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ORIGINAL ARTICLE

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Meddling with Medusa: on genetic manipulation, art and animals

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Abstract Turning animals into art through genetic manipulation poses many questions for how we think about our relationship with other species. Here, I explore three rather disparate sets of issues. First, I ask to what extent the production of such living "artforms" really is as transgressive as advocates claim. Whether or not it counts as radical in terms of art I cannot say: but it is not at all radical, I argue, in terms of how we think about our human place in the world. On the contrary, producing these animals only reinforces our own sense of our importance. The second theme I explore is the extent to which making transgenic organisms for any purposes is radical in terms of complexity. Here, I focus on the idea of complexity as a concept in developmental biology; genetic manipulation may be successful to commercial companies, but it is deeply troubling to many biologists who consider that its deeply entrenched reductionism is enormously problematic. What risks do we run by ignoring nature's own complexity—and creativity? And—in particular—what risks do we run of damaging or compromising animal welfare? The third theme turns to public perceptions of these new technologies (whether in science or art), and notes the extent of public unease. This unease is not simply a question of public ignorance about the technology, but reflects the enormously rich ways in which we make meanings about animals, and relate to them. These are, I suggest, a far more potent source of creativity than simply moving genes around to make photogenic animals.

Keywords Art · Animals · Genetic manipulation · Complexity · Creativity · Meaning

> "Across the clearing to the south comes a rabbit, hopping, listening, pausing to nibble at the grass with its gigantic teeth. It glows in the dusk, a greenish glow filched from the iridocytes of a deep-sea jellyfish in some long-ago experiment. In the half-light the rabbit looks soft and almost translucent, like a piece of Turkish Delight; as if you could suck off its fur like sugar." [Margaret Atwood, *Oryx and Crake*, 2004:109–110]

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Humankind have been interfering with nonhuman genetics for centuries, trying to shape animals and plants to our own ends, including aesthetic ones. Alongside that we have a long history of fear and fascination with hybrid kinds, expressed as the strange animal/human hybrids who inhabit our mythologies—as well as littering our dystopias. If new genetic technologies offer renewed means of tinkering, and if humans use them for "aesthetic" ends, then we should not be surprised.

What does surprise me, however, is the way that genetic manipulations in the name of art are so often portrayed as radical or innovative. Perhaps there is a trivial sense in which making a monkey or rabbit which glows in the dark because of genes "filched from.deep-sea jellyfish" is innovative. Whether it is either aesthetic or ethical is more debatable. But it is not radical: first in the obvious sense that tinkering with other species' genetics is something we have been doing for a very long time, and second in the more restricted sense that moving genes around in this way is not the radical cutting edge of biology that so many of its advocates seem to imply.

In this paper, I want to explore some of the issues that "bio-art" raise, to my eyes, for our relationship with animals, especially when the bioart entails deliberately making whole new organisms.[1] I must begin by confessing my biases. I am a biologist, but one who is not enamoured by the reductionist logic of new genetic technologies. On the contrary, I am much more excited by areas of biology that explicitly reject reductionism and seek alternative ways of understanding how life works. I am far more awed and stunned by the incredible beauty out there in nature than I am by the possibilities of fiddling around with those shapes and forms in the laboratory—or in any other space.

I want to explore these issues through three, rather disparate, themes—ways in which the production of these animals is, for me, problematic. The first concerns some of the claims made by artists and advocates—is the production of transgenic animals as art transgressive, for example? Does it challenge human centrality in the world? Does it involve human/animal communication in new or radical ways? The second theme is more concerned with how we think about biology, and the reductionist assumptions underpinning any work in genetic engineering, assumptions which are not at all radical. The third asks questions about public perceptions of both animals and science: does the production of these organisms promote public engagement with science, as some have claimed?

1 Is it new? Or transgressive?

Human intervention in the processes of natural selection—by which nature changes the genetic inheritance of species—has a long history. Although humans have engaged in some selective breeding of both plants and animals for centuries, it intensified in the seventeenth and eighteenth centuries, and more and more breeds of domesticated animals and plants were produced by selective mating. The human motives were various—economic, utility, aesthetics. For

[1] Some forms of bioart involve tissue engineering, using cells derived from (dead) animals to grow into artificial media. Here, I focus more on the production of live animals through genetic manipulation, although all forms of bioart raise a number of troubling questions.

several resultant breeds, there were ethical issues, as the desired characteristics created welfare problems (breathing difficulties created by the shortened nose of some pet dog breeds for instance).

The twentieth century, and the beginning of modern genetic understanding, saw further developments in breeding. Where before selection was simply a case of bringing together males and females of particular phenotypic traits, now it became possible to select for traits with known genetic linkage, and so make inheritance more predictable. In the second half of the century, the identification of DNA's structure meant that very precise genetic detail could be identified and, eventually, manipulated.

Advocates of genetic manipulation frequently argue that there are huge potential benefits to biotechnology (feeding the world, yielding new medicines, for example), and that changing the genetics of an organism through biotechnology is not fundamentally different from the breeding programmes that preceded it. Whatever one thinks about potential benefits versus possible harms, it is certainly true that human attempts to alter the genetics of other organisms are not new. We have been doing it for a long time: but we are just better now at focusing in on specific genes.

Artists, meanwhile, have long sought inspiration in the forms of nature, often seeing themselves as Leonardo's descendents, crossing the art/science border (see Gigliotti 2006). That border has undoubtedly become more permeable in recent years, partly through initiatives to promote public understanding of science. These aim not only to make complex scientific and technological ideas more accessible, but also to promote debate about ethical issues, using artworks as a means of making the science (and the art) more accessible. Thus, a recent project funded by the Wellcome Trust in London used art to explore the deeply contentious question of euthanasia and assisted suicide, for example.[2]

What makes recent developments in "bioart" new is that biological materials or organisms, and biological techniques, are now becoming part of the processes of producing art. Precisely because of this challenge to old boundaries between science and art, bioart has been called "transgressive" or "radical". And transgressive it indeed is, in the sense that it uses art to go beyond representation, to breach the boundaries of what it is to be living. Yet there are also ways in which the creation of such animals as art is not transgressive. For a start, it uses techniques that are now commonplace in the labs. Done in those places, it may be worrying for many people (wondering, what *are* scientists creating?), but it is hardly rare. It is transgressive only because bioart takes the techniques (partly) *out* of the laboratory and into the everyday world, an act that changes the relationship between laboratories and the wider society.

Not surprisingly, there have been heated ethical debates about the practice and potential of bioart, particularly when new, living, organisms are thus created. I must admit to mixed feelings, depending on what is done to living tissue in the name of art. The idea of performance art based on the extraction of tissue and its growth into "victimless meat", for instance, does appeal to me as a lifelong vegetarian (though it appeals more in the sense of it becoming commercial practice than in the sense of it as "art"). Some of it offends my sense of

[2] "Euthanasia and assisted suicide", Sciart project developed by Tracy Mackenna and Edwin Janssen, from Wellcome Trust website, Jan 2005: www.wellcome.ac.uk/node2530.html.

beauty inherent in nature—I am bewildered by the use of biotechnology to create ''nonsense'' patterns in living butterfly wings, and at the same time amused that this creation provoked much more public outcry than alterations in the name of art to a cockroach's nervous system (Catts and Zurr 2003, website, accessed Dec., 2004). The mixed message here is, of course, a speciesist one: we live in a culture that values butterfly wings and their bright colours, and associates cockroaches with dirt and disease. So, if artwork based on butterflies is more highly valued it should not come as a surprise (except perhaps to those of us who value the original butterfly more).

2 Breaking down species barriers, or shoring them up?

Crossing the borders of art and science is all very well, even desirable in some senses. But making transgenic animals is a border crossing that raises more than just eyebrows and provocative headlines. It poses a number of questions that, for me, remain unanswered. One is the issue of anthropocentrism: is crossing the boundaries of living organisms anti-anthropocentric in the way that its practitioners claim?

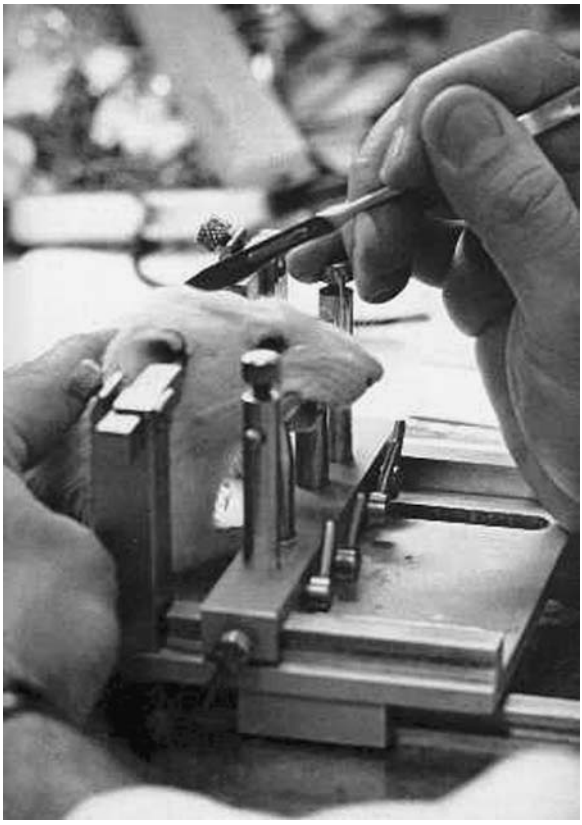

Fig. 1 Rat prepared for brain surgery
Credit: Uncredited

Anthropocentrism has indeed dominated the way we view the rest of the living world; from the Judeo Christian traditions we in the west have inherited a relationship to nature that is profoundly one of dominion, in which we arrogantly place ourselves at the centre. We undoubtedly need to challenge that in any way we can. But moving bits of DNA or pieces of animal tissue around—whether for purposes of basic science, pharmaceutical production, or art—does not do so. Humans remain, as other contributors to this volume also note, right at the centre of all these endeavours: it is our interests that remain paramount, and it is human motives that shape the direction and practices of both art and science.

Moreover, for all that artists may speak of "making humans part of the continuum" and breaking down species barriers, it is not humans whose genetic integrity is thus compromised. We have not yet seen a GFP (fluorescent) human baby. That would, no doubt, produce a much stronger "yuk" reaction, and a sense of public revulsion, than GFP bunnies—which in itself underlines the strength of anthropocentrism. For if genetic boundary crossing is really so radical a challenge to our place at the centre of our universe, why should we balk at making human-baby art installations?

"Manipulating life will not be as alarming as it now seems" when humans realize they are part of the continuum of life, suggest Zurr and Catts (2003) in their essay on bioart and ethics. This, notes Gigliotti, is absurd, given how much we humans have been manipulating other species for millennia. It is also absurd given how much of our (Western) culture relies on maintaining the separation of we humans from "the continuum of life". None of that manipulation, including extensive breeding programmes to produce rather peculiar shapes of animal for our own purposes, has ever made a dent in our anthropocentrism. We have certainly been altering the genomes of nonhuman species for a very long time. But these extensive interventions do not count as an "artwork". They are usually produced by large numbers of breeders over long periods of time, which means that no one person can easily make claims that this or that is "their" creation. And breeding programmes are far from precise: so much is left to nature's complexity. What makes creatures like GFP bunny into an "artwork" is precisely the deliberate and precise introduction of a bit of known DNA into the rabbit genome for "artistic" purposes, *by specific people*. Whatever the origins of particular breeds of dogs or sheep, say, through old-fashioned breeding programmes, no one usually claimed artistic merit or intellectual property rights for them.

Similarly, it is only when making transgenic organisms into art that claims are made that it involves "communication between human and animal", across the species barrier. Scientists producing genetically altered organisms make no such claims. In science labs, these animals become "bioreactors"; in the context of art, they become pals. Eduardo Kac emphasises this point, presenting "GFP Bunny" in a "social and interactive context"[3]—that is, the presentation of the animal in the social world of cultured humans. We undoubtedly need to learn more about communication between ourselves and other species: we are singularly bad at it. But why is it that Kac seeks to call his relationship between the artist and the bunny an art form? Many people strive to understand the needs of nonhuman animals around them, to understand what the animals are telling

[3] See Kac's website: www.ekac.org/gfpbunny.

them, to communicate with them however limited our abilities. It is not, however, generally called art (though some of us may feel that it is more wondrous than human-made artworks). The only difference is that Alba, the GFP bunny, was made by someone who calls himself an artist and who wants to emphasise the communication.

The "social and interactive context" is, of course, a human one, into which the rabbit must fit. What humans bring to this is a multiplicity of assumptions. Kac rhapsodises on his website: "I will never forget the moment when I first held her in my arms. My apprehensive anticipation was replaced by joy and excitement. Alba—the name given her by my wife, my daughter, and I—was lovable and affectionate and an absolute delight to play with. As I cradled her, she playfully tucked her head between my body and my left arm, finding at last a comfortable position to rest and enjoy my gentle strokes. She immediately awoke in me a strong and urgent sense of responsibility for her well being". In using language so redolent of the nuclear family, Kac deflects the reader from considering the more distant concept of "artwork" or "scientific artefact"—or from considering Alba in any context other than that of "cute pet". And, for all that Kac insists on understanding Alba and the project in a wider social and political context, what comes over in this narrative is a sense of Alba as *his*—his creation, his baby—a sense that is reinforced by the campaign (listed on his website) to "bring Alba home".

Alba's contribution to this "social and interactive context" is, not surprisingly, a largely silent one. Little is said about her specific responses or about how she has attempted to engage herself in that human social world. On the contrary, she remains apart in her alterity, her rabbitness. Family cuddles notwithstanding, it remains unclear how she (or other such creations) can effectively participate in interspecies social contexts, as active agents.

Embracing a bunny is a far cry from those researchers who try to communicate with animals on their terms, attempting to find out how animals think, what they perceive, and how humans and animals together engage in creating intersubjectivities. There is now a great deal of scholarship exploring these very issues, which seems to be omitted from the eulogies to DNA manipulation.[4] Communication between species remains a challenge to research, however; it entails subtle, bodily, responses to equally subtle cues—a kind of "becoming animal" on the part of the human and vice versa (Birke and Parisi 1999; also see Game 2001 for a discussion of the importance of bodily responses in riding horses, and Sanders' 1999 discussion of human–dog relationships). It is, moreover, very much easier to think about such communication when the participants are both mammalian than it is when one is not.

Difficult to study they may be, but what these new studies underline is the intricacies of interspecies interaction, emphasising the subjectivities and integrities of both participants. Given these burgeoning literatures on human–animal relationships and cognitive ethology, I find it hard to see what light fluorescent bunnies shed. Glow in the dark they may do, but what, precisely, does this tell us about the intricacies of communication and intersubjectivity?

Their creation might, on the other hand, promote communication *about* biotechnologies, as Kac suggests on his website. He clearly sees these organisms

[4] See, for example, papers contributed to the journal *Society and Animals*.

and their production as transgressive, and capable of provoking renewed discussion between various interested people (scientists, artists, legislators and so on) and a wider public about (among other things) ethics of genetic engineering, and about our relationships with the natural world. As he explains, ''My transgenic artwork 'GFP Bunny' comprises the creation of a green fluorescent rabbit, the public dialogue generated by the project, and the social integration of the rabbit.'' The artwork, then, resides not only in the specific creation of this modified creature, but also in the social nexus in which we find her. It is a performance art, in which both humans and the GFP bunny are performers.[5]

Whether or not such an act is radical in terms of art is for other people to judge. But I do not find it radical in terms of how we think about animals. If ''Art'' can now include the deliberate manipulation of one's own body boundaries through cosmetic surgery (as in Orlans' bodily performance art), then it is but a small step to include that of other bodies, such as animals.[6] This does not seem to me to offer a radical rethink of anthropocentrism, as proponents claim. We have undoubtedly been manipulating animal bodies, and using animal parts, for a very long time; but then, just when we have begun to take seriously the possibility that other species have minds, we begin to devise new ways of exploiting their bodies. And, no sooner have animals been exploited in these ways in the service of art, than similar techniques are used to produce them as trivial artefacts, part of the entertainment industry—illustrated by the production of ''GloFish'', zebra fish manipulated to glow red in the dark, presumably to perk up jaded aquarium-keepers (Pollack 2003).

Trivialising animals in such ways is certainly not radical; on the contrary, it draws on centuries of trivialisation, demeaning behaviour, and vicious cruelty towards all kinds of others (including, of course, many other humans). It is a sad irony that, just as our arrogance begins to admit that other creatures with whom we share the planet might be worthy of respect, might be subjects of a life, then we try to find renewed ways of trivialising them, of denying the complexities of their lives and experiences.

3 Complexity and animals—what kind of biology?

If animal lives are trivialised, then, what about the complicated ethical questions surrounding genetic manipulation? I want to turn now to a different claim made by some artist advocates, which is that production of transgenic organisms for art helps to confront the *complexity* of the issues. Perhaps it does, in the sense that it can pose questions about the convoluted ethical questions. But here I want to use a different take on complexity, in relation to science. To begin with, it does not seem to me that the production of transgenic animals in the name of

[5] Although Alba is a performer only in a limited sense. Birke et al. (2004) have used the idea of performativity (developed in feminist theory for example) to apply it to the human/animal relationship, asking how we might understand the animal's part in terms of its own agency and engagement. Given Alba's creation by very explicit human intervention and the role she plays on a human stage, the potential for her own engagement is limited indeed.

[6] Indeed, the production of artificial ears from human tissue, a production by Zurr and Catts, has been developed as an artwork for potential transplantation onto the head of another performance artist, Stelarc.

art does anything at all to help us to understand the complexity of science as a whole. On the contrary, it draws on very narrow conceptions of science—such as genetic technology. New developments in genetics certainly gain enormous numbers of column inches in newspapers, and occupy nearly all those academics who concern themselves with analysing the sciences from, say, sociological perspectives. But genetics is not all of science.

More importantly, genetic reductionism is not the only way within science to understand organisms and how they work. As Kac and others note, the new genetics is reductionist; it relies on an understanding of DNA as a master molecule, and of the organism as a kind of accident, a by-product of those selfish genes. DNA, in this story, is the blueprint for the manufacture of the huge array of proteins that act as building blocks for all living organisms. Thus, cutting up fragments of DNA and moving them into other locations within a chromosome (of the same or different organism) makes sense: what is being moved is a tiny piece of a plan, a piece which organises the production of a specific material. That is why transgenic organisms are commercially so desirable, to tap into the production of materials for particular uses. In light of the meteoric rise of biotechnology and biotechnology companies, there is clearly some truth in this: animals are indeed being produced as ''bioreactors''.

That does not mean, however, that we really understand what is going on, except in the relatively trivial and reductionist sense that we have altered the output of one or two particular proteins. If a gene brings about the production of a particular protein, *how* does that work within the enormously complex structure of the cell, in concert with other chemical constituents? How does it help to generate patterns or the form of the organism? Although they are rather drowned out by the cacophony of excitement about the wonders of DNA technology, there are a number of voices who have expressed concern and doubt about the reductionist framework and these unanswered questions. Is DNA as central as we have been led to believe, they ask? Does moving genes have implications beyond the immediate effect on a protein?[7]

What the critics draw on is a recognition of the far greater complexity of life and living organisms than the ''master molecule'' rhetoric implies. It is ironic that Kac and other artists producing transgenic organisms cite some of the biologists who develop complexity theory. Yet they do so while exploiting the technologies that are deeply rooted in a reductionist framework.

It is also ironic that these transgenic organisms are represented as art—that is, a product of creativity—while using methods that seem to minimise nature's role in the process.[8] Biologists developing complexity theory have emphasised the *creativity* of the processes of life, and how these cannot easily, or only, be understood as the sum of component parts. On the contrary, they point out,

[7] See for example various critical articles published on the webpages of ISIS—the Institute for Science in Society (http://www.i-sis.org.uk/). Many of these point to evidence that manipulated genes can have multiple and unpredictable effects, and can cause problems if organisms escape into other environments. They also suggest that genetically manipulated genomes are not as stable as advocates claim.

[8] Arguably, there is more of nature's creativity at work in the use of tissue engineering to create artworks, such as that by Zurr and Catts. They use tissue from dead animals (pigs, for example) and allow the cells to grow along artificial structures. The ''art'' is thus partly created by whatever forms the cells take as they move along these structures.

complex systems create emergent order, which simply does not appear at the level of the parts. Whirling dust storms in the desert might for example create specific patterns of sand that are not predictable from the apparent chaos of the dust. The mammalian heart beats with regularity, yet that regularity emerges from what appears at the cellular level to be electrical chaos. In the development of living organisms, patterns emerge from the engagement of a multitude of complex processes which influence each other—the intricate whorls of a snail's shell for example: those patterns are not necessarily predictable from gene sequences alone. And even if they are predictable, in the sense that we might say that removing gene X stops pattern Y, how those patterns emerged is not really well known. Take, for example, the beautiful patterns of butterfly wings—patterns that have been altered deliberately by moving genes in yet other kinds of "artwork" installations. True, moving certain genes alters the pattern. But so what? It is a very long way from specifying a gene to the emergence of complex order, and knowing *how* it unfolds.[9]

Patterns emerge in nature not simply because A causes B causes C, but through the complex interactions of many processes; these act together in ways we often cannot understand through reductionist frameworks, creating new orders and patterns not predictable from the component parts. That, to me, is more creative than merely moving a gene or two.

It also underlines the reasons why critics of gene technology are so concerned. The trouble with moving a gene or two is that, while we may refer glibly to the way "this gene codes for X"—that is, that the information encoded in the DNA is crucial for the production of protein X—what we usually do not know is how that gene works in collaboration with other genes in the genome or other parts of the cell. That is precisely why, say critics, we should be concerned about the production of transgenic organisms: we do not know enough about what happens to the biological processes into which the transposed gene fits, with the result that the development of the individual or of wider ecosystems might be disturbed or damaged.

Defenders of gene technologies will, at this point, throw up their hands and refer to the ways that humans have been interfering in animal and plant breeding for millennia. Transgenics is simply a more focussed way of doing the same thing, they argue. Perhaps. But, while we tend to assume that what we are selecting through breeding programmes is a "gene for X", what we usually operate with is not genotypes but phenotypes, and what we select is more likely to be a whole complex of genes and cellular components that normally operate in and around that gene.

It is precisely that complex set of unknown reactions and processes that have evolved over millennia along with the ecosystems of which they are part, and which we deliberately ignore in producing transgenic organisms. Those, by contrast, may well not inherit all the cellular paraphernalia that help to keep organisms in balance both within themselves and in their environments. Natural selection is likely to maintain those cellular and developmental checks and balances that promote survival: creating transgenics means that we risk

[9] There are several theorists developing complexity theory, such as Kauffman (2000), and Solé and Goodwin (2000). Also see discussions by contributors to Oyama et al. (2001).

producing organisms that do not have these balances and which would not survive at all without our intervention.

More relevant to the current theme, if we do not know enough about ecosystem consequences, neither do we know what the longer-term implications are for the welfare of the animals manufactured by gene technologies. Dazzled by the possibilities of biotechnology, it seems that artists using it take for granted that moving a particular bit of DNA has only those consequences claimed by the biotechnology lobby (and commercial companies). Animals like GFP bunny have, we are assured on websites, a wonderful life, free of the vicissitudes of pain and stress confronting many of their laboratory-based peers. This may or may not be true, but is hardly the point. What concerns me is the possibility of creating animals whose physical integrity is clearly compromised in ways that cause them to suffer—whatever the stated purpose of producing those animals.[10] Now, natural checks and balances are not a complete barrier to animal suffering—we have only to think of some of the breeds of dogs we have produced through breeding programmes, dogs with breathing difficulties or congenital hip dysplasia. But developmental systems do put some constraints on our interventions, constraints that might be bypassed by directly fiddling with the genes. If we can move individual genes at will, who knows how far we can go in creating appalling suffering?

I have long been hostile to reductionist biology (see, e.g., Birke 1999). Reductionism has undoubtedly been useful, allowing a great deal of predictability

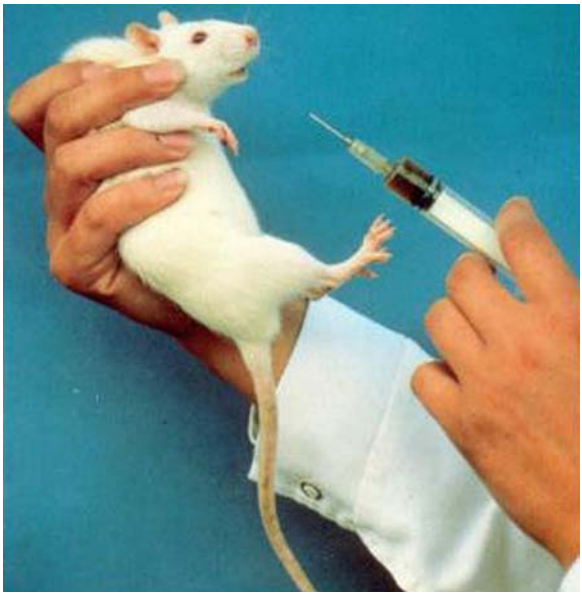

Fig. 2 Rat about to be injected
Credit: Uncredited

[10] There are, furthermore, regulatory frameworks that help to control the scientific production of transgenic organisms. These may be partial, even inadequate (and are criticised by many), but they can help to set limits. There may be no such limits if transgenic organisms are made for art.

in experimental outcomes, a predictability which humans have made great use of in developing new medicines and all kinds of technologies. But reductionism masks so much of the complexity of biological processes and fails to explain a great deal about how, for example, organisms develop into the myriad fascinating forms that they do.

It troubles me as a biologist that the predominant framework is not encouraging us to understand these complex processes, which inhere in the *whole* organism. On the contrary, biology is increasingly focussing on fragmentation: whole organisms are simply not relevant. But it also troubles me for political or ethical reasons, since a way of looking at the world through fragmentation encourages acceptance of a literal fragmentation of organisms. Humans and nonhumans alike thus quickly become merely sets of (and potential suppliers of) body parts. There is considerable potential here not only for human rights abuses, but also for the creation of even more animal suffering, as well as the production of environmental havoc if genetically altered animals escape (a very real risk in the case of altered zebra fish: Pollack 2003). If we care about animal suffering, then I believe we should be arguing passionately for a more enlightened approach to understanding how animals and their bodies work, one which acknowledges and celebrates their complexity and integrity—as well as their own intrinsic aesthetic qualities—and having valued them, leaves them alone.

4 Widening public debate?

According to Machado (2000), the critics of ''bioart'' have a conservative bias. Bioart, advocates argue, not only challenges many of our long-held preconceptions about what it is to be human, or animal, but does so in ways that must promote wider public debate. In that I am deeply unimpressed by the kind of art under discussion, then I guess that that conservative label could well apply to me, or to the people who express disgust or dismay at the art installations. But in that I am also deeply unimpressed by the extremely unradical reliance on reductionist genetics underlying this art, then maybe not. I cannot see how using such a conservative approach to understanding living processes, thus denying their very complexity, can be called ''radical''.

And maybe it is as much about that denial as the ''yuk'' factor that makes many people wary of new developments in biotechnology. Its defenders amongst the scientific community often derogate the public, complaining that the public are often hostile out of ignorance. But ignorant of what? Recent research in the public understanding of science has found time and time again that lay people are not necessarily as ''ignorant'' as scientists sometimes assume; on the contrary, they may well take quite a sophisticated and nuanced approach to the difficult ethical dilemmas thrown up by new biotechnologies (Irwin and Michael 2003). And, while we live in a culture that is clearly often cruel and abusive, it is also a society in which animals play a huge, and complex, symbolic role and in which they sometimes become ''part of the family''. Accordingly, some of the widespread public unease about using animals in biotechnology has to do with the way that it is seen as unnatural, and compromising animal integrity (Schroten 1997). Not surprisingly then, surveys of public opinion indicate that,

while citizens may be more willing to accept genetic alteration of plants, they are much less willing to countenance interference with animals.[11]

I suggested earlier that one way in which the production of transgenic organisms for art might be considered to be transgressive is that it takes the organism out of the laboratory. Laboratories, argues sociologist of science Latour (1983), are the key to understanding just what it is that makes the production of scientific knowledge so special, so authoritative in our culture. Laboratories, and the sometimes arcane activities taking place in them, help to create a kind of smokescreen around the production of science, that render it less accessible to wider publics and in turn help to maintain the authority of scientific knowledge. So, breaking down the barriers between publics and laboratories might be thought of as desirable, as encouraging more access.

In writing about their use of tissue engineering to create bioart forms, Catts and Zurr (2003) note that their "semi-living" sculptures (made by growing cells) cannot be simply installed in a conventional artspace: they need laboratory apparatuses to maintain them. The tissue culture lab, in short, must be brought into the spaces where the art is installed, so transgressing boundaries of what counts as appropriate activities in particular spaces.

Bringing the lab to the gallery might be seen as promoting public awareness: yet, what happens in laboratories remains something often to be abhorred. At the same time as labs in artspaces open up possibilities of public dialogue, laboratories using animals must increasingly shore up their boundaries with the public for fear of reprisals from antivivisectionist organisations. Not for nothing do scientists speak of feeling besieged, or "behind the barricades" (Birke and Michael 1992). Public abhorrence is partly to do with the potential for animal suffering in lab experiments, but it is also to do with the potential of science to create new forms of animals.

Public responses to Kac's production of Alba illustrate both these reactions. His website discussion includes links to the campaign to "bring Alba home". This centred on a dispute with the French laboratory with whom Kac worked to produce the rabbit. The lab scientists claimed that Alba was only one of a number of GFP rabbits produced experimentally, while Kac claimed her special status meant that she was his, and could "come home" to Chicago. What is interesting, however, is not the dispute, but the following emails to the website. There is an overwhelming rhetoric to "free Alba", to "liberate" her from "captivity" or from her "cage". No matter that Alba herself was actually dead by the time many of these emails were written (she apparently died in 2002); what is clear from the passionate tone is that whatever else happens to her, it is preferable to being "held captive" in the laboratory. What happens behind the closed door of the labs continues to hold the public imagination, and Alba stands for (or stood for) all those rabbits "deprived of their liberty" by science.

Different groups of the lay public may, of course, have different "takes" on animal biotechnology: patients with as-yet untreatable genetic diseases might feel, for example, that genetic alteration of animals is acceptable if a new cure for genetic disease could ensue. In general, however, most surveys of public opinion on new developments in science have found that people are, at best,

[11] Survey conducted by the Pew Initiative on Food and Biotechnology. See http://pewagbiotech.org/research/2003update/4.php.

ambivalent about animal use. If animals are to be used in experiments at all, many seem to feel, there must be a clear benefit; otherwise, the experiments, with their risk of animal suffering, cannot be justified. With genetically manipulated animals, too, people seem to seek justifications through utility. So, in studies of how people understand and react to the use of animals for xenotransplantation (as potential organ donors), lay people draw parallels with the incorporation of animal tissue into our bodies via eating meat (Michael and Brown 2004). That is, using animals as organ donors becomes less objectionable seen as a variant of a pre-existing cultural practice, eating meat.

Media representations of developments in xenotransplantation, too, reflect this need to emphasise benefits. Donor pigs for example are often represented in newspaper reports as heroes or saviours, dying to help save humankind (Birke and Michael 1998).[12] Part of the public ambivalence about animal biotechnology, so regretted by scientist advocates, is based on the complex ethical dilemmas entailed; to find their way through these moral mazes, people must draw on ideas of these unfortunate animals as somehow doing good, their lives and deaths thus having a greater meaning.

Yet if the wider public struggles to find meaning for genetic manipulations that do, ostensibly, have a potential medical benefit, then what happens to that form of justification if the manipulation involves inserting a gene yielding fluorescence? And for purposes of art? If lay people use familiar examples of cultural practices (such as meat-eating) as an anchor to understand the moral issues involved in using animals as organ donors, then what kind of familiar example might be used in relation to fluorescence? The problem here is that few people are likely to see much point in using the GFP gene, even for medical research, or be able to make sense of GFP rabbits in terms of ''doing good''. It is not surprising that there was public furore following the announcement of Alba's production.

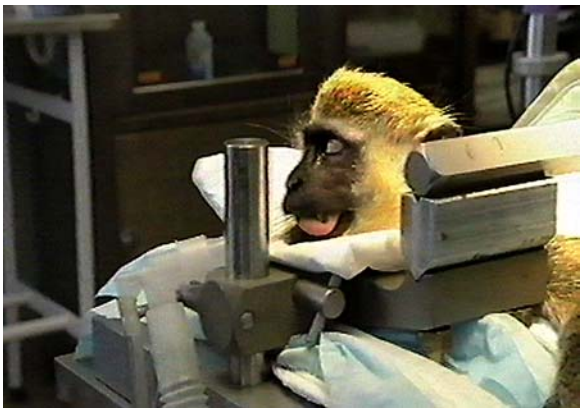

Fig. 3 Baboon in vice in xenotransplantation experiment
Credit: ©2001 Organ Farm/Carlton TV

[12] The trope of the animal as dying for our sins—our saviour—is a recurrent motif in science, as Haraway (1997) has argued.

Writing about public anxieties about the production of animals "made-to-order" through biotechnology, Michael (2001) notes the highly complex symbolic role of animals, a symbolic potency that depends on their alterity and difference. Rabbits, for example, convey a multitude of cultural referents, in cartoons, films and children's books (and Kac himself draws on the image of the cute pet rabbit on his website). This complexity, argues Michael, is inextricably linked to a wide range of (human) identities in Western culture, such that animals become a highly significant cultural resource. This in turn is a source of public anxiety: if animals are imbued with so many meanings, then those meanings are threatened by technological interventions. Yet, at the same time, what Michael calls "technoscientific bespoking"—making animals to order—dramatically curtails their symbolic value, which can further promote unease.

A key part of public opposition to these (and other) new technologies is that people sometimes perceive science as too instrumental, too obsessed with techniques and oblivious to consequences (other than the sometimes grandiose claims used to justify the research, such as "potential cure for cancer").[13] That, I believe, is critical. Advocates of genetic manipulation, whether for purposes of science or art, often seem far too much in love with the techniques, and not the outcome, in the form of a live and sentient animal. Yet it is the outcome—what happens to the animals—with which the lay public are most concerned?[14] And this point raises further questions in relation to public perception: what will happen in the future, as new techniques are developed? What techniques will be thus appropriated as aesthetic, turned into "artforms"? And, when these involve living creatures, what happens to the future of the relationships we have with other animals—to identities, both theirs and ours? These are the questions that we should be asking, and with considerable urgency—for these are the questions that underlie public unease.

While many geneticists might bemoan public anxieties over genetic manipulation, perceiving the public as misguided, other writers explore those anxieties. I began this article with a quotation from Margaret Atwood's novel, *Oryx and Crake* (2004); in this novel, she portrays a dystopian future where genetically manipulated and monstrous animals have escaped and cause havoc in a world laid waste. Among these are the green glow-in-the-dark rabbits "with gigantic teeth". These strange (and usually dangerous in the story) figures draw upon our profound anxieties about crossing species boundaries. But the story goes further, for the other side of the genetic experiments that led to disaster was the creation of tailor-made humans made, among other things, with built-in obsolescence—a terrible vision for a species so obsessed with dreams of immortality.

And we should heed where our dreams and symbols can take us. Perhaps we might pay attention to the way that those glow-in-the-dark genes came from jellyfish, whose free-swimming adult form is called a Medusa. Remember

[13] Jasper and Nelkin (1992) point out how the rhetoric of animal rights and environmental campaigners draws on an explicitly anti-instrumentalist stance, opposed to what they see as the excessive instrumentalism of modern science and technology.

[14] I am grateful to Mike Michael for drawing my attention to this point. In noting public concern about the outcome, I mean to include both concern over animal integrities and public concerns over potential medical outcomes. These are far more important to lay observers, I would argue, than the techniques.

Medusa? Her vanity about her own beauty got her into a great deal of trouble with the goddess Athena, and she was made into a horrible monster, with her hair becoming a halo of hissing serpents. She was a monster so terrible that no one could look on her without being turned to stone.

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