



2015

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Kerry L. Macintosh

Santa Clara University School of Law, kmacintosh@scu.edu

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Recommended Citation

47 Ariz. L.J. 183 (2015)

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CHIMERAS, HYBRIDS, AND CYBRIDS: How Essentialism Distorts the Law and Stymies Scientific Research

Kerry Lynn Macintosh*

“If man could be crossed with a cat, it would improve man but deteriorate the cat.”¹—Mark Twain

Imagine a scientist friend invites you to visit her research laboratory. She directs you to a cage. You see a small, furry creature with round ears and a long tail crouched in one corner of the cage. Based on these visual cues you assume the creature is a mouse. You quickly draw some basic inferences: the mouse is fond of cheese, afraid of cats, and none too bright.

Then your friend surprises you. She informs you that she engrafted the mouse with human brain stem cells; as a result, all the neurons in its tiny brain are of human origin. She made the mouse so she could study the function of human neurons in a living model. You ask whether the mouse thinks like a human. Your friend laughs and explains that its brain is too small for that.

You glance at the mouse again. Despite what your friend has said, the mouse’s glittering black eyes now seem to hold a spark of human intelligence. You shudder in revulsion.

This hypothetical is not an idle academic exercise. Stanford scientist Irv Weissman proposed creating just such a “human neuron mouse” years ago.² Moreover, scientists across the nation are busily creating embryos,³ fetuses, and life forms that combine human and non-human cells or genetic material.

*. Professor of Law, Santa Clara University School of Law. I am grateful to Professor Gary Spitko for his comments on the draft of this article. I also thank Marshall Olin, J.D. 2014, Santa Clara University School of Law, for his able research assistance.

1. THE WIT AND WISDOM OF MARK TWAIN 33 (Alex Ayres ed., 1987).

2. The term “human neuron mouse” comes from the bioethical literature. E.g., Henry T. Greely et al., *Thinking About the Human Neuron Mouse*, 7 AM. J. BIOETHICS, no.5, 2007, at 27. For a more detailed discussion of Weissman’s proposal, see *infra* Part I.F.

3. This Article generally uses the word “embryo” to refer to a preimplantation embryo from its initial conception to blastocyst stage. In humans, a blastocyst is an embryo that has developed over the course of five to seven days to the point where it has hundreds of embryonic stem cells in its interior. HARVEY LODISH ET AL., *MOLECULAR CELL BIOLOGY* 950 (Katherine Ahr et al. eds., 6th ed. 2008). A more technical, medical definition of “embryo” extends from conception through eight weeks of development. WILLIAM K. PURVES ET AL., *LIFE THE SCIENCE OF BIOLOGY* 425 (Sinauer Associates, Inc. ed., 7th ed. 2004).

Scientists who conduct such research doubtless believe themselves to be contributing to knowledge and the public good. In some states, however, their hard work is more likely to garner a prison sentence than a Nobel Prize. In Louisiana and Arizona, it is illegal for a scientist to create certain types of human/nonhuman chimeras,⁴ hybrids,⁵ and cybrids⁶—including, perhaps, the human neuron mouse.⁷ Legislators in other states are attempting to enact similar bans.⁸

This Article analyzes the Louisiana and Arizona laws and describes their impact on scientific research. However, it does not stop with statutory analysis. It digs deeper to question *why* a person (including a legislator) might expect a human neuron mouse to possess human intelligence and feel repulsed enough to demand a ban. The answer lies in a heuristic⁹ known as psychological essentialism. By exposing the roots of the Louisiana and Arizona laws, this Article seeks to discourage state and federal lawmakers from enacting similar laws in the future.

Towards that end, this Article proceeds in four parts. Part I reviews several bills that failed in Congress but became the templates for the Louisiana and Arizona laws. It details the prohibitions contained in the bills and explains their relation (or lack thereof) to science in the real world. Building on that background, Part II describes the Louisiana and Arizona laws and their consequences for scientific research.

Next, Part III describes the policy rationales that ostensibly justify the Louisiana and Arizona laws. Finally, Part IV defines psychological essentialism and explains how it influences our intuitions and opinions about animals and humans. Psychological essentialism provides a coherent account of the Louisiana and Arizona laws. However, essentialism does not justify the laws or their impact on scientific research.

4. A chimera is an organism containing cells that originated in two or more embryos of either the same or different species. ANDREA L. BONNICKSEN, CHIMERAS, HYBRIDS, AND INTERSPECIES RESEARCH: POLITICS AND POLICYMAKING 27 (2009); *see also* Henry T. Greely, *Defining Chimeras . . . and Chimeric Concerns*, 3 AM. J. BIOETHICS, no. 3, 2003, at 17, 18 tbls. 1, 2 & 3 (listing possible chimera types).

5. Hybrids are conceived when sperm from one species fertilizes an egg from another species. BONNICKSEN, *supra* note 4, at 60. If born alive, the resulting organism has DNA from two species in each of its cells. *Id.*

6. A cybrid is an interspecies embryo cloned from the DNA of one species and the egg of another. *Id.* at 78. The term appears to be an abbreviation of another term: cytoplasmic hybrid embryo. *See id.* (listing various terms).

7. For a detailed discussion of the Louisiana and Arizona laws, *see infra* Parts II.A and II.B.

8. For a discussion of laws proposed in other states, *see infra* Part II.C.

9. A heuristic is a mental rule of thumb that we humans use to help us understand our world and resolve problems. KERRY LYNN MACINTOSH, HUMAN CLONING: FOUR FALLACIES AND THEIR LEGAL CONSEQUENCES 64 (2013) [hereinafter MACINTOSH, FOUR FALLACIES].

I. THE HUMAN-ANIMAL HYBRID PROHIBITION ACT OF 2007: A
WARPED TEMPLATE FOR STATE LEGISLATION

Early in his presidency, George W. Bush created a President's Council on Bioethics (Council) to advise him on bioethical issues associated with biomedical science and technology.¹⁰ In 2004, the Council issued a report entitled *Reproduction & Responsibility: The Regulation of New Biotechnologies*.¹¹ The report discussed assisted reproductive technologies,¹² research on human embryos,¹³ and genetic modification of human embryos.¹⁴

At the end of its report, the Council recommended several "targeted legislative measures" that would bar "questionable" practices while leaving legitimate scientific research intact.¹⁵ The first item on the Council's wish list was a law to preserve the boundary between human and nonhuman in procreation.¹⁶

The Council did not object to the mixing of human and animal tissues in general. For example, it accepted the transplantation of animal organs into human beings, and even approved the introduction of human stem cells into animals as part of biomedical research.¹⁷ However, the Council urged Congress to ban two practices: first, the transfer of human embryos into animal uteri; and second, the fertilization of human eggs by animal sperm, or animal eggs by human sperm.¹⁸ The Council reasoned as follows:

One bright line should be drawn at the creation of animal-human hybrid embryos, produced *ex vivo* by fertilization of human egg by animal (for example, chimpanzee) sperm (or the reverse): we do not wish to have to judge the humanity or moral worth of such an ambiguous hybrid entity (for example, a "humanzee," the analog of the mule); we do not want a possibly human being to have other than human progenitors. A second bright line would be at the insertion of *ex vivo* human embryos into the bodies of animals: an *ex vivo* human embryo entering a uterus belongs *only* in a *human* uterus.¹⁹

10. See Exec. Order No. 13,237, 66 Fed. Reg. 59,851 (Nov. 30, 2001).

11. THE PRESIDENT'S COUNCIL ON BIOETHICS, REPRODUCTION & RESPONSIBILITY: THE REGULATION OF NEW BIOTECHNOLOGIES (2004) [hereinafter REPRODUCTION & RESPONSIBILITY].

12. *Id.* chs. 2, 3, and 6.

13. *Id.* ch. 5.

14. *Id.* ch. 4.

15. *Id.* at 218–19.

16. *Id.* at 220.

17. *Id.*

18. REPRODUCTION & RESPONSIBILITY, *supra* note 11, at 221.

19. *Id.* at 220.

One year later, the Council's recommendations bore fruit. Sam Brownback, then a United States Senator from Kansas, introduced a bill entitled the Human Chimera Prohibition Act of 2005. This Act sought to ban the two specific practices that the Council had identified, along with several other types of scientific experiments that blended human and nonhuman elements.²⁰ Although this bill did not become law,²¹ Senator Brownback did not give up. He introduced a similar bill in the next Congressional session, rebranding it as the Human-Animal Hybrid Prohibition Act of 2007 and substituting the term "human-animal hybrid" for "human chimera."²² Eighteen Senators co-sponsored the 2007 Brownback bill, including John McCain (R-Ariz).²³ Representative Chris Smith (R-N.J.) introduced a companion bill in the House of Representatives that garnered six cosponsors.²⁴ Both bills failed to make it to the floor for a vote.²⁵

Still, Senator Brownback persisted. He introduced essentially the same bill as The Human-Animal Hybrid Prohibition Act of 2009.²⁶ This time he had 20 cosponsors,²⁷ but the 2009 Brownback bill also died without the Senate taking a vote.²⁸

The 2007 and 2009 Brownback bills may have failed in Congress, but they are not truly dead, for they live on in copycat Louisiana and Arizona laws. No analysis of the state laws would be complete without consideration of these federal progenitors. However, since the provisions of the 2007 and 2009 Brownback bills are identical, only one of the bills need be discussed. This

20. Senator Brownback first introduced the Human Chimera Prohibition Act of 2005 as Senate Bill 659 on March 17, 2005. Shortly thereafter, on July 11, 2005, he reintroduced the Act with minor amendments as Senate Bill 1373. This Article discusses and cites the later of these two versions.

21. *S.1373—Human Chimera Prohibition Act of 2005*, LIBRARY OF CONG., <https://www.congress.gov/bill/109th-congress/senate-bill/1373> (last visited Mar. 13, 2015) (indicating bill was sent to Committee on the Judiciary but went no further).

22. S. 2358, 110th Cong. (2007).

23. *S.2358—Human-Animal Hybrid Prohibition Act of 2007*, LIBRARY OF CONG., <https://www.congress.gov/bill/110th-congress/senate-bill/2358/> (last visited Mar. 13, 2015) (listing cosponsors).

24. H.R. 5910, 110th Cong. (2008).

25. *S.2358—Human-Animal Hybrid Prohibition Act of 2007*, *supra* note 23 (showing Brownback bill died in Senate Committee on the Judiciary); *H.R. 5910—Human-Animal Hybrid Prohibition Act of 2008*, LIBRARY OF CONG., [https://www.congress.gov/bill/110th-congress/house-bill/5910?q={%22search%22%3A\[%22human-animal+hybrid%22}\]](https://www.congress.gov/bill/110th-congress/house-bill/5910?q={%22search%22%3A[%22human-animal+hybrid%22}]) (last visited Mar. 13, 2015) (showing Smith bill died in House Committee on Judiciary).

26. S. 1435, 111th Cong. (2009).

27. *S.1435—Human-Animal Hybrid Prohibition Act of 2009*, LIBRARY OF CONG., <https://www.congress.gov/bill/111th-congress/senate-bill/1435/> (last visited on Mar. 13, 2015) (listing cosponsors).

28. *Id.* (indicating bill never went beyond Senate Committee on the Judiciary).

Article will focus on the 2007 Brownback bill because it has a more extensive legislative history than does the 2009 Brownback bill.

The 2007 Brownback bill seeks to implement the two recommendations of the President's Council on Bioethics. First, the bill prohibits the knowing transfer of a human embryo into a nonhuman womb or a nonhuman embryo into a human womb.²⁹ Second, the bill prohibits the knowing creation, transportation, or receipt of a human-animal hybrid.³⁰ Scientists who flout these prohibitions face prison sentences of ten years, criminal fines, and civil penalties of one million dollars or more.³¹

The bill's prohibition against inter-species uterine transfers is harmless enough. Theoretically, one could transfer a human embryo into a non-human uterus in order to study embryonic development; but federal funds are not available for such bizarre experiments³² and scientists are not conducting them.³³ Conversely, one could transfer a non-human embryo into a human uterus; but scientists have no reason to employ human surrogates when animal surrogates are available.³⁴

However, the remainder of the 2007 Brownback bill must be taken seriously. It defines "human-animal hybrid" to include no less than *eight categories of forbidden organisms*.³⁵ This Part discusses these categories in the order presented in the bill. Each subpart sets forth a category definition and then describes its impact (or lack thereof) on scientific research.

29. S. 2358, 110th Cong. § 3 (2007). The bill defined human embryo as "an organism of the species *Homo sapiens* during the earliest stages of development, from 1 cell up to 8 weeks." *Id.*

30. *Id.*

31. *Id.*

32. The Dickey-Wicker Amendment is a rider that Congress regularly attaches to the appropriations bill for the Department of Health and Human Services. Per the Amendment, federal funds are not available for experiments that destroy human embryos or subject them to risk of injury or death greater than permitted under federal regulations that govern research on fetuses in utero. Kerry Lynn Macintosh, *Psychological Essentialism and Opposition to Human Embryonic Stem Cell Research*, 18 J. TECH. L. & POL'Y 229, 252 (2013) [hereinafter Macintosh, *Human Embryonic Stem Cell Research*].

33. BONNICKSEN, *supra* note 4, at 91–93. In the recent past, some members of Congress worried that researchers might initiate pregnancies in order to create human fetuses that later could be killed and harvested for their tissues. 152 CONG. REC. 5,345–48, 5,351–52 (2006). These concerns were inspired in part by animal experiments in which fetuses were cloned, killed, and harvested for research. *Id.* Congress enacted the Fetus Farming Prohibition Act of 2006 to address these concerns. Pub. L. No. 109-242, 120 Stat. 570 (2006) (codified at 42 U.S.C. § 298g-2). One of the Act's provisions makes it illegal to "knowingly acquire, receive, or accept tissue or cells obtained from a human embryo or fetus that was gestated in the uterus of a nonhuman animal." *Id.* at § 2(c)(2). This legislation eliminates one rather grisly incentive that scientists might otherwise have had for introducing human embryos into animal uteri.

34. See BONNICKSEN, *supra* note 4, at 91, 95 (noting lack of scientific justification for transfer of non-human embryos to human surrogates).

35. S. 2358, 110th Cong. § 3 (2007).

A. *Chimeric Embryos*

The term ‘human-animal hybrid’ means—

(A) a human embryo 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[.]³⁶

Technically, this category describes not a hybrid, but a chimera: that is, an organism containing cells that originated in two or more embryos.³⁷ What makes this particular chimera offensive is that one or more non-human cells have been added to a human embryo. The bill does not explain what it means to render an embryo’s membership in the human species uncertain. However, during his remarks on the Senate floor, Senator Brownback opined that it would be unfair to create a person who was only eighty or fifty percent human.³⁸

This category does not serve any scientific purpose. Chimeric embryos comprised of cells from disparate species are unlikely to survive to birth,³⁹ so we need not fear the birth of half-human, half-animal monsters. Nor do we need to worry that human embryos will be corrupted or wasted in the course of experiments. Scientists who wish to study non-human cells in a living system do not need to involve human embryos; non-human embryos, fetuses, and life forms can serve as hosts.⁴⁰

This category does not serve much legal purpose, either. The Food and Drug Administration (FDA) claims the authority to regulate human cells employed in therapy if genetic material is transferred other than by union of egg and sperm.⁴¹ The FDA is unlikely to tolerate the transfer of genetic

36. *Id.*

37. BONNICKSEN, *supra* note 4, at 27; Greely, *supra* note 4, at 17. A true hybrid results when a sperm of one species fertilizes an egg of a different species. BONNICKSEN, *supra* note 4, at 60. The hybrid is distinguished from the chimera in that each of the hybrid’s individual cells carries DNA from two species. *Id.* By contrast, a chimera is comprised of cells derived from more than one embryo, but each individual cell has a single embryonic origin. *Id.* at 29.

38. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (statement of Sen. Samuel Brownback).

39. BONNICKSEN, *supra* note 4, at 45.

40. *See id.* at 53 (asserting there is “no rationale” to transfer animal ESCs to human embryos).

41. Kerry Lynn Macintosh, *Brave New Eugenics: Regulating Assisted Reproductive Technologies in the Name of Better Babies*, 2010 U. ILL. J.L. TECH. & POL’Y 257, 271 [hereinafter Macintosh, *Brave New Eugenics*].

material from non-human animals into human embryos for reproductive purposes.⁴²

Finally, to a large extent, industrial and financial factors render this category moot. The National Academies⁴³ have issued Guidelines for Human Embryonic Stem Cell Research (NAS Guidelines)⁴⁴ that discourage researchers from introducing any embryonic stem cells (ESCs)⁴⁵ or human pluripotent⁴⁶ stem cells into human blastocysts.⁴⁷ The NAS Guidelines are voluntary⁴⁸ but most major research institutions in the United States have adopted them⁴⁹ so they have considerable influence.⁵⁰ In addition, scientists cannot obtain federal funding for experiments that introduce non-human cells into human embryos because such experiments might harm the embryos.⁵¹

42. *Cf. id.* at 271–72 (describing the FDA’s crackdown on a technique in which fertility doctors inject donor ooplasm from human eggs into the eggs of infertile women to improve the odds that insemination will result in a viable human embryo).

43. The National Academies include four entities. *Who We Are*, NATIONALACADEMIES.ORG, <http://www.nationalacademies.org/about/whoweare/index.html> (last visited Mar. 13, 2015). The oldest is the National Academy of Sciences (NAS), a private, non-profit organization established under a Congressional charter to counsel the federal government on scientific issues. *Id.* The National Research Council, National Academy of Engineering, and Institute of Medicine are also private, non-profit entities designed to provide impartial advice. *Id.*

44. The National Academies established a committee to draft guidelines that would encourage responsible hESC research. COMM. ON GUIDELINES FOR HUMAN EMBRYONIC STEM CELL RESEARCH, NAT’L RESEARCH COUNCIL & INST. OF MED., GUIDELINES FOR HUMAN EMBRYONIC STEM CELL RESEARCH 3 (The Nat’l Academies Press 2005) [hereinafter NAS GUIDELINES 2005]. The original NAS Guidelines have been amended several times, most recently in 2010. HUMAN EMBRYONIC STEM CELL RESEARCH ADVISORY COMM., NAT’L RESEARCH COUNCIL & INST. OF MED., FINAL REPORT OF THE NATIONAL ACADEMIES’ HUMAN EMBRYONIC STEM CELL RESEARCH ADVISORY COMMITTEE AND 2010 AMENDMENTS TO THE NATIONAL ACADEMIES’ GUIDELINES FOR HUMAN EMBRYONIC STEM CELL RESEARCH (The Nat’l Academies Press 2010) [hereinafter NAS GUIDELINES 2010]. This Article cites the NAS Guidelines 2010 when describing the NAS Guidelines as they are today. However, this Article occasionally cites the NAS Guidelines 2005 when explaining the rationale behind a rule.

45. Embryonic stem cells (ESCs) are cultured from early embryos. *See* LODISH ET AL., *supra* note 3, at 911. They can differentiate into a wide variety of cell types either in vitro or after re-insertion into a host organism. *Id.* at 906–07. This Article refers to ESCs derived from human embryos as human embryonic stem cells (hESCs).

46. The term “pluripotent” refers to the ability of a stem cell to develop into any cell in the body. *See* James A. Thomson et al., *Embryonic Stem Cell Lines Derived from Human Blastocysts*, 282 SCIENCE 1145, 1146 (1998) (discussing the pluripotency of hESCs).

47. NAS GUIDELINES 2010, *supra* note 44, at 23, 35; *see also* NAS GUIDELINES 2005, *supra* note 44, at 55 (arguing that such experiments could erode “human dignity”).

48. The NAS Guidelines are the product of private entities and do not have the force of law. BONNICKSEN, *supra* note 4, at 17–18.

49. NAS GUIDELINES 2010, *supra* note 44, at 1.

50. Federal guidelines may supersede the NAS Guidelines when research is federally funded. *Id.* at 20.

51. *See* Macintosh, *Human Embryonic Stem Cell Research*, *supra* note 32, at 252–54 (discussing Dickey-Wicker Amendment).

In sum, this category is not helpful. Instead, it is potentially harmful to science. To grasp the hidden peril, one must first understand current research.

Today, scientists introduce human embryonic stem cells (hESCs) into non-human embryos, fetuses, or newborns in order to study the migration, differentiation, and function of the cells in a non-human experimental model.⁵² The transfer of human pluripotent stem cells to non-human embryos may also yield medical applications. Consider the following hypothetical, which is based on research a Japanese scientist plans to conduct at Stanford University.⁵³

Suppose Jane is dying because her pancreas is failing. A scientist genetically engineers a pig embryo so that it cannot make a pancreas. He derives induced pluripotent stem cells (hiPSCs)⁵⁴ from Jane's skin cells and transplants them into a pig embryo.⁵⁵ He transfers the chimeric embryo to a sow that will serve as surrogate mother. In theory, the embryo will draw upon the DNA in the human cells to build the pancreas.⁵⁶ After the pig is born and raised to a sufficient developmental stage, the scientist can harvest its human pancreas and transplant it into Jane, who should tolerate the organ because it matches her DNA.⁵⁷ In the future, chimeric pigs may be used to grow human kidneys, hearts, and other organs that patients need.⁵⁸ Experiments of this kind do not create human-pig monsters, though the scientist who has proposed the research worries that people might view his work that way.⁵⁹

He is right to be concerned. Once politicians accept the principle that non-human cells should not be introduced into human embryos, as per the 2007 Brownback bill, they may be tempted to prohibit the introduction of human cells into non-human embryos also. Indeed, the Louisiana State Legislature

52. See BONNICKSEN, *supra* note 4, at 40–41 (mentioning several experiments).

53. For an account of his research plan, see Dennis Normile, *Chimeric Embryos May Soon Get Their Day in the Sun*, 340 SCIENCE 1509 (2013).

54. Human induced pluripotent stem cells (hiPSC) are cells that have been taken from human tissue and modified through various means so that they behave like embryonic stem cells. See NAT'L INSTS. OF HEALTH, U.S. DEP'T OF HEALTH & HUMAN SERVS., STEM CELL BASICS 13 (2009), available at <http://stemcells.nih.gov/staticresources/info/basics/SCprimer2009.pdf>. These cells, like hESCs, have the ability to form all human adult cell types. *Id.*

55. See Normile, *supra* note 53, at 1509.

56. Japanese scientists already have used a similar method to create a chimeric pig. Hitomi Matsunari et al., *Blastocyst Complementation Generates Exogenic Pancreas In Vivo in Apancreatic Cloned Pigs*, 110 PNAS 4557, 4558–60 (2013). Using genetic engineering and cloning, they created embryos that would ordinarily develop into pigs without a pancreas. *Id.* The scientists then inserted blastomeres harvested from donor pig embryos. *Id.* The reconstructed embryos produced healthy chimeric pigs with pancreases that matched the genotype of the donor embryos. *Id.*

57. Normile, *supra* note 53, at 1509.

58. *Id.* at 1510.

59. *Id.*

has already given into that temptation, thereby endangering an entire field of important scientific research. This threat to research is further discussed in Part II.A below.

B. *Hybrid embryos*

The term ‘human-animal hybrid’ means—

(B) a hybrid human/animal embryo produced by fertilizing a human egg with non-human sperm;

(C) a hybrid human/animal embryo produced by fertilizing a non-human egg with human sperm.⁶⁰

The President’s Council on Bioethics asked Congress to bar the creation of human-animal hybrid embryos via fertilization, lest mad scientists create ambiguous entities that could possibly be human, such as the humanzee.⁶¹ These two categories in the 2007 Brownback bill aim to satisfy the Council’s request.

Hybrids of animal species do exist. For example, when a male donkey mates with a female horse, a mule may result.⁶² This hybridization occurs even though a horse egg has thirty-two chromosomes and a donkey spermatozoon has thirty-one.⁶³ Nevertheless, hybrids are rare; differing numbers of chromosomes often prevent members of different species from generating viable offspring.⁶⁴ Human-animal hybrid embryos, in particular,

60. S. 2358, 110th Cong. § 3 (2007).

61. REPRODUCTION & RESPONSIBILITY, *supra* note 11, at 220. Fear of humanzees may stem from experiments conducted in the early twentieth century. A Soviet scientist named Ilya Ivanovich Ivanov artificially inseminated female chimpanzees with human sperm; no pregnancies resulted. SAM KEAN, *THE VIOLINIST’S THUMB* 179–81, 187–88 (2012). He also wanted to artificially inseminate human women with chimpanzee sperm, but he was unable to arrange in one time and place all that he needed for the experiment: proper scientific facilities, healthy chimps, and women willing to volunteer. *Id.* at 189–90. Ivanov also overestimated his chances of success; at the time, scientists incorrectly believed that human beings had forty-eight chromosomes. *Id.* at 192–94. Chimpanzees do have forty-eight chromosomes. BONNICKSEN, *supra* note 4, at 67.

62. BONNICKSEN, *supra* note 4, at 61.

63. RAY V. HERREN, *THE SCIENCE OF ANIMAL AGRICULTURE* 284–85 (Dave Garza ed., Delmar Cengage Learning 4th ed. 2011); *see also* KEAN, *supra* note 61, at 196 (discussing fact that horses have sixty-four chromosomes and donkeys sixty-two chromosomes).

64. *See* BONNICKSEN, *supra* note 4, at 60–61 (discussing chromosomal mismatches and other factors that make hybridization between animal species rare).

have no realistic chance of coming to term.⁶⁵ To illustrate, consider Mark Twain's hypothetical cross between man and cat.

When a man reproduces with a woman, a human spermatozoon with a load of twenty-three chromosomes unites with a human egg, also bearing twenty-three chromosomes, to create a normal human embryo with forty-six chromosomes arrayed in twenty-three pairs.⁶⁶ Cat reproduction differs: a cat spermatozoon with nineteen chromosomes unites with a cat egg with nineteen chromosomes to create a normal cat embryo with thirty-eight chromosomes arrayed in nineteen pairs.⁶⁷ Now, suppose a human spermatozoon bearing twenty-three chromosomes attempts to fertilize a cat egg, which has nineteen chromosomes. Due to the significant numerical mismatch, these gametes cannot produce an embryo that bears chromosomes in the standard two copies. In other words, cat lovers can rest easy: a cross between man and cat will never be born.

What about the Council's humanzee, that is, a hybrid created by inseminating chimpanzee eggs with human sperm? Reputable scientists have no reason to create such a hybrid,⁶⁸ but even if they made the attempt, they would have little chance of success. The numerical mismatch between a chimp egg (twenty-four chromosomes)⁶⁹ and a human spermatozoon (twenty-three chromosomes) reduces the chances of a successful conception and viable offspring.⁷⁰ Significantly, the existence of a live-born human/non-human hybrid of *any* kind has never been verified.⁷¹

Setting live-born hybrids aside, might stem cell researchers have incentives to create human/non-human hybrid embryos? Embryos that include such a heavy proportion of non-human genetic material and have such poor developmental potential are unlikely to produce ESC lines that are useful in research aimed at curing human maladies. In her recent book,

65. See, e.g., Henry T. Greely, *Human/Nonhuman Chimeras: Assessing the Issues*, in THE OXFORD HANDBOOK OF ANIMAL ETHICS 671, 684–85 (Tom L. Beauchamp & R. G. Frey eds., 2011) [hereinafter Greely, *Human/Nonhuman Chimeras*] (discussing the improbability of creating a functional human-rodent hybrid embryo, and noting that there are no credible accounts of human/non-human hybrids).

66. SHERMAN J. SILBER, HOW TO GET PREGNANT 291–94 (paperback ed. 2007).

67. LAURA L. GOULD, CATS ARE NOT PEAS: A CALICO HISTORY OF GENETICS 27 (1996).

68. See BONNICKSEN, *supra* note 4, at 67–68 (questioning why scientists would waste time and energy trying to create a viable human-chimpanzee hybrid); Greely, *Human/Nonhuman Chimeras*, *supra* note 65, at 686 (asking why any scientist would want to know whether human-chimpanzee hybrid embryos were viable).

69. BONNICKSEN, *supra* note 4, at 67.

70. See KEAN, *supra* note 61, at 192–93 (citing the chromosomal mismatch as one among several biological reasons why scientists are unlikely to succeed in creating a humanzee hybrid); see also Greely, *Human/Nonhuman Chimeras*, *supra* note 65, at 685 (opining that human-chimpanzee hybrid embryos would fail to develop in the womb due to natural causes).

71. Greely, *Human/Nonhuman Chimeras*, *supra* note 65, at 685.

Professor Andrea Bonnicksen, an expert in biomedical and biotechnology policy, studied the field and concluded that “there appears to be no rationale for creating animal-human hybrids in research.”⁷² Here again, the 2007 Brownback bill flies wide of the scientific mark.

C. *Cloned embryos*

The term ‘human-animal hybrid’ means—

(D) an embryo produced by introducing a non-human nucleus into a human egg;

(E) an embryo produced by introducing a human nucleus into a non-human egg.⁷³

These two categories are an attempt to corral the technology of somatic cell nuclear transfer, popularly known as cloning. In cloning, a scientist joins a donor cell (or just its nucleus) with an enucleated egg.⁷⁴ He applies electricity or chemicals to activate the reconstructed egg.⁷⁵ The egg “reprograms” the nuclear DNA from the donor cell so that it can support the development of a new individual.⁷⁶ If the reconstructed egg develops into an embryo, the scientist transfers it to a surrogate mother; if all goes well, it develops into a healthy newborn.⁷⁷

The most commonly cloned animals are cattle, mice, and pigs.⁷⁸ As a general rule, scientists who wish to clone these and other animals use donor cells and eggs that belong to the same species.⁷⁹ They do not need to join a non-human nucleus to a human egg; so the first category listed above is a scientific dead letter.

However, the second category packs a real punch. To understand why, consider these scientific milestones: in 1997, Ian Wilmut publicized the birth

72. BONNICKSEN, *supra* note 4, at 62.

73. S. 2358, 110th Cong. § 3 (2007).

74. MACINTOSH, *FOUR FALLACIES*, *supra* note 9, at 2.

75. *Id.* at 2, 11.

76. *Id.* at 10.

77. For a detailed account of the cloning process that brought about the birth of Dolly the sheep, see *id.* at 2. For a discussion of technical variations on that original process, see *id.* at 11–15.

78. *Id.* at 8.

79. See *id.* at 9–15 (describing several experiments involving cattle and mice). For a discussion of cloning experiments in which scientists transfer non-human nuclei to eggs of a *different* non-human species, see BONNICKSEN, *supra* note 4, at 81.

of Dolly the sheep,⁸⁰ one year later, James Thomson announced the derivation of the first ESC line from a human embryo.⁸¹ Together, these discoveries inspired hopes that scientists would learn how to clone human embryos and derive ESC lines from them, thereby ushering in a new medical era of made-to-order tissues and organs.⁸²

Some scientists in this new field joined human cells or nuclei to non-human eggs to create embryos known as cybrids,⁸³ while others used human eggs to produce cloned human embryos.⁸⁴ In 2013, Oregon researchers announced a momentous achievement: the derivation of ESC lines with normal diploid karyotypes from cloned human embryos.⁸⁵ This success was due in part to the high-quality human eggs used in the experiment.⁸⁶

Cloned human embryos activate thousands of genes in the donor DNA, including key developmental genes like Oct-4, Sox-2, and nanog.⁸⁷ By contrast, cybrids made with rabbit or cow eggs activate fewer genes in general, and none of the key developmental genes.⁸⁸ Thus, cybrids are unlikely to produce hESCs that are safe for therapeutic use.⁸⁹

Nevertheless, cybrids continue to be useful as a basic research tool. For example, Nobel Prize winner John B. Gurdon has suggested that scientists should study cybrids since non-human eggs seem to be better than human

80. Ian Wilmut et al., *Viable Offspring Derived from Fetal and Adult Mammalian Cells*, 385 NATURE 810 (1997); Robert Langreth, *Cloning Has Fascinating, Disturbing Potential*, WALL ST. J., Feb. 24, 1997, at B1.

81. Thomson et al., *supra* note 46, at 1146.

82. PRESIDENT'S COUNCIL ON BIOETHICS, HUMAN CLONING AND HUMAN DIGNITY: AN ETHICAL INQUIRY 129–33 (2002).

83. BONNICKSEN, *supra* note 4, at 78–81; *see also* REPRODUCTION & RESPONSIBILITY, *supra* note 11, at 125 (discussing use of rabbit and cow eggs in human cloning experiments).

84. *E.g.*, Andrew J. French et al., *Development of Human Cloned Blastocysts Following Somatic Cell Nuclear Transfer with Adult Fibroblasts*, 26 STEM CELLS 485 (2008).

85. Masahito Tachibana et al., *Human Embryonic Stem Cells Derived by Somatic Cell Nuclear Transfer*, 153 CELL 1228 (2013). In 2011, New York researchers had reported success in cloning human embryos and deriving stem cell lines from them; however, those embryos and lines were triploid (bearing three copies of each chromosome rather than the standard two) because the researchers did not enucleate the eggs before joining them to somatic cells. *See generally* Scott Noggle et al., *Human Oocytes Reprogram Somatic Cells to a Pluripotent State*, 478 NATURE 70 (2011) (giving an account of that experiment).

86. Tachibana et al., *supra* note 85, at 1235. One particularly fertile donor contributed eight eggs; from this cycle of eggs, the researchers generated five cloned embryos and four embryonic stem cell lines. *Id.*

87. Young Chung et al., *Reprogramming of Human Somatic Cells Using Human and Animal Oocytes*, 11 CLONING & STEM CELLS 213, 220 (2009).

88. *Id.*

89. *Id.* at 222.

eggs at reprogramming the DNA in donor cells.⁹⁰ Researchers might also prefer cybrids because animals do not have to be paid for their eggs. The Oregon researchers paid their egg donors \$5,000 each as compensation for the time, effort, discomfort and risk endured in the course of superovulation and egg retrieval.⁹¹ In other states, such as Massachusetts and California, human eggs are hard to obtain due to laws that prohibit the compensation of research donors.⁹²

Therefore, to the extent the 2007 Brownback bill prohibits the creation of cybrids, it impedes the use of a helpful research tool. This roadblock might seem like a necessary precaution if there were any chance that scientists could implant cybrids and bring human-animal clones to term. Due to inherent biological flaws, however, cybrids are unlikely to give rise to viable offspring.⁹³ Moreover, the Food and Drug Administration (FDA) has claimed jurisdiction over human reproductive cloning and declared that it will not

90. Patrick Narbonne, Kei Miyamoto & J.B. Gurdon, *Reprogramming and Development in Nuclear Transfer Embryos and in Interspecific Systems*, 22 CURRENT OPINION GENETICS & DEV. 450, 455 (2012).

91. See Alice Park, *Scientists Report First Success in Cloning Human Stem Cells*, CNN (May 16, 2013, 6:48 AM), www.cnn.com/2013/05/15/health/time-cloning-stem-cells/index.html (explaining that Oregon allows the compensation of research donors); Tachibana et al., *supra* note 85, at 1236 (detailing the experimental procedures for the egg donation); Gretchen Vogel, *Human Stem Cells From Cloning, Finally*, 340 SCIENCE 795 (2013) (explaining that the research donors received the same pay as donors to infertility patients).

92. Massachusetts law prohibits researchers from compensating women for eggs. MASS. GEN. LAWS ANN. ch. 111L, § 8(c) (West 2005). In 2008, the journal *Nature* reported that researchers at Harvard University's Stem Cell Institute found only one egg donor after spending two years and \$100,000 in advertising. Other potential donors withdrew after realizing they could get paid if they donated eggs to infertility patients instead. Brendan Maher, *Egg Shortage Hits Race to Clone Human Stem Cells*, 453 NATURE 828, 828 (2008).

California law prohibits researchers from paying egg donors anything beyond reimbursement for direct expenses. CAL. HEALTH & SAFETY CODE § 125355 (West 2006). Moreover, researchers may not use public funds obtained through the California Institute for Regenerative Medicine (CIRM) to pay gamete donors for anything other than permissible expenses. CAL. CODE REGS. tit. 17, § 100090(b) (2010). Such restrictions have discouraged women from donating eggs and slowed the pace of cloning research in the Golden State. Marcus Wohlsen, *Egg Shortage Hits Stem Cell Studies: Research Slowed by California's Ban on Paying Donors*, SFGATE (July 31, 2008, 4:00 AM), <http://www.sfgate.com/business/article/Egg-shortage-hits-stem-cell-studies-3201935.php>.

93. See Narbonne, Miyamoto & Gurdon, *supra* note 90, at 454 (noting that most cybrids cannot develop beyond the blastocyst stage and have various biological defects).

permit clinical trials for safety reasons.⁹⁴ The FDA policy is broad enough to prohibit reproductive cloning whether human or animal eggs are used.^{95,96}

D. Engineered hybrid embryos

The term ‘human-animal hybrid’ means—

(F) an embryo containing at least haploid sets of chromosomes from both a human and a non-human life form.⁹⁷

94. Macintosh, *Brave New Eugenics*, *supra* note 41, at 269–71. Lawyers have questioned the authority of the FDA to regulate human reproductive cloning. *E.g.*, Elizabeth C. Price, *Does the FDA Have Authority to Regulate Human Cloning?*, 11 HARV. J.L. & TECH. 619 (1998). However, the threat of FDA action has been enough to drive human cloning experiments offshore. Macintosh, *Brave New Eugenics*, *supra* note 41, at 271.

95. The FDA claims jurisdiction over “human cells used in therapy involving the transfer of genetic material by means other than the union of gamete nuclei.” Letter from Kathryn C. Zoon, Dir. of the Ctr. for Biologics Evaluation & Research, FDA, to Sponsors/Researchers, Human Cells Used in Therapy Involving the Transfer of Genetic Material by Means Other Than the Union of Gamete Nuclei (July 6, 2001), *available at* <http://www.fda.gov/BiologicsBloodVaccines/SafetyAvailability/ucm105852.htm>. For example, researchers who wish to transfer the genetic material in cell nuclei via cloning cannot proceed without submitting an Investigational New Drug application to the FDA. *Id.* This FDA policy does not articulate any exceptions for researchers who wish to use animal eggs in reproductive human cloning. *See id.*

96. Many states also prohibit human reproductive cloning. Some accomplish this goal by banning human reproductive cloning specifically, whereas others simply prohibit the creation of a cloned human embryo. *See* MACINTOSH, FOUR FALLACIES, *supra* note 9, at 185–86 (listing and categorizing the state laws).

Some of these state laws anticipate that scientists might use non-human eggs to clone human babies. California law is the most specific: a person “clones” when she transfers a nucleus from a human cell into either a human or non-human egg and implants the product in a woman to initiate a pregnancy. CAL. HEALTH & SAFETY CODE § 24185(c)(1) (West 2003). Illinois, Missouri, and Virginia laws include definitions that are broad enough to halt the use of non-human eggs to clone babies. 410 ILL. COMP. STAT. ANN. 110/40 (West 2008); MO. CONST. art. III, § 38d.6(2) (“clone” means the transfer of “anything other than the product of fertilization of an egg of a human female by a sperm of a human male” to a uterus in order to start a pregnancy); VA. CODE ANN. § 32.1-162.21 (West 2001) (“human cloning” means the creation of a human being by introducing a human cell nucleus into an oocyte; “oocyte” means an ovum or egg, presumably from any species).

South Dakota falls within the class of states that ban all human cloning, including the creation of embryos for research. S.D. CODIFIED LAWS § 34-14-27 (2014). There, “human cloning” involves the transfer of nuclear material from a human cell into an oocyte to generate a living organism with a “human or predominantly human genetic constitution”; and “oocyte” is a female germ cell, rather than as a human female germ cell. *Id.* § 34-14-26. Thus, in South Dakota, it is illegal to clone a baby using a non-human egg. The effect of this law on basic research is considered in Part II.C, *infra*.

97. S. 2358, 110th Cong. § 3 (2007).

A normal human being or non-human animal has diploid chromosomes, that is, chromosomes that come in pairs.⁹⁸ Since the word “haploid” refers to a single set of chromosomes,⁹⁹ this category anticipates that scientists will use genetic engineering to create embryos with one set of human chromosomes and one set of non-human chromosomes.

As explained above, if a scientist tried to fertilize a human egg with a non-human spermatozoon, or a non-human egg with a human spermatozoon, she would create a dysfunctional hybrid embryo that would be useless in stem cell research and unviable in reproduction.¹⁰⁰ Embryos containing haploid sets of chromosomes from a human and a non-human life form would suffer from the same chromosomal mismatches; logically, such engineered hybrid embryos would be equally useless and unviable. Therefore, this category appears to attack a straw man.

E. Non-human life forms with human gametes

The term ‘human-animal hybrid’ means—

(G) a non-human life form engineered such that human gametes develop within the body of a non-human life form.¹⁰¹

This category addresses a type of non-human life form. Unfortunately, its scope is unclear. Here is how an online dictionary defines the phrase “such that”: “so that: used to express purpose *or* result.”¹⁰² The disjunctive “or” creates an ambiguity illustrated through the following hypotheticals.

First, suppose a scientist wishes to study spermatogenesis in a living model other than a human being. Accordingly, he engineers a cat *for the purpose* of giving it human sperm in its testes. There is little doubt that the scientist has knowingly created a “human-animal hybrid” as defined.¹⁰³

Second, suppose a scientist introduces hESCs or hiPSCs into a feline embryo or fetus in order to study cellular differentiation and function. Later, a cat is born with some human sperm because the hESCs or hiPSCs migrated within its body and contributed to its germ line. The scientist is surprised. He

98. LODISH ET AL., *supra* note 3, at 255.

99. *Id.*

100. *See supra* Part I.B.

101. S. 2358, 110th Cong. § 3 (2007).

102. “*Such That*” *Definition*, COLLINS ENGLISH DICTIONARY, <http://www.collinsdictionary.com/dictionary/english/such-that> (last visited Mar. 13, 2015) (emphasis added).

103. S. 2358, 110th Cong. § 3 (2007).

did not intend this outcome, but he knew it was possible because hESCs and hiPSCs are pluripotent.¹⁰⁴

In this second case, whether the cat is a human-animal hybrid depends on the meaning of “such that.” If the phrase expresses purpose, the category does not apply because the scientist did not engineer the cat *for the purpose* of giving it human sperm. However, if the phrase expresses result, the category applies because the cat was engineered *with the result* that it has human sperm. In that event, the scientist has knowingly created a human-animal hybrid.¹⁰⁵ If the 2007 Brownback bill had been enacted into law, the scientist would be guilty of a federal crime.¹⁰⁶

As discussed above, scientists introduce hESCs and hiPSCs into non-human embryos, fetuses, or life forms for research and medical purposes.¹⁰⁷ Thus, giving this category a broad scope could chill useful research.

Nevertheless, some might argue that the category deserves the broadest reading possible. A cat inadvertently created with human sperm might mate with an ordinary cat and sire a human/non-human hybrid embryo. Worse, if one cat with human sperm and another cat with human eggs encounter each other in the lab, the two might mate and conceive a human embryo.¹⁰⁸

In response to such concerns, one might point out that a human-cat hybrid embryo will not be viable for the reasons explained in Part I.B, *infra*. Moreover, if two cats with human gametes mate, a human embryo might result, but can never come to term in the immunologically alien (and tiny) uterus of a cat.¹⁰⁹ In other words, even in the worst-case scenario, no cat will give birth to a hybrid monster or human child.

Still, some people might be troubled at the idea that a human or half-human embryo might be created only to die in the reproductive tract of a cat. Industry self-regulation can avert such undesired outcomes. Per the NAS Guidelines, research institutions must establish an “Embryonic Stem Cell Research Oversight” (ESCR0) committee¹¹⁰ to review and approve

104. See NAS GUIDELINES 2005, *supra* note 44, at 39–41, 55 (discussing potential contribution of hESCs to germ line). Since an animal’s germ line is established prior to birth, research that introduces hESCs into a postnatal animal is not likely to result in the development of human gametes. See *id.* at 39 (commenting on role of hESCs in postnatal animals).

105. As this author reads the bill, the scientist need not have predicted the final outcome, so long as he knowingly introduced hESCs or hiPSCs into the cat.

106. S. 2358, 110th Cong. § 3 (2007).

107. See *supra* Part I.A.

108. Greely, *Human/Nonhuman Chimeras*, *supra* note 65, at 684–85.

109. See BONNICKSEN, *supra* note 4, at 95 (making the same point but using a mouse as an example).

110. The NAS Guidelines set forth detailed instructions for the establishment and function of an ESCRO committee. NAS GUIDELINES 2010, *supra* note 44, at 21, 24–26.

experiments that introduce hESCs into non-human animals.¹¹¹ Likewise, an ESCRO committee must approve an experiment in which there is a significant risk that human pluripotent stem cells introduced into animals might generate human gametes.¹¹² Through this review and approval process, a research institution can gauge the odds that an experiment will create human gametes in the body of an animal and adopt precautionary measures to avoid the inadvertent conception of hybrid or human embryos.

Furthermore, the NAS Guidelines direct research institutions to take one specific precautionary measure: if implanted hESCs or human pluripotent stem cells could contribute to the germ line of an animal, that animal should not be bred.¹¹³ Similarly, under the National Institutes of Health Guidelines for Human Embryonic Stem Cell Research¹¹⁴ (NIH Guidelines), the federal government will not fund research involving the breeding of animals in cases where hESCs or hiPSCs may contribute to the germ line.¹¹⁵ This practical solution is far more sensible than shutting down hESC and hiPSC research in animal models.

F. Non-human life forms with human neural tissues

The term ‘human-animal hybrid’ means—

(H) a non-human life form engineered such that it contains a human brain or a brain derived wholly or predominantly from human neural tissues.¹¹⁶

Academic observers believe this final category addresses the human neuron mouse that Irv Weissman once wanted to create.¹¹⁷ Therefore, before analyzing this category, the reader may benefit from some background on that experiment.

111. ESCRO committee review and approval is required when hESCs are introduced into most non-human animals at any stage of development, or into non-human primates at fetal or postnatal stages. *Id.* at 22. Introducing hESCs into non-human primates at the blastocyst stage is prohibited. *Id.* at 23. The NAS Guidelines counsel the ESCRO committee to monitor the integration, differentiation, and effects of the hESCs. *Id.* at 22.

112. *Id.* at 34. The ESCRO committee should monitor the integration, differentiation, and effects of the human pluripotent stem cells. *Id.* at 34–35.

113. *Id.* at 23, 35. The original NAS Guidelines were somewhat stricter, providing that “[n]o animal into which hES cells have been introduced at any stage of development should be allowed to breed.” NAS GUIDELINES 2005, *supra* note 44, at 99.

114. National Institutes of Health Guidelines for Human Stem Cell Research, 74 Fed. Reg. 32,170 (June 30, 2009) [hereinafter NIH Guidelines].

115. *Id.* at 32,175.

116. S. 2358, 110th Cong. § 3 (2007).

117. Greely et al., *supra* note 2, at 30.

Around the turn of the millennium, Stanford professor Irv Weissman proposed two experiments in which he would transplant brain stem cells from aborted human fetuses into the brains of mice.¹¹⁸ In the more dramatic of the two experiments, he planned to transplant the human cells into fetal mice that had been engineered so that their own neurons were doomed to die. He hoped the human cells would migrate into the structures of the murine brains and take the place of the dying neurons. If the mice survived to birth, most of the neurons in their brains would be derived from the human cells.¹¹⁹ In theory, scientists could use these human neuron mice to study how neurons function, observe the effects of pathogens, and test new drugs, all without harming a human test subject.¹²⁰

An ad hoc group of Stanford bioethicists studied the proposed experiments and advised Weissman how to conduct them in an ethical manner.¹²¹ The group was not concerned that the mice might develop human traits such as consciousness; it reasoned that human brain stem cells transplanted into the tiny cranium of a mouse were unlikely to develop into the larger and unique structures that characterize the human brain.¹²² In the end, the matter came to naught: Weissman did not conduct the experiments because he could not find or breed mice with the right sorts of neuronal deficiencies.¹²³

Today, more than a decade later, the NAS Guidelines provide a source of regulation for scientists working in this field. Noting that human neural stem cells may contribute to neural tissue if introduced into animals, the Guidelines suggest that research institutions consider subjecting such experiments to ESCRO committee review.¹²⁴ Other provisions of the Guidelines address the risk that experiments could inadvertently create animals with at least some human neurons. ESCRO committee review and approval is required for experiments that introduce hESCs into animals.¹²⁵ Likewise, ESCRO committee review and approval is required for experiments that introduce human pluripotent stem cells into animals, where there is a significant chance that the human cells could develop into neural cells or tissues.¹²⁶

118. *Id.* at 31.

119. *Id.*

120. *Id.* at 32.

121. *Id.* at 32, 37.

122. *Id.* at 35.

123. *Id.* at 31.

124. NAS GUIDELINES 2010, *supra* note 44, at 35.

125. *Id.* at 22. More specifically, an ESCRO committee should get involved when hESCs are introduced into most animals at any stage of development, or into non-human primates at fetal or postnatal stages. *Id.*

126. *Id.* at 34. This principle applies whether a scientist creates a chimeric embryo or transplants neurons into an existing embryo or postnatal animal. *Id.*

With this background, this Article returns to the 2007 Brownback bill and its final category. Some question whether the language used in the bill bars the creation of the human neuron mouse. A mouse brain is composed primarily of cells other than neurons; thus, even if every neuron in the brain is of human origin, the brain cannot be derived wholly or predominantly from human neural tissues.¹²⁷ Though this argument is clever, it might not prevail. Given the academic consensus that this category aims to ban the human neuron mouse, a court may very well interpret the statutory language to cover any non-human life form with *neurons* that are wholly or predominantly of human origin. The mere prospect of such a ruling could be enough to discourage many scientists from pursuing this line of research. Industry self-regulation would be a better response to the field, given the low odds that experimental animals will develop anything close to human cognition.¹²⁸

Fortunately, this final category of the 2007 Brownback bill does not reach other valuable experiments involving human brain stem cells. For example, in 2013, a research team created chimeric mice by engrafting neonates with human glial¹²⁹ progenitor cells. The purpose of the experiment was to create models for studying the function of human glial cells in a living brain.¹³⁰ The chimeric mice also turned out to have better memories and learning capacity than control mice.¹³¹ The team dissected the chimeric mice and discovered that their brains contained high numbers and proportions of human astrocytes (brain cells that coordinate and modulate the transmission of neural signals).¹³² Even in a murine brain, the human astrocytes kept their

127. Greely et al., *supra* note 2, at 30.

128. For a discussion of the special risks involved in the neural grafting of non-human primates, see *infra* Part II.A.5.

129. Glial cells are the supporting cells of the nervous tissue. Glial cells, unlike neurons, do not conduct electrical impulses. Three types of glial cells exist in the mature central nervous system of the human brain—microglial cells, oligodendrocytes, and astrocytes. Microglial cells are found in the central *and* peripheral nervous system and act primarily to repair neural damage. LODISH ET AL., *supra* note 3, at 1014–15; see also *Glial cell definition*, GENETICS HOME REFERENCE, <http://ghr.nlm.nih.gov/glossary=glialcell> (last visited Mar. 13, 2015). Oligodendrocytes and astrocytes are restricted to the central nervous system (brain and spinal cord). Oligodendrocytes act to lay down a laminated myelin sheath around some axons which affects the speed of action potential conduction along neural pathways. *Oligodendroglia definition*, GENETICS HOME REFERENCE, <http://ghr.nlm.nih.gov/glossary=oligodendroglia> (last visited Jan. 16, 2015). Astrocytes are star shaped glial cells, which coordinate and modulate neural signal transmission by acting to maintain, in a variety of ways, an appropriate chemical and physical environment for neuronal signaling. *Astrocytes definition*, GENETICS HOME REFERENCE, <http://ghr.nlm.nih.gov/glossary=astrocytes> (last visited Jan. 16, 2015).

130. Xiaoning Han et al., *Forebrain Engraftment by Human Glial Progenitor Cells Enhances Synaptic Plasticity and Learning in Adult Mice*, 12 CELL STEM CELL 342, 351–52 (2013).

131. *Id.* at 351.

132. *Id.* at 342, 351.

characteristic shape, size, and complexity.¹³³ However, there is no indication that the “smart mice” were capable of consciousness or human thought processes. In any event, since the cells of human origin in these mice are glia rather than neurons, the experiment falls outside the scope of the 2007 Brownback bill.

The final category also fails to reach experiments in which scientists introduce hESCs or hiPSCs into animals with unexpected results. For example, suppose scientists add hiPSCs to pig embryos in an effort to create DNA-matched pancreases.¹³⁴ If the hiPSCs migrate within the bodies of the pigs and generate some stray human neurons, the scientists would not be guilty of a crime. A life form falls within the final category only if its brain is derived *wholly or predominantly* from human neural tissues. To be sure, research institutions may still be concerned about the inadvertent generation of large numbers of human neurons, but the ESCRO committee review and approval process should allow them to anticipate and avoid such unlikely outcomes without shutting down an entire class of valuable research.

To summarize, the 2007 Brownback bill mounts a blunderbuss attack on a wide variety of real and imaginary scientific experiments. Because it never became law, scientists might think they can breathe a sigh of relief. Unfortunately, the coast is not clear for scientists in Louisiana, Arizona, or other states that may adopt similar legislation in the future.

II. SCIENTIST BEWARE: LAWS IN LOUISIANA, ARIZONA, AND OTHER STATES

When his second term in the U.S. Senate ended in 2010, Sam Brownback left that office and became the Governor of Kansas.¹³⁵ No bills seeking to regulate human-animal hybrids have been introduced in Congress since his departure. Thus, it might seem as if scientists could safely ignore the Brownback bills. However, phoenix-like, the bills have risen from the ashes of Brownback’s Senatorial career in a new form: state legislation.

A. Louisiana

In 2009, Louisiana enacted a law similar to the 2007 Brownback bill. The law prohibits the knowing transfer of a human embryo into a non-human

133. *Id.* at 351.

134. Normile, *supra* note 53, at 1509.

135. See KANSAS OFFICE OF THE GOVERNOR, <https://governor.ks.gov/about-the-office/governor-sam-brownback> (last visited Mar. 13, 2015).

womb or a non-human embryo into a human womb.¹³⁶ The law also prohibits the knowing creation of a human-animal hybrid¹³⁷ and defines the term to include eight categories of prohibited organisms, most of which are quite close to those contained in the 2007 Brownback bill.¹³⁸ Those who violate the Louisiana statute face imprisonment at hard labor for up to ten years, a criminal fine of up to \$10,000, and a civil fine of one million dollars or more.¹³⁹

The Louisiana law impacts five types of useful scientific research. More specifically:

1. The Louisiana law makes it illegal for scientists to introduce non-human cells into a human embryo. Unlike the 2007 Brownback bill, the Louisiana law does not require that the experiment render the embryo's membership in the human species uncertain.¹⁴⁰ A scientist could go to prison for the crime of introducing a *single* non-human cell into a human embryo. Fortunately, scientists generally have no interest in adding non-human ESCs or iPSCs to human embryos.¹⁴¹

Unfortunately, however, the Louisiana law *expands* the original Brownback definition of human-animal hybrid to include the converse: non-human embryos into which human cells or cell components have been introduced.¹⁴² As a result, it prohibits scientists from engaging in certain forms of stem cell research. For example, a researcher could not use hiPSCs to grow human pancreases in pigs as discussed in Part I.A, *supra*.

To be sure, a safe harbor provision allows the xenotransplantation of human cells into animals *other than* animal embryos.¹⁴³ Presumably, this means that scientists can introduce hESCs and hiPSCs into animals while they are fetuses and after they have been born. However, this safe harbor does not offer as much comfort as it should because the law does not define the point in time when an animal embryo becomes a fetus and can be used in such experiments.¹⁴⁴

Advocates of the law might claim it halts riskier experiments involving non-human primates. For example, hESCs introduced into the embryo of a

136. LA. REV. STAT. ANN. §§ 14:89.6.A(2)–(3) (West, Westlaw through 2013 Reg. Sess.).

137. *Id.* § 14:89.6.A(1) (In contrast to the 2007 Brownback bill, this law does not prohibit transportation or receipt of a human-animal hybrid).

138. *Id.* § 14:89.6.D(1).

139. *Id.* §§ 14:89.6.B–C.

140. *Id.* § 14:89.6.D(1)(a).

141. *See supra* Part I.A.

142. LA. REV. STAT. ANN. § 14:89.6.D(1)(a).

143. *Id.* § 14:89.6.E(2).

144. The law defines human embryo to encompass a span of development from one cell to eight weeks. *Id.* § 14:89.6.D(2).

chimpanzee could make a significant (and unpredictable) contribution to the development of the resulting life form.¹⁴⁵ However, the NAS Guidelines already provide that research institutions should not conduct experiments in which hESCs or human pluripotent stem cells are added to non-human primate blastocysts.¹⁴⁶ Likewise, under the NIH Guidelines, the federal government will not fund research in which hESCs or hiPSCs are introduced into non-human primate blastocysts.¹⁴⁷ If the Louisiana State Legislature believed that the NAS and NIH Guidelines did not afford enough protection, it could have enacted a more limited law that prohibited only the introduction of hESCs or hiPSCs into non-human primate blastocysts. It did not need to prohibit the introduction of human cells into *all* non-human embryos regardless of species.

2. The Louisiana law is drafted so broadly that it may prohibit certain forms of transgenic research. For example, suppose a scientist introduces human genes into a non-human embryo in order to create a transgenic model for research. The Louisiana law has a safe harbor provision that allows “[r]esearch involving the use of transgenic animal models containing human genes.”¹⁴⁸ Thus, at first glance, the scientist’s work appears to be permissible. However, the safe harbor applies only if the research does not otherwise violate the law or meet the definition of human-animal hybrid.¹⁴⁹ Louisiana’s first category of human-animal hybrid encompasses “a nonhuman embryo into which a human cell or cells *or the component parts thereof* have been introduced.”¹⁵⁰ If genes inside a human cell qualify as “component parts” of that cell, the scientist has knowingly created a human-animal hybrid in violation of Louisiana law and could go to prison.¹⁵¹

3. The Louisiana law makes it illegal for scientists to introduce a human nucleus into a non-human egg in order to create a cybrid for research.¹⁵² Curiously, scientists are free to clone human embryos using human eggs in Louisiana.¹⁵³

145. NAS GUIDELINES 2005, *supra* note 44, at 41.

146. NAS GUIDELINES 2010, *supra* note 44, at 23, 35.

147. NIH Guidelines, *supra* note 114, at 32175.

148. LA. REV. STAT. ANN § 14:89.6.E(1).

149. *Id.* § 14:89.6.E.

150. *Id.* § 14:89.6.D(1)(a) (emphasis added).

151. *Id.* §§ 14:89.6.A(1), B, D(1)(a).

152. *Id.* §§ 14:89.6.A(1), D(1)(e).

153. Louisiana once forbade all human cloning too, but this law was temporary and expired in 2003 without being renewed. KERRY LYNN MACINTOSH, *ILLEGAL BEINGS: HUMAN CLONES AND THE LAW* 240 n.63 (2005) [hereinafter *MACINTOSH, ILLEGAL BEINGS*]; *see also* LA. REV. STAT. ANN. §§ 40:1299.36–.36.6 (terminated by Acts 1999, No. 788, § 3, eff. July 1, 2003).

4. The Louisiana law could also discourage scientists from conducting other useful experiments. For example, it defines human-animal hybrid to include “a nonhuman life form engineered such that human gametes develop within the body of a nonhuman life form.”¹⁵⁴ Like its predecessor in the 2007 Brownback bill, this category is unclear in its scope due to the ambiguous phrase “such that.” Suppose a scientist wishes to introduce hESCs or hiPSCs into a non-human fetus¹⁵⁵ to observe their migration and function. If the human cells might become human sperm or eggs, the category might apply.¹⁵⁶ A scientist could conclude that experiments of this type are simply too risky to undertake in Louisiana.

5. Finally, the Louisiana law also defines human-animal hybrid to include “a nonhuman life form engineered such that it contains a human brain or a brain derived wholly or predominately from human neural tissues.”¹⁵⁷ As explained in greater detail above,¹⁵⁸ this category holds the potential to chill certain kinds of research. For example, suppose a scientist wants to introduce human brain stem cells into a mouse or other experimental animal in order to form a living model of human neurons. Once she realizes that the Louisiana law was modeled after the 2007 Brownback bill, and that the 2007 Brownback bill was, in turn, aimed at the human neuron mouse, she (or her institutional review board) may conclude that the experiment is too risky to conduct in Louisiana. Such a result would be unfortunate, given the unlikelihood that a mouse or other typical experimental animal could develop human cognition.¹⁵⁹

To be sure, experiments that engraft human cells into the brains of primates may present greater concerns. In 2005, a group of bioethicists warned that a human/non-human primate chimera might exhibit cognitive

154. LA. REV. STAT. ANN § 14:89.6.D(1)(g).

155. An experiment that introduced human cells into a non-human embryo would be prohibited in Louisiana under a different subpart of the human-animal hybrid definition. *Id.* § 14:89.6.D(1)(a).

156. *See supra* Part I.E.

157. LA. REV. STAT. ANN. §14:89.6.D(1)(h).

158. For a discussion of whether the 2007 Brownback bill that served as the model for the Louisiana law reaches the human neuron mouse, *see supra* Part I.F. In addition to the interpretive difficulties outlined there, it should be noted that the meaning of the word “predominately” is also in doubt. The only guidance comes from a witness who testified before the State Legislature that the word “predominately” signifies more than fifty percent. *Hearing on S.B. 115 Before the Senate Committee on the Judiciary C*, 2009 Leg., 35th Reg. Sess. (La. 2009), (May 12, 2009) (statement of Dorinda Bordlee), available at <http://senate.la.gov/JudiciaryC/Archives/2009/video.htm>. She did not specify how much more. *Id.*

159. *See* Greely et al., *supra* note 2, at 35 (discussing the human neuron mouse experiment and concluding that human brain structures were unlikely to emerge in a mouse cranium).

abilities that called its moral status into question.¹⁶⁰ The group identified several factors for research oversight committees to evaluate, including the proportion of human cells involved and the developmental stage, species, brain size, engrafting site, and health of the recipient primate.¹⁶¹ Large numbers of human cells implanted early in development raised the greatest concerns about cognitive effects.¹⁶² The group agreed with the NAS that special review was appropriate for such experiments,¹⁶³ and advised that researchers conducting human-to-primate neural grafting should observe and report alterations in cognitive function.¹⁶⁴

If the Louisiana State Legislature believed that the NAS Guidelines and private monitoring were inadequate to regulate human-to-primate grafting, it could have crafted a narrower law. For example, some of the bioethicists in the aforementioned group argued that scientists should not be allowed to introduce human neural stem cells into the immature brains of our closest evolutionary relatives, the great apes.¹⁶⁵

B. Arizona

In 2010, Arizona enacted a law that prohibits the intentional or knowing transfer of a human embryo into a non-human womb or of a non-human embryo into a human womb.¹⁶⁶ The law also bars the intentional or knowing creation, transportation, or receipt of a human-animal hybrid.¹⁶⁷ In comparison with Louisiana, Arizona disciplines its wayward scientists with a lighter hand: those who violate its law are guilty only of a misdemeanor.¹⁶⁸

The Arizona law has eight categories of human-animal hybrid that closely resemble those found in the 2007 Brownback bill (and its 2009 successor).¹⁶⁹ The first category varies slightly in that a chimeric embryo qualifies as a human-animal hybrid even if its membership in the human species is not in

160. Mark Greene et al., *Moral Issues of Human–Non-Human Primate Neural Grafting*, 309 SCIENCE 385, 385–86 (2005).

161. *Id.* at 386.

162. *Id.*

163. *Id.*; see also NAS GUIDELINES 2010, *supra* note 44, at 35.

164. Greene et al., *supra* note 160, at 386.

165. *Id.*

166. ARIZ. REV. STAT. ANN. §§ 36-2312(B)(2)–(3) (2013).

167. *Id.* §§ 36-2312(B)(1), (4). The same statute also prohibits the intentional or knowing creation of a human embryo through methods other than fertilizing a human egg with a human sperm—a roundabout reference to human cloning. *Id.* § 36-2312(A). A companion statute makes it a felony to knowingly engage in “destructive human embryonic stem cell research”—that is, to derive a hESC line. *Id.* §§ 36-2311(1), 36-2313.

168. *Id.* § 36-2312(D).

169. *Id.* § 36-2311(2).

doubt.¹⁷⁰ Luckily, scientists have no reason to add non-human ESCs or iPSCs to human embryos.¹⁷¹ Even more fortunately, the Arizona State Legislature did not expand the category to include non-human embryos into which human cells or cell components have been introduced. Thus, unlike the Louisiana law, the Arizona law does not threaten the stem cell projects discussed in Part I.A., nor does it place transgenic research at risk.¹⁷²

However, the Arizona law does impact three types of scientific research. More specifically:

1. The Arizona law makes it illegal for scientists to introduce a human nucleus into a non-human egg to make a cybrid.¹⁷³ Nor can they substitute human eggs because all human cloning is forbidden in Arizona.¹⁷⁴ Taken together, these prohibitions deter Arizona scientists from studying cloning and advancing efforts to derive ESC lines matched to the DNA of a specific person.

2. The Arizona law defines human-animal hybrid to include a “nonhuman life form engineered so that human gametes develop within the body of a nonhuman life form.”¹⁷⁵ “So that” is a more careful linguistic choice than “such that” (which appears in the 2007 Brownback bill and the Louisiana law). “So that” expresses purpose and is the equivalent of “in order that.”¹⁷⁶ Thus, a researcher who introduces hESCs or hiPSCs into a non-human embryo or fetus should not be deemed to have created a human-animal hybrid, even if the cells unexpectedly transform themselves into human gametes.

However, this statutory analysis does not obviate all risks. Suppose that a scientist working in Arizona conducts a stem cell experiment that inadvertently produces an animal with human gametes. The media find out and sensationalize the matter, leading to public demands for a crack-down. An ambitious prosecutor charges the scientist with a crime. The trial court interprets the phrase “so that” broadly so that the law covers the experiment. The scientist is convicted and his career ruined. Given risks like these,

170. *Id.* § 36-2311(2)(a).

171. *See supra* Part I.A.

172. Like Louisiana, Arizona expressly permits research involving transgenic animal models or transplants of human cells, tissues, or organs into animals other than embryos; however, this provision does not override the prohibitions in the statute or the definition of human-animal hybrid. ARIZ. REV. STAT. ANN. § 36-2311(2)(e).

173. *Id.* §§ 36-2311(2)(e), 36-2312(B)(1).

174. *Id.* § 36-2312(A).

175. *Id.* § 36-2311(2)(g).

176. “So that” definition, COLLINS ENGLISH DICTIONARY, <http://www.collinsdictionary.com/dictionary/english/so-that?showCookiePolicy=true> (last visited Jan. 16, 2015).

scientists may shun such experiments in Arizona until and unless an appellate court ruling clarifies the meaning of “so that” and narrows this category of human-animal hybrid.

3. The Arizona law also defines human-animal hybrid to include a “nonhuman life form engineered so that it contains a human brain or a brain derived wholly or predominantly from human neural tissues.”¹⁷⁷ As explained in Part I.F., *supra*, this provision endangers any scientist who introduces human brain stem cells into a non-human animal. If a court deems the resulting proportion of human neurons too great, the scientist could be found guilty of creating a human-animal hybrid.¹⁷⁸ Realizing this, scientists in Arizona may veer away from the human neuron mouse and similar research projects.

In sum, the Louisiana and Arizona laws prohibit some research projects and render others too legally risky to conduct. These laws burden not only scientists in these states, but also the entire nation. Although some scientists may leave Louisiana and Arizona for safer laboratories, others may stay where they are for professional or personal reasons. If those who stay are forced to abandon promising lines of work out of fear of legal consequences, important knowledge may be lost, along with potential medical applications.¹⁷⁹

C. Other states

The anti-human-animal-hybrid crusade does not stop with Louisiana and Arizona. Three other state legislatures have considered bills that are similar to the 2007 Brownback bill. In 2010, the Oklahoma House of Representatives passed a comparable human-animal hybrid bill;¹⁸⁰ but the Oklahoma Senate amended the bill and it died in a conference committee.¹⁸¹ The Ohio Senate passed a human-animal hybrid bill in 2010 but the bill did not go far in the

177. ARIZ. REV. STAT. ANN. § 36-2311(2)(h).

178. *Id.* §§ 36-2311(2)(h), 36-2312(B)(1).

179. See JOHN CHARLES KUNICH, THE NAKED CLONE: HOW CLONING BANS THREATEN OUR PERSONAL RIGHTS 101 (2003) (discussing the incalculable losses that result when the law places prior restraints on scientific inquiry).

180. H.B. 3078, 2010 Leg., Reg. Sess. (Okla. 2010).

181. See *Bill Information for HB 3078 (2009-2010)*, OKLAHOMA STATE LEGISLATURE, <http://www.oklegislature.gov/BillInfo.aspx?Bill=HB3078&session=1000> (last visited Mar. 13, 2015).

House.¹⁸² Similar bills failed in 2011,¹⁸³ but the proponents introduced a new bill in the Ohio House in 2013.¹⁸⁴ Also in 2013, a member of the Mississippi House of Representatives introduced a bill that included definitions of human-animal hybrids and prohibitions akin to those in the 2007 Brownback bill, but it died in committee.¹⁸⁵

Based on this recent history, it seems likely that politicians will continue to introduce state legislation modeled after the 2007 Brownback bill and the Louisiana and Arizona laws. Thus, the list of states that prohibit research involving human-animal hybrids may grow over time.¹⁸⁶

Finally, scientists should pay close attention to laws against human cloning, which may inadvertently affect research that blends human and non-human elements. For example, South Dakota does not have a law against human-animal hybrids per se; but it does prohibit human cloning,¹⁸⁷ which it defines this way: “human asexual reproduction accomplished by introducing

182. S.B. 243, 128th Gen. Assemb., Reg. Sess. (Ohio 2010). For the history of the bill, see *Status Report of Legislation*, OHIO STATE LEGISLATURE, <http://lsc.state.oh.us/coderev/sen128.nsf/Senate+Bill+Number/0243?OpenDocument> (last visited Mar. 13, 2015).

183. S.B. 94, 129th Gen. Assemb., Reg. Sess. (Ohio 2011); H.B. 171, 129th Gen. Assemb., Reg. Sess. (Ohio 2011). For the histories of the bills, see *Status Report of Legislation: SB 94*, OHIO STATE LEGISLATURE, <http://lsc.state.oh.us/coderev/sen129.nsf/Senate+Bill+Number/0094?OpenDocument> (last visited Mar. 13, 2015) and *Status Report of Legislation: HB 171*, OHIO STATE LEGISLATURE, <http://lsc.state.oh.us/coderev/hou129.nsf/House+Bill+Number/0171?OpenDocument> (last visited Mar. 13, 2015).

184. H.B. 308, 130th Gen. Assemb., Reg. Sess. (Ohio 2013).

185. H.B. 819, 128th Leg., Reg. Sess. (Miss. 2013); *Mississippi Legislature, 2013 Regular Session*, *House Bill 819*, MISS. LEGISLATURE, <http://billstatus.ls.state.ms.us/2013/pdf/history/HB/HB0819.xml> (last visited Mar. 13, 2015).

186. This conclusion is supported by the legal history of an equally controversial area of research. In 2001 and again in 2003, Representative Dave Weldon introduced bills that would have criminalized all human cloning (Weldon bills). The U.S. House of Representatives passed the bills, but the bills did not become law because the U.S. Senate disagreed: liberal members opposed the cloning of babies but wanted scientists to be able to derive stem cell lines from cloned human embryos. MACINTOSH, *FOUR FALLACIES*, *supra* note 9, at 181. Even though the United States does not have a federal statute that directly addresses human cloning, legislatures in conservative states have boldly gone where Congress feared to go. Today, all human cloning is prohibited in Arizona, Arkansas, Indiana, Oklahoma, Michigan, North Dakota, and South Dakota. *Id.* at 185–86. The Arkansas, Oklahoma, North Dakota and South Dakota laws use language that is similar to that found in the Weldon bills. *Compare* H.R. 2505, 107th Cong. (2001) and H.R. 534, 108th Cong. (2003) *with* ARK. CODE ANN. §§ 20-16-1001-04 (West, Westlaw through 2013 Reg. and First Ex. Sess.); N.D. CENT. CODE ANN. §§ 12.1-39-01, 12.1-39-02 (Westlaw through 2013 Reg. Sess. of the 63rd Legislative Assembly); OKLA. STAT. ANN. tit. 63, § 1-727 (West, Westlaw through Chapter 23 (End) of the First Extraordinary Sess. of the 54th Legislature (2013)); S.D. CODIFIED LAWS §§ 34-14-26, 34-14-27 (2014). These similarities show the impact of the Weldon bills.

187. S.D. CODIFIED LAWS § 34-14-27 (2014).

the nuclear material of a human somatic cell into a fertilized or unfertilized oocyte whose nucleus has been removed or inactivated to produce a living organism, at any stage of development, with a human or predominantly human genetic constitution.”¹⁸⁸ The law defines “oocyte” simply as “the female germ cell, the egg.”¹⁸⁹ Reading these definitions together, a scientist working in South Dakota could unwittingly commit a felony¹⁹⁰ if she inserted human nuclear material into non-human eggs to create cybrids, even if all she wanted to do was conduct basic research or derive stem cells.¹⁹¹

III. POLICY RATIONALES FOR BANNING HUMAN-ANIMAL HYBRIDS

If this onslaught of anti-science legislation is to be turned back, the hidden psychology behind it must be exposed. Before analysis can proceed, however, this Article must consider the rationales that policymakers and legislators have articulated in support of such laws. This Part examines rationales associated with the 2004 report from President’s Council on Bioethics, the 2007 Brownback bill, and the Louisiana and Arizona laws.

A. *President’s Council on Bioethics report*

The 2004 report from the President’s Council on Bioethics inspired Senator Brownback to propose his original bill. The Council demanded the enactment of laws to preserve the boundary between humans and non-humans *in procreation*.¹⁹² The Council’s obsession with that particular boundary reveals much about the psychology behind the Louisiana and Arizona laws, as Part IV of this Article will demonstrate.

B. *The 2007 Brownback bill*

The 2007 Brownback bill includes five findings in support of its provisions.¹⁹³ The 2009 Brownback bill includes the same findings,¹⁹⁴ so, for

188. *Id.* § 34-14-26(1).

189. *Id.* § 34-14-26(5).

190. *Id.* § 34-14-27.

191. North Dakota has a similarly-worded law against human cloning. *See* N.D. CENT. CODE §§ 12.1-39-01, 12.1-39-02 (West, Westlaw through 2013 Reg. Sess. of the 63rd Legislative Assembly). However, its definition of “oocyte” as a “*human* female germ cell” allows cybrid research to slip through the cracks of its ban. *Id.* § 12.1-39-01(5) (emphasis added).

192. REPRODUCTION & RESPONSIBILITY, *supra* note 11, at 220.

193. S. 2358, 110th Cong. § 2 (2007).

194. S. 1435, 111th Cong. § 2 (2009).

brevity's sake, this discussion will focus on the earlier bill. Each finding will be analyzed in turn.

1. Technological advances

The first finding articulates no public policy rationale. Rather, it simply notes that technological advances have made it feasible to create human-animal hybrids.¹⁹⁵

2. Blurring the line between species

The second finding warns that human-animal hybrids raise ethical problems because they “blur the lines between human and animal, male and female, parent and child, and one individual and another individual.”¹⁹⁶ The finding does not explain what these lines are, or how experiments blur them, and legislative history sheds a dim light at best.

On the floor of the Senate, Senator Brownback stated that it was acceptable to provide a human patient with a pig heart valve transplant, or to create a mouse with a human immune system for the purpose of testing drugs for AIDs patients.¹⁹⁷ In other words, he did not object to the commingling of human and animal tissues or cells *per se*. Only the “creatures” described in his bill were unacceptable because they blurred the line between species.¹⁹⁸

Perhaps these remarks refer to a *genetic* line that distinguishes the human species from all others. However, such a bright line does not exist. No single genome (or element within the genome) characterizes all human beings; each of us has a distinct genome.¹⁹⁹ Moreover, much of the DNA found in human beings is also found in members of other species.²⁰⁰

Alternatively, perhaps the remarks refer to a *procreative* line between species. According to the biological species concept, a species can be defined in terms of procreative engagement or isolation.²⁰¹ For example, cats are a species because cats mate with other cats and generate kittens; cats and dogs do not mate and, therefore, must be separate species.

195. S. 2358, 110th Cong. § 2(1) (2007).

196. *Id.* § 2(2).

197. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007).

198. *Id.* Co-sponsor Senator Mary Landrieu (D-La) also complained about human-animal hybrids that blur species lines. *Id.* at 14491.

199. Jason Scott Robert & Françoise Baylis, *Crossing Species Boundaries*, 3 AM. J. BIOETHICS, no. 3, 2003, at 1, 4.

200. *Id.*

201. *Id.* at 3.

The biological species concept has been criticized as scientifically inaccurate; specifically, it fails to address asexual species and falsely suggests that human groups can be identified as independent species based on their reproductive insularity.²⁰² But even if the biological species concept is inaccurate, the 2007 Brownback bill did arise out of a Council report that stressed the importance of maintaining a boundary between humans and non-humans in procreation.²⁰³ Thus, the second finding may indeed rest on the notion that there is a procreative line between species that must not be transgressed. However, that line will turn out to be more psychological than biological in character, as Part IV will explain.

3. Undermining human dignity

The third finding states that human-animal hybrids threaten respect for “human dignity and the integrity of the human species.”²⁰⁴ Although human dignity is a vague concept, its association with the integrity of the human species gives it a bit more specificity. One dictionary meaning of the noun “integrity” is “the quality or state of being unimpaired; perfect condition; soundness.”²⁰⁵ Thus, the third finding associates human dignity with a human species that is unimpaired, perfect, and sound. However, this conception of our species is biologically inaccurate. Species are not static; they change and evolve over time.²⁰⁶

Senator Brownback’s remarks on the floor of the Senate appear to be related to the third finding: “The reason to oppose the creation of human-animal hybrids is that the creation of such entities is a grave violation of human dignity and a defilement of the human person.”²⁰⁷ “Defile” means “to make filthy; dirty; pollute.”²⁰⁸ In context, the word links human-animal hybrids with contamination of an otherwise pure human species. Like the third finding, this rhetoric does not make biological sense. The human species

202. *Id.*

203. REPRODUCTION & RESPONSIBILITY, *supra* note 11, at 220.

204. S. 2358, 110th Cong. § 2(3) (2007).

205. WEBSTER’S NEW WORLD DICTIONARY OF THE AMERICAN LANGUAGE 759 (College ed. 1968).

206. SUSAN A. GELMAN, THE ESSENTIAL CHILD: ORIGINS OF ESSENTIALISM IN EVERYDAY THOUGHT 299–300 (2003).

207. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007). In her remarks, Senator Landrieu also claimed human-animal hybrids violate human dignity. *Id.* at 14491.

208. WEBSTER’S NEW WORLD DICTIONARY OF THE AMERICAN LANGUAGE 385 (College ed. 1968).

does not stand apart from all other species on Earth; it shares DNA with non-human species.²⁰⁹

Though false in a biological sense, the idea of a human species that is perfect, sound, and/or pure is interesting in a psychological sense; it suggests that we *perceive* the human species as having boundaries that ambiguous creatures transgress. This point will be developed in Part IV, *supra*.

Thus far, the analysis has focused on human dignity as it relates to the human *species*. However, in his comments on the Senate floor, Senator Brownback also addressed the dignity of the human *individual*:

Human beings have a fundamental right to be born fully human. To create a human-animal hybrid whose identity as a member of the species *Homo sapiens* is in doubt is a violation of that human dignity and a grave injustice.

Think about this for a minute. What if—beyond your control—some mad scientist were to have created you as only 80-percent human or 50-percent human? That would not be fair to you, but it would be something that you could not change and it would be something that you would have to live with for the whole of your existence on earth.²¹⁰

This rhetoric does not explain why there is a fundamental right to be born fully human, or why it would be unfair to give a person a significant proportion of non-human genes or cells. However, the rhetoric clearly implies that a person who is less than fully human is thereby diminished. Part IV, *infra*, explores the psychological basis for this perception.

4. Uniqueness

In the 2007 Brownback bill, the last two categories of prohibited human-animal hybrid are the non-human life form with human gametes and the non-human life form with a human brain or neural tissue. The fourth finding appears related to these categories; it states that “the uniqueness of individual human beings is manifested in a particular way through their brain and their reproductive organs/cells.”²¹¹ In other words, the 2007 Brownback bill seeks to limit human brains and human gametes to human beings because those body parts are associated with individuality. Moreover, psychologists have discovered that research subjects associate individuality with human nature;

209. Robert & Baylis, *supra* note 199, at 4.

210. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007).

211. S. 2358, 110th Cong. § 2(4) (2007). In her remarks, Senator Landrieu also suggested that human-animal hybrids impair the uniqueness of humans. 153 CONG. REC. S14,491 (daily ed. Nov. 15, 2007).

that is, individuality goes to the core (essence) of what we are.²¹² Thus, it follows that human brains and human gametes are associated with human nature and human essence. The implications of that association are taken up in Part IV, *infra*.

5. Zoonotic infections

Finally, the fifth finding raises the risk of zoonotic infections; it claims human-animal hybrids involve genetic transfers that might heighten the efficiency or virulence of disease.²¹³ However, as a law intended to curb zoonotic infections, the 2007 Brownback bill is under-inclusive. For example, it does not prohibit the transplantation of organs from animals to humans, despite the potential for disease transmission.²¹⁴ Indeed, as previously noted, Senator Brownback approves of such transplants.²¹⁵ Given this under-inclusiveness, it seems unlikely that public health is the primary motivation behind the bill. More likely, the bill is based on the concerns articulated in the second, third, and fourth findings.

C. State legislative history

The Louisiana and Arizona laws are similar on their faces to the 2007 and 2009 Brownback bills. Louisiana patterned its law after the 2007 Brownback bill²¹⁶ while Arizona appears to have been influenced by the 2009 Brownback

212. MACINTOSH, *FOUR FALLACIES*, *supra* note 9, at 107.

213. S. 2358, 110th Cong. § 2(5) (2007).

214. While there is no definitive evidence that xenotransplantation transmits infectious agents leading to disease, there is data providing a reasonable basis for caution. U.S. DEP'T HEALTH & HUMAN SERVS., *PHS GUIDELINE ON INFECTIOUS DISEASE ISSUES IN XENOTRANSPLANTATION* (2001), *available at* <http://www.fda.gov/biologicsbloodvaccines/guidancecomplianceregulatoryinformation/guidances/xenotransplantation/ucm074727.htm>. Xenotransplantation has the potential to transmit an infectious agent (such as a virus) from animals to humans. *Id.* Retroviruses are the chief concern, because such viruses are sometimes capable of moving from one species to another. *Id.*

215. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007).

216. A witness testified before a Louisiana State Senate committee that the Louisiana law was necessary due to the failure of the 2007 Brownback bill and a companion bill that Representative Chris Smith introduced in the U.S. House of Representatives in 2008. *Hearing on S.B. 115 Before the Senate Committee on the Judiciary C*, 2009 Leg., Reg. Sess. 35 (La. 2009), (May 12, 2009), *available at* <http://senate.la.gov/JudiciaryC/Archives/2009/video.htm> (statement of Rob Tasman).

The 2009 Brownback bill probably came too late to inspire the Louisiana law. Senator Brownback introduced it in the U.S. Congress on July 9, 2009. S. 1435, 111th Cong. (2009). The Louisiana law was signed by the Governor earlier, on June 19, 2009. *See* SB 115, 2009 Leg., Reg. Sess. (La. 2009), *available at*

bill.²¹⁷ Therefore, one can infer that the rationales for enacting the Louisiana and Arizona laws are likely the same as those proffered in support of the 2007 Brownback bill and its 2009 successor. An exploration of the limited legislative history available reinforces this conclusion.

1. Louisiana

After the 2007 Brownback bill failed to become law, Louisiana State Senator Daniel Martiny introduced a similar bill at the request of the Louisiana Conference of Catholic Bishops (LCCB).²¹⁸ Three witnesses testified in support of the bill before a Senate committee. Rob Tasman, who represented the LCCB, touched upon several concerns that Senator Brownback had first raised in the U.S. Senate. Specifically, Tasman objected to human-animal hybrid research because it created unnatural species, blurred lines between human and animal, and violated human dignity.²¹⁹

Along with Dorinda Bordlee of the Bioethics Defense Fund,²²⁰ Tasman emphasized that the bill was necessary because human-animal hybrid research was real and ongoing. As an example, they cited the United Kingdom,²²¹ where legislation permits scientists to create cybrids for research purposes when licensed to do so.²²² Dr. W. Krotoski, who represented a pro-

<http://www.legis.la.gov/Legis/BillInfo.aspx?s=09RS&b=SB115&sbi=y> (setting forth history of the Louisiana law).

217. In Arizona, a fact sheet stated that the U.S. Senate had introduced but not acted on the Human-Animal Hybrid Prohibition Act of 2009. The fact sheet also noted that Louisiana had passed a bill prohibiting human-animal hybrids. SENATE RESEARCH, FINAL AMENDED FACT SHEET FOR S.B. 1307, 49th Leg., Second Reg. Sess. (Ariz. 2010), available at http://www.azleg.gov/FormatDocument.asp?inDoc=/legtext/49leg/2r/summary/s.1307pshs_ase.nacted.doc.htm&Session_ID=93.

218. *Hearing on S.B. 115 Before the Senate Committee on the Judiciary C*, 2009 Leg., Reg. Sess. 35 (La. 2009), (May 12, 2009), available at <http://senate.la.gov/JudiciaryC/Archives/2009/video.htm> (statement of Daniel Martiny).

219. *Id.* (statement of Rob Tasman).

220. The Bioethics Defense Fund is “a public-interest law firm whose mission is to advocate for the human right to life via litigation, legislation and public education.” *BDF Mission and Biographies*, BIOETHICS DEF. FUND, <http://www.bdfund.org/about> (last visited Mar. 13, 2015). It addresses various bioethical issues, including human cloning and destructive human embryo research. *Id.*

221. *Hearing on S.B. 115 Before the S. Comm. on the Judiciary C*, 2009 Leg., Reg. Sess. 35 (La. 2009), available at <http://senate.la.gov/JudiciaryC/Archives/2009/video.htm> (May 12, 2009, statement of Dorinda Bordlee).

222. BONNICKSEN, *supra* note 4, at 90; Human Fertilisation and Embryology Act, 2008, c. 22, §§ 4A(2)(b), sch. 2 (U.K.). In the United Kingdom, a license cannot authorize a scientist to place the cybrid in an animal. *Id.* at § 4A(4). Transfer of a cybrid to a woman is also prohibited. *Id.* at § 4A(1)(a).

life group known as The Hippocratic Resource,²²³ claimed that the creation of human-animal hybrids would spread diseases from animals to humans.²²⁴

The bill produced little debate on the floor of the Louisiana State House of Representatives and Senate.²²⁵ In an attempt to ensure that ongoing research in the state would not be affected, legislators added the safe harbor provisions authorizing transgenic animal models and the transplant of human organs, tissues, or cells into animals other than embryos.²²⁶ The bill passed in both chambers without any negative votes.²²⁷

2. Arizona

The Arizona law originated in a bill designed to curtail four practices deemed offensive to human dignity: human cloning, the sale of human embryos, the creation of human-animal hybrids, and the destruction of human embryos in research.²²⁸ This complicated bill faced opposition, but eventually passed in the Arizona State House of Representatives and Senate.²²⁹

223. As part of its pro-life agenda, Hippocratic Resource serves “as a resource of accurate, current and truthful biologic and medical knowledge regarding life issues for our community leaders, state and federal legislators, members of the judiciary, and the media.” HIPPOCRATIC RES., <http://www.lahealthprofs4life.org/> (last visited Mar. 13, 2015).

224. *Hearing on S.B. 115 Before the S. Comm. on the Judiciary C*, 2009 Leg., Reg. Sess. 35 (La. 2009), available at <http://senate.la.gov/JudiciaryC/Archives/2009/video.htm> (May 12, 2009, statement of Dr. W. Krotoski).

225. S. Chamber, 2009 Leg., Reg. Sess. 35 (La. 2009), available at <http://senate.la.gov/video/2009/june.htm#15> (June 15, 2009); House Chamber, 2009 Leg., Reg. Sess. 35, (La. 2009), available at http://house.louisiana.gov/H_Video/2009/Jun2009.htm (June 10, 2009); S. Chamber, 2009 Leg., Reg. Sess. 35 (La. 2009), available at <http://senate.la.gov/video/2009/May.htm#18> (May 18, 2009).

226. S. Journal, 2009 Leg., Reg. Sess. 35, at 21–22 (La.2009), available at <http://senate.la.gov/sessioninfo/2009/rs/journals/Default.htm> (June 15, 2009, Senate concurs in House amendments); S. Chamber, 2009 Leg., Reg. Sess. 35 (La. 2009), available at <http://senate.la.gov/video/2009/june.htm#15> (June 15, 2009, Daniel Martiny explains purpose of House amendments).

227. S. Journal, 2009 Leg., Reg. Sess. 35, at 21–22 (La. 2009), available at <http://senate.la.gov/sessioninfo/2009/rs/journals/Default.htm> (June 15, 2009, Senate concurs in House amendments); H. Journal, 2009 Leg., Reg. Sess. 35, at 26–27 (La. 2009), available at http://house.louisiana.gov/H_Journals/H_Journals_All/2009RSJournals/2009_RSJournals.htm (June 10, 2009, final passage of bill); S. Journal, 2009 Leg., Reg. Sess. 35, at 16 (La. 2009), available at <http://senate.la.gov/sessioninfo/2009/rs/journals/Default.htm> (May 18, 2009, final passage of bill).

228. *Hearing on S.B. 1307 Before the House Committee on Health and Human Services*, 49th Leg., 2d Reg. Sess. (Ariz. 2010), available at http://azleg.granicus.com/MediaPlayer.php?view_id=13&clip_id=7287 (Mar. 31, 2010, statement of Nikolas Nikas).

229. SENATE RESEARCH, FINAL AMENDED FACT SHEET FOR S.B. 1307, 49th Leg., 2d Reg. Sess. (Ariz. 2010), available at

Much of the legislative history addressed topics other than human-animal hybrids. However, some relevant comments were made during legislative committee meetings. For example, Senator Linda Gray, who supported the bill, asserted in one meeting that making human-animal hybrids violated the respect and protection that human life deserved.²³⁰ Her assertion is similar to the claim that human-animal hybrids violate human dignity.

In another committee meeting, Representative Ed Ableser, who opposed the bill, asked whether the bill aimed to prevent *The Island of Dr. Moreau*²³¹ from becoming a reality.²³² Nikolas Nikas of the Bioethics Defense Fund responded by discussing research in the United Kingdom. Describing cybrids as ninety-nine percent human and one percent animal, he worried aloud over what would happen if scientists started down the path of creating human embryos with greater proportions of animal cells. At some point, he opined, a human embryo with animal cells might no longer be human; conversely, an animal embryo with human cells might have human rights.²³³ This testimony resonates with Senator Brownback's claim that an individual created to be only part human would suffer a blow to his or her human dignity.²³⁴

In a different committee meeting, Representative Nancy Barto warned that scientists had already created cybrids in the United Kingdom. In her view, that research "raised concerns over human rights and dignity and the integrity of the human species."²³⁵ Her remarks echo the third finding in the 2007 Brownback bill.

http://www.azleg.gov/FormatDocument.asp?inDoc=/legtext/49leg/2r/summary/s.1307pshs_ase.nacted.doc.htm&Session_ID=93 (reporting a 35-24-1-0 vote in the State House of Representatives and a 16-12-2-0 vote in the State Senate).

230. *Hearing on S.B. 1307 Before the Senate Committee on Public Safety and Human Services*, 49th Leg., 2d Reg. Sess. (Ariz. 2010), available at http://azleg.granicus.com/MediaPlayer.php?view_id=13&clip_id=6784 (February 17, 2010).

231. In the novel, Dr. Moreau, a scientist skilled in the art of vivisection, lives on an island with animals he has humanized. The book is somewhat vague about his methods, but certainly they include surgery, tissue transplants, and hypnotism. H.G. WELLS, *THE ISLAND OF DR. MOREAU* (1896), reprinted in H.G. WELLS, *SIX NOVELS* 59, 102-04 (2012). Consistent with essentialism, however, the true nature of each creature tends to reemerge despite all his efforts. *Id.* at 107. Dr. Moreau is killed by one of his creations, a puma he tried to humanize in vain. *Id.* at 126.

232. *Hearing on S.B. 1307 Before the House Committee on Health and Human Services*, 49th Leg., 2d Reg. Sess. (Ariz. 2010), available at http://azleg.granicus.com/MediaPlayer.php?view_id=13&clip_id=7287 (Mar. 31, 2010).

233. *Id.* (statement of Nikolas Nikas).

234. See *infra* note 313 for further comments on Nikas' testimony.

235. *Hearing on S.B. 1307 Before the H. Comm. of the Whole*, 49th Leg., 2d Reg. Sess. (Ariz. 2010), available at http://azleg.granicus.com/MediaPlayer.php?view_id=13&clip_id=7659 (April 28, 2010).

In sum, an investigation of the legislative history of the Louisiana and Arizona laws yields the following rationales: human-animal hybrid research blurs lines between species; human-animal hybrid research threatens human dignity and the integrity of the human species; and human-animal hybrid research raises the specter of zoonotic infection. These rationales are consistent with the legislative findings and history of the 2007 and 2009 Brownback bills. However, the legislative history does not explain how the research imposes these harms, or, in the case of zoonotic infection, why the threat is more urgent than that posed by organ transplants. To grasp the true meaning of the state laws, one must dig deeper to expose the psychological roots of the political rhetoric.

IV. PSYCHOLOGICAL ESSENTIALISM AND THE LAW

Psychological essentialism is a heuristic²³⁶ that helps human beings make sense of living kinds (that is, animal and plant categories) we encounter in the world.²³⁷ This mental shortcut also affects perceptions of individuals, including human beings.²³⁸

This Part begins with a brief discussion of ways in which human beings use essentialism to evaluate living kinds and individuals. From there, this Part analyzes the Louisiana and Arizona laws to show that their provisions and rationales are more consistent with essentialism than scientific fact. In other words, essentialism is the likely but unacknowledged culprit behind the enactment of these laws.

A. *Living kinds*

Psychological essentialism refers to the intuition that a living kind has a hidden nature or essence that causes members to have the traits of their kind.²³⁹ Essentialism facilitates induction.²⁴⁰ If a person observes traits that link a creature to a kind and its essence, she can infer additional traits that she

236. MACINTOSH, *FOUR FALLACIES*, *supra* note 9, at 64. It is important to distinguish psychological essentialism from philosophical essentialism. The latter theorizes that a thing has a true nature or essence. That theory cannot be correct, because the supposedly “true” essence of a thing depends on how we describe the thing. But even if philosophical essences are not real, people might act like they are—and that is why psychological essentialism matters. Douglas Medin & Andrew Ortony, *Psychological Essentialism*, in *SIMILARITY AND ANALOGICAL REASONING* 179, 183 (Stella Vosniadou & Andrew Ortony eds., 1989).

237. MACINTOSH, *FOUR FALLACIES*, *supra* note 9, at 69–70.

238. *Id.* at 126–30.

239. Medin & Ortony, *supra* note 236, at 183–86.

240. GELMAN, *supra* note 206, at 27, 58–59.

cannot observe directly.²⁴¹ For example, suppose you see a quadruped with a triangular face, whiskers, and a long tail. Those traits might link the quadruped to cat-kind in your mind, allowing you to infer that it is independent and likes to hunt mice. Now, suppose you see a stuffed animal of the same general size and appearance. You would not expect it to be an independent-minded hunter because it lacks cat essence. Thus, psychological essentialism has more explanatory power than simple forms of categorization that lump things together if they look alike.²⁴²

Psychological essentialism has other important aspects. For example, there is a certain mystery to essence. We associate it with insides rather than outward appearances.²⁴³ Parents who possess this unseen element have the power to transmit it to their offspring.²⁴⁴ Once acquired, essence is enduring: creatures retain the essence of their kind even as they pass through developmental stages that cause their appearance to change.²⁴⁵

Further, a creature that bears the essence of its kind belongs to that kind, even if it possesses atypical traits. The classic example is the penguin, which is a bird even though it cannot fly.²⁴⁶ However, we also treat living kinds as having relatively strict boundaries, and are prone to assign creatures (or even people) to one category or another.²⁴⁷

Psychological essentialism is not consistent with modern biology,²⁴⁸ but still functions as a heuristic that allows us to render quick judgments. It can do that job no matter what the essence is, and even if there is no such thing as essence.²⁴⁹

241. MACINTOSH, FOUR FALLACIES, *supra* note 9, at 65; Medin & Ortony, *supra* note 236, at 186.

242. MACINTOSH, FOUR FALLACIES, *supra* note 9, at 72.

243. GELMAN, *supra* note 206, at 75–83.

244. *Id.* at 89–95.

245. *Id.* at 64–66.

246. *Id.* at 69–70.

247. *Id.* at 67–73. Professor Gelman offers the “one-drop rule” as an example of the human tendency to view boundaries as stricter than they truly are. This notorious legal principle classified a human being of mixed ancestry as black rather than white if he had even a single African ancestor. *Id.* at 68.

248. Some might locate a true cat essence in what they imagine to be the genes of the cat species. However, that belief is wrong for two reasons. First, in essentialism, every member of a living kind possesses the kind essence. By contrast, in modern biology, species classifications describe entire populations rather than individuals. No one cat possesses the traits or genes of its entire species. Second, in essentialism, the essence of a living kind is constant. In modern biology, species evolve and change. Macintosh, *Human Embryonic Stem Cell Research*, *supra* note 32, at 236 n.45.

249. Medin & Ortony, *supra* note 236, at 184–85.

B. *Individuals*

Classic psychological essentialism deals with the essences of kinds. However, we humans sometimes act as if individuals also have their own *unique* essences.²⁵⁰

Consider the experiences of organ transplant recipients. It is not uncommon for a recipient of a heart, or lungs, or kidney to feel as if she has taken on the traits, acquired tastes, and even the memories of her donor (who is typically deceased).²⁵¹ Such reactions are consistent with the intuition that the donor had an individual essence. After the donor's death, his essence continues in his organ despite massive physical transformation (the transplant into the recipient).²⁵² Moreover, like a kind essence, the donor's individual essence is causal: it is the source of the traits, tastes, and memories that the recipient acquires along with the organ.²⁵³

Because these reactions are the product of a heuristic, rather than logical deduction, the recipient of the organ need not consciously reason in terms of essence. If she thinks about the matter at all, she may characterize the donor's essence as a spirit that has come to inhabit her body,²⁵⁴ along with her own. Thus, the recipient is in the curious position of possessing two individual essences: her own, and that of the donor.

C. *Offensive embryos*

Armed with this background, this Article now turns to its central task: explaining how psychological essentialism provides a coherent account of the Louisiana and Arizona laws. With so many prohibitions and categories of human-animal hybrid involved, it is important to organize the analysis as efficiently as possible. Towards that end, this Article breaks the statutory provisions into two groups: those that address embryos, and those that address life forms.

This Part IV.C discusses statutory provisions related to embryos. Analysis will begin with the two practices the President's Council on Bioethics originally asked Congress to ban: the creation of human-animal hybrid embryos and inter-species embryo transfers.²⁵⁵

250. GELMAN, *supra* note 206, at 126.

251. MACINTOSH, FOUR FALLACIES, *supra* note 9, at 128–29.

252. *Id.* at 129.

253. *Id.*

254. *Id.*

255. REPRODUCTION & RESPONSIBILITY, *supra* note 11, at 220–21.

1. Hybrid embryos

In Louisiana and Arizona, scientists cannot create human-animal hybrids by fertilizing a human egg with a non-human spermatozoon or a non-human egg with a human spermatozoon.²⁵⁶ Nor can scientists engineer equivalent hybrids by joining haploid chromosomes taken from a human with haploid chromosomes taken from a non-human.²⁵⁷

As Parts I.B. and I.D explained, such human-animal hybrid embryos would be chromosomally abnormal, useless in stem cell research, and unviable.²⁵⁸ Thus, it is hard to justify a ban on the creation of such embryos on scientific grounds. However, human-animal hybrid embryos are psychologically troubling because they violate two principles of essentialism.

Procreation and kind boundaries: parents transmit essence to offspring.²⁵⁹ In common experience, two individuals possessing the essence of the same kind mate with each other and transmit the kind essence to their offspring. For example, a female cat mates with a male cat. She conceives, gestates, and gives birth to kittens with essence of cat.²⁶⁰ All procreative acts occur within kind boundaries.

Contrast this example with Mark Twain's hypothetical cross between a man and a cat. Suppose a scientist fertilizes a cat egg with human sperm. This inter-species conception is a procreative act, even though it takes place in a lab. However, the act crosses kind boundaries. It provokes an instinctive opposition because it runs counter to essentialist expectations. If a scientist engineers conception by combining haploid chromosomes from a man and cat, the same conclusion holds.

When the President's Council on Bioethics demanded a ban on human-animal hybrids, it spoke of the need to preserve a boundary between humans and non-humans in procreation.²⁶¹ Similarly, the 2007 Brownback bill aimed to halt scientific research that blurred the line between species.²⁶² Later, a witness who testified in support of the Louisiana law warned that human-animal hybrids blurred lines between human and animal.²⁶³ This continuing emphasis upon the importance of boundaries between humans and non-

256. ARIZ. REV. STAT. ANN. §§ 36-2311(2)(b)–(c), 36-2312(B)(1) (2013); LA. REV. STAT. ANN. §§ 14:89.6(A)(1), 14:89.6(D)(1)(b)–(c) (West, Westlaw through 2013 Reg. Sess.).

257. ARIZ. REV. STAT. ANN. §§ 36-2311(2)(f), 36-2312(B)(1) (2013); LA. REV. STAT. ANN. §§ 14:89.6(A)(1), 14:89.6(D)(1)(f) (West, Westlaw through 2013 Reg. Sess.).

258. See *supra* text accompanying notes 65–72, 100.

259. GELMAN, *supra* note 206, at 89–95.

260. Jussi Niemelä, *What Puts the 'Yuck' in the Yuck Factor?*, 25 *BIOETHICS* 267, 273 (2011).

261. REPRODUCTION & RESPONSIBILITY, *supra* note 11, at 220–21.

262. S. 2358, 110th Cong. § 2(2) (2007); see 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (Senator Brownback commenting on the need to avoid blurring lines between species).

263. *Supra* text accompanying note 219.

humans is consistent with a subconscious essentialist belief that procreative acts should occur only within kinds.

Existence and kind boundaries: Returning to the hypothetical cross between man and cat, since parents transmit essence to offspring, a hybrid human-cat embryo must possess human and cat essence in equal measure. However, as discussed above, essentialism posits that living kinds are marked by strict boundaries; something either belongs to a kind or not.²⁶⁴ An embryo that possesses both human essence and cat essence violates that principle: it *might* belong to the human kind, or cat kind, or perhaps both but only in part. Thus, its very existence challenges the lines we subconsciously draw around the human kind and cat kind.

To be sure, not all entities bearing dual essences are anathema. For example, Senator Brownback expressly approved transplants of pig heart valves to human beings who needed them.²⁶⁵ But the true hybrid proscribed in Louisiana and Arizona differs from this example. If a man accepts a heart valve from a pig, he may be considered to gain some small measure of pig essence along with the organ,²⁶⁶ however, the proportion of non-human essence is smaller overall than in the case of the hybrid human-cat embryo, where the split is fifty-fifty.

Similarly, an essentialist can accept hybrids that occur in nature, such as the mule.²⁶⁷ However, a mule is a familiar animal that has existed as a part of human culture for thousands of years.²⁶⁸ Moreover, it is a blend of two animals that are relatively similar in appearance (the horse and the donkey) and thus may intuitively seem to harbor two similar essences. It is a much bigger stretch for the essentialist to accept an unfamiliar blend of disparate species, such as the human-cat embryo in the hypothetical.

Historical evidence reinforces the conclusion that essentialism helped to inspire the Louisiana and Arizona laws. Legislative history indicates that both laws were deemed necessary to protect human dignity.²⁶⁹ Moreover, in Arizona, a legislator echoed the 2007 Brownback bill²⁷⁰ in linking human dignity to the integrity of the human species.²⁷¹ As discussed above, the word “integrity” implies that the human species is perfect and needs to be protected

264. GELMAN, *supra* note 206, at 73.

265. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (statement of Sen. Brownback).

266. For an account of organ transplants and essence transfer, see *supra* Part IV.B.

267. GELMAN, *supra* note 206, at 67, 70.

268. *History of the Mule*, AM. MULE MUSEUM, http://mulemuseum.org/History_of_the_Mule.html (last visited Mar. 13, 2015).

269. *Supra* Part III.C.

270. S. 2358, 110th Cong. § 2(3) (2007).

271. *Supra* text accompanying note 235.

against defilement by other species.²⁷² Although biologically questionable, this belief in species integrity is consistent with the essentialist faith in strict boundaries. Human-animal hybrid embryos may very well threaten the “integrity” of the human species in the sense that they blur kind boundaries.

Further, human dignity can refer to an individual as well as a species. Recall that Senator Brownback declared it unfair to create a being who was only eighty or fifty percent human.²⁷³ As he saw it, the problem with such an embryo was that its identity as a member of the human species was in doubt.²⁷⁴ Viewed through an essentialist lens, his objection to such an embryo is that its membership within the human *kind* is in doubt. Applying this intuition to the hypothetical, a hybrid human-cat embryo lacks human dignity because only fifty percent of its essence is human.

2. Embryos in the wrong uterus

Louisiana and Arizona make it a crime to knowingly transfer a human embryo into a non-human uterus, or a non-human embryo into a human uterus.²⁷⁵ Part I established that scientists are not conducting such experiments.²⁷⁶ Nevertheless, since some may fear the mad scientist, consider a variation on the hypothetical cross between man and cat.

Suppose a researcher transfers a human embryo into the uterus of a surrogate mother cat. As Part I.E explained, a human embryo transferred into a cat uterus will almost certainly die for immunological reasons.²⁷⁷ Thus, there is no scientific reason to believe that legislators must act now to stop cats from giving birth to babies.

To be sure, those who consider the human embryo to be the moral equivalent of a born person²⁷⁸ could find the transfer of a human embryo to a surrogate cat mother objectionable on that ground alone. But even though most people do not feel solicitude for cat embryos, Louisiana and Arizona also prohibit the transfer of a cat embryo into a human uterus. Thus, solicitude for human embryos cannot entirely justify these laws; the answer must lie elsewhere.

272. *Supra* Part III.B.

273. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (statement of Sen. Brownback).

274. *Id.*

275. ARIZ. REV. STAT. ANN. § 36-2312(B)(2)–(3) (2013); LA. REV. STAT. ANN. § 14:89.6(A)(2)–(3) (West, Westlaw through 2013 Reg. Sess.).

276. *Supra* text accompanying notes 32–34.

277. *Supra* text accompanying note 109.

278. For example, the Roman Catholic Church teaches that the human being deserves respect from the moment of conception. Macintosh, *Human Embryonic Stem Cell Research*, *supra* note 32, at 239–240.

Intuition holds that parents transmit essence to offspring. We expect cats to gestate and give birth to kittens, and humans to gestate and give birth to humans. If a scientist transfers a human embryo to the uterus of a surrogate mother cat, he engineers a procreative act that transgresses kind boundaries. Moreover, this experiment complicates the essence of the embryo. At first, the man and woman who conceived the embryo transmit human essence; subsequently, the surrogate mother cat that incubates the embryo transmits cat essence (at least as long as gestation continues). Even if the embryo is incapable of completing its development in the feline womb, it carries human and cat essence for some period of time. Thus, the existence of the ambiguous embryo also challenges kind boundaries.

3. Cloned embryos

The Louisiana and Arizona laws do not stop with the prohibitions that the Council demanded. Like the 2007 Brownback bill, the laws prohibit the creation of other embryos via technological means.²⁷⁹ For example, suppose a scientist fuses a human cell to a cat egg and stimulates the product so that it commences cell division. This human-cat cybrid has human nuclear DNA (from the cell) and feline mitochondrial DNA (from the egg). Louisiana and Arizona laws class this organism as a human-animal hybrid.²⁸⁰ If the scientist flips the experiment around, and introduces the nucleus of a cat cell into a human egg, the resulting organism is also classed as a human-animal hybrid.²⁸¹ Both types of inter-species cloned embryos are forbidden.²⁸²

As Part I.C explained, researchers who engage in such experiments do so in order to learn what they can about stem cells.²⁸³ However, even if a renegade scientist chose for some inscrutable reason to transfer inter-species cloned embryos to surrogate mothers, the results would be anti-climactic. Cybrids have inherent biological flaws that would prevent them from coming to term.²⁸⁴ Thus, when looking for a justification for the prohibitions in the Louisiana and Arizona laws, one must look beyond science, and consider psychological essentialism.

279. ARIZ. REV. STAT. ANN. § 36-2312(B)(1) (2013); LA. REV. STAT. ANN. § 14:89.6(A)(1) (West, Westlaw through 2013 Reg. Sess.).

280. ARIZ. REV. STAT. ANN. § 36-2311(2)(e); LA. REV. STAT. ANN. § 14:89.6(D)(1)(e).

281. ARIZ. REV. STAT. ANN. § 36-2311(2)(e); LA. REV. STAT. ANN. § 14:89.6(D)(1)(e).

282. ARIZ. REV. STAT. ANN. § 36-2312(B)(1); LA. REV. STAT. ANN. § 14:89.6(A)(1).

283. *Supra* text accompanying notes 82–90.

284. *Supra* text accompanying note 93.

Parents transmit the essence of their kind to offspring, ordinarily via sexual reproduction.²⁸⁵ Since cloning is a form of *asexual* reproduction,²⁸⁶ essentialism can lead to the intuition that the product of cloning does not possess the essence of a living kind and is, instead, an artifact (a common fallacy in science fiction movies).²⁸⁷ However, since the birth of Dolly the sheep was announced, hundreds of animals belonging to many species have been cloned.²⁸⁸ It is plausible that some members of the public (including lawmakers) have come to accept cloning as a form of procreation. If it is a form of procreation, it is a means of transmitting kind essence.²⁸⁹

To illustrate, consider the human-cat cybrid. It has a human progenitor (the nuclear DNA donor) and a feline progenitor (the egg donor). Arguably, the experiment that creates the cybrid involves procreation; if so, the experiment crosses the kind boundary between human and cat in procreation, as the Council feared.²⁹⁰ Furthermore, the human nuclear DNA donor and the feline egg donor both transmit essence to the offspring embryo; thus, the experiment results in an ambiguous organism that is not readily classified as human or cat. If the scientist flips the experiment around and fuses a cat cell to a human egg to generate a cloned embryo, the same two objections apply.

To be sure, the genetic contribution from the nuclear DNA donor is likely to outweigh the relatively small genetic contribution of mitochondrial DNA from the egg donor.²⁹¹ Thus, an essentialist might interpret an inter-species cloning experiment as conferring primarily one essence, either human or non-human. Why, then, would such an experiment be any more troubling than a man with a pig heart valve? Nikolas Nikas' testimony before the Arizona State Legislature suggests a possible answer. He argued that cybrids would open the door to more extreme experiments in which human embryos were

285. *Supra* text accompanying note 244.

286. MACINTOSH, *ILLEGAL BEINGS*, *supra* note 153, at 13–14.

287. MACINTOSH, *FOUR FALLACIES*, *supra* note 9, at 117–22.

288. MACINTOSH, *ILLEGAL BEINGS*, *supra* note 153, at 2.

289. Alternatively, an essentialist could interpret the cloning process as a transplant capable of transmitting the individual essence of the cell donor to the cloned embryo. That interpretation is consistent with fictional, media, and policy portrayals of humans conceived through cloning as imposters or resurrections of their donors. MACINTOSH, *FOUR FALLACIES*, *supra* note 9, at 134–35, 141–42, 159–60. However, essentialism is a flexible heuristic that can be applied in various situations; the intuitions derived from it depend on context. *Id.* at 168. Therefore, cloning may also be interpreted as a procreative process that transmits kind essence. This latter interpretation best accounts for the Louisiana and Arizona laws and their supporting rationales.

290. See *REPRODUCTION & RESPONSIBILITY*, *supra* note 11, at 220.

291. See MACINTOSH, *ILLEGAL BEINGS*, *supra* note 153, at 23–24 (discussing the role of mitochondrial DNA in cloning experiments). *But see* BONNICKSEN, *supra* note 4, at 87 (noting disagreement among scientists as to the importance of non-human mitochondrial DNA to the development of an otherwise human cloned embryo).

no longer readily classifiable as human.²⁹² Viewing his testimony through an essentialist lens, an experiment that confers even a small quantum of non-human essence upon a human embryo is problematic; it raises the specter of a near future in which scientists force more and more non-human essence onto human embryos until they no longer fit within the human kind.

4. Chimeric embryos

Louisiana and Arizona also define the term “human-animal hybrid” to include a human embryo into which a non-human cell or cells (or their components) have been introduced.²⁹³ Both states prohibit the creation of this type of chimeric embryo.²⁹⁴

As Part I.A explained, this prohibition is not scientifically necessary. A researcher who wishes to investigate the potential of non-human stem cells gains nothing by working with human embryos when non-human embryos will do.²⁹⁵ Moreover, even if a maverick transferred a chimeric embryo to a human or non-human womb, the embryo would have no realistic chance of coming to term.²⁹⁶

Essentialism provides a possible explanation for this particular ban. To see why, consider yet another variation on the Mark Twain cross between man and cat. This variation begins with a human embryo created when human sperm fertilizes a human egg. This embryo is consistent with the essentialist intuition that living kinds have strict boundaries; it clearly belongs to the human kind and only the human kind.

Next, suppose a scientist introduces cat cells into the human embryo. If ESCs are used, they have come from a cat embryo. If iPSCs are used, they have been derived from a cat that has already been born, or perhaps a fetal cat. Either way, the experiment involves the transfer of cells derived from a cat into a human embryo, resulting in a chimera.

A recipient of a transplanted organ sometimes believes she has acquired the donor’s traits, tastes, and memories along with his organs.²⁹⁷ In other words, she feels as if the donor’s individual essence has been transferred to her along with the organ.²⁹⁸ Similarly, the hypothetical experiment confers

292. *Supra* text accompanying note 233.

293. ARIZ. REV. STAT. ANN. § 36-2311(2)(a) (2013); LA. REV. STAT. ANN. § 14:89.6(D)(1)(a) (West, Westlaw through 2013 Reg. Sess.).

294. ARIZ. REV. STAT. ANN. § 36-2312(B)(1); LA. REV. STAT. ANN. § 14:89.6(A)(1).

295. *Supra* text accompanying note 40.

296. *Supra* text accompanying note 39.

297. *Supra* Part IV.B.

298. *Id.*

upon the human embryo the individual essence associated with the transplanted cat cells. Through scientific manipulation, a human embryo has acquired an individual essence that is feline. The kind membership of the altered embryo is uncertain. Its existence is an implicit challenge to kind boundaries that we expect to be clear-cut.

Can this account be squared with Senator Brownback's willingness to accept human beings who receive transplants of pig heart valves?²⁹⁹ The heart valves are transplants; thus, they also could be viewed as transmitting some measure of pig essence to the recipient. However, the 2007 Brownback bill prohibits the introduction of non-human cells into a human embryo only when the embryo's membership in the human species is rendered uncertain.³⁰⁰ Thus, Senator Brownback is not an absolutist when it comes to kind boundaries. Just as he tolerates the man with the pig heart valve, he tolerates the introduction of some non-human essence into a human embryo, as long as the embryo still falls within the boundaries of its kind. It is the embryo that is only eighty or fifty percent human that troubles him.³⁰¹

The Louisiana and Arizona laws derive from the 2007 and 2009 Brownback bills.³⁰² However, both flatly prohibit the introduction of any non-human cells into a human embryo, whether membership in the human species is rendered uncertain or not. This approach may reflect a stricter view of kind boundaries, in which any degree of non-human essence impairs the dignity of both the human species and human individual.³⁰³

Finally, Louisiana extends the prohibition to include experiments that introduce human cells (such as ESCs or iPSCs) into non-human embryos.³⁰⁴ This flat ban on all experiments resulting in human/non-human chimeric embryos may rest on a particularly rigid form of essentialism that is unable to tolerate even the slightest breach of kind boundaries.³⁰⁵

299. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (statement of Sen. Brownback).

300. S. 2358, 110th Cong. § 3 (2007).

301. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (statement of Sen. Brownback).

302. *See supra* text accompanying notes 216–17.

303. *See supra* Part IV.C.1.

304. LA. REV. STAT. ANN. § 14:89.6(D)(1)(a) (West, Westlaw through 2013 Reg. Sess.).

305. By contrast, in Arizona, such experiments are tolerated because the definition of human-animal hybrid does not include a nonhuman embryo into which human cells have been introduced. *See* ARIZ. REV. STAT. ANN. § 36-2311.2(a) (2013). Perhaps Arizona simply values human essence more highly than non-human essence. If a scientist conducts an experiment that muddies the essence of a non-human embryo, there is no great cause for concern.

5. The Embryonic Island of Dr. Moreau

To summarize the discussion thus far, the Louisiana and Arizona laws make it illegal to transfer human embryos to a non-human uterus, or vice versa. Yet, as explained above, scientists have no interest in conducting such experiments³⁰⁶ and immunological barriers would prevent misplaced embryos from coming to term in any event.³⁰⁷ The laws also forbid the creation of certain hybrid, cloned, and chimeric embryos. Yet, chromosomal abnormalities and other biological barriers would prevent such embryos from coming to term.³⁰⁸ Thus, the laws are not necessary to prevent scientists from bringing *The Island of Dr. Moreau* to life. Why are some activists and politicians so determined to prevent the creation of mere embryos?

To understand, one must return to the basics of psychological essentialism. The members of a living kind may pass through developmental stages, and their appearances may change accordingly, but they always possess the essence of their kind.³⁰⁹ Further, atypical members can belong to a kind if they bear the essence of the kind.³¹⁰ So, for example, since a human embryo can develop into a human baby, one can infer that it must possess human essence from the outset.³¹¹ The fact that the human embryo does not look like a baby is irrelevant; we expect members of living kinds to change in appearance as they develop. The fact that the human embryo is an atypical member is unimportant; if we can accept that a penguin is a bird, we can accept that a two or four-celled organism is a human being.³¹² Taken together with the principle that all human beings are created equal, these elements of essentialism can lead to the conclusion that a human embryo is the moral equivalent of a human baby.³¹³

Extending this logic to human-animal hybrids, *it does not matter whether any of the proscribed embryos are viable*. An embryo that possesses dual essences is as much an affront to essentialist intuitions as a half-human, half-animal brute. Indeed, to dramatize the point, an essentialist might argue that

306. See *supra* text accompanying notes 32–34.

307. See *supra* text accompanying note 109.

308. See *supra* text accompanying notes 39, 65–71, 93. As discussed above, hESCs or other human pluripotent stem cells introduced into non-human primate blastocysts might contribute to the resultant life forms in unpredictable ways. See *supra* text accompanying note 145. However, the NAS Guidelines and NIH Guidelines already disapprove and discourage such experiments. See *supra* text accompanying notes 146–47. Moreover, the Louisiana and Arizona laws are not narrowly tailored to address this concern.

309. See *supra* text accompanying note 245.

310. See *supra* text accompanying note 246.

311. Macintosh, *Human Embryonic Stem Cell Research*, *supra* note 32, at 246.

312. *Id.*

313. *Id.* at 263.

H.G. Wells' nightmare vision has already come to fruition: not on a distant island populated with man-beasts, but in research institutions across the nation, where scientists have thoughtlessly populated lab dishes with thousands of monstrous embryos. To the essentialist, embryos that violate kind boundaries contradict our most basic instincts about the world around us; therefore, it is morally wrong to create them.³¹⁴

D. *Offensive life forms*

Although the Louisiana and Arizona laws prohibit the creation of various embryos, they do not criminalize the creation of most chimeric life forms—that is, humans with some cells or tissues derived from non-humans, or non-humans with some cells or tissues derived from humans. Indeed, both states specifically authorize the xenotransplantation of human organs, tissues, or cells into non-humans other than embryos.³¹⁵ However, the Louisiana and Arizona laws define two particular life forms as human-animal hybrids: the non-human life form engineered such that (or so that) human gametes develop within it³¹⁶ and the non-human life form engineered such that (or so that) its brain is made entirely or mostly of human neural tissues.³¹⁷ Scientists in these states are barred from creating such life forms.³¹⁸ Each life form raises its own distinct issues, so the two will be assessed separately here.

314. Ten years ago, Jason Scott Robert and Françoise Baylis articulated a theory as to why people object to part-human, part-animal creatures. Robert & Baylis, *supra* note 199. They correctly noted that there are no fixed species boundaries in a genetic sense and that fears about crossing species boundaries are essentialist. *Id.* at 4–6. However, they theorized that people really are worried about something else: the prospect that research could create moral confusion in our relationships with existing animals and the novel creatures that scientists create. *Id.* at 9. “To protect the privileged place of human animals in the hierarchy of being, it is of value to embrace (folk) essentialism about species identities.” *Id.* at 10.

This argument is clever but does not account for the Louisiana and Arizona laws or their Brownback predecessors. Proponents of such laws generally appeal to species boundaries, human dignity, species integrity, and the like. Only Nikolas Nikas, in his testimony before the Arizona State Legislature, suggested problems that might occur if animal embryos acquired human rights. *See supra* text accompanying note 233. Opposition to human-animal hybrids appears to be rooted in essentialist intuitions, rather than concern about long-range consequences for human-animal relations.

315. ARIZ. REV. STAT. ANN. §§ 36-2312(E)(2) (2013); LA. REV. STAT. ANN. § 14:89.6(E)(2) (West, Westlaw through 2013 Reg. Sess.).

316. ARIZ. REV. STAT. ANN. §§ 36-2311.2(g); LA. REV. STAT. ANN. § 14:89.6(D)(1)(g).

317. ARIZ. REV. STAT. ANN. §§ 36-2311.2(h); LA. REV. STAT. ANN. § 14:89.6(D)(1)(h).

318. ARIZ. REV. STAT. ANN. § 36-2312(B)(1); LA. REV. STAT. ANN. § 14:89.6(A)(1).

1. The life form with human gametes

As Part I.E explained, a scientist engaged in routine stem cell research might transplant hESCs or hiPSCs into a non-human life form only to find that the cells migrated and contributed to the germ line.³¹⁹ In Louisiana, and possibly Arizona, the resulting life form could qualify as a prohibited human-animal hybrid.

Intuitively, a transplant of human cells or tissues into a non-human life form amounts to a transfer of an individual human essence,³²⁰ resulting in a creature that poses a challenge to kind boundaries. However, most chimeric life forms are *not* banned; thus, there must be some other reason why this *specific* type of human/non-human chimera is prohibited.

Such human/non-human chimeras do raise concerns about mating. Hypothetically, one could mate with a standard animal and produce a hybrid embryo, or two could mate and produce a human embryo.³²¹ These embryos would not produce viable offspring due to chromosomal abnormalities and inappropriate uterine environments.³²² But that fact is not reassuring if the fundamental problem that the laws seek to address is a psychological rather than biological one.

A cat is supposed to mate with another cat. This procreative act results in the conception, gestation, and birth of kitten that bears cat essence.³²³ By contrast, if a cat with human sperm mates with a standard cat, this act may produce an inter-species embryo that bears essence of both human and cat. If a cat with human sperm mates with another cat with human eggs, a human embryo with human essence is conceived, but experiences a brief inter-species gestation that confers cat essence. To the essentialist, inter-species procreative acts are repugnant because they violate kind boundaries. Moreover, the existence of dual-essence embryos also challenges kind boundaries. The hybrid human-cat embryo, with its fifty-fifty split of essence, is especially troubling.³²⁴

But this analysis raises another question: if inter-species conception and gestation are so troubling, isn't there a simple solution? Instead of enacting a law that discourages scientists from transplanting hESCs or hiPSCs into animals, Louisiana and Arizona could simply have prohibited the breeding of such animals.³²⁵ Failure to do so implies that the existence of a non-human

319. See *supra* text accompanying note 104.

320. See *supra* Part IV.B.

321. Greely, *Human/Nonhuman Chimeras*, *supra* note 65, at 684–85.

322. See *supra* text accompanying note 109.

323. See *supra* Part IV.C.1.

324. *Id.*

325. See *supra* Part I.E.

with human gametes poses an inherent psychological problem, even if the non-human never mates.

In its fourth finding, the 2007 Brownback bill states that individual human beings manifest their uniqueness through their reproductive organs and cells.³²⁶ In other words, human gametes are associated with human individuality. Individuality is, in turn, associated with human nature;³²⁷ it could be considered a marker for human essence. Thus, human gametes are special because of their association with human nature and essence. This reasoning might explain why Louisiana and Arizona can tolerate most chimeric life forms but not an animal that carries human gametes in its body.

2. The life form with a human brain

Finally, the Louisiana and Arizona laws prohibit the creation of a non-human life form with a brain composed in whole or part of human neural tissues.³²⁸ The archetype is the human neuron mouse, but other animals could theoretically undergo grafts of human neural cells and tissues.

Again, the 2007 Brownback bill is instructive. Its fourth finding avers that individual human beings express their uniqueness not only through their reproductive organs and cells, but also through their brains.³²⁹ If the human brain is associated with human individuality, and individuality is associated with human nature and essence, then, the human brain is special because of its particular association with human nature and essence.³³⁰ This logic could explain why legislators in Louisiana and Arizona find the human neuron mouse more worthy of prohibition than other chimeric life forms.³³¹

Another possible explanation for legislative disapproval of the human neuron mouse may stem from a key element of psychological essentialism. Essence is believed to be causal;³³² that is, the essence a life form carries within its body is responsible not only for the traits we can see, but also for hidden traits that we can infer.³³³ To illustrate the impact of this element, this Article returns to the hypothetical posed in the Introduction.

326. S. 2358, 110th Cong. § 2(4) (2007).

327. MACINTOSH, FOUR FALLACIES, *supra* note 9, at 107.

328. ARIZ. REV. STAT. ANN. §§ 36-2311.2(h), 36-2312(B)(1) (2013); LA. REV. STAT. ANN. §§ 14:89.6(A)(1), 14:89.6(D)(1)(h) (West, Westlaw through 2013 Reg. Sess.).

329. S. 2358, 110th Cong. § 2(4) (2007).

330. *See supra* text accompanying note 327.

331. *Cf.* 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (reporting Senator Brownback's approval of experimental mice engineered to have a human immune system).

332. Medin & Ortony, *supra* note 236, at 183–86.

333. *See supra* Part III.A.

Recall the facts: you visit a scientist friend and she shows you a small, furry creature with round ears and a long tail in a cage. Psychological essentialism explains how you are able to identify the creature: visible traits, such as the round ears and long tail, link the creature to essence of mouse. That intuition, in turn, enables you to draw inferences about non-obvious traits, such as fondness for cheese, fear of cats, and low intelligence.

Next, your friend tells you that she has engineered the mouse so that all the neurons in its brain are of human origin. She is correct that the mouse cannot think like a human; its tiny brain lacks the size and complexity of a human brain.³³⁴ But a subconscious belief in causal essence points you in the opposite direction. Once you realize the mouse carries human essence, it is only natural to infer that the essence causes non-obvious traits, such as human intelligence. Thus, the mouse suddenly acquires an aura of intelligence, and your emotional reaction is one of revulsion, rather than wonder at your friend's scientific achievement.

Herein lies what may be the most dangerous aspect of psychological essentialism, at least insofar as human/non-human mixes are concerned. The presence of a causal, human essence sends a strong subconscious message that human traits are present, even if the presence of such traits is scientifically unlikely or even impossible. Worse, most lawmakers are probably not aware that essentialist intuitions are influencing their judgments about scientific facts.

Indeed, anyone who has studied the drive to ban human-animal hybrids has to wonder which research will become the next political target. The 2013 experiment that transplanted human glial progenitor cells into newborn mice is precisely the sort of experiment that could renew the call to halt "mad science." The chimeric mice ended up with brains that had high numbers and proportions of human astrocytes; their memories and learning capacities were better than those of control mice.³³⁵ A legislator who hears about this experiment could easily draw the false inference that the transplanted cells conferred human essence—and thus, human intellect—upon these mice.

334. *See supra* text accompanying note 122. As others have noted, experiments that transfer brain stem cells or tissues from humans to other great apes could raise legitimate concerns about the subjects developing something akin to human intellect and thought. *See supra* text accompanying notes 160–64. But the Louisiana and Arizona laws are not narrowly tailored to address this concern.

335. *See supra* text accompanying notes 129–33.

V. CONCLUSION

Louisiana and Arizona have criminalized the creation of embryos and life forms categorized as “human-animal hybrids.” They have also banned inter-species embryo transfers. Some of these prohibitions are laughable: no scientist will care if she cannot fertilize human eggs with cat sperm or transfer a human embryo to the uterus of a cat. But the laws also criminalize experiments that could lead to useful knowledge. For example, it is unlawful for scientists to create cybrids and certain human-animal chimeras, even though such experiments have no realistic chance of generating man-beasts as in *The Island of Dr. Moreau*.

This Article has argued that the Louisiana and Arizona laws are best understood as a manifestation of psychological essentialism. In the words of Senator Brownback, who authored the forerunner of the state laws, “[T]he reason to oppose human-animal hybrids is embedded in our very fabric as human beings.”³³⁶ In other words, the reason to ban useful research comes down to essence. Experiments provoke a legislative backlash when they cross boundaries that our minds erect around living kinds.

With so many scientific advances and medical therapies waiting to be discovered, the “yuck factor”³³⁷ cannot be allowed to have the last word. Scientists must arm themselves with a greater understanding of the powerful instincts working against them in the political realm. Lawmakers must also take note, lest their good intentions lead to bad laws that drive scientists out of their states. Psychological essentialism may provide a useful rule of thumb in some situations; but when we allow it to become a hidden basis of public policy and legislation, we only make monkeys of ourselves.

336. 153 CONG. REC. S14,490 (daily ed. Nov. 15, 2007) (statement of Sen. Brownback).

337. The “yuck factor” is a term that bioethicists use to refer to the instinctive revulsion that many people feel when confronted with novel biotechnologies. Niemelä, *supra* note 260.
