock. First, it is not clear that the research at stake is creating creatures with any claim of belonging to the *H. sapiens* lineage. The notions of reproduction and development are complicated and controversial, to say the least (n.b., Griesemer 2000), and moving parts between species will not necessarily create a locus of overlap between those species lineages. Lateral gene transfer, for example, is a widely (and naturally) occurring phenomenon, but not one that necessarily complicates species identity. So, even though the worries raised in arguments from IMC are easy to see, it is not obvious they will be borne out—especially in the context of an evolutionary perspective.

Let's suppose, for sake of argument, that the human/nonhuman chimeras produced by interspecies research *would* constitute a crossing of lineages (whatever that might mean). Suppress, for now, the question of whether moving human neural progenitor cells into fetal mice creates a part-human mouse, a mouse with human-derived neural tissue, a humanized mouse, or whether these are meaningful distinctions to draw (Benham and Haber 2008; Piotrowska 2011). Let's simply treat this as a locus of overlap between the mouse and human lineages, i.e., the creature belongs, partially, to both *Mus musculus* and *H. sapiens*. The necessity condition tells us how to consider human parts of the human lineage, but what of those parts (organismal or otherwise) that are also parts of other lineages, and only 'part-human'?

As formulated, the necessity condition is not up to the task; a more subtle approach is called for. Recall that Robert and Baylis articulate the necessity condition as "the claim that humanness is a necessary (if not sufficient) condition for full moral *standing*" (2003:2, emphasis added). If the *H. sapiens* lineage were to start resembling other lineages and become more fluid, what becomes of 'belongs to *H. sapiens*' as a necessary condition for full moral standing? Notice that the 'belongs to' relation has been complicated; it may no longer simply be understood categorically, but, as with other species, denotes a more complex relation. Does any organism that belongs to the *H. sapiens* lineage trigger the necessity condition, regardless of whether it belongs to other lineages as well? Or is there a threshold for how tightly bound or integrated an organism must be in

H. sapiens before full (or partial) moral standing is conferred? In other words, should the necessity condition be modified such that *exclusive* (i.e., non-overlapping) location in the *H. sapiens* lineage is a necessary condition for full moral standing? Should any relationship binding an organism into *H. sapiens* trigger the necessity condition, or only genealogical ones? On the IMC presumption of naïve developmental essentialism and a categorical divide between human and nonhuman moral standing, these questions will be hidden from view. Arguments from IMC simply lack the resources to locate, let alone address, these questions.

A reassessment of the necessity condition is in order. We recommend that critics of human/nonhuman interspecies research are better off abandoning the necessity condition for a weaker stance, what we call the *genealogical contingency stance* (GCS):

> Belonging to the *Homo sapiens* lineage by virtue of genealogical relations is a sufficient condition for full moral *consideration*; other binding relations confer (partial to full) moral *status* contingent on other morally relevant features.

Inclusion in the *H. sapiens* lineage by genealogy is sufficient to warrant full moral consideration (leaving aside how moral status might be derived from this on competing moral theories). What of part-humans? These partially belong to the *H. sapiens* lineage by virtue of non-genealogical relations, and so their moral status will depend, in large part, on what morally relevant features they possess, and the strength of relation to the *H. sapiens* lineage.[11] Though we are primarily

discussing relations that bind or partially locate individuals in the *H. sapiens* lineage, other relations might also amplify the significance of morally relevant features. For example, we may have greater moral obligations to lab animals or house pets, than to wild organisms of the same species. This greater obligation would be justified on the GCS by appeal to the companionship and stewardship relations these individuals stand to humans, in that these amplify our moral obligation towards, or the moral standing of, those individuals.

Notice that the two senses of *humanness* are collapsing in terms of how they provide guidance through the ethical issues at stake, and what facts are morally relevant. These facts, though, are often unknowable prior to production of these creatures. There is an inferential gap that cannot be bridged, similar to what Robert describes as *Xenopus' paradox* (Robert 2006).[12] Namely, even if we have the tools at hand to assess the moral status of a creature upon production, it is the ethics of production that are at stake. Since this assessment is only possible after the fact, production thus carries a genuine moral risk (Streiffer 2005 comes to much the same conclusion, though by different means). What critics can demand, and proponents must answer, is that this uncertainty of moral status be balanced against the possible risk of moral harm that may be done to those created individuals.[13] This reframes the debate into one of how much that uncertainty or moral risk may be mitigated given other facts about which we have more solid empirical or theoretical grounding. That is, it is arguments from *uncertainty of moral status* that ought to give us pause, rather

than from confusion (inexorable or not) about species identity. *This* is where we think the locus of the debate should rest—what triggers a precautionary attitude, and what does that triggering entail? This is a benefit of our reframing: the morally relevant facts are identified without presumption of outcome.

The upshot is that on either viable reading of *humanness*—being human-like, or belonging to *H. sapiens*—very similar ethical questions may be raised against the production of part-humans, questions that no longer rely on a suspect biological essentialism. Though an organism may not possess any essential features, critics might argue that genealogical relations between it and *H. sapiens* carry morally significant weight, such that they constitute sufficient conditions for full moral consideration. Genealogical relations depend on reproduction and development. Thus the intuition of the centrality of development to biological identity is retained without necessitating commitment to ontologically dubious premises, and without worry of unduly amplifying the significance of developmental material. At the same time organisms may possess other morally relevant features that may be amplified by non-genealogical relations to the *H. sapiens* lineage. Those relations may be novel, and we may stand in a position of uncertainty with regard to how they may be instantiated in the case of production of part-humans. Indeed, it is just this uncertainty that may warrant appeal to the precautionary principle—and situates those appeals in a familiar and traditional mode of precautionary argument.

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5. Conclusion

Above we continued the discussion initiated by Robert and Baylis (2003) over the ethics of human-to-nonhuman interspecies research. We considered the viability of objections from IMC, identifying intrinsic flaws in these arguments. They are undermined by the assumption of naïve developmental essentialism and the presumption of an incommensurable moral divide between humans and nonhumans. Expunging essentialist assumptions removes a source of confusion in IMC arguments: the *two-essence* problem. Yet, critics of this research still have objections available to them. Rather than motivated by *confusion* over species identity, these reframed objections turn on *uncertainty* about the moral status of the resulting creatures. This shift better tracks traditional precautionary appeals and helps identify the morally significant and relevant facts. Of course, this uncertainty may trigger a variety of precautionary stances, ranging from loose regulation to universal prohibition. However, like Robert and Baylis before us, we are not endorsing these lines of objection. We present them as stronger candidate objections to human-to-nonhuman interspecies research than those from IMC, and suggest that their consideration will produce a more fruitful discussion. Whether these objections are forceful enough to justify prohibitions or restrictions is an open question, and will depend, for example, on the severity of the consequences and scope of benefits (e.g., Bhan et al. 2010). But this is the productive landscape in which the moral debate should occur.

Arguments from IMC do not simply fail to identify the relevant biological and moral facts in play, they distort them. In selecting terminology, biologists and ethicists should avoid falling into this same trap. Describing a mouse with human-derived neural tissue as a 'mouse with a human brain' undercuts good ethical discussions of that work. This terminology presumes something to be a fact, where that fact is very much unsettled; the *status* of that fact is itself a morally relevant feature of the debate. Furthermore, it fails to account for how the same term may be understood in varying contexts. We endorse a more precise yet cautious terminology, e.g., describing creatures as possessing tissue derived from human cells or material (e.g., Chang et al. 2010), or "animals with human-derived materials" (The Academy of Medical Sciences 2011). The framing of the ethics of human-to-nonhuman interspecies research is not merely the concern of policy makers, working groups, and the like, but should also resonate with day-to-day practitioners of the research in question. Given the potential value of this research, moral questions should be articulated in a manner consistent with good biological thinking yet encourage a productive and inclusive ethical discourse among all interested parties.

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[1] Recent empirical work suggests this trend of discovery will continue (Parikh et al. 2010; Royo et al. 2011).

[2] Thanks to an anonymous reviewer for bringing our attention to this point, and extending the preceding point to 'part-human' assignment of cells.

[3] Siegel (2003) argues for a similar point.

[4] Utilitarian accounts, for example, will apply in familiar ways—and will likely generate familiar controversies. Johnston and Eliot (2003) and de Melo-Martin (2008) consider how human dignity may pertain here.

[5] How moral consideration due to species identity might play out, of course, is a matter of dispute. See Singer (1975), Francis and Norman (1978) and Tanner (2008) for more on the moral relevancy of species identity. Suffice to say that we do not consider moral consideration, moral standing and moral status to be equivalent.

[6] These correspond, roughly, to competing views about species and natural kinds, e.g., naïve typology, sophisticated pheneticism, and evolutionary accounts.

[7] The best case for an exception to this would be an extrinsic essentialism, with essential characters extrinsic to the individual, e.g., origin essentialism (Griffiths 1999; Okasha 2002). We do not think this is the sense of essence being described here. Even if it were, the two-essence problem would be undermined for reasons already discussed. Robert and Baylis consider another option, Richard Boyd's Homeostatic Property Cluster (HPC) Kinds (Boyd 1999). The HPC view is not the right kind of essentialism; there is no essence but a cluster of homeostatic properties, not all of which need be applied and may vary over different contexts. Yet another option would be to adopt a teleological version of essentialism. The best candidate is Denis Walsh's (2006) resurrection of Aristotelian essentialism, yet this account would almost certainly undermine naïve developmental essentialism. Devitt (2008) attempts to resurrect species essentialism, though it is unclear whether his account would support the necessity condition. Barker (2010) offers a convincing critique of Devitt-style essentialism. Sober (1980) addresses how debates over the nature of essentialism, natural kinds, and variation play out with regard to an evolutionary account of species.

[8] Moral theories, of course, will differ in how individuals who fail to possess species-typical morally relevant features ought to be treated (e.g., anencephalic newborns). Our view has the advantage that it allows space for this complex debate, rather than settling it by presupposition. (Thanks to an anonymous reviewer for bringing this to our attention.)

[9] Sagoff (2007) and Piotrowska (2011) consider an additional dimension: the relevance of *origin* of morally relevant features. Sagoff, for example, asks whether it would

be morally relevant that a mouse's enhanced capacity for some character was due to certain cells being derived from transferred human neural stem cells as opposed to dolphin neural stem cells, if that capacity were identical in either case.

[10] At least no extant lineages!

[11] One significant exception bears mentioning. Some part-humans could be born, e.g., by manipulation of germ-line cells in nonhumans, or as a result of a mating between two part-humans produced by research. In these cases, part-humans might belong, partial or otherwise, to the *H. sapiens* lineage by virtue of genealogical (i.e., developmental and reproductive) relations. Should this production raise greater ethical concerns than production through non-genealogical methods? If so (see Academy of Medical Sciences 2011), the GCS could explain and perhaps justify a stricter prohibition on production of these sorts of part-humans. Alternatively, drawing a moral divide between part-humans based on mode of origin may well undermine something like a GCS stance, in much the same way we have argued that arguments from IMC are ultimately untenable.

[12] To know what features a chimera or hybrid might possess, we might first need to produce a creature halfway between the chimera/hybrid and one of the progenitor species. Of course, to know what features *this* creature might posses (and, thus, to determine its moral status) the inferential gap must also be filled, perhaps by creation of some other interspecies creature, and so on *ad infinitum*.

[13] This is reminiscent, with obvious added dimensions, of debates over the production of human clones that consider the moral harm that may be done to that clone, e.g., can a child born as a result of cloning be said to be harmed by being brought into existence, or do some harms that may accompany cloning justify prohibition (Brock 1997, Smajdor 2010, and many others)? Streiffer (2010) sees connections to the abortion debate.