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CHAPTER 10. Animal, Mechanical, and Me

Organ Transplantation and the Ambiguity of Embodiment

Gill Haddow

Organ donation and transplantation is a largely successful treatment used to replace failing organs. However, donation rates have never met the demand for transplantable or gans. Biomedical researchers are exploring alternative sources from nonhuman animal donors such as pigs; improved biotechnological solutions such as total artificial hearts; and 3D printed organs developed from the recipient's own cells. These solutions are in various stages of development, and they may or may not prove viable in terms of cost, functionality, and/or compatibility with the recipient's body. In this chapter, I ask not about the viability of these proposed solutions, but rather, about the acceptability of the various technologies to potential recipients. Simply put: were these organ transplant al ternatives to become available, would patients agree to them? Analyzing answers from fo cus group interviews and surveys, I use the responses to show that individuals imagine these various technologies as familiar or foreign, self or other, clean or dirty, and so on. People envisage that using different materials will certainly affect their bodies but also their subjectivities. New biotechnologies are raising questions about altering subjectivity through body modification, and the answers to these questions demonstrate ambiguity.

> "A Czech story tells of a blind man who asked for the eyes of a young girl and was given instead, in secret substitution, the eyes of various animals. Each time, he saw what the animals saw: when he was given the eyes of fish, he saw fins and scales; when he was given the eyes of birds, he saw the sky and clouds. This story reflects the widespread folk belief that when you see with someone's else's eyes, you see what that creature sees; more broadly, when you are given someone else's organs, you take on that person's personality in some way"
>
> (Doniger 1995, 202).

The transference of qualities between humans and animals, described in the Czech folk story above, shares similarities with the alterations in subjectivity reported by some human organ transplant recipients. Changes in gender or behavior, a resurgence of youth, or discovering new tastes and preferences are often attributed by transplant recipients to the act of taking an organ from one person and transplanting it into another (Fox and Swazey 1974, 1992; Pearsall et al. 2002; Sharp 1995; Simmons and Klein 1987; Sylvia and Novack 1997).

If such an alteration is said to happen in the case of human-to-human organ transplant, could similar alterations in subjectivity happen if an organ from a pig were ever to be transplanted into a human? Would a person expect to inherit pig-like characteristics? What about mechanical implants? If an implantable device changed an individual's body to part-machine, would it make her feel robotic as a consequence? Alternatively, what if a replacement organ could be grown from the recipient's own cells? Would a recipient feel different after implantation of such an organ?

While human organ transplantation from deceased or living donors is in widespread use, other kinds of transplantation are still mostly speculative. Using organs from animals—a procedure known as xenotransplantation—remains experimental and largely unsuccessful. Replacing entire organs, such as the heart, with implantable devices, is a rare occurrence, used only as a stop-gap measure until a human organ can be transplanted. Use of three-dimensional (3D) bioprinted organs (made up of the patient's own cells) has recently received publicity as a potential procedure to alleviate the shortage of human organs, but it has yet to be tested in humans. In this chapter, I discuss people's reactions to imagined encounters with these technologies. I asked people to consider (1) what they would prefer if given a hypothetical choice between human, animal, and mechanical transplantation; (2) whether they thought changes in their subjectivity could happen as a result of receiving a transplant; and (3), if so, whether they felt that the change in subjectivity would vary depending on the source of the transplanted material. My intention in this chapter is to highlight how the answers to those questions illuminate the relationship that people experience with their bodies—how they experience "embodiment," in other words.

The data in this chapter are drawn from a mixed-method study conducted in 2016 in the United Kingdom, comprised of four focus groups followed by a representative survey questionnaire with young people. The focus groups helped elucidate the five options (deceased human organ donation, living human organ donation, xenotransplantation, mechanical devices, and 3D bioprinting) that were then presented to over one thousand young people in a questionnaire. The data are part of a larger Wellcome Trust–funded study called "Animal, Mechanical, and Me: The Search for Replaceable Hearts" (2013–2018).

The study results demonstrate that individuals believe that using different kinds of materials to replace or regenerate human organs could cause different changes in subjectivity. Our data, both from the focus groups and the survey, suggest that xenotransplantation would be hugely unpopular. Partly, this is due to concerns about the ethical treatment of animals as well as thoughts about physiological, functional, and immunological compatibility with humans. The qualitative and quantitative findings show pigs—the species scientists most commonly cite as a candidate for growing human-compatible organs—were thought to be "dirty." But xenotransplantation was also seen to have adverse implications for the subjectivity of the individual recipient, and more generally for human beings as a species.

3D bioprinting of organs and transplantation from a living known donor emerged as the preferred options both in focus groups and among survey respondents. The popularity of 3D bioprinting highlights the desire to maintain the borders that separate human beings from other species, as well as the boundaries of the individual's own body—hence participants' descriptions of 3D bioprinted organ as "your own," "part of my body," "part of me," and "my own cells in my own life." Such responses indicate that participants saw 3D bioprinting as compatible, in terms of species, biology, and identity, with maintaining boundaries that they believed would be transgressed with xenotransplantation.

The data also showed that the option of implanting mechanical devices would be less popular than the possibility of 3D bioprinted organs. Respondents were concerned at the possibility of mechanical breakage and malfunction. But they also mentioned potential changes in subjectivity with mechanical implants: "you'd feel like a robot or a freak," "makes me less human," and "because I don't want a machine inside my body." These anticipated changes in subjectivity differed from those associated with xenotransplantation, however. Replacing

organs with a mechanical equivalent was associated with a loss of human identity, whereas the idea of xenotransplantation prompted fears that a recipient could gain animal attributes.

In what follows, I first outline the current status of whole organ replacement focusing on the three real and imagined biotechnologies: xenotransplantation, implantable medical devices, and 3D bioprinting. Next, I describe the mixed-method approach taken for this study. In the third section, I present the findings, drawing out key figures, statements, and discussions from the participants' accounts of their preferences for animal, mechanical, and human transplantation. Finally, I discuss these findings, focusing on what the imagined changes in subjectivity alterations can tell us about a person's everyday experience of embodiment. If a person experiences herself as distinct from her body—possessing a body as she would a car say—then she does not imagine her subjectivity changing when her body is modified. If a person experiences her body as closely intertwined with her personal identity, then she is more inclined to suppose that body modification will result in a change in subjectivity. However, these categories of embodiment—"I have/have not" versus "I am/am not" my body—are fluid and dynamic experiences and never as static as this dichotomy suggests. I therefore argue that embodiment is an ambiguous experience—and one, moreover, that is being confronted with new techno-scientific interventions to repair, replace, or regenerate the human body in pursuit of gains in the length and quality of life (Haddow 2015).

Organ Replacement Technologies: The Current State of Play

Animal: Xenotransplantation

At the moment, human organ transplantation is widely used as an effective means of repairing and replacing an individual's failing organs. However, this effectiveness is limited by the shortage of human donors. Attempting to use whole animal organs, a procedure called xenotransplantation, remains a highly experimental procedure and there are no successful cases of it to date.[1] Some individuals live with small amounts of animal-based products in their bodies (such as bio-prosthetic heart valves and porcine islet cells). But this has not proved possible with whole organs, as animal organs maintain their cellular structures, making them liable to attack by the recipient's immune system. Clinical and ethical attention to xenotransplantation continues, however, driven partly by researchers' interest in exploiting the biological similarities between human and animals. Pigs are preferred due to their comparable organ size, while appearing to raise fewer ethical concerns than using primates. An early report into ethical and social questions around xenotransplantation was conducted by the United Kingdom's Nuffield Council (1996) and emphasized how clinical trials of xenotransplantation might proceed in an ethical and responsible manner (Fovargue 2007) while preserving "human dignity" (Degrazia 2007). However, the report highlighted concerns over disease control (e.g., porcine endogenous retrovirus) that would require close monitoring of individuals (Nuffield Council on Bioethics 1996). It also suggested that:

> It is difficult to predict how people's views of their bodies and of their identities might be affected by xenotransplantation. On the one hand, the use of animal organs might eliminate any disturbing implications associated with receiving a human organ. On the other hand, receiving an animal transplant might cause different stresses. The response is likely to reflect the emotions of what it is to be a person, to

1 Genetic modifications such as CRISPR-Cas9 show some success (Lundin and Widner 2000; Lundin 1999, 2002). Indeed, a breakthrough occurred in 2016, when it was reported that a genetically modified pig's heart, placed inside a baboon's abdomen, had survived for over 900 days (Mohiuddin et al. 2016). Chimeric 2C10R4 anti-CD40 antibody therapy is critical for long-term survival of GTKO.hCD46.hTBM pig-to-primate cardiac xenograft. The success of gene modification could be significant as it demonstrates how gene editing and immunosuppressant therapy could potentially the ability of bodies to be able to reject those organs not recognized as the person's own. However, this success is not yet an example of a functioning heart in a human body.

> be human, and to be an animal. These notions are not uniform for this or any other society, but vary according to social and cultural background.
>
> (Nuffield Council on Bioethics 1996)

Due to the lack of success with xenotransplantation, little is known about how modifying the body in this way might alter the identity of the recipient. Early work examined the narratives and reactions of a number of patients who received porcine islets for the treatment of diabetes, and it found a minority of patients relating anxieties about the transference of animal qualities (Lundin 1999, 2002; Lundin and Widner 2000). One diabetic patient who had received porcine islets reflected: "It feels like something big and meaty. And I am wondering what way it can change me as a person. Yes, not that I'll develop a tail or anything like that—but that something will happen to me all the same" and "Like small piglets … tiny pig cells that I have no control over and that can pump something animal like into my body" (Lundin 2002, 337) although studies have also found little concern, however (Idvall 2006; Lundin 2002; Teran-Escandon et al. 2005).

Mechanical: Implantable Medical Devices

Implantable medical devices are becoming smaller, cheaper, and far more advanced (Haddow et al. 2016; Harmon et al. 2015). Semiautonomous and (partially) implanted devices range from cochlear and retinal implants, neurobionics, deep brain stimulators, neuroimplants, vagus nerve stimulators, pacemakers, and left ventricular assist devices (LVADs), to artificial pancreases and implantable cardiac defibrillators (ICDs). Even the entire human heart can now be temporarily replaced with a mechanical substitute. SynCardia, an American biotechnology company, reports implanting over a thousand total artificial hearts (TAHs) as bridging devices until a human heart transplant can be found (http://www.syncardia.com/). These TAHs are increasingly being relied upon for longer periods of time as a destination therapy, for example when a heart transplant has been ruled out. Whereas xenotransplantation has failed due to problems of organ *rejection*, implantable mechanical devices can cause *infection* as well as sometimes failing themselves:

> As of 2011, 47 patients had been supported with a SynCardia TAH for greater than one year worldwide. The mean support time was 554 days … Device failure occurred in 10% of patients. Systemic infections were observed in 53% of patients, driveline infections in 27% of patients, thromboembolic events in 19% of patients, and hemorrhagic events in 14% of patients.
>
> (Cook et al. 2015, 2178)

In addition to these problems, there is also the inconvenience of a power supply to be carried around in a rucksack by the recipient (Standing et al. 2017). The few patient testimonials available on the SynCardia website are superficial and positive, making no mention of infection or inconvenience; for example, see https://syncardia.com/patients/home/.

Despite the risk of infection and malfunction, studies report that, hypothetically at least, individuals are more likely to accept a medical device for organ replacement, preferring it to animal parts. Despite small numbers and selective participants, in Sharp's study of fifty undergraduates, she found that the majority preferred human organs, followed by mechanical, with none choosing an organ from a baboon (Sharp 2006). A few of her survey respondents reflected on why they would prefer a mechanical option, declaring for instance that "Nobody's used it before me and infected it" (Sharp 2006, 229). A few of Sharp's respondents worried about taking on characteristics of the baboon, suggesting that "If it all worked equally well, I wouldn't care. Though it would be a little strange to have a baboon heart. Would I start baring my teeth and bottom?" (Sharp 2006, 232). Sharp attributes these responses to an "aversion to … strangeness, monstrousness, and hybridity … to the imagined possibilities borne by xenotransplantation" (Sharp 2006, 240). A study of the Swedish public found that 77

percent said they would be more willing to accept an organ from a relative, 69 percent from a deceased person, 63 percent an artificial "organ," and 40 percent an animal organ (Sanner 1998, 2001, 2006). These comparative studies showing the unpopularity of animal organs compared to mechanical devices are important. However, they do not identify the pig as the most likely organ source, as is currently the case. Nor do these studies include recent innovations such as 3D bioprinting as an option (Kranenburg et al. 2005).

Human: 3D Bioprint Me?

Proponents argue that, if successful, 3D bioprinting could avoid the challenges of rejection and immunosuppression that xenotransplantation raises, as well as the risks of infection and malfunction that mechanical devices pose. 3D bioprinting of organs would take personalized medicine to a new level, offering the possibility of on-demand printing of organs grown from an individual's own cells. Specialized printers use biological inks (such as differentiated-, human embryonic-, or induced pluripotent stem cells [iPSCs]) to print layers of living materials one slice at a time, one on top of another (Vermeulen et al. 2017). "[A]chieving the desired level of cell density, effective vascularization and accelerated tissue maturation are remaining challenges," however (Mironov et al. 2011, 669). The risks of the procedure, especially using iPSCs, are unknown and have never been attempted for fear that the procedure could prove fatal (Vermeulen et al. 2017).

Methods

Focus Groups and Questionnaires

In 2016, we conducted four focus groups followed by a representative survey of young people, in order to explore people's beliefs about using human, animal, or mechanical biotechnologies to replace failing human organs. The focus group study was conducted first, primarily to explore questions and issues about embodiment and biomedical technology that could be discussed generally, and then to identify and operationalize questions specifically for the later survey.

The focus groups were purposively sampled for age, religion, sporting activity, and familiarity with technology—demographics that we believed might influence participants' responses to the questions about the hypothetical use of animal, mechanical, or human organs. Identification of group members was based on the following primary characteristics: (1) being older and therefore pre-Internet citizens in the case of the over 65 years of age focus group; (2) "technology embracers" such as members of a computer gamer club; (3) individuals focused on body work such as the University competitive fencers who were recruited to a focus group; and finally (4) individuals with known religious views regarding the consumption of meat, hence inclusion of members of a University's Islamic faith group. Individual participants' identities did not match one to one with these chosen characteristics, varying by experiences, demographics, and interests. For example, Roy in the over-65 group and a "pre-Internet citizen" was also a committed lifelong vegan, which strongly affected his views of xenotransplantation.

The focus group discussions took place in a mutually agreeable location generally lasting an hour and a half. On average, there were about five members in each group. Areas of discussion began with exploring ideas about the relationship an individual has with his or her body, followed by conversations about human organ transplantation and willingness to accept novel technologies such as xenotransplantation and 3D bioprinting.[2]

2 In the focus groups, permission was sought to record and reassurances about confidentiality given (a mixture of first names and pseudonyms are widely used in the following accounts). Focus groups were transcribed verbatim and the text imported into a computer-aided qualitative data analysis package (Nvivo 11). A constant comparative method for generating codes from the data and themes from the interrelations between codes was used; this approach is loosely informed by grounded theory (Charmaz 2006). However, a more abductive approach to thematic generation was taken overall, that is, with a knowledge of previous research and a sensitivity that new and unanticipated data would emerge (Blaike 2007).

The focus groups also generated data through the unique interactions between participants and therefore offer important data.[3] The focus group data also helped inform the next phase of data collection, elucidating the options to be offered to a representative survey of young adults.

A total of 1,550 young people between 11 and 17 years of age were targeted as survey respondents. We recruited young people as they are thought to be more open to technoscientific solutions given their status as Internet citizens.[4] The survey question was phrased as follows:

> Sometimes people's organs (e.g., their heart or their liver) can stop working properly. If this happens, they need to have that organ replaced. Imagine you needed to have an organ replaced because it wasn't working properly, how would you want it replaced? Please rank the following options from 1 to 5 in order of preference (1 being the option you most prefer and 5 being the option you least prefer).
>
> An organ taken from a pig;
> A mechanical device that did the work of the organ;
> A spare organ taken from someone you knew who was alive;
> An organ grown from your own cells in a laboratory;
> An organ taken from a stranger who has recently died;
> Don't know;
> Prefer not to say.

The responses to this question were analyzed using SPSS v.11.5. Survey respondents were encouraged to give additional open comments at the end of the questionnaire explaining their choice. Open comment responses were analyzed by categorizing and quantifying in Excel. The findings that follow draw on data from both the survey results and the focus group discussions.

Results

All the Humans: It Has To Be Me, You, and Then Someone Else

The results from the survey (see Table 10.1) demonstrate a majority of the young people in the survey suggesting the most popular choice for organ replacement was an organ grown from their own cells in the laboratory (3D bioprinting) (n = 345):

All the human organ options were the most popular in the focus groups and the survey. Living donation (n = 336) and 3D bioprinting (n = 345) were far more popular than deceased organ donation (n = 179). This is surprising given the reliance on deceased human organ transplantation procedures carried out today. There appeared to be two reasons for this response. It was partly because the organ would come from a stranger and, as survey respondents suggest, "I don't know the person or how they lived their life," "because it seems risky and I wouldn't know their past"; and also because the organs came from a deceased donor: "Because they are dead and that's weird," "I don't like the thought of someone's dead organs in me they wouldn't work," and "it would be kind of gross to have a complete stranger's organ in your body." For those who supported deceased donation, the main

3 I am very grateful to Dr. Tirion Seymour for the organization, recruitment, and conduct of the focus groups.

4 The overall sample of young people comprised around three hundred state secondary schools throughout Scotland, UK. The sampling frame was stratified by local authority, school size, and urban-rural classification and a random start point ensured a representative sample of secondary schools was produced. Each school agreeing to participate in the research was randomly allocated 2-year groups from S1 to S6. The survey was administered by class teachers, using self-completion online questionnaires in a mixed-ability class such as Personal, Health, and Social Education. The questions were generated in close collaboration with Ipsos MORI, a large UK market research company commissioned to carry out the study (https://www.ipsos.com/ipsos-mori/en-uk).

reason for preferring it was "because the person was dead" and the "organs would not go to waste." No mention was made about subjective changes due to modification of the body through deceased organ donation, either in focus groups or by survey respondents. Overall the human connection was preferred, as Muriel in the over-65 group suggests: "I would prefer to have something that is connected in some way to a human being either past or present or manufactured from something in the … Well, just having a connection to a human in some way, even it was made from cells cultured in the lab originally."

Indeed, 3D bioprinting was very popular. Statements in the open comments of the survey reflected the perceived importance of being human, being from "my own cells," "it was your own," "part of my body," "part of me," "my own cells in my own life," from "my own body and not from someone else's," "my own body, nothing else," "they come from me." However, 3D bioprinting was also believed to be a future luxury and an option for only those that could afford it. Diana, in the University Islamic group, pointed out that this would be an expensive first-world option:

> I think I would of course prefer my own stem cell and my reason is like what I pointed out earlier, sometimes our body rejects a new organ, someone else's stem cell might have a different reaction, there is a risk, the issue of risk, but however, going back to the initial stem cells in, yes, I would prefer that, but on the other hand I think it's quite an exclusive option because there are many countries, we cannot afford such technology, and we have to depend on a human donor, so it's great, but it's very limited in how it reaches up to people, and there are a lot of people who are in need of organs, and probably people from a first-world country could develop this technology. The only thing your own stem cells do for organs that can be in turn donated to people who cannot afford it in third-world countries, I think that's a great option, yeah.

In sum, use of 3D bioprinting and using organs from a known living individual are the most preferred imagined options, although the data overall indicate an interest in receiving an organ from any human being. Ideally, organs that are transplanted are human, and they come from the self or as close to self as possible and a known living donor, although an organ from a deceased stranger will do. As I turn to next, animal transplantation simply will not do.

Table 10.1. How Would You Most Want the Organ Replaced?

Â	Frequency	Percent
An organ taken from a pig	25	1.6
A mechanical device that did the work of the organ	123	7.9
An organ taken from a stranger who has recently died	179	11.5
A spare organ taken from someone you knew who was alive	336	21.7
An organ grown from your own cells in a laboratory	345	22.3
Â	Â	Â
Don't know	407	26.3
Prefer not to say	135	8.7
Total	1550	100.0

Pigs, People, and Pollution

When the topic of xenotransplantation was introduced, participants in both focus groups and survey respondents made ethical statements about protecting animals from cruelty, abuse, and suffering, invoking principles of fairness and sympathy. In the survey's open comment section, mentions about the pig's status as

dirty and unclean were numerous. Examples such as "It's yuck, disgusting, gross, unclean" and "It's a farm animal with a very unhealthy diet." Words commonly used were disgusting, not natural, grim, vile, and rank. Often the response was stated baldly and simply: "It's a pig." No additional justification was offered, as the statement was presumed to be self-explanatory.

Individuals also shared concerns about the human body's ability to reject what it perceives as foreign. In the fencers' focus group, Zoe discussed the greater amounts of immunosuppressants she thought would be required for the recipient's body to accept a nonhuman animal organ:

> If it was a last resort, I would definitely accept an animal organ. But I would accept a human organ over an animal organ if they were both available. Because even if it was like perfectly functional, the same, but there are risks associated with animals because they are different, physiologically. So, if you get down to like cellular level with all the receptors and everything, it means you have to be on … I know you have to be on immunosuppressants in a human, but you have to be on more, I think, with an animal.

There was also sociocultural antipathy to xenotransplantation. Results from the survey sample showed no difference in attitudes toward xenotransplantation between those who said they ate meat and those who said they preferred not to (46 percent versus 48 percent). Some authors have argued that it is ethically acceptable for Muslims and Jews to accept pigs as substitute organ donors despite religious instruction not to eat pork (Welin and Sandrin 2006). The survey results do not support this position however. None of the young adults who identified as Muslim (n = 27), Buddhist (n = 10), Sikh (n = 3), Jewish (n = 3), or Pagan (n = 5) chose the xenotransplanted option. In the following exchange between Assad and Halima in the University Islamic Group, Assad articulates the relationship between pigs and feces:

> *ASSAD:*
>
> For example, like pigs are seen in Islam as … so if you look like … I'm trying to say … like for example, pigs and stuff, like they also like … the reason why they don't … I think the reason is because pigs are like … they play around in mud and stuff.
>
> *HALIMA:*
>
> Lay there in fecal matter.
>
> *ASSAD:*
>
> And they also eat their …
>
> *HALIMA:*
>
> Fecal.
>
> *ASSAD:*
>
> Yes, and their own poo, so they're generally seen … I was thinking of a way not to say that, by the way, if you didn't get it. So yeah.

Religious instruction forbidding the consumption of pork thus appears more important than lifestyle choices when asking people to make hypothetical decisions about accepting an animal organ. This is borne out in the comments in the open sections of the questionnaire with some participants self-identifying as Muslim, suggesting that using pigs for transplantation is not halal. In the commentary section of the survey where respondents were offered space to further elaborate on their answers to the survey, the association of the pig to dirt was often made regardless of religious affiliation, however.

The risks the respondents associated with using nonhuman animal organs were not only about practical, ethical, or religious issues but had to do with consequences for personal identity. "Making them feel different" was offered by survey and focus group participants as a reason for their rejection of xenotransplantation. In the open comments section of the questionnaire, many comments were recorded, such as "It just feels strange" and "It doesn't sound right," "It would especially make me feel mentally uncomfortable," "It would creep me out," "It's not nice to think about," "I don't want a pig/animal inside me." A recurrent theme was that having a pig organ would make someone "part-pig." Comments included: "I would hate to have an organ from an animal," "I wouldn't feel right having a pig's organ," "I don't wanna be part pig, cause I would be pig," "I don't want a pig inside me," and "I would feel awkward about having a pig organ." Not everyone thought that having pig's organ would affect their identity; thus, Diana suggests: "I don't think it affects me as a person. I think it … if I needed, it's urgent, I might die without it, I think I would take it and it will not affect me as a person, I'm really sure of it."

These results suggest that, in the xenotransplantation context, pig organs invoke a "yuck" factor. This is in line with previous studies, which have found that proposals to mix animal and human materials produce public reactions of disgust or "yuck" (Brown 1999) and are possibly related to a "wisdom of repugnance" (Kass 2002). In the context of this study, "yuck" responses expressed concerns about pollution behavior, mixing up human and animal bodies, and blurring the boundaries between species. Whether or not pigs (or any other nonhuman animal) are considered unclean, their use in transplants challenges known schemata of what it is to be a "pig" and what it is to be "human." According to Mary Douglas, "Pollution behaviour is the reaction which condemns any object or idea likely to confuse or contradict cherished classifications" (Douglas 1966, 36). By raising questions about how animals, and pigs in particular, can transgress the boundaries between animals and humans, xenotransplantation prompts pollution behavior expressed as a "yuck" response (Alter 2007; Chakrabarty 2003; Robert and Baylis 2003). In this respect, views about xenotransplantation are closer to social reactions regarding chimeras and hybrid animals than to vegetarianism. Despite widespread practices of animal breeding, the creation of chimeras and hybrids is commonly seen as "an affront to the hierarchical superiority and separateness of the human species" (Knoppers and Joly 2007, 284). By the same token, placing animal organs inside a human body would create a hybrid entity that transgresses familiar and taken-for-granted boundaries between species (Alter 2007; Chakrabarty 2003; Robert and Baylis 2003). The use of pig organs, in particular, would further compound the problem, since the pig, Douglas suggests, is the "odium of multiple pollution" (Douglas 1972, 79). Respondents' views on xenotransplantation thus demonstrate concerns both about policing species boundaries and—significantly—about protecting the individual's subjective identity.

What about Machines?

Study participants did not view mechanical devices as positively as human organs, nor as negatively as animal organs. Participants expressed fears that harm to the body and changes in subjectivity would result from the use of implantable devices. The reasons they gave for not wanting to use machine parts to repair the human body included that "you'd feel like a robot or a freak," "makes me less human," "because I don't want a machine inside my body," "I don't want to be cyborg," and "I don't want metal inside me." Those who selected a mechanical device as their most favored option suggested that, due to thorough testing and technological advances, technology was "smart": "Because technology now is really smart so I would feel safe having something smart doing the work," "I want to be like Iron Man or the Terminator eh," "It would be cool being part robot," "It would be cool to be Robocop." However, others expressed concerns about the reliability of implantable devices.

A few focus group participants expressed a pragmatic view that whatever kind of replacement or repair was used, its ability to function correctly overrode any clear preferences about where it came from or what it was made of. Carlos, in particular, was notably consistent in expressing such a view: when I asked him about his preferences between the five options, he suggested that he did not have any strong feelings. "Not really, *as long as it works*, I keep saying this, I know" (Carlos, Gamers Focus group, emphasis added). It is notable, in this regard, that participants' concerns about possible *mal*function—unlike issues of organic compatibility—only related to

machines, raising distinctive questions of technological vulnerability: not only would implants break, but also could they be broken or hacked into by malevolent others. Although the issue of biohacking did not come up in the survey, it was mentioned frequently in the gamer focus group:

SCOTT:

Well, I think my point was the same technology that could be used to control the misfiring of epilepsy could be used in other ways that aren't quite as seemly …

DOMINIQUA:

Also to murder people potentially just find the right frequency and you fry your brain or stop your heart.

ASSAD AND DIANA:

in the University Islamic group exchanged views around the difference between a human-made and a living thing, with Diana stating that she would prefer the human option:

ASSAD:

And also the system, it's a man-made thing, as in it's not exactly … I say man-made … I mean, I think I would rather use that, yeah.

GILL:

Can I push you a little bit more on the distinction between it being artificial, say, man-made, we'll go with man-made, that's fine, it's okay, and animal, is there something …

ASSAD:

Well, I mean, there is obviously a difference because it is not a living creature. I don't want to go all hippy and try and like …

GILL:

No, no …

ASSAD:

But obviously it is different, it's a completely different thing because it's not a living thing, it's not something that God has created, it's just something … it's not a man creation, but it's not real, it's not that valuable.

DIANA:

Quite the opposite, actually, I wouldn't take it (machine). I would put it last (in terms of preference), simply because I think the human connection is very important. Taking an organ from a human donor to me, is the best option. I know it sounds macabre, but because I myself, I have … expressed earlier, when I die I would like to strip myself bare in the sense that you take everything I have for use of someone who really needs it, and I think on that note I would prefer to take from human being who is obviously deceased, but it's not that I undermined the competency or the value of machines, but it's just that taking something human is essentially human of me. It's more sentimental, there's nothing … I have no scientific or religious opinion on this, it's just sentimental.

Both Assad and Diana started from the same premise: that there is something peculiarly valuable about human organs. But they reached different conclusions. Assad and Diana *agreed* about what is natural, and they agreed that natural (and especially human) things are more valuable than artificial things. Their disagreement was solely over whether they would choose the unnatural, less valuable implant (Assad) or the natural, more valuable one (Diana).

The Nuffield Council on Bioethics (1996), mentioned in the introduction, conducted a recent analysis of the role that the concept of "natural" plays in public debate. It concluded it is a term to be avoided in a public context, because of the variability in its use over time.

Embedded within the exchange between Diana and Assad, was a firm idea, not just of what is natural, but of how choices about what is thought to be natural, are being created by the way that technology is challenging what is considered as such. As Science and Technology Studies (STS) scholars have noted:

> The contemporary need for naturalness can be better understood as a response to the fact that technology makes reality more and more makeable and, consequently, more contingent. Advancing technology changes everything that is, into our object of choice … [I]f human nature itself becomes makeable, it can no longer naively be laid down as the norm.
>
> (Swierstra et al. 2009, 274)

Conclusion

The argument presented in this chapter is based upon research that was deliberately mixed method in attempting to gauge both the depth and breadth of views, as well as generating new findings about, for example, 3D bioprinting. The research suffers from a number of methodological and conceptual issues. The focus groups were difficult to recruit. Informal feedback suggested that this was partly due to people feeling they did not know enough. Indeed, in the focus group, I felt I spent too much time explaining the benefits and risks of the technologies, which restricted further opportunities for contribution from the participants. Lack of information during the survey contributed to a high number (over 25 percent) of "don't know" responses. The methodological context is hampered by using hypothetical questions ("what if this happened?"). Posing questions about future technologies that are both conjectural (preferences for using human or animal technologies that do not exist) and rhetorical (even if they did exist, patient choices would be clinically informed and not based solely on individual choice) are demanding for participants to answer.

It is reassuring, therefore, that the results from both focus groups and survey are clear overall, and are in line with previous studies. The data contribute in important ways to questions about how much and what kind of body modification would be required before a person's subjective identity is thought to be altered. This recalls a philosophical problem called "The Ship of Theseus": how much of a ship needs to be changed before it is no longer the same ship? In the case of organ transplantation and body modification the question is: "how much of the human body can be changed before a person becomes someone else."

In this chapter, I have focused not on how much body modification is thought needed to alter subjectivity, but what kind of modification. The protection of human boundaries from contamination by animals, in particular the pig, was a strong theme emerging from the data. Xenotransplantation challenges human identity producing "yuck"-type responses in relation to the individual's subjectivity, to animal and human ontologies, and to a perceived threat to human beings at the species level. Using implantable medical devices to replace whole organs provokes fears of mechanical malfunction and a change in subjectivity that is imagined to be both "robotic" and unnatural. Preference for human donors can be seen as part of protecting the boundaries of the individual, as well as the species, from machines that are perceived to diminish humanity, and from animals that are imagined to contaminate identity.

This research did not seek to ascertain the "truth" of the subjective consequences of modifying the body by animal, mechanical, or human means. Moreover, some comments indicate a lack of understanding of how transplantation works and thus participants might not be well positioned to assess the relative merits of different methods (e.g., in relation to comments about the importance of knowing the background of a living donor). Rather, it builds a narrative of what the likely effects of different sources of substitute organ are imagined to be. Techno-scientific advances in biomedicine such as xenotransplantation, organ transplantation, and the increasing turn to mechanical that is "implantable medical devices" can pose challenges to experiential accounts of embodiment. According to those philosophies of embodiment that presume some form of Cartesian dualism —a perspective that informs much current reflection on biomedical innovation—subjectivity is typically considered to be quite separate from the body. On this view, body modification has little or no effect on subjectivity. From more phenomenological perspectives, however—the body is the experiential basis of being in the world, and the person is inseparable from one's body. Embodiment then can simultaneously be experienced as both having and being a body. Embodiment is thus not a static state, but an ambiguous one: a dynamic and fluid process that becomes more or less important to everyday living depending on the circumstances that bring it to the fore (Cregan 2006; Crossley 1995; Haddow 2015; Howson and Inglis 2001; Turner 2008). Given potential organ recipients' expressed beliefs, about the ambiguity of embodiment in reaction to xenotransplantation, 3D printed organs, and implantable medical devices, such findings may be of interest to researchers determining which avenues of research to pursue.

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