Constructing and Fracturing Alliances:
Actant Stories and the Australian
Xenotransplantation Network

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“The XWP [Xenotransplantation Working Party] agree that, in retrospect, a sociologist would have been a useful addition to the group to help understand these issues” (Xenotransplantation Working Party 2004: 14, emphasis added).
Keywords

sociology; xenotransplantation; transplantation; allotransplantation; actor-network theory; science and technology studies; public understanding of science (PUS); critical public understanding of science (critical PUS); scientific knowledge; public consultation; risk; animals
Abstract

Xenotransplantation (XTP; animal-to-human transplantation) is a controversial technology of contemporary scientific, medical, ethical and social debate in Australia and internationally. The complexities of XTP encompass immunology, immunosuppression, physiology, technology (genetic engineering and cloning), microbiology, and animal/human relations. As a result of these controversies, the National Health and Medical Research Council (NHMRC), Australia, formed the Xenotransplantation Working Party (XWP) in 2001. The XWP was designed to advise the NHMRC on XTP, if and how it should proceed in Australia, and to provide draft regulatory guidelines. During the period 2001-2004, the XWP produced three publicly available documents one of which, 'Animal-to-Human Transplantation Research: A Guide for the Community' (2003), was specifically designed to introduce the general public to the major issues and background of XTP.

This thesis examines XTP in Australia as guided and influenced by this community document. Explicitly, drawing upon actor (actant)-network theory, I will reveal the Australian XTP network and explore, describe and explain XTP problematisations and network negotiations by the enrolled actants on two key concepts and obligatory passage points - animals and risk. These actants include those providing regulatory advice (members of the XWP and the associated Animal Issues Subcommittee), those developing and/or critiquing XTP (official science and scientists), and those targeted by the technology (people on dialysis, with Type-1 diabetes, Huntington’s disease, Parkinson’s disease, pre-or post-human-to-human transplantation, and their partner/spouse). The stories are gathered through focus groups, semi-structured interviews and document analysis. They reveal ambiguous and sometimes contradictory stories about animals and risk, which influence and impact the problematisations of XTP and its networks. Therefore, XTP mobilises tension; facilitating both support and apprehension of the XTP network and its construction by both the sciences and the publics.
Publications and Conference Presentations

Publications *(related to this thesis)*


Conference Presentations (related to this thesis)

Cook, P.S. 2008. “We’ve got enough problems”: Subjective understandings of infectious risk in xenotransplantation, Acting with Science, Technology and Medicine, Society for the Social Studies of Science (4S)/European Association for the Study of Science and Technology (EASST) 2008, Erasmus University, Rotterdam, the Netherlands, 20th-23rd August 2008


Cook, P.S. 2006. ‘Overcoming and Reinforcing Dichotomies: The Animal/Human Divide and Xenotransplantation’, Reviewing Humanness: Bodies, Technologies and Spaces, European Association for the Study of Science and Technology (EASST) 2006, University of Lausanne, Lausanne, Switzerland, 23rd-26th August 2006

Cook, P.S. 2006. ‘Xenotransplantation and the Fragility of Human Rights’, Life, Death and Human Nature: Bioethics and Biolaw in the Twenty-First Century, ABA/ANZHILE 2006, Queensland University of Technology, Faculty of Law, Brisbane, Australia, 5th-8th July 2006

Cook, P.S. 2006. ‘Challenges and Hurdles for Xenotransplantation Regulation in Australia’, Immunology and Cell Biology, 84 (suppl.) Abstracts from the TSANZ 24th Annual Scientific Meeting, Australian Academy of Science, Canberra ACT, 29th-31st March 2006
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<td>Jeremy Batt*</td>
<td>Diagnosed with Type-1 diabetes</td>
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<td>Daniel Layton</td>
<td>Immunologist, CSIRO Australian Animal Health Laboratory and Austin Research Institute, Molecular Immunogenetics Laboratory</td>
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<td>Rod Logan*</td>
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<td>Professor in Animal Genetics; Centre for Advanced Technologies in Animal Genetics and Reproduction, Faculty of Veterinary Science, University of Sydney</td>
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<td>Sue Reilly*</td>
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<td>Diagnosed with Parkinson's disease</td>
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<td>Kevin Robins</td>
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<td>Mauro Sandrin</td>
<td>Co-Deputy Director of the Austin Research Institute and Head of the Molecular Immunogenetics Laboratory and the John Connell Laboratory for Glycobiology, and the Surgery Department (Austin Health Campus) of the University of Melbourne</td>
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<td>Denbigh Simond</td>
<td>Geneticist/cell biologist; Centre for Transplant Research, Westmead Millennium Institute, University of Sydney, Westmead Hospital</td>
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<td>Granddaughter's husband diagnosed with Type-1 diabetes; partner of Frank Smart*</td>
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<td>Frank Smart*</td>
<td>Diagnosed with Type-2 diabetes; partner of Bethany Smart*</td>
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<td>Scientist in livestock welfare and pig immunology; CSIRO</td>
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<td>Endocrinologist; Professor of Medicine; Senior staff specialist in endocrinology and Director of the Diabetes Transplant Unit at the Prince Wales Hospital, University of New South Wales</td>
<td>Telephone interview</td>
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</table>

Total (human) research participants - 40

* indicates pseudonym has been used at the participant's request
Glossary and Abbreviations

α-Gal (Galα1-3Gal) A sugar molecular (blood group) “present on the surface of the cells of lower mammalian species, including the pig. [α-Gal …] is recognized as foreign by human xenoreactive [natural] antibodies. […] α-Gal is recognized by human antibodies and hyperacute rejection is triggered” (Cooper and Lanza 2000: 255). Also plays a role in acute vascular rejection. α-Gal blood group is present in all mammals except for Old World primates and humans. In turn, α-Gal antibodies (xenoreactive natural antibodies) prevent the infection of porcine endogenous retrovirus (PERV) in humans (McKane et al. in Buhler 2004b: 6; 2004d: 477; Weiss 2004: 291).

α-Gal antibodies Refer to xenoreactive natural antibodies (XNAs).

α-GalF (α1,3galacosyltransferase) The enzyme that manufactures α-Gal.

ACR (acute cellular rejection) Also known as cell-mediated rejection, T-cell-mediated rejection and elicited immune responses. “An immunological process that occurs within a few days, weeks, or months following organ or tissue transplantation. It is mainly caused by the action of a group of white blood cells — the T cells — acting against the grafted tissue” (Cooper and Lanza 2000: 253).

Actant Refers to human and nonhuman actors alike.

Acute cellular rejection Refer to ACR.

Acute vascular rejection Refer to AVR.

AG/s (allograft/s; allotransplant/s) “The tissue or organ that has been transplanted from one individual to another genetically different member of the same species. An example would be a kidney transplanted from one human to another” (Cooper and Lanza 2000: 253).

AIDS (acquired immunodeficiency syndrome) “Disease caused by human immunodeficiency virus [HIV…], which […] destroys the patient’s cell-mediated immune response. This leaves the individual susceptible to a variety of opportunistic diseases, particularly certain infections and cancers” (Cooper and Lanza 2000: 253). AIDS/HIV is a human epidemic that is predicted to kill 74 million people by 2015 (Agence France-Presse (AFP) 2004a: para.1).

AIS Animal Issues Subcommittee.

Allograft/s Refer to AG/s.

Allotransplant/s Refer to AG/s.

Allotransplantation Refer to AT.

Animal cellular therapies Refer to cellular xenotransplantation.
**Animal external therapies** Refer to xenoperfusion.

**Animal source** See organ source.

**ANT** Actor(actant)-network theory.

**Antibody molecules** Target foreign bodies to elicit a non-specific immune system response (Sherwood 1993: 383; Guyton 1992: 265).

**AT (allotransplantation)** “Transplantation of living tissue, organs or cells between the same species (for example, from human to human)” (Xenotransplantation Working Party 2003a: 23).

**AVR (acute vascular rejection)** Also known as delayed xenograft rejection, delayed graft rejection, delayed vascular rejection, antibody-mediated immune response and acute humoral rejection. “An immunological process which occurs when foreign antigens, such as those expressed in the endothelium of a xenotransplanted organ, stimulate the production of antibodies in the recipient. There may also be additional activity associated with various groups of recipient white blood cells. This process causes rejection within days or weeks” (Cooper and Lanza 2000: 253). B-cells are also involved.

**B-cell** Involved in acute vascular rejection. B-cells are designed to fight infection (Huizinga 2002: 261).

**Bovine** Relating to cows.

**Cellular xenotransplantation** Also known as animal cellular therapies or cellular therapies. Refers to “transplants involving the use of living tissues, such as skin or bone marrow, or clusters of specialised cells, such as brain cells or insulin-producing pancreatic islet cells” (Xenotransplantation Working Party 2003a: 23).

**CD46** A human complementary regulatory protein (CRP). Also known as membrane cofactor protein. Pigs have been genetically engineered to express CD46 to downplay or inhibit the complement cascade.

**CD59** A human complementary regulatory protein (CRP). Also known as protectin. Pigs have been genetically engineered to express CD59 to downplay or inhibit the complement cascade.

**Chimerism** Refer to microchimerism.

**Chronic rejection** Refer to CR.

**Clinical trials** Also known as therapeutic trials. Trials that occur in humans following experimental trials in animals with the aim of therapeutic outcomes.

**Cloning** Also known as nuclear transfer. Refers to a “process (which was used to create Dolly the sheep) that involves removing the nucleus of an egg and replacing it with the nucleus of another cell. The cell is then stimulated to grow and proliferate and, under certain ideal conditions, can
develop to form a whole viable organism or animal. This animal would be a clone of the original animal from which the cell nucleus was derived” (Cooper and Lanza 2000: 257).

**CMV (cytomegalovirus)** An exogenous retrovirus that in humans, is rendered harmless through T-cell immunity. Pharmaceutical immunosuppressive therapies however, suppress T-cell immunity, meaning CMV can become lethal. CMV can also increase the chances of other opportunistic infections (Madden 2003: 361).

**Cobra-venom factor** Refer to CVF.

**Complement cascade/system** The complement system consists of serum proteins (xenoreactive natural antibodies), which travel in the bloodstream in search of invaders, such as infectious micro-organisms, bacterium and, most significantly for transplantation, organs (Allen 1995: 73). When a foreign body is found, the xenoreactive natural antibodies elicit a sequential series of cascade action and reaction, where the activation of C1 triggers C2, and so on up to C9, B and D (Sherwood 1993: 379; Guyton 1992: 265). The majority of this immune reaction in xenotransplantation targets the sugar molecule, Galα1-3Gal (α-Gal), which is found on the vascular surface of pig organs (Fishman and Patience 2004: 1384; Berney et al. 2002: 677; Perico et al. 2002: 46; Cooper and Lanza 2000: 63; Platt 1998: 12; Platt and Lin 1998: 9). Importantly, while xenoreactive natural antibodies will sometimes bind to self-surfaces, the complement cascade and subsequent tissue damage is inhibited by complement regulatory proteins (CRPs). The complement cascade inactivates porcine endogenous retrovirus (PERV) (Buhler 2004b: 6), and plays a role in hyperacute rejection and acute vascular rejection.

**Concordant** “Indicates a closely related species” (Cooper and Lanza 2000: 255). For example, baboons and humans.

**CR (chronic rejection)** Also known as long-term rejection. “An immunological process that usually occurs many months or years after transplantation, and results in a deterioration in function of the transplanted organ. The immune mechanisms are poorly understood, but are thought to involve antibodies and cellular (including T cell) mechanisms” (Cooper and Lanza 2000: 254). It is unknown if this occurs in xenotransplantation.

**CRPs (complement regulatory proteins)** “A group of molecules found on the surface of the body’s cells that prevent complement from attacking the body’s own tissues. […] These include [human] decay accelerating factor ([h]DAF), cluster of differentiation 59 (CD59), and membrane cofactor protein (MCP [also known as CD46]). Transgenic animals can be genetically modified [engineered] to express a complement regulatory protein from a different species” (Cooper and Lanza 2000: 254-255).

**CVF (cobra-venom factor)** Used to combat hyperacute rejection. CVF is administered to the potential xenotransplant recipient in order to inhibit, suppress or deplete the complement cascade.

**Cytokines** Proteins that influence the behaviours and activities of other cells. This includes cellular growth and death, and the immune response to

**Cytomegalovirus** Refer to CMV.

**Deoxyribonucleic acid** Refer to DNA.

**Discordant** “Indicates a distantly related species” (Cooper and Lanza 2000: 255). For example, the relationship between pigs and humans.

**DNA (deoxyribonucleic acid)** “A molecule found principally in the nucleus of the cells. It bears the coded genetic information required to determine the structure and function of an organism” (Cooper and Lanza 2000: 255).

**Encapsulated cells** See immunoisolation.

**Endogenous retrovirus/es** “A retrovirus that is incorporated in the genetic material in every cell in the body of its host [i.e. – it is found in every tissue], and is passed down from generation to generation [vertically transmitted]. Normally, an endogenous retrovirus does not cause any obvious signs of disease [in the species of origin]” (Xenotransplantation Working Party 2003a: 23). Furthermore, “in some circumstances, endogenous retroviruses become active and produce infectious virus particles that cause disease. Such activated retroviruses can remain clinically latent in the host of a long time before emerging to cause varying types of disease. They can also be transmitted to others by various routes [for example, as zoonoses]” (Xenotransplantation Working Party 2003b: 105).

**Exogenous retrovirus/es** Horizontally transmitted diseases. May also be vertically transmitted from mother to child. Causes disease in the host. “A feature of this group is their ability to move across species barriers and emerge in the new species with a different pattern of disease and mode of transmission” (Xenotransplantation Working Party 2003b: 105).

**Experimental trials** Occur in animals with the aim of understanding the processes and function of a particular therapy before proceeding to human clinical trials.

**Extracorporeal perfusion/support** Refer to xenoperfusion.

**FDA (Food and Drug Administration)** “The FDA is responsible for protecting the public health [in the United States of America] by assuring the safety, efficacy, and security of human and veterinary drugs, biological products, medical devices, our nation’s food supply, cosmetics, and products that emit radiation. The FDA is also responsible for advancing the public health by helping to speed innovations that make medicines and foods more effective, safer, and more affordable; and helping the public get the accurate, science-based information they need to use medicines and foods to improve their health” (U.S. Food and Drug Administration n.d.: para.1).

**Gal1α1-3Gal** Refer to α-Gal.
GE (genetic engineering; genetically engineered) Also known as genetic modification; genetically modified. This refers to “any live organism that has inherited characteristics produced by altering the genetic material of its ‘parent’ organism” (Xenotransplantation Working Party 2003a: 24).

GT-KO pigs ('knockout' pigs) The enzyme $\alpha$-GalF is eliminated from these pigs in order to prevent $\alpha$-Gal production. As a result, the human antibody response to pig whole organ xenotransplants is reduced or abolished. GT-KO pigs are used to combat hyperacute rejection.

GVHD (graft-versus host disease) A form of acute cellular rejection, where the graft’s immune system rejects the recipient. It is unknown if this occurs in xenotransplantation.

HAR (hyperacute rejection) “The most rapid form of transplant rejection. It occurs between discordant species because of the effect of xenoreactive [natural] antibodies in the recipient’s blood. In hyperacute rejection, [...] blood clots throughout the donor organ within minutes, causing dramatic failure of the organ” (Cooper and Lanza 2000: 256).

hDAF (human decay accelerating factor) A human complementary regulatory protein. Also known as CD55. Pigs have been genetically engineered to express hDAF to downplay or inhibit the complement cascade.

Hepat- (hepato-) “Prefix denoting the liver [i.e., hepatic failure, hepatocyte, etc.]” (Martin 1994: 301, original emphasis).

HIV (HIV-1, HIV-2; human immunodeficiency virus) A human exogenous retrovirus of zoonotic origin (from nonhuman primates). It destroys the virus-fighting white blood cells of the immune system and is the causative agent of AIDS (Carson 1996: 12).

Host See organ source

Hyperacute rejection Refer to HAR.

Immune response “The body’s mechanism for distinguishing ‘self’ from ‘other’ and eliminating invading microorganisms or other foreign material from the body. In transplantation, the immune response can lead to rejection of the transplanted organ, tissue or cells” (Xenotransplantation Working Party 2003a: 24). Also refer to hyperacute rejection, acute vascular rejection, acute cellular rejection and chronic rejection.

Immuinoisolation (encapsulated cells) Involves encapsulating the xenograft inside a semi-permeable membrane within the body. This allows smaller molecules to pass through the membrane, while blocking large molecules and the white blood cells of the immune system (Lanza et al. 1997: 43-44).

Immunosuppressant drugs See PITs.

Immunosuppressed The immune system of an individual, which fights infections, is suppressed. This could be pharmaceutical (PITs),
through radiation or chemotherapy, or through immunodeficiency disease such as rheumatoid arthritis, HIV or AIDS.

**in vitro** outside of the body; in culture

**in vivo** inside the body

**Islet cells** “Groups of cells scattered throughout the pancreas that secrete insulin and other hormones involved in regulating blood sugar levels. Destruction of insulin-producing cells of the islets results in type 1 diabetes” (Cooper and Lanza 2000: 257).

**‘Knockout’ pigs** Refer to GT-KO pigs.

**Microchimerism** A way of inducing graft tolerance. Refer to xenotolerance.

**MLI** Meat and livestock industry/ies

**NGAOS** Nongovernmental animal advocacy organisations.

**NHMRC (National Health and Medical Research Council)** “Is a statutory authority within the portfolio of Australian Government Minister for Health and Ageing […]. The NHMRC advises the Australian community and the Australian Government, State and Territory governments on standards of individual and public health, and supports research to improve those standards.

The NHMRC advises the Australian Government on the funding of medical and public health research and training in Australia […]. The NHMRC also develops guidelines and standards for the ethical conduct of health and medical research” (Xenotransplantation Working Party 2003a: 26). The NHMRC are the peak funding body for medical, scientific and public health research in Australia.

**OPP** Obligatory passage points.

**Organ source** In xenotransplantation, also known as the source animal, organ host or host. Refers to “the ‘donor’ animal from which [cells,] tissues or organs are taken” (Cooper and Lanza 2000: 258). In this thesis, the terms ‘source animal/s’, ‘animal source’ and ‘host’ are applied, as the terms ‘organ source’ and ‘organ host’ do not adequately cover all forms of xenotransplantation.

**Pathogen** “An infectious agent (often a microorganism) that is capable of causing disease” (Cooper and Lanza 2000: 257).

**PERV (porcine endogenous retrovirus)** An endogenous retrovirus carried by pigs. In 1997, Patience et al. (1997) discovered PERV can infect human cells *in vitro*. Subsequent studies have found PERV has not infected humans *in vivo*, though “the magnitude of the risk is the subject of considerable debate among experts” (Xenotransplantation Working Party 2003b: 105).
Phylogenesis “The evolutionary history of a species or individual” (Martin 1994: 509).

**PIT/s (pharmaceutical immunosuppressive therapy/therapies)**
Also known as immunosuppressant drugs. These “drugs […] suppress the natural immune response to foreign material. These drugs are usually given to transplant patients to help prevent rejection of the transplant” (Xenotransplantation Working Party 2003a: 24).

**Plasmapheresis** The separation of XNAs from the plasma in the blood (Dorland’s Illustrated Medical Dictionary 2003: 1446; Martin 1994: 515; Miller and Keane 1987: 973). Requires the conjunctive use of PITs (Ogle and Platt 2002: 301).

**Porcine** “Relating to pigs” (Cooper and Lanza 2000: 257).

**Porcine endogenous retrovirus** Refer to PERV.

**Renal** “Relating to the kidney” (Cooper and Lanza 2000: 258).

**SARS (severe acute respiratory syndrome)** The first global human epidemic of the 21st century (Fidler 2003: 485, 490). An exogenous retrovirus of zoonotic origin, which is believed to have spread to humans from civets, also known as the masked palm cat. In a period of seven months, SARS spread from the southern Chinese city of Guangzhou, the capital of the Guangdong Province, to 32 countries and all five continents. The result of this outbreak was 8 098 infectious cases in humans, including 800 deaths (Agence France-Presse (AFP) 2004b: para.4; Drosten et al. 2004: 2200; Gallagher and Garrett 2004: para.1,85; Lingappa et al. 2004: 167). International urgency and collaboration identified SARS as a coronavirus, which spread easily as a respiratory disease through the inhalation of and/or contact with air-borne infectious droplets (Gallagher and Garrett 2004: para.76,94,96; Poutanen and McGeer 2004: 221-222). While SARS was declared contained in July 2003, other infectious outbreaks have occurred in Singapore (September 2003), Taiwan (December 2003) and China (December 2003, January 2004 and April 2004) (Poutanen and McGeer 2004: 220). This highlights the difficulties and problems of controlling and containing new and unknown infectious diseases.

**Sertoli cells** Testicular cells. These protect developing germ-line cells from immunological rejection (Dufour et al. 2004: 694; Dufour et al. 2003: 275). This protective function allows Sertoli cells to survive in foreign immunological environments and has been achieved with AGs, concordant XT (rat-to-mouse), and discordant XT (pig-to-rat and fish-to-mouse) (Dufour et al. 2004: 694; Dufour et al. 2003: 284). Based on this potential immunoprotection, Valdes-Gonzalaez et al. (2002), have conducted human clinical trials of porcine islets with Sertoli cells to combat the insulin-dependence of Type-1 diabetics. While these trials and the respective results have been questioned (Dufour et al. 2003: 286-287), Doctor Valdes recently offered this treatment as a form of xenotourism (see Laboratorio de Xenotrasplates n.d.; Jiménez 2006; Cook et al. 2005).

**Source animal/s** See organ source.
**SPF (specific-pathogen free)**  “The term given to animals that have been bred in captivity and isolated from other animals in order to avoid infection by excluding specific known pathogens. The animals are kept in conditions that reduce the risk associated with contracting these infectious agents. No contact is allowed with non-SPF animals” (Cooper and Lanza 2000: 258). These biosecure conditions are known as a specific-pathogen free environment. To keep the animals SPF, they often carried by a surrogate mother, who is scarified after giving a caesarean birth.

**SSK**  Sociology of scientific knowledge.

**SST**  Sociology of science and technology.

**T-cell**  Involved in acute cellular rejection. T-cells are designed to fight infection (Huizinga 2002: 261).

**Transgenesis (transgenic)**  “Term used to describe an organism that, through genetic modification [engineering], has a heritable foreign gene […] incorporated into the genome of each cell” (Cooper and Lanza 2000: 258). Examples of transgenic pigs include GT-KO pigs and hDAF pigs.

**Type-1 diabetes**  “The form of diabetes that starts in childhood or adolescence. The disease is also called [juvenile or] insulin-dependent diabetes because sufferers […] have little or no ability to produce insulin and are therefore dependent on insulin injections for survival” (Xenotransplantation Working Party 2003a: 25). Type-2 diabetics can also be insulin-dependent and/or progress to Type-1 diabetes.

**vCJD (variant Creutzfeldt Jakob Disease)**  “vCJD is a new and distinct form of human prion disease, which is […] believed to represent spread of the BSE [bovine spongiform disease, more commonly known as ‘mad cow disease’] agent to humans. […] A striking feature is the young age of the patients. The average age of onset in vCJD is 29 years […]. To the end of the year 2000, there have been 88 cases of vCJD in the United Kingdom, three in France and one case in the Republic of Ireland. Prion disease in man [sic] has an incubation period of up to 40 years and it is not known how many Britons are currently incubating vCJD. Projected estimates have ranged from less than 100 to several million cases, although recent estimates suggest an upper limit of 136,000 cases” (Scott 2001: 5).

**Whole organ xenotransplantation (whole organ xenotransplant)**  “Transplants involving the use of whole living organs such as kidneys or hearts” (Xenotransplantation Working Party 2003a: 25).

**Xenograft/s**  “The tissue or organ that has been transplanted from a member of one species to a member of another species. An example would be a transplanted pig kidney in a baboon or human” (Cooper and Lanza 2000: 259). Importantly, while a xenograft is an interspecies transplant, these grafts do not necessarily contain any living substances or materials. An example would be a porcine heart valve in a human. Xenografts and xenotransplants are distinguished in this thesis.

**Xeno-havens**  Countries that lack or possess weak restrictive guidelines on xenotransplantation. Such countries may attract experiments.
from other parts of the world, where stricter guidelines do not allow these trials to occur. As a result, xeno-havens might be exposed to significant risks.

**Xenoperfusion**  Also known as animal external therapies, extracorporeal perfusion and extracorporeal support. These “therapies […] occur outside of the patient’s body, such as when blood from a patient with liver failure is passed through a machine containing liver animal liver cells, to remove toxic substances (a procedure similar to kidney dialysis)” (Xenotransplantation Working Party 2003a: 23). May be used as a bridge to whole organ xenotransplantation or allotransplantation, as preparation for whole organ xenotransplantation, and/or as a therapy in its own right.

**Xenoreactive natural antibodies**  Refer to XNAs.

**Xenotolerance**  Also known as microchimerism, chimerism, accommodation and antigen-specific immunologic unresponsiveness. Involves “the acceptance of a transplanted organ (i.e., without rejection) without continued immunosuppressive drug therapy” (Cooper and Lanza 2000: 256). This means the white blood cells of the different immune systems (i.e. – organ host and recipient), generate a hybrid immune system in the recipient (Lanza et al. 1997: 42). The recipient therefore has their own DNA and DNA of other origins. In this fashion, the immune system recognises the graft as self, allowing the graft to survive despite immunological reactions (Perico et al. 2002: 49; Platt 1996: 724). The infectious possibilities of xenotolerance are yet to be determined (Fishman and Patience 2004: 1384; Fung et al. 1997: 959).

**Xenotourism (xenotravel)**  The offering of xenotransplantation to tourists with sufficient monetary funds. This was recently offered to Type-1 diabetics at the Laboratorio de Xenotrasplantes, Fedrico Gomez Children’s Hospital in Mexico City (Mexico) (see Laboratorio de Xenotrasplantes n.d.; Xenomexico n.d.; Jiménez 2006; Cook et al. 2005).

**Xenotransplant/s**  Refer to XT/s.

**Xenotransplantation**  Refer to XTP.

**Xenozoonosis/xenozoonoses/xenosis**  “A zoonosis that can be [or has been] transmitted by the xenotransplantation of animal tissues or organs” (Cooper and Lanza 2000: 259).

**XNAs (xenoreactive natural antibodies)**  Also known as α-Gal antibodies. XNAs are serum proteins that circulate in human bloodstream in search of invaders, such as infectious micro-organisms, bacterium and organs. If the outer membrane of this mass is strange, the XNAs bind to the surface of the blood vessels and initiate the complement cascade (Cooper and Lanza 2000: 63; Bach 1998: 303; Janeway Jr. and Travers 1997: 12:23; Knox et al. 1994: 507). In xenotransplantation, XNAs recognise and target the blood sugar α-Gal, found on the vascular surface of all pig organs.

**XT/s (xenotransplant/s)**  A xenograft placed in a human that implicates living animal materials.
XTP (xenotransplantation)  Also referred to animal-to-human transplantation. This is “any procedure that involves transplantation, implantation or infusion into a human recipient of cells, tissues or organs from a nonhuman animal source” (Xenotransplantation Working Party 2003b: 22, original emphasis). Involves the use of living animal materials, and includes whole organ xenotransplantation, cellular xenotransplantation and/or xenoperfusion (extracorporeal perfusion/support).

XWP (Xenotransplantation Working Party)  Established in 2001 by the NHMRC, the Xenotransplantation Working Party of Australia was designed “to provide advice on the scientific, ethical and technical issues relating to xenotransplantation research, produce guidelines for assessment of animal-to-human transplantation research trial proposals, and consult widely with the community about these issues” (Xenotransplantation Working Party 2003a: iii).

Zoonosis; zoonoses  “Any infectious disease that can be transmitted by the transfer of an infectious microorganism (or pathogen) from an animal to a human” (Cooper and Lanza 2000: 259). This may also occur from human-to-animal or animal-to-animal (of a different species).
Statement of Original Authorship

“The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made”.

Signature: 

Date: 22 October 2008
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HHS has been very important to my academic development; from a student (undergraduate and postgraduate) to a fulltime academic staff member in sociology. It pains me to know that with the completion of this thesis also comes the closure of this wonderful
School, the annihilation of the Bachelor of Arts and Bachelor of Social Science degrees (and their associated double degrees), and an uncertain future for the humanities and social sciences, including sociology, at QUT. This is truly a tragedy. I acknowledge the collegiality, solidarity and support of the academic staff members of HHS. I would particularly like to thank Professor Clive Bean, Dr Barbara Hanna, Dr Paul Harrison and Professor Gavin Kendall. It would be remiss of me not to further acknowledge Gavin and Paul for their respective roles as my supervisor and associate supervisor, and their ongoing, invaluable advice and support in my professional development.

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Science is an important, socially influential discipline. It produces bodies of knowledge and cultural artefacts within particular institutional contexts and frameworks, which are guided by their own procedures and rationalities. In this process, science is generally perceived to operate autonomously from other institutions and the social in general. Their apparent expertise also brings high social value and status, whereby scientists are considered to have greater insight and cognitive abilities than the publics\(^1\). Therefore, science and the social, including the publics, stand in stark contrast to each other.

At the same time, the sciences present significant social challenges and anxieties. Recent developments such as the human genome project, nanotechnology, genetic engineering (GE) and transgenesis, cloning and biotechnologies, present regulatory and political problems, conflicts between national and international interests, social anxieties, and concerns over risk and potential negative consequences. These social complexities cannot be separated from science as a process, product or as an institution. Consequently, science does not operate in a social vacuum, as there is a dynamic

\(^1\) I use the term ‘publics’ to acknowledge the diversity of and in the public.
overlap with material and social progress (or regress). Furthermore,
science influences (and is influenced by) various social channels,
such as public funding bodies, contemporary social events, and
individual moral beliefs. As a result, there is a need for the sciences
to take the knowledges and beliefs of the publics seriously. To ignore
the publics is at science’s peril. In other words, two-way
communication between the sciences and the publics (and visa
versa), is integral to build productive and trustworthy relationships.

This thesis is partly driven by and in response to such challenges,
supporting an unwavering belief that science and social knowledges
should be equally valued. Each involves a production and
manufacturing of ‘truths’ and ‘facts’; each has its own affirmative and
dubious qualities; each shares space and time. To separate and
draw distinctions between ‘what is science’ and ‘what is social’, and
to privilege one over the other, does a great injustice. After all, “no
story ever tells it all” (Law 1994: 152, original emphasis).

Of particular interest are the scientific and social stories that centre
and emanate from one controversial and current scientific
development in Australia – animal-to-human transplantation
(xenotransplantation; XTP). Like Latour’s (1996: 80, original
emphasis) ‘Aramis’, XTP “is a narrative program, a story that is told”.
As XTP rests at an interesting intersection and amalgam of complex
scientific and social questions, many stories have the potential to
emerge. For example, XTP presents dilemmas for animal/human relations and questions about acceptable levels of risk, particularly given that the risks are currently unknown and immeasurable. In addition, XTP has been a subject of recent public debate in Australia, and is currently under a five year moratorium that expires in December 2009. As XTP mobilises scientific and social tensions and anxieties, both science and social stories are highly important and dependent on context.

Hence, this thesis presents stories\(^2\) and problematisations\(^2\) that surround two central concepts and obligatory passage points (OPP)\(^2\) to XTP – animals\(^3\) and risk. These stories come from a variety of sources, including documents, science and the publics. Each story told employs various techniques and methods (or problematisations) to justify particular versions of ‘reality’ and ‘truth’. Therefore, stories are building blocks; heterogeneous assemblages that are joined together to create networks of knowledge. These networks implicate multiple enrolled human and nonhuman actors (or actants)\(^2\). This concern with actants, networks, problematisations and stories, links to the chosen methodology, actor (actant)-network theory (ANT). I will return to ANT soon.

\(^2\) The relevance of such terminology will be explored in the chapter ‘Entering the Network: Methodology’.
\(^3\) I acknowledge the use and importance of the terms ‘human animals’ and ‘nonhuman animals’. These are commonly used in the sociology of animals as a way of overcoming and challenging traditional dualisms between humans and animals. For clarity and ease, I use the term ‘animal’ throughout the thesis to refer to nonhuman animals.
To understand the stories told and the relationships that may or may not exist between them, they have been contextually divided into three voices or categories – official science, research participants and the sociological. Official science is science that is portrayed as reliable and factual, attempting to disguise the heterogeneity of sciences. It appears in books (often collections of peer-reviewed articles, reviews of the field, or congratulatory praise lavished on XTP scientific research/ers), popular scientific magazines (for example, ‘Scientific American’ and ‘New Scientist’), and peer-reviewed journals. Therefore, official science is a reference to particular documents, the problematisations they create, and the stories that they tell. These are collected through document analysis, and primarily feature in the chapters ‘The Biological Gaze: Selecting an Animal’ and ‘The Sociozoologic Gaze: Using Animals’.

Official science does not necessarily encompass scientists as individuals. That is, the stories told by scientists outside of these official scientific channels might be more ambiguous, subjective and/or different to that narrated by official science. Therefore, science stories can be found in both official science and the research participants. Research participants also covers those humans conducting public consultations and providing regulatory advice in

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4 It should be noted that official science stories can also be found in other sources, such as ethical reviews and analyses of XTP, which are also drawn upon in this thesis.
Australia (the Xenotransplantation Working Party and the Animal Issues Subcommittee), and people targeted by the technology (people on dialysis, with Type-1 diabetes, Huntington’s disease, Parkinson’s disease, pre- or post-human-to-human transplantation, and their partner/spouse). While these various actant collectivities are sometimes separated in the thesis, they are also interwoven. These stories are gathered through interviews and focus groups, and feature in all four data chapters.

Lastly, the sociological story that runs throughout this thesis is an exploration of what is perceived to be happening and the problematisations that are circulating. Therefore, while official science and the research participants tell layers of stories about and on XTP that problematise animals and risk/s, these are then told as stories in my own sociological narrative: “I formulate and I tell stories of them: my stories, too, are just a further moment in the productive but parasitic story-telling” (Law 1994: 19, original emphasis). These problematisations and stories form triptychs – sometimes complementary, sometimes contrasting, often conflicting, and always intriguing. To make these easy to navigate, they have been distinguished by font, presenting a polyphonic (or polyfontic) text – official science, research participants, sociology. This use of a

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5 I thank Gavin Kendall for suggesting this term.
6 This use of polyphonic/polyfontic text is not used in ‘Xeno-what? A Literature Review’, as this chapter provides the reader a background understanding of XTP and the existing scientific and social research. Furthermore, in the data chapters, footnotes are used to largely complement and expand the sociological story.
polyphonic/polyfontic text is similar to that employed by Latour (1996).

The complexities of XTP are initially explored in Chapter 2 – ‘Xeno-what? A Literature Review’. This long and comprehensive chapter outlines the heterogeneous sciences operating behind XTP, and why XTP is notoriously difficult. This includes having to deal with and ‘conquer’ immunology, the use of immunosuppressive drugs, psychology, physiology, the GE and cloning of animals, and microbiology and virology. Of course, significant ambiguity and social concerns are encompassed within these categories. This chapter also examines the limited socio-cultural research into XTP, which is particularly inadequate in the Australian context. For example, no qualitative research on the social concerns and doubts surrounding XTP has been conducted in Australia. Consequently, while much research is and has been conducted in and on the scientific viability and possibilities of XTP, very little has examined and addressed the social implications, negotiations and understandings. This research is particularly crucial in the current XTP Australian context. The chapter concludes by briefly considering some literature from the burgeoning field of the sociology of animals.

The shortcomings of existing research lead into Chapter 3 – ‘Entering the Network: Methodology’. In this chapter, I outline what ANT is, and how this approach is relevant to gathering and telling actant stories.
and problematisations on XTP. Significantly, ANT advocates a heterogeneous approach, where all knowledges, perspectives and narratives are equally valued. Furthermore, the current state of XTP in Australia and the lead-up to this situation is explored, which encompasses a brief critique of the Australian public consultations that occurred in 2002 and 2004. Therefore, this chapter justifies the approaches and undertakings of this research.

Chapters 4, 5, 6, and 7 present the actant stories, namely their problematisations and narratives of XTP surrounding the two OPP of animals (chapters 4 and 5) and risk (chapters 6 and 7). All of these problematisations and stories, regardless of their origin, are rich and diverse. Both animals and risk are revealed to be flexible concepts, with a multiplicity of conflicting and contemplementary understandings in their relationship to and influence on XTP. In the sociological story, the stories of official science and the research participants are mixed, but are also separated as their stories part ways or differ. Importantly, many networks within the XTP network emerge in this story-telling process. That is to say, there are diverse networks within all actant collectivities, and finer networks also emerge within these networks. This conglomerate of networks results in stories and problematisations that are never straightforward and are full of ambiguity. At this stage, I am loathe to explore these chapters, as I would like the reader to see them emerge in their full complexity, doubts, and conflictual processes.
Of course, these problematisations and stories should not be seen as the complete picture. It is the same for this thesis – it is inherently incomplete. It will always be incomplete. Networks have a way of expanding, of becoming rhizomatic and increasingly complex.

Furthermore, stories are always selective – they tell of particular realities and truths, and not of others. Problematisations and stories are also fluid, subject to change and contestation. As a result, these limitations should not been seen as shortcomings. Rather, this is a reflection of the complexity of XTP and its networks and concepts. XTP, in other words, has multiple realities. This is science in the making.
Introduction

XTP is of contemporary interest in Australia and internationally. Due to various concerns, this technology has prompted much debate and controversy across various traditionally distinct disciplines, including medicine, science, ethics, psychology and sociology. These concerns encompass immunology, immunosuppression, physiology, biotechnology (GE and cloning), microbiology and animal/human relations. Importantly, these debates are often stimulated by risk anxieties, including cost/risk-benefit/opportunity.

In this literature review, the concerns of XTP will be examined by firstly progressing through the what, why and how of XTP, before considering the limited sociocultural research available on this topic, and the sociology of animals. Through these explorations, the numerous complexities and difficulties of XTP are exposed, thus demonstrating the problems encountered in and by this scientific development and the diverse possibilities open for sociological investigations.
Xenotransplantation

What?

As defined by the Xenotransplantation Working Party (XWP) of the National Health and Medical Research Council (NHMRC) (2003b: 22, original emphasis), XTP is “any procedure that involves transplantation, implantation or infusion into a human recipient of cells, tissues or organs from a nonhuman animal source” 7.

Importantly, XTP involves the use of living animal substances, which distinguishes it from the established use of inert and sterilised animal material (Xenotransplantation Working Party 2003a: 2). This latter category includes porcine (pig) and bovine (cow) heart valves for heart disease, and the traditional use of porcine insulin for diabetes 8.

Notably, as indicated by the XWP definition (2003: 1-2, 6-7; 2003b: 22), XTP should not be conceptualised as whole organ XTP alone. Rather, XTP also encompasses animal external therapies, such as bioartificial devices that contain animal cells or organs through which human blood is perfused (‘extracorporeal perfusion’ or 

7 This was influenced by the XTP definition of the United States of America’s (USA) Food and Drug Administration (FDA), which describes xenotransplantation as: “[…] any procedure that involves the transplantation, implantation, or infusion into a human recipient of either (a) live cells, tissues, or organs from a nonhuman animal source or (b) human body fluids, cells, tissues or organs that have had ex vivo contact with live nonhuman animal cells, tissues, or organs” (U.S. Food and Drug Administration 2003: 1; 2001: 4).

8 These preserved tissues lack living cells. This deficiency of cellular activity means they do not carry viral infections and are rarely rejected (Weiss 2003: 281; Andersen 2000: 6; Weiss 1998a: 931). There have been cases, however, of heart valves transmitting tuberculosis and hepatitis B (Eastlund 1995: 455).
‘xenoperfusion’)⁹ and cellular therapy (‘animal cell therapies’), which refers to the implantation of animal cells directly into the human body¹⁰ (Xenotransplantation Working Party 2003a: 1-2; 2003b: 1, 14-16, 22). These different xenotransplants (XTs)¹¹ are illustrated in Figure 1.

As a transplant procedure, XTP moves beyond allotransplantation (AT; same species transplantation; more specifically human-to-human transplantation), as it can treat conditions that previously could not be treated through such techniques (Fishman and Patience 2004: 1383). For example, it is possible that cellular XTs may reverse or partially reverse the debilitating symptoms of neurodegenerative disorders such as Parkinson’s and Huntington’s disease, or provide blood-clotting factors for haemophiliacs (Lanza et al. 1997: 44). XTP may also be used for skin reconstruction, where nonhuman and human cells are grown together to replace the skin of burns victims¹² (Bloom 2001: 312).

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⁹ This may also act as an alternative therapy or bridge to transplantation.
¹⁰ Cellular therapies may involve immunoisolation, where the xenotransplant is encapsulated inside a semi-permeable membrane within the body. This allows smaller molecules to pass through the membrane, while blocking large molecules and the white blood cells of the immune system (Lanza et al. 1997: 43-44).
¹¹ I purposefully differentiate between xenografts (XGs) and XTs, even though XTs are a type of XG. XGs refer to grafts taken from a different species, which includes materials that lack living cells. As XTP specifically refers to living animal materials, it is important to distinguish XTs from other types of xenografts. This differentiation is not often made in scientific circles.
¹² There are several types of animal biological products designed to be used as human skin substitutes. Some of these are derived from pig materials, but also cow, shark and mouse tissues. Importantly, some of these applications, such as tissue engineered skin substitutes (organogenesis) and biological/biosynthetic dressings, use irradiated and acellular animal sources and are therefore not forms of XTP. Other products, such as the biological substitute EZ Derm™ and
Furthermore, the XT might resist or diminish the affects of human
diseases and/or viruses that could destroy an allograft (AG; same
species transplanted graft, also known as an allotransplant; AT)

Mediskin™, are forms of XTP. For more information, see Chiu et al. (2004),
Genzyme Biosurgery (2003-2004), Enoch et al. (2003), and Hansen et al. (2001).
Therefore, individuals who are not eligible for AT due to infection or disease may be eligible for XTP. Figure 2 presents some diseases and conditions potentially treatable by cellular XTP.

![Figure 2 – Some Human Conditions Potentially Treatable with Cellular Xenotransplantation](image)


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Though all XTP procedures involve risks (Bloom 2001: 312), cellular XTs and xenoperfusion presently hold more promise than whole
organ XTs, owing to significant immunological and physiological differences between animals and humans (Weiss 1998a: 931). Furthermore, as porcine insulin has been used to treat diabetics in the past, it is believed islet cell\textsuperscript{13} XTs hold significant potential (O’Connell in Armstrong 2004: 23:30; Berney et al. 2002: 676). In addition, unlike AGs, some XT materials such as porcine hepatocytes\textsuperscript{14}, can be indefinitely frozen in liquid nitrogen while retaining their function and viability (Buhler 2004d: 476), meaning they can be used when needed.

While nonhuman primates seem the obvious host for XTP due to their immunological and physiological similarity to humans (Fung et al. 1997: 956), pigs have generally been accepted as the source animal\textsuperscript{15} in XTP. This is based on ethical, medical and physiological reasons\textsuperscript{16}. As outlined in numerous articles\textsuperscript{17} and as explored in the

\textsuperscript{13} Islet cells are the insulin-producing cells found in the pancreas (Cooper and Lanza 2000: 257).

\textsuperscript{14} Hepatocytes are liver cells (Miller and Keane 1987: 565, 568).

\textsuperscript{15} It should be noted that ‘animal source’, ‘source animal/s’ and ‘host’, are preferred in this thesis over the more altruistic words of ‘gift’ or ‘donation’. This is because animal parts are not given with consent and the animal is purely bred as a XTP source for humans (Xenotransplantation Working Party 2003b: 15). Furthermore, I refrain from using other commonly accepted terminology such as ‘organ source’ and ‘organ host’. These terms do not appropriately acknowledge XTP applications beyond whole organ XTP, such as cellular XTP and xenoperfusion.

\textsuperscript{16} While pigs have been nominated as the most appropriate XT source, other animals have recently been explored as a potential XT source, such as goats (Vijayalakshmi et al. 2004; Jayaraman 2003), emus and ostriches (ratites) (Taniguchi et al. 1996), Nile tilapia fish (Leventhal et al. 2004) and hamsters (Tibell and Lundgren 2002: 21; Andersen 2000: 4).

chapter ‘The Biological Gaze: Selecting an Animal’, miniature pigs are the choice source animal due to a/an:

- history of domesticity and close proximity to humans;
- perceived requirement for minimal space;
- extensive human knowledge on pig husbandry;
- ease of availability;
- early sexual maturity and regular mating cycle;
- short gestation time;
- perceived ease of raising and breeding;
- large litter production;
- life expectancy compatibility with humans;
- close organ size to adult humans;
- existing exploitation and slaughter as a human food source;
- established knowledge and practice of specific pathogen-free (SPF)\(^{18}\) rearing;
- less infectious risk to humans than nonhuman primates; and
- capacity to be GE, including transgenesis and cloning\(^{19}\).

\(^{18}\) SPF environments are biosecure settings that are designed to eliminate, prevent, or minimise infection and disease in animals. To guarantee such an environment, animals need to be delivered by caesarean section and reared in isolation. At the same time, appropriate mechanisms for social interaction must be maintained for pig health and development (Bach et al. 1998: 143). This is addressed further in ‘Animals by Animals?’ in the chapter ‘The Biological Gaze: Selecting an Animal’.

\(^{19}\) Significantly, “it is not possible for these genetically modified[engineered] ‘donor’ pigs to enter the food chain” (Australian Pork Limited n.d.: para.5, original emphasis).
Cooper and Lanza (2000: 50, emphasis added) additionally suggest “some observers have even pointed out certain similarities between [the] eating habits and social behavior[s] of the two [pig and human] species!” For XTP advocates, existing animal (pig) exploitation for food and clothing morally and ethically justifies exploiting animals for medicine (Bramstedt 2000: 633-634; 1999: 428; Daar 1997: 975)\(^{20}\).

In contrast to pigs, nonhuman primates are not considered an appropriate source for XTP due to:

- ethical concerns of using closely related relatives as a “tissue and organ farm” (Weiss 1998a: 931);
- their organs are generally too small for human adults;
- the prohibitive cost of breeding (long gestation and single births) and providing a SPF primate environment\(^{18}\) (Fishman and Patience 2004: 1384; Bach 1998: 302; Daar 1997: 976; Fishman 1997: 43);
- the difficulty in eliminating nonhuman primate pathogens (Boneva and Folks 2004: 505; Weiss 2004: 284);

\(^{20}\) This will be further explored in the chapters ‘The Biological Gaze: Selecting an Animal’ and ‘The Sociozoologic Gaze: Using Animals’.
their requirements for extensive socialisation and exercise (Weiss 1998a: 931; Fishman 1997: 43);

- the limited supply of nonhuman primates (Boneva and Folks 2004: 505; Tibell and Lundgren 2002: 20); and

- some nonhuman primates are endangered (Xenotransplantation Working Party 2003b: 30; Cooper and Lanza 2000: 45; Daar 1997: 975).

Consequently, the heightened potential of genetic and immunological compatibility between nonhuman primates and humans (Fung et al. 1997: 956), as well as other characteristics, make nonhuman primates an unsuitable species. Pigs are also seen to pose less ethical hurdles. At the same time, phylogenetic discordance between pigs and humans means pigs as the source animal presents significant barriers to transplant success. These barriers of immunology, physiology and microbiology, shall be examined later in this chapter.

**Why?**

While XTP incorporates the knowledges and advancements of biotechnology and biomedicine, experimental and clinical trials of

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21 These issues will be outlined in more detail in the chapter ‘The Biological Gaze: Selecting an Animal’.
XTP have endured a precarious cycle of interest and disinterest for centuries (see Appendices 1.0 to 1.3 for a history of XTP).

In the 1960s, XTP interest surged due to the uncertainties surrounding the definition of ‘death’, the shortage of transplantable organs, early successes of AT\textsuperscript{22} (Holzknecht and Platt 2003: 323), and the successes of Reemtsma et al.’s (1964c: 392, 407) renal (kidney) chimpanzee-to-human clinical trials (Holzknecht and Platt 2003: 323-324; Tibell and Lundgren 2002: 19). These developments were accompanied by an increasing knowledge of human physiology, the progress with immunological drugs in the late 1950s/early 1960s, and a developing understanding of antibody molecules\textsuperscript{23} (Holzknecht and Platt 2003: 323; Perico et al. 2002: 45; Fredrickson 1997: 430; Lanza et al. 1997: 41). The continued success of AT, discovery of renal dialysis in the 1970s, repetitive failure of XTP, increasing immunological knowledge and the advent of ‘brain death’, drew attention away from XTP (Holzknecht and Platt 2003: 324; Tibell and Lundgren 2002: 19; Fredrickson 1997: 430). Nonetheless, historical setbacks have not diminished XTP curiosity, which was revitalised in the 1990s and has continued into the early 21\textsuperscript{st} century. This has occurred due to:

\textsuperscript{22} This achievement is particularly strong in kidney AT, which has been successfully performed since the early 1950s (Green 2003: 1696; Lanza et al. 1997: 40).

\textsuperscript{23} Antibody molecules target foreign bodies to elicit a non-specific immune system response (Sherwood 1993: 383; Guyton 1992: 265).
increased understandings of the relationship between XTP and human biology (Transplantation Society of Australia and New Zealand 1998: 12);

the successful use of inert animal tissue, such as porcine heart valves, in treating human diseases (King 1998: 25);

problems with artificial organs and stem cell research (Dwyer et al. 2002: 32); and

the continuing and increasing success of AT (Holzknecht and Platt 2003: 326).

The primary contemporary medical argument for XTP is the gap between human organ need and supply. The successes of AT have resulted in an expanding organ waiting list. In turn, this has produced a shortage of suitable transplantable human organs and a limitation on the number of people who can be treated24 (Breen 2002: 175; Cooper et al. 2002: 133; Hoffman 2000: 343-344; Clark 1999: 142; Platt 1999: 193; Allen 1995: 75). In this vein, waiting lists will continue to grow as not only new people are listed, but as more diseases are deemed treatable through transplantation (Weiss 1998a: 931). Consequently, XTP is viewed by some as a medical solution and necessity of ‘clear need’ that can potentially overcome such ‘extreme’ and ‘crucial’ organ shortages. This would occur by providing an ‘unlimited supply’ of ‘made-to-order’ organs, which will potentially relieve the human suffering, uncertainty and disease

24 As I will continue on to outline, however, there have always been limitations on treatment numbers.

In Australia, organ shortages mean between 23.9 to 28.7% of people waiting AT receive an organ25 (Excell et al. 2004: 3, see Figure 3)26. This shortage is partially caused by organ donor criteria, where less than 1% of deaths in Australia can qualify for organ donation, which then can only take place under certain circumstances27 (Excell et al. 2004: 3; Healey 2003: 42). As a result, it is more likely that an

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25 In the USA, organ shortages mean only 5 to 15% of people waiting AT receive an organ, with approximately eight people per day dying while waiting AT (Holzknecht and Platt 2003: 326; Bach 1998: 301; Platt 1998: 11; Platt and Lin 1998: 5).
26 This means that up to 15% of people will die on the waiting list (Healey 2003: 42), with an average of two people dying per week (Queenslander's Donate 2003: para.5).
27 After the family has given consent for organ donation, the potential donor is assessed for their suitability. This includes assessing their age, lifestyle prior to death, and various virological tests for infections and diseases (Red Cross Australia n.d.: para.4). This may result in the individual being deemed unsuitable for organ donation, or only suitable for certain tissues and organs. Moreover, the coroner may refuse for inquiry purposes or the ‘brain dead’ donor may have a cardiac arrest prior to transplantation (Excell et al. 2004: 11, 14).
individual would require an organ than be able to donate (Queenslander's Donate 2003: para.7). XTP advocates believe this widening gap between availability and need cannot be bridged with increased donation rates or assumed organ-donation consent policies (Weiss 1998a: 931).

The limited number of suitable organs means patients need to wait significant and expanding amounts of time for a suitable organ, which may result in death before an appropriate organ is found (Excell et al. 2004: 20, see Figure 3 and Figure 4). The waiting list figures presented in Figure 3, however, do not accurately reflect the numbers of people who could potentially benefit from AT. For example, medical conditions that result from organ failure (such as renal disease), ongoing social behaviours (such as alcoholism) or pre-existing alignments (such as human immunodeficiency virus-1; HIV-1), may withdraw an individual from the waiting list (National Health and Medical Research Council 1997: 17-18). Thus, it is asserted that “the size of the waiting list is an unacceptable indicator of the need for xenotransplantation” (Evans 2001b: 155).

As many organ recipients eventually lose graft function (Cooper et al. 2002: 133), XT could replace deteriorating AGs (McKenzie 2004: 230) and eliminate the risks and ethical concerns of ‘living’ organ
donations (Cooper et al. 2002: 134). Furthermore, xenoperfusion or whole organ XTs may provide a bridge to AT\textsuperscript{28}.

![Graph showing number of solid organ allotransplants and patients on the waiting list, Australia 1995-2006](image)

**Figure 3 - Number of Solid Organ Allotransplants and Patients on the Waiting List, Australia 1995-2006**

Information from Excell et al. (2007: 3; 2004: 3).

Based on these experiences of AT, XTP advocates often mix medicine with emotion by promoting the professional and personal difficulties faced in the life/death situations of end-stage organ failure (Allan 1996: 19):

\textsuperscript{28} As outlined by Gollackner and Cooper (2001: 139), this would not reduce the demand for human organs, but “actually increase the demand by maintaining a patient alive until allografting was possible”.

- 22 -
It is a mother’s worst fear. Standing at the bedside of her sleeping child, who is lying there so peacefully, sleeping quietly while a vicious disease infects his liver. The doctors come, but the news is not good. All these months on the waiting list have produced nothing. Without a miracle, this precious life will not continue. (Hoffman 2000: 339)

<table>
<thead>
<tr>
<th>Actual Transplant Cost (AUS$)</th>
<th>KIDNEY</th>
<th>LIVER</th>
<th>LUNG</th>
<th>HEART(^{30}); HEART/LUNG (H/L)</th>
<th>PANCREAS (P); PANCREAS ISLETS (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$14,754</td>
<td>$47,030</td>
<td>$96,067</td>
<td>$34,894 (Heart only)</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Average waiting time in years (2003/2002)</td>
<td>3.7/3.8</td>
<td>1.1/1.5</td>
<td>1.0/1.2</td>
<td>1.3/2.2</td>
<td>P: 1.9/1.7; I: 1.4/0.7</td>
</tr>
<tr>
<td>Percentage of people who died waiting for a transplant (2003)</td>
<td>3.024%</td>
<td>9.09%</td>
<td>10.48%</td>
<td>9.23%</td>
<td>0%</td>
</tr>
<tr>
<td>Deaths on waiting list (2002)</td>
<td>49</td>
<td>22</td>
<td>23</td>
<td>10</td>
<td>P: 3; I: 0</td>
</tr>
<tr>
<td>Patient survival at 1 year (no date)</td>
<td>93%</td>
<td>83%</td>
<td>77%</td>
<td>Heart: 90%; H/L: 76%</td>
<td>P: 94%; I: n/a</td>
</tr>
<tr>
<td>Patient survival at 5 years (no date)</td>
<td>87%</td>
<td>73%</td>
<td>63%</td>
<td>Heart: 70%; H/L: 60%</td>
<td>P: 87%; I: n/a</td>
</tr>
</tbody>
</table>

**Figure 4 - Allotransplantation in Australia: Waiting Times, Patient Survival and Medical Cost**

Information from Australia and New Zealand Organ Donation Registry (2004: para.4,6,8,9), Excell, et al. (2004: 20, 22, 28, 32, 38), and Red Cross Australia (2001: para.8,13).

\(^{29}\) Similar fictional, yet potentially ‘real life’ case-study stories can be found in Cooper and Lanza (2000: 3-7, 10-16, 120, 133, 136-142). Of course, scenarios which depict dying children are particularly emotive.

\(^{30}\) New drug treatments for heart AT recipients show promise of increasing the survival rate. For more information, see Scott (2004).

\(^{31}\) This does not include ongoing costs that follow AT, such as pharmaceutical immunosuppressive therapies (PITs).

\(^{32}\) It should be noted transplantation costs in the USA are significantly more expensive, ranging from approximately US$111 400 (kidney) to US$473 900 (intestine) (Evans 2001b: 154).
Despite these appeals to human need, practical and speculative questions on the potential reality of XTP, such as “would surgeons transplant earlier, or for palliations, perhaps? And how would the medical establishment cope with the demand for operations?” (Miller in Melton 1999: 1272), are yet to be answered. In addition, the focus is placed on increasing organ supply over methods and means to decrease organ demand (Hoffman 2000: 345). Therefore, existing lifestyle practices that can lead to ill health and the need for AT, are left unaddressed. On the other hand, some question whether the commodification of animal organs would meet human organ need (Daar 1997: 975; Nelson 1993: 316). The expense of whole organ XTP also does not equate to human need on a public health basis, as “the numbers of patients involved at present [waiting organ transplantation] is relatively small in public health terms” (Butler 1998: 320).

The primary problem with using animals in XTP is “one of the parties being discussed does not participate in the debate, and we are restricted to evaluating Homo sapiens’ own moral sensibilities, principles, and values” (Daar 1997: 976, original emphasis). Some therefore caution that scientific-medical reasoning for animal use “does not empower the scientific world to exploit the animal kingdom” (Fano 2001: 56). Moreover, while “strongly held views can rapidly become overturned when the grim reaper knocks on one’s door” (Cooper and Lanza 2000: 198), the desperation of patients should
not empower medicine and clinicians to deliver solutions (ends) regardless of the method (means) (Arundell and McKenzie 1997: 66). In turn, as one patient may require the sacrifice of multiple animals for a XT, let alone its success, questions arise regarding how many animal lives should be taken to potentially benefit one human. Concern has also been raised that the availability of animal organs may drop the altruistic ‘gift’ rates of human organ donation further (Gold and Adams 2002: 54). Additionally, as “transplantation does not assure immortality, and many transplant recipients, at a later date, die extremely expensive deaths” (Evans 2001b: 155), a similar outcome from the privileging of life over death regardless of the cost, could be expected from XTP.\footnote{And, finally, in my opinion, the exorbitant cost of living, as reflected by enormous health care costs, may offer sufficient justification for choosing death as an alternative preferable to life (Evans 2001b: 154).}

It should be remembered that while XTP is marketed on organ shortages and emotive appeals for human life, cellular XTs and xenoperfusion hold the most potential and promise, and have already been subjected to human clinical trials (Perico et al. 2002: 52, see Appendices 1.0 to 1.3). Recent results from porcine pancreatic islet XTP suggests this has the “potential to be the first successful clinical application of XTP” (Yong-Guang and Sykes 2007: 519, emphasis added). Clinical trials that have occurred include treating patients with:

\footnote{And, finally, in my opinion, the exorbitant cost of living, as reflected by enormous health care costs, may offer sufficient justification for choosing death as an alternative preferable to life (Evans 2001b: 154).}
- severe burns (porcine skin and/or other animal sources);
- liver failure (xenoperfusion through encapsulated porcine liver cells and/or whole porcine liver);
- renal failure (xenoperfusion through porcine kidney/s);
- chronic pain in cancer patients (encapsulated bovine adrenal cells);
- Lou Gehrig’s disease (encapsulated GE hamster cells);
- diabetes (porcine islet cells, sometimes administered with Sertoli cells\(^{34}\));
- Parkinson’s disease (porcine neural cells);
- Huntington’s disease (porcine neural cells);
- epilepsy (porcine neural cells); and

The results have been mixed. In addition, some of these trials have stopped due to withdrawal of interest, the closure of biotechnology companies (Pierson III 2004: 391-392), and/or clinical side effects.

XTP has also recently been a medical tourism option, known as ‘xenotourism’ or ‘xenotravel’ (Cook et al. 2005). Specifically, suitable

\(^{34}\) Sertoli cells are testicular cells, which provide developing germ cells immunoprotection. Therefore, by mixing the two cell types together, it is hoped the Sertoli cells will protect the islet cells from the immune response.
people with Type-1 diabetes and US$30,000-$35,000, could receive a co-XTP of Sertoli and porcine islet cells, at the Laboratorio de Xenotrasplantes, Federico Gomez Children’s Hospital in Mexico City (Mexico) (Laboratorio de Xenotrasplantes n.d.). Two Canadians - one adult female and one male child - underwent this procedure in 2005, and have subsequently returned to Canada. In response to concerns raised by the International Xenotransplantation Association, this xenotourist option has temporarily ceased (Jiménez 2006: A4), with a waiting list of future potential patients still being compiled in the hope of again proceeding35 (see Xenomexico n.d.).

Importantly, XTP is not the only technology and/or health intervention that could relieve organ shortages. XTP advocates assert that it holds more promise than these alternatives, including artificial/biomedical devices, tissue engineering and organogenesis36, disease prevention and health education, policy changes, human stem cells and cellular replacement therapy. This justification is based on the:

- historical knowledge of and developments in overcoming immunological barriers;

35 Issues implicated in xenotourism is further examined in this chapter in ‘Microbiology: Zoonosis and Xenozoonosis’, particularly in relation to xeno-havens. See also Cook et al. (2005).

36 Organogenesis is, however, being successfully used for the skin reconstruction of burns victims. Furthermore, scientists in Zurich (Switzerland), have recently successfully tissue-engineered heart valves, which have subsequently been transplanted into sheep (Moreno-Borchart 2004: 1025).
- immediacy of human need;
- ethical dilemmas of financial incentives for organ donation\(^{37}\); and

**Examples?**

Attempts at clinical XTP date back to the sixteenth century with blood perfusions from animals. Historically, human have received tissues from dogs, cats, rabbits, rats, chickens, cockerels, pigeons, frogs, goats, sheep, apes, baboons, macaques, rhesus monkeys, goats, sheep, apes, baboons, macaques, rhesus monkeys,

\[^{37}\text{In the USA for example, while organ 'selling' is illegal, there are various forms of organ 'acquisition'. The shortage of organs has lead to a re-evaluation of donation rules, and individuals have used cash incentives to attract donors in order to not only reduce waiting times but to avoid waiting lists. Moreover, living organ donors might be reimbursed their costs of donation by the organ recipient (including lost wages), and/or given tax breaks. The living donor may also engage in an 'exchange system', where organ donation to a stranger will either guarantee a suitable organ for their loved one, or move someone they nominate up the waiting list. Similarly, 'paired exchange' involves two recipients trading living organ donors. In turn, the international organ blackmarket and 'transplant tourism', both of which exploit illness and money, can be linked to the inequities and inequalities between the developed and developing worlds (Rohter 2004). In Australia, the State Government of New South Wales has recently passed guidelines that allow altruistic living kidney donations to strangers ('Govt clears way for kidney transplants' 2004: para.1). This does not, however, carry the financial or familial incentives of American regulations.}\]

\[^{38}\text{It should be noted that not all organs can be transplanted. As a result, tissue engineering and organogenesis has focused on 'growing' organs and/or tissues that cannot be transplanted. These include blood vessels and urinary bladders (Moreno-Borchart 2004: 1025, 1028). In addition, the impetus behind such developments is the short life of some transplanted grafts. For example, “a transplanted heart [...] has an average lifetime of only one decade” (Moreno-Borchart 2004: 1025). Furthermore, as alternatives such as tissue engineering can use the patient’s own cells, responses from the immune system and the need for immunosuppressive drugs are eliminated (Moreno-Borchart 2004: 1025-1026).}\]
hamsters, chimpanzees, cows, lizards and pigs (see Appendices 1.0 to 1.3). With the exception of some limited positive results in recent human clinical trials of xenoperfusion and cellular XTP, the results have generally been disappointing failures (Cooper and Lanza 2000: 43), which is largely the result of physiological and immunological dissimilarities. Two scientifically important XTs of the late twentieth century, which sparked social, medical and ethical controversy, are now examined briefly.

Case 1: Baby Fae, 1984

On 13th October 1984, Baby ‘Fae’ was born with hypoplastic left heart syndrome, a rare congenital cardiac defect that usually results in death within one month of life (Bailey et al. 1985: 3321). After parental consultations, Bailey et al. (1985) performed a baboon cardiac XT to Baby Fae on 26th October 1984. The choice to perform XTP was based on the belief that the undeveloped neonatal immune system could tolerate the foreign body (Boneva et al. 2001: 2; Bailey et al. 1985: 3321). Further clinical justifications included: clinical urgency; results in animal models; developments in and experience of using pharmaceutical immunosuppressive therapies (PITs) in neonatal animal models; and the homology between humans and baboons (Bailey et al. 1985: 3321; Reemtsma 1985: 10). Baby Fae, however, died 20 days after receiving the XT with heart, lung and kidney damage (Bailey et al. 1985: 3321, 3324-3325).
Questions surround Baby Fae’s role in surgery, where her terminally-ill status and new-born vulnerability made her an ‘advantageous’ victim that could not provide voluntary consent (Annas 1985: 15-17; Capron 1985: 9; Regan 1985: 9). The procedure also raised questions on:

- whether Bailey et al. (1985) searched for a human heart before attempting the XTP\(^\text{39}\) (British Union Anti-Vivisection (BUAV) Organisation 2000; Capron 1985: 9);
- the over-optimistic predictions of medical staff\(^\text{40}\) (Daar 1999: 55);
- \textit{a priori} expectations of death based on XTP history (Annas 1985: 15; McCormick 1985: 12);
- the minimalism of risk and discomfort (McCormick 1985: 12);
- the inadequacy of scientific evidence, including the lack of tissue matching and pharmacological knowledge in human neonates (Daar 1999: 55; Annas 1985: 15); and

\(^{39}\) According to Middleton (in Armstrong 2004: 13:56), a human heart was available at the time. For Bailey (in Armstrong 2004: 14:13), whether a human heart was available is irrelevant as “our research has been in the area of xenotransplantation”. This attitude serves to treat Baby Fae and her family as experimental tools for science and its development. Furthermore, it fails to consider the feelings and possible preferences of Baby Fae, her family and the source animal, towards the availability of a human, rather than baboon, heart.

\(^{40}\) At the time, Bailey (in Annas 1985: 16) believed “[…] in the best scenario, Baby Fae will celebrate her 21\(^\text{st}\) birthday without the need for further surgery. That possibility exists”.

- 30 -
• issues surrounding parental consultation, including adequacy of information, parental expectations and voluntary informed consent (Daar 1999: 55; Annas 1985: 16; Capron 1985: 9).

Furthermore, while Bailey (in Annas 1985: 16) believed the operation to be a “tremendous victory”, this experimental victory was for medical science and not a therapeutic outcome of long-term survival for Baby Fae and her family (McCormick 1985: 12).

Case 2: Jeff Getty, 1995

In 1995, a prospective clinical trial of injecting baboon bone marrow into people with acquired immunodeficiency syndrome (AIDS) raised scientific, public and regulatory concerns in the USA. This apprehension was due to an unquantifiable yet possible risk of a known or unknown infection being passed from animal-to-human, and subsequent human-to-human viral transmission\(^{41}\) (Lehrman 1995b: 8). Despite these concerns, an advanced-stage AIDS patient, Jeff Getty, received the XT on 14\(^{th}\) December 1995. The intent of the trial was for the baboon bone marrow cells, which are believed HIV-1\(^{42}\) resistant (Fricker 1996: 457), to engraft to Getty’s bone marrow. Getty’s chimeric bone marrow cells would then produce a HIV-1-

\(^{41}\) These concerns will be further explored later in this chapter in ‘Microbiology: Zoonosis and Xenozoonosis’.

\(^{42}\) HIV-1 destroys the virus-fighting white blood cells of the immune system and is the causative agent of AIDS (Carson 1996: 12).
resistant immune system that would suppress the AIDS virus

For Getty, the potential benefit of receiving a XT to conquer a(nother) foreign body inside his own body, outweighed any uncertainties about the trial or XTP itself (Lundin and Widner 2000: 1175; Lundin 1999: 11). Like Baby Fae, however, Getty was vulnerable and facing mortality: “Doctors had given him a year to live at most, unless he was willing to undergo a highly dangerous and experimental operation” (Sugg 1996: 48).

While Getty survived the experiment, the trial and its results were brought into scientific dispute. Initially after receiving the XT, Getty’s health and physical appearance improved. While this could indicate XTP success, the lack of bone marrow engraftment indicated that the pre- and post-transplantation treatments of radiation, PITs and anti-viral drugs, decreased the HIV-1-infected cell levels and not the XT43 (Coffman et al. 1998: 380; Fricker 1996: 47; Jasieński 1996: 10; Thompson 1995: 346). This also highlights the unknown placebo effect of the trial, as no control subjects were utilised to show similarities and differences between recipients (Jasieński 1996: 10). Moreover, at the time of the experiment, no XT cell engraftment had

43 The success of engraftment is indicated by a blood sample. As Getty’s blood exhibited an inadequate level of baboon DNA (deoxyribonucleic acid), engraftment was shown to have failed (Fricker 1996: 457).
been demonstrated in animal studies, and a previous medical trial of similar nature conducted at Pittsburgh (USA) had resulted in the death of the recipient (Thompson 1995: 369). Questions also continued on whether baboon cells were truly resistant to HIV-1 and if they would appropriately function in a human environment (Thompson 1995: 369). Furthermore, despite his personal feelings towards XTP, Getty did not anticipate the consequent social problems and anxieties he was to experience as a XT recipient\(^{44}\) (Mohacsi et al. 1999: 40). In this vein, such clinical trials treat the human body as a tool for the impetus of medical development, where experimental knowledge is privileged over prolonged individual survival (Lundin 1999: 11).

1) Main Points

- XTP is "any procedure that involves transplantation, implantation or infusion into a human recipient of cells, tissues or organs from a nonhuman animal source" (Xenotransplantation Working Party 2003b: 22, original emphasis).
- XTP could potentially treat organ failure, diabetes, Parkinson's disease, Huntington's disease, haemophilia and burns, amongst other human diseases and conditions.
- Pigs have been accepted as the source animal XTP.
- Nonhuman primates are considered an unsuitable XT source for humans.
- The primary argument for XTP is the human suffering caused by the gap between organ supply and need.
- Many people die while waiting for an AT.
- "The number of patients at present [waiting organ transplantation] is relatively small in public health terms" (Butler 1998: 320).

\(^{44}\) These problems included Getty being the butt of monkey, baboon, and banana jokes (Cooper and Lanza 2000: 201; Dreifus 1998: F3), and receiving threatening telephone calls from animal activists during his recovery (Sugg 1996: 49). Getty was also referred to as “baboon boy” in the media (Cooper and Lanza 2000: 201).
Concern has been expressed over animal exploitation and the impact of XTP on altruistic human organ donation rates. Despite the focus on organ need and supply, xenoperfusion and cellular XTs hold more potential for success than whole organ XTs. Failures in XTP are a result of physiological and immunological dissimilarities between species. Even recent clinical trials of XTP have stirred social, ethical, scientific and medical controversy, as evidenced in the case of Baby Fae and Jeff Getty. XTP has a comprehensive history, as detailed in Appendices 1.0 to 1.3.

How? The Concerns of Xenotransplantation

As indicated by Appendices 1.0 to 1.3 and the clinical trials of Baby Fae and Jeff Getty, XTP presents many difficulties and problems that extend beyond experimental, scientific protocols. Many overlapping concerns of XTP are thus echoed by different actors across traditionally separate disciplines (Welsh and Evans 1999: 198). This interactive relationship is demonstrated in Bach et al. (1998: 144) where, despite their various alliances with private and public institutions with vested XTP interests (Daar 1997: 977), called upon “a moratorium on all human xenotransplantation” (Bach et al. 1998: 141). This dynamism of XTP debates means it is appropriate to address medical, ethical and social concerns together, which are generally related to the welfare of human beings and animals. These issues are broadly categorised in this section as: immunology,
Immunological Barriers and Solutions to Organ Rejection

A significant hurdle for transplantation therapies, particularly XTP, has been the human immune response, which attacks and rejects a foreign body to prevent opportunistisic infections and invaders (Czaplicki et al. 1992: 393). While rejection episodes exist in AT, the increased levels of molecular incompatibility between the host (pig) and recipient (human) presents new challenges and rejection phases.

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for XTP (Gold and Adams 2002: 37). Hence, much research has been dedicated to overcoming the varying phases of immune-mediated rejection. In turn, the type of XT vascularisation is important for determining which rejection phases will possibly be stimulated\(^{46}\) (Cascalho and Platt 2001: 440).

Chronologically, rejection episodes in XTP have been identified as: hyperacute rejection (HAR); acute vascular rejection (AVR)\(^{47}\); acute cellular rejection (ACR)\(^{48}\); and chronic rejection (CR; or long-term rejection) (Ogata and Platt 2004: 517; Cooper et al. 2002: 133, 138; Cooper and Lanza 2000: 57; Gunzburg 2000: 388-390; Platt 1999: 194-196; Collignon 1998b: 516; Platt 1998: 12-16; Platt and Lin 1998: 10; Czaplicki et al. 1992: 393). Other potential problems include graft-versus-host-disease (GVHD) and the complexities of immunosuppression\(^{49}\). Each of these rejection phases stimulates particular immune mechanisms, which ultimately lead to graft rejection and potential patient death. These rejection process and associated immune responses are summarised in Figure 5, while

\(^{46}\) For example, if the blood vessels are entirely from ‘donor’ origin, as occurs in whole organ XTP, the transplant will be subjected to increased immunological responses (Cascalho and Platt 2001: 440). In contrast, free tissue (cellular and skin) XT\(\text{s}\) and xenoperfusion involve partial or nil donor vasculature, and therefore rely on recipient vessels for successful engraftment (Cascalho and Platt 2001: 440). As a result, these XT\(\text{s}\) are subjected to less rejection episodes.

\(^{47}\) Also known as delayed XG rejection, delayed graft rejection, delayed vascular rejection, antibody-mediated immune response and acute humoral XG rejection.

\(^{48}\) Also known as cell-mediated rejection, T-cell-mediated rejection and elicited immune responses.

\(^{49}\) Problems with immunosuppression shall be addressed in later in this chapter in ‘Immunosuppression and Allotransplantation: Infection, Side Effects and Psychology’.
techniques used in an attempt to overcome XT rejection are outlined in Figures 6.0 and 6.1.

Notably, studies on XTP rejection episodes do not occur in humans, but in nonhuman primates. Much of the knowledge on organ rejection therefore primarily stems from human AT and animal XTP trials. It needs to also be remembered that the techniques to overcome these rejection phases may inflame conflict between clinicians and scientists. This is because the techniques used in animal models may be undesirable or impossible for human applications. For example:

I believe people dealing with xenotransplantation should give more thought to the patient rather than [...] research that may never be applied in clinical practice because it is too complicated. Have such researchers any idea what a child looks like after several years of immunosuppressive treatment? (Macchiarini 1998: 12)

Furthermore, regardless of the interventions aimed at the initial rejection phases, Thomson and McWhir (2004: 237-238) and Lambrigts et al. (1998: 549) assert long-term survival will not occur unless other rejection phases are overcome. In this light, Professor McKenzie (in Reuters 2004b: para.9), believes “at least six genes will need to be modified or eliminated in transgenic pigs to allow the
survival of donor organs. McKenzie (2004: 2) adds this may require some immunosuppressive treatment. Combining interventions in the bodies of the human recipient and the source animal may therefore lead to improved success rates (Lambrigts et al. 1998: 547), as recently explored by Kuwaki et al. (2005) (α-Gal knockout (GT-KO) pigs and recipient depletion of α-Gal and complement activity), Lam et al. (2005) (human decay accelerating factor (hDAF) pigs and recipient immune suppression by depleting α-Gal activity with soluble complement receptor 1), and Yamada et al. (2005) (GT-KO pigs and thymokidneys for renal transplantation). Despite combining approaches, long-term survival is yet to be achieved. Furthermore, the relevancy of the pig-to-nonhuman primate experimental model as a precursor for pig-to-human clinical trials is unknown due to possible biological, physiological and immunological differences between humans and nonhuman primates (Cascalho and Platt 2001: 444; Morris 1997: 257). It should also be remembered AT is still a developing technique. For example, half of the individuals with a heart or kidney AG will lose graft function within ten years, and only a small number of AG recipients will retain graft function for twenty to thirty years (Moreno-Borchart 2004: 1025; Cooper and Lanza 2000: 59, 107; VanBuskirk et al. 1997: 1997).

50 Problems of GE, including cloning and trangensis, will be explored later in this chapter in ‘Physiology and Genetic Engineering’.
B-cells and T-cells are designed to fight infection (Huizinga 2002: 261). This stage is yet to be well characterised due to the difficulties in overcoming HAR and AVR (Yong-Guang and Sykes 2007: 521).


**Figure 5 - Rejection Phases and Immunological Responses**

<table>
<thead>
<tr>
<th>REJECTION</th>
<th>XT</th>
<th>OCCURS</th>
<th>IMMUNE RESPONSE</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAR</td>
<td>Discordant whole organ</td>
<td>Minutes or hours</td>
<td>Xenoreactive antibodies (XNAs; or Galα1-3Gal antibodies) in the complement system; XNAs trigger the complement (coagulation) cascade</td>
<td>XNAs and the complement cascade primarily target the sugar molecule (blood group) Galα1-3Gal (α-Gal), as found on the vascular surface of pig organs; α-Gal is produced by enzyme α1,3galacosyltransferase (α-GalF); Human surfaces protected from the complement cascade by complement regulatory proteins (CRPs): human decay accelerating factor (hDAF), CD59 and CD46; Porcine XT does not express human compatible CRPs to prevent XNA binding</td>
</tr>
<tr>
<td>AVR</td>
<td>Discordant and concordant whole organ</td>
<td>Days or weeks</td>
<td>Xenoreactive antibodies (XNAs), the complement system and the complement cascade; Xenoreactive antibodies other than those involved in the complement cascade; Humoral B-cell antibody manufacturing response (B-cells); Inflammatory cells (natural killer cells and macrophages); Possible - biological incompatibilities</td>
<td>Similar processes to HAR; Lower importance on the complement cascade; Extends beyond α-Gal antibody activity (antibodies may not trigger AVR); Low levels of XNA activity can cause AVR; Other possible physiological processes; Interacts with ACR; AVR immune-based response suspected to be greater than equivalent rejection stage in AT</td>
</tr>
<tr>
<td>ACR&lt;sup&gt;52&lt;/sup&gt;</td>
<td>Discordant and concordant XTs</td>
<td>Weeks or months</td>
<td>T-lymphocytes (T-cells); Inflammatory cells (natural killer cells and macrophages); Leukocytes</td>
<td>Triggers antibody immune activity in response to surface antigens on foreign matter; Interacts with AVR; ACR immune-based response suspected to be greater than equivalent rejection stage in AT</td>
</tr>
<tr>
<td>ACR&lt;sup&gt;52&lt;/sup&gt; (GVHD)</td>
<td>Bone marrow XT</td>
<td>Unknown</td>
<td>Graft's immune system rejects the recipient</td>
<td>Graft's immune system rejects the recipient</td>
</tr>
<tr>
<td>CR</td>
<td>Unknown (all?)</td>
<td>Months or years (in AT)</td>
<td>Unknown</td>
<td>Unknown – no vascularised XT have survived to this stage; Occurs in AT despite use of PITs</td>
</tr>
</tbody>
</table>

<sup>51</sup> B-cells and T-cells are designed to fight infection (Huizinga 2002: 261).

<sup>52</sup> This stage is yet to be well characterised due to the difficulties in overcoming HAR and AVR (Yong-Guang and Sykes 2007: 521).

<table>
<thead>
<tr>
<th>REJECTION</th>
<th>TARGET</th>
<th>XT</th>
<th>AIM</th>
<th>OPTION/S</th>
<th>HURDLES</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipient</td>
<td>Whole organ</td>
<td>Reducing or depleting α-Gal antibodies</td>
<td>- Oligosaccharides&lt;sup&gt;55&lt;/sup&gt;</td>
<td>HAR and other forms of rejection may still occur</td>
<td>Prolonged graft survival with and without PITs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inhibit, suppress or deplete complement activity</td>
<td>- Plasmapheresis&lt;sup&gt;56&lt;/sup&gt; and PITs</td>
<td>Problems with PITs (also ineffective in HAR prevention)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Immunoadsorption&lt;sup&gt;57&lt;/sup&gt;</td>
<td>Need for repeat treatments (short-term/temporary therapy)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Xenoperfusion</td>
<td>Increase in infectious risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAR</td>
<td>Host</td>
<td>Whole organ</td>
<td>Downplay or inhibit the complement cascade</td>
<td>HAR and other forms of rejection may still occur</td>
<td>- Prolonged graft survival in animal models</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Genetic engineering of source animal to express human CRPs (hDAF, CD59 and/or CD46)</td>
<td>Expression in human CRP porcine XTs low when compared to human expression levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Problems with PITs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No survival difference between single and double transgenic pigs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Possible increase of infectious risk to humans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eliminate or reduce the antibody response to α-Gal by disrupting the α-GalF enzyme</td>
<td>Low levels of α-Gal in double GT-KO pigs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Insert human gene α-(1-2)-fucosyltransferase to compete with α-GalF or genetic engineering and cloning of pigs to eliminate α-Gal: single or double GT-KO pigs</td>
<td>Human antibodies target new and/or other sugars in place of α-Gal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Possible increase of infectious risk to humans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Health problems in GE/cloned animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low success rate of cloning</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.0 - Overcoming Rejection: Technologies, Hurdles and Results<sup>58</sup>

<sup>54</sup> Unless otherwise stated, these are experimental (animal-to-animal) results.

<sup>55</sup> Oligosaccharides involves using specific sugars and/or proteins to combat αGal (Dorland's Illustrated Medical Dictionary 2003: 1306).

<sup>56</sup> Plasmapheresis is the separation of XNAs from the plasma in the blood (Dorland's Illustrated Medical Dictionary 2003: 1446; Martin 1994: 515; Miller and Keane 1987: 973).

<sup>57</sup> Immunoadsorption involves the specific separation of XNAs from the recipient by using certain sugars (Dorland's Illustrated Medical Dictionary 2003: 910).

### Figure 6.1 – Overcoming Rejection: Technologies, Hurdles and Results

<table>
<thead>
<tr>
<th>REJECTION</th>
<th>TARGET</th>
<th>XT</th>
<th>AIM</th>
<th>OPTION/S</th>
<th>HURDLES</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVR</td>
<td>Recipient</td>
<td>Whole organ</td>
<td>Suppress the immune system</td>
<td>• PITs</td>
<td>Problems with PITs</td>
<td>Dilutes and delays AVR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reducing or depleting antibodies</td>
<td>• Plasmapheresis</td>
<td>Does not facilitate long-term XT survival</td>
<td>Reduces AVR response</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Minimise inflammatory cell activity</td>
<td>• Anti-inflammatory agents</td>
<td>Does not facilitate long-term XT survival</td>
<td>Unknown</td>
</tr>
<tr>
<td>Host</td>
<td>Whole organ</td>
<td></td>
<td></td>
<td>As per HAR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| AVR and ACR | Recipient or in host | Whole organ | Suppress the immune system | • PITs | Problems with PITs | Slight delays graft rejection |
|            | X | Thymokidney                | • Bone marrow XT | Preoperative toxicity levels (bone marrow) | Eliminates PITs and other recipient interventions |
|            | X | Thymus XT                  | Long-term engraftment yet to be achieved | Decreases α-Gal antibodies |         |
|            | X | Thymokidney XT             | Could lead to GVHD (bone marrow) | Rejection temporarily reversed |         |
|            | X | Thymokidney XT             | Possibility of infection |         |         |

| Created in vitro | Cellular | Suppress immune system | • Sertoli cell XT | Unavailable | Promising results in humans but some questionable results |
|                 |         |                        |                |            | Eliminates PITs |

| ACR (GVHD) | Recipient | Whole organ | Suppress immune system | • PITs | Problems with PITs | Unknown if occurs across species barriers |

| CR | Plays an unknown role, as vascularised XTs are yet to survive to this stage |

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59 For example, the thymokidney can be created inside the source animal prior to human XTP. 

60 *In vitro* means outside of the body; in culture. 

61 See Appendices 1.0 to 1.3 for more information. 

Immunosuppression and Allotransplantation: Infection, Side Effects and Psychology

As indicated, the use of PITs in AT presents medical problems and complications that deserve consideration for XTP. By partially suppressing the human immune system in order to accept a foreign graft, PITs reduce the body’s resistance to various diseases and infections. The individual’s capacity to fight virions further reduces as PIT dosage increases. Therefore, the immunosuppressed individual is exposed to an increased risk of developing or contracting diseases and/or infections. This means that in addition to rejection, opportunistic infections such as protozoa, fungi and bacteria (Madden 2003: 361), are serious AT complications that are a major cause of post-transplant mortality (John et al. 2004: 2). For example, people on PITs are more likely than the general population to develop disease and cancer, such as skin cancer\(^{63}\) (Guttman 2004: 41), diabetes, renal failure\(^{64}\), osteoporosis, atherosclerosis (arterial disease) and lymphoproliferative malignancies (John et al. 2004: 3; Sherwood 1993: 291, 659, G-2).

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\(^{63}\) “Between 35-50% of transplant recipients will develop one or more skin cancers by the tenth year following organ transplantation” (Donovan et al. 2004: 1852). Furthermore, “in Australia, during the 10 year period 1981-1990, there was a 12% probability of skin cancer by 5 years after transplantation” (Okada-Takagi and Williams 1993: 16).

\(^{64}\) In itself, renal failure may require the individual to undergo regular dialysis treatments and/or a kidney transplant.
Individuals also carry ‘silent’ infections, such as cytomegalovirus (CMV). This is normally rendered harmless through T-cell immunity. In AT, however, the impact of PITs on T-cells can cause CMV to become lethal (Madden 2003: 367; Weiss 1998a: 933). CMV also increases the chances of other opportunistic infections such as fungal disease, which PITs can render more aggressive, invasive and atypical than usually presented (Madden 2003: 361). Further complications are posed by the pharmaceutical drugs, over-the-counter medications and/or herbal remedies used to treat these infections, which in themselves may interfere or interact with PITs (Fireman et al. 2004: 354-357; Madden 2003: 381; Jowsey et al. 2001: 408). Infections can also build resistance to such interventions (see Basgoz 1999).

In addition, endemic human infections can also be spread through AT. Exogenous retroviruses (horizontally transmitted infectious viruses)\(^65\), such as HIV-1, variant Creutzfeldt Jakob disease (vCJD), human T-cell leukaemia (lymphotropic) virus, hepatitis, tuberculosis, Epstein-Barr virus, varicella-zoster virus (chicken pox) and various herpes viruses, have been transmitted through human AGs\(^66\) (Sedgman 2004; Bloom et al. 1999: 79; Snydman 1999: 24; Eastlund

\(^{65}\) These cases refer to human-to-human transmission. Exogenous retroviruses, however, can also be transmitted as a one-time infectious event between animal-to-human and human-to-animal.

\(^{66}\) Donated tissue and organs are screened for such viral infections. Due to the health status of the potential recipient, however, these infected tissues/organs may still be used. Such pathogens may also remain undetected (Morens et al. 2004: 245).
Importantly, exogenous retroviral infection may have increased acceleration in immunosuppressed individuals. HIV-1 for instance, is known to progress to AIDS within six months following AT (Fishman and Patience 2004: 1385). Furthermore, the increased number of immunosuppressed humans worldwide has allowed diseases previously believed to be eliminated or under control to re-emerge (Morens et al. 2004: 245). Accordingly, the increased dosage of PITs required for XT acceptance would intensify infectious risk (Guttman 2004: 41, 45; Game et al. 2001: 836).

To minimise the possibility of rejection and infection, organ recipients need to accept a variety of lifestyle changes (see Figure 7). At the same time, PITs can cause significant side effects that may compromise quality of life (see Figure 8). The complications of PITs thus remain a major concern and barrier to successful XTP (Fishman and Patience 2004: 1383).

Despite significant risks, transplant recipients do not necessarily accept and/or practice lifestyle modifications and changes. For example, Donovan et al. (2004: 1852, 1854-1855) found 23% of 205 AG recipients continued to seek a suntan, and only 18% practiced high levels of sun-protective behaviours. Furthermore, non-compliance to rigorous medical regimes and lifestyle changes in general are prevalent (Jowsey et al. 2001: 405). As a result, post-

67 Morens et al. (2004: 245) believe “probably more than 1% of the world’s population” is immunocompromised either through PITs, chemotherapy or disease.
### LIFESTYLE FOR ORGAN RECIPIENTS

- Minimise exposure to unfiltered water
- Regularly wash hands
- Maintain and/or increase physical exercise
- Maintain and/or install home climate control
- Practice safe sex
- Maintain sexual health
- Maintain vaccination schedule (including influenza)

- Maintain personal hygiene
- Maintain and ensure food hygiene and safety
- Minimise contact with animals
- Maintain travel safety
- Eliminate or minimise alcohol consumption
- Eliminate or minimise smoking
- Eliminate or minimise exposure to smoke
- Minimise sun exposure
- Practice sun-protective behaviours

### Figure 7 - Lifestyle Changes and Modifications Required by Organ Recipients

Information from ‘Strategies for safe living following solid organ transplantation’ (2004), Donovan et al. (2004: 1852), and John et al. (2004: 3).

### SIDE EFFECTS OF PITs

<table>
<thead>
<tr>
<th>Hypertension</th>
<th>Hyperlipidemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep disturbance</td>
<td>Osteoporosis</td>
</tr>
<tr>
<td>Gastric ulcers</td>
<td>Mood change</td>
</tr>
<tr>
<td>Oedema</td>
<td>Cataracts</td>
</tr>
<tr>
<td>Delirium</td>
<td>High blood pressure</td>
</tr>
<tr>
<td>Depression</td>
<td>Psychosis</td>
</tr>
<tr>
<td>Obesity</td>
<td>Dysarthria</td>
</tr>
<tr>
<td>Menstrual irregularities (women)</td>
<td>Seizures</td>
</tr>
</tbody>
</table>

### Figure 8 - Some Potential Side Effects of Pharmaceutical Immunosuppressive Therapies


Surgical everyday life can pose challenges and various stressors for the AG recipient (Achille et al. 2004: 64). Such experiences reveal that psychosocial issues are significant for pre- and post-surgical lifestyle expectations and adjustments, including accepting a foreign

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68 For a more detailed list of side effects as related to specific PITs, refer to Cooper and Lanza (2000: 84-85).
69 For more explorations of these tensions and the treatment of noncompliant AT recipients by the medical profession, see Cook and McCarthy (2007).
body as own (John et al. 2004: 3; Daar 1997: 979). Such difficulties and complex negotiations, including noncompliance, can be expected in XT recipients.

As Daar (1997: 979) indicates, the psychological effects of accepting an organ are paramount in AT. Importantly, pre- and post-surgical challenges for recipients of cadaver and live organs involve psychological body-image challenges to coherent self-perception (Rauch and Kneen 1989: 47-48; Mai 1986: 1160). These issues include lifestyle adaptations such as “inability to work, loss of income, loss of status, family role reversals, anxiety about sexual activity and fear of death” (Rauch and Kneen 1989: 49). Accordingly, numerous emotional feelings and states accompany waiting for and/or receiving an organ (Rauch and Kneen 1989: 50). Such feelings might be directed towards the organ donor and/or the organ itself (Rauch and Kneen 1989: 50, 54; Mai 1986: 1159-1160).

In addition, organs such as the heart are powerful sociocultural symbols associated with the soul and love (Rauch and Kneen 1989: 52-53). Heart AT therefore involves a loss of self (old heart),

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70 These complex feelings may include interest, curiosity, euphoria, gratitude, sympathy to donor family (cadaver AGs), elation, ambivalence, guilt, anxiety and apprehension (Fukunishi et al. 2001: 341; Rauch and Kneen 1989: 51, 54-55; Mai 1986: 1160). Such issues are also explored by Okada-Takagi and Williams (1993). In interviews with AG recipients immediately post-transplant, Sanner (2003: 393) additionally found that these emotions could be categorised as “(a) joy and sorrow, (b) gratitude and indebtedness, (c) guilt, and (d) inequity”. Such coping strategies have led to over 50% of AG recipients displaying mood changes, adjustment disorders, depression, posttraumatic stress, delirium and psychiatric problems (Dew et al. 2004: 1077; Fukunishi et al. 2001: 340-341; Jowsey et al. 2001: 408; Rauch and Kneen 1989: 48).
accompanied with the social and psychological associations of a new heart (Rauch and Kneen 1989: 54). The integration of another person’s organ (non-self; other) and the realities of organ donation, thus challenge a cohesive sense of self (Rauch and Kneen 1989: 55; Dubovsky et al. 1979: 1091). This highly charged emotional complexity and attendant psychological struggle links to protective and adaptive coping techniques of “denial, avoidance and suppression against anxiety” (Sanner 2003: 394).71

Inversely, ways of perceiving the donor by the recipient could aid in AG acceptance. These include “(a) identification with the deceased donor, (b) influences of the deceased donor, and (c) relationship to the living donor” (Sanner 2003: 394). This ambiguity of identity and relationship could potentially be more psychologically complicated and difficult when attempting to ‘normalise’ the XTP body through associations to the pig and/or pig organ (Okada-Takagi and Williams 1993: 23). At the same time, however, as “several [AG] recipients attempted to objectify their transplant and even their own body by using metaphors of machines and spare parts” (Sanner 2003: 399), the incorporation of a pig organ may present less or equivalent complexities to AG ontological adjustment72.

71 Isabelle Dinoire (in Agence France-Presse (AFP) 2007: para.12), the world’s first face transplant recipient, recently outlined her difficulties in psychologically accepting her new face: “The hardest thing to accept was to have the inside of someone else’s mouth. It wasn’t mine, it was all soft, it was atrocious”.

72 To accompany this complexity, caregiver support is an important component of patient adjustment and medical compliance (Konstam et al. 1999: 23; Canning et al. 1996: 599, 605; Frazier et al. 1995: 106). This means that the psychosocial status and the health condition of the caregiver/s needs to be considered in and as
To further complicate such issues, additional problems are apparent for the donors of living AT. These include:

- lack of emotional support;
- possible suffering over organ loss;
- emotional turmoil before and after donation;
- feelings of ‘no choice’ in organ donation;
- ‘nonpatient’ status leads to ineffective medical surveillance and pain management;
- financial strains;
- coercive relationships;
- avoidance-coping behaviours;
- difficulties in returning to normalcy;

While the implications of human living donations are irrelevant for XTP, it needs to be remembered a live animal ‘donor’ is involved who, as a consequence of organ ‘donation’, must die. Daar (1997: 979) believes this could result in an increase in psychosocial distress part of patient recovery (Dew et al. 2004: 1065). Thus, the cost-benefit of AT not only involves the patient, but also the wellbeing of the caregiver (Dew et al. 2004: 1066). Additionally, as hospitalisation times decrease and medical budgets are restrained, more pressure is being placed on caregivers for long-term support (Dew et al. 2004: 1077). The increase of transplants available through XTP would therefore not only increase the number of caregivers, but could also increase the psychosocial burden and emotional difficulties on both the recipient and caregiver/s.
amongst XT recipients. To reemphasise, the affect of a porcine XTP on the recipient’s identity, self-integration and self-image, is unknown (Appel III et al. 2000: 223). In turn, social stigma and public fear may follow, as experienced by Jeff Getty (Appel III et al. 2000: 224). Of particular concern are the psychological affects of an ontological nature, namely what it means to be ‘human’ and the degree of being ‘human’ when one receives an animal XT (Gold and Adams 2002: 41).

With these understandings, AT should be viewed as a developing medical therapy. Due to these challenges, “transplant does not constitute a cure but a palliative treatment” (Achille et al. 2004: 63). Such considerations are additionally relevant for XTP and its development.

2) Main Points

- The immune response to a foreign body results in the rejection of the XT.
- There are four rejection phases of concern in XTP: hyperacute rejection, acute vascular rejection, acute cellular rejection and chronic rejection.
- Rejection phases might be overcome by modifying the recipient, XTP source and/or in vitro (in culture).
- Modifications to the source animal may include GE, transgenesis and cloning.
- In AT, infection is a major concern.

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73 Research by Lundin (2002; 2001; 1999) and Lundin and Widner (2000), however, have examined such issues in porcine islet recipients. This will be examined later in this chapter in ‘Sociocultural Research: Quantitative and Qualitative’.

74 The limited research available addressing such concerns will be examined in ‘Sociocultural Research: Quantitative and Qualitative’. 
• PITs, as used in AT to prevent graft rejection, increase the chances of infection, cancer, disease, and may cause side effects, including psychological disorders.
• Experiences of PITs in AT, as well as allotransplantation experiences themselves, are important for XTP development.
• Integrating a foreign body as own can be a difficult and complex experience.
• Organ recipients need to make many lifestyle changes, though non-compliance is common.
• The psychological and social effects of receiving a XT are unknown.
• “Transplant does not constitute a cure but a palliative treatment” (Achille et al. 2004: 63).

Physiology and Genetic Engineering

As previously outlined, pigs have been identified as the most appropriate animal source for XTP. Two of the main scientific reasons are physiological similarities, and the relative ease in which pigs can be GE to become even more physiologically and immunologically compatible to humans (Cooper 2003: 559; Brown and Michael 2001a: 9; Platt and Lin 1998: 5)\textsuperscript{75}. Despite physiological similarities, Fano (2001: 36), Breimer (1999: 905-907) and Holliday (1995: 434) highlight that despite overcoming immunological barriers, there remain physiological, molecular, metabolic and ageing differences that could pose barriers to successful XTP. Furthermore, species dissimilarities that remain despite GE may or may not compromise the functioning of the XT within the specific demands of the human body\textsuperscript{76} (Bloom 2001: 312; Bloom et al. 1999: 78). That is,

\textsuperscript{75} This is further explored in the chapter ‘The Biological Gaze: Selecting an Animal’.
\textsuperscript{76} This functional capacity may differ between tissue types (Weiss 1998a: 932).
it is expected that XT will have functional deficiencies (Gold and Adams 2002: 36). In turn, human/pig compatibility is difficult to assess given the unknown relevancy of nonhuman primate experimental studies for human therapeutic applications (Cascalho and Platt 2001: 444; Morris 1997: 257). Even if these physiological barriers cannot be overcome, pig organs may be used as a bridge to AT (Lanza et al. 1997: 45). This does not, however, reduce the strain on organ waiting lists, the patient, their family, and the healthcare system (Gollackner and Cooper 2001: 139).

GE animals are also of welfare and ethical concern. While animals are already commodified for various human uses, GE extends this exploitation by specifically and artificially creating animals for their ‘parts’ (Gold and Adams 2002: 41). Such issues are heightened in the unpredictability of GE, where animals have been stillborn or born with conditions such as arthritis, stomach ulcers, muscle weakness and defective vision (British Union Anti-Vivisection (BUAV) Organisation 2000). Furthermore, recent studies on cloned pigs have shown that while they are born with satisfactory immune systems, the lack of cytokines\textsuperscript{77} explains why many clones die of bacterial infections soon after birth (‘US ARS: Study shows differences in natural immunity in cloned pigs’ 2004: 1). This means GE remains a technoscience in development, as it “is inefficient and results in

\textsuperscript{77} Cytokines are proteins that influence the behaviours and activities of other cells. This includes cellular growth and death, and the immune response to fight infectious agents (\textit{Dorland’s Illustrated Medical Dictionary} 2003: 469; Janeway Jr. and Travers 1997: G:6).
random integration and variable expression patterns in the transgenic offspring” (Niemann and Kues 2003: 3). For example the first cloned animal, Dolly the ewe, was the only embryo of 29 to survive, and was the result of 277 GE implanted eggs (Cooper and Lanza 2000: 104). Furthermore, the rate of success in creating hDAF pigs in the early 1990s was only at 1.3% (Ho and Cummins n.d.: para.9), and GT-KO pigs at less than 1% (Bollen and Ritskes-Hoitinga 2004: 285).

As outlined by Cooper and Lanza (2000: 91, 93), GE is an inefficient technique that will take significant time and money to produce large transgenic pig herds. Thus, the rate of transgenic failure results in large amounts of pigs being exploited and killed in XTP processes.

Such concerns extend beyond animal welfare advocates to the general community.

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78 For example, “of >400 manipulated embryos, one sheep survived; [in other cases,] of 250 embryos, eight calves survived; and of 2500 embryos, 31 newborn mice survived” (Ogle and Platt 2002: 301).

79 “Of 85 surrogate mothers implanted with [hDAF] embryos, 49 delivered litters with 311 piglets, 49 of which were transgenic […] with one to 30 copies of the gene. Only 33 expressed the gene for hDAF, however” (Ho and Cummins n.d.: para.9).

80 See Almond (2000) for a more in-depth exploration of these issues.

81 As Macnaghten (2004: 534) indicates, public responses to GE animals need to be considered, respected and appreciated, as such interventions impact upon human/animal embodied interactions and social practices. These types of concerns extend beyond ethics by considering the complex and intimate relationships between human/animal, where animals are simultaneously individuals (“ends of themselves”) and “human ends” (Macnaghten 2004: 535, 538). Importantly, Macnaghten’s (2004: 539-540) research indicates the ambivalency and reflexive feelings towards animals as ‘human ends’. As a result traditional practices, such as meat eating and animal testing, are flexible and open to question, which will be explored more in this thesis. Furthermore social relationships, rather than ethical concerns, determined the GE of animals as: unnatural; dangerous in the unforeseen; unnecessary; and indicative of human arrogance in using animals to solve human-made problems (Macnaghten 2004: 543, 545-546). Significantly, these arguments often embrace a hybrid co-existence over independency, and are often underappreciated and derided as ‘emotional’ or nonsensical rather than ‘rational’ and ‘intellectual’ (Macnaghten 2004: 536). Accordingly, the complexity of social understandings and relationships is marginalised in the making of scientific public policy. It is important, however, not to undermine these strong ‘hybrid’ ties,
To further complicate the issues in XTP and GE debates, humans genetically differ only 2% from monkeys, thus a 0.5% change could be very significant (Dixon in Cooper and Lanza 2000: 195). As Dixon further elaborates: “How many human genes does an animal have to have to gain human rights?” Consequently not only are rejection, infection and disease of concern in XTP, but also the technologies employed to overcome potential physiological disparities. Such techniques also highlight the danger of cross-species viral infection (zoonosis).

**Microbiology: Zoonosis and Xenozoonosis**

A major concern to and in XTP debates and public health are zoonoses. In XTP, this is called xenozoonosis. Some researchers believe humans do not have a significant infectious risk from pigs, as pigs and humans have been living together for some time. Therefore, humans have already acquired any microbes that could be infectious, including some serious influenza strains (Weiss 1998a: 933; Lanza et al. 1997: 45). Such considerations, however, fail to account for the new intimacies created in XTP (Weiss 1998a: 933), and continual discoveries of previously unknown infections (Weiss 2004: 285). Due as the social acceptability of hybridity and risks needs to be considered and respected (Gold and Adams 2002: 52).
to the rarity of XTP in the past and its continued failure, xenozoonosis has only recently become a concern.

Significantly, XTP breaks down the protective physical species barriers provided by skin and mucous membranes (Andersen 2000: 2; Bach et al. 1998: 142). This physical breakdown allows viruses to efficiently carry diseases and infections to humans without a transmission carrier (vector), such as mosquitoes. Therefore, animal viruses not previously capable of infecting humans could become infectious to humans through XTP, such as those transmitted sexually and/or through blood-to-blood contact (Allan 1998: 92). Importantly, the behaviours of potential xenozoonoses in immunosuppressed humans is unknown (Fishman and Patience 2004: 1384).

Of serious concern is not animal-to-human transmission per se, but subsequent human-to-human transmission. XTP could introduce novel diseases to the population that spread to become a new human epidemic (Gold and Adams 2002: 39; Bloom et al. 1999: 79). Consequently, a struggle exists between the potentialities of a positive individual benefit (private) and a negative collective societal risk (public) (Gold and Adams 2002: 32; Bach et al. 1998: 141). Furthermore, while possible infection from a XT may be acceptable for an individual with organ failure who has the least to lose, the potential of an irreversible human pandemic has differing
considerations in public health terms (Gold and Adams 2002: 46; Weiss 1998a: 933). In this vein, Collignon (1998b: 516, 519) believes XTP to be “one of the best experiments we could devise to ‘create’ new infectious agents”\(^{82}\).

While some believe disease transmission is possible though unlikely (Pierson III 2004: 391), concerns of cross-species infections are not unjustified\(^{83}\). For example, “75% of emerging infectious diseases have been identified as zoonotic in origin” (Marano and Pappaioanou 2004: 2065), with 62% of known human infections originating in animals (Kruse et al. 2004: 2067). Brief lists of animal pathogens that have infected and/or adapted to humans are presented in Figure 9.

Unlike the financial and geographical limitations borne by XTP experiments, viruses traverse geopolitical borders, as evidenced by the human spread of HIV and severe acute respiratory syndrome (SARS)\(^{84}\) (Gold and Adams 2002: 41). XTP and infectious diseases are therefore a global legal and political issue (Cook 2007, 2005a; Cook et al. 2005; Bradsher and Altman 2004; Gold and Adams 2002: 33; Florencio and Weizmann 1999: 21). This creates a conflict

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\(^{82}\) Further views of Collignon will be explored later in this thesis.

\(^{83}\) These types of views will be explored more thoroughly in the chapters ‘Risk and Trust: Science, Infection and Health’, and ‘Risk and Uncertainty: Science and Zoonosis’.

\(^{84}\) SARS killed around 800 people from 8 098 infectious instances within approximately six months (Skatssooon 2004; Tu et al. 2004), while HIV/AIDS is predicted to kill 74 million people by 2015 (Agence France-Presse (AFP) 2004a: para.1).
<table>
<thead>
<tr>
<th>SOURCE</th>
<th>PATHOGEN</th>
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<tbody>
<tr>
<td>Nonhuman primates</td>
<td>HIV-1 and -2</td>
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<td></td>
<td>Herpesvirus B</td>
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<td></td>
<td>Ebola virus</td>
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<td>Marburg virus</td>
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<td></td>
<td>Monkeypox</td>
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<td></td>
<td>Simian foamy virus</td>
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<tr>
<td>Pigs</td>
<td>Swine influenza</td>
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<td></td>
<td>Nipah virus</td>
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<tr>
<td>Rodents</td>
<td>Hantavirus</td>
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<td></td>
<td>Bubonic plague</td>
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<tr>
<td>Birds</td>
<td>West Nile virus</td>
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<td></td>
<td><em>Salmonella spp.</em></td>
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<tr>
<td>Cows</td>
<td>Foot and mouth disease</td>
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<td></td>
<td>vCJD</td>
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<tr>
<td>Horses</td>
<td>Hendra virus</td>
</tr>
<tr>
<td>Civets</td>
<td>Severe acute respiratory syndrome (SARS)</td>
</tr>
<tr>
<td>Ticks</td>
<td>Lyme disease</td>
</tr>
<tr>
<td>Household pets and fleas</td>
<td>Bubonic plague</td>
</tr>
<tr>
<td></td>
<td>Ringworm</td>
</tr>
</tbody>
</table>

Figure 9 - Examples of Zoonotic Infections from Animals-to-Humans


between the sovereignty of State decision-making and the impact of decisions made by other States (Cook 2007: 31-32; 2005a: 3; Gold and Adams 2002: 50). Moreover, any human pandemic from XTP would result in risk inequality as developing nations would not possess the resources and public health infrastructure to deal with a viral outbreak\(^87\) (Gold and Adams 2002: 41).

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85 May also originate in reptiles.
86 Civets are also known as the masked palm cat, and are sold in Chinese markets for consumption (Gallagher and Garrett 2004: para.98). Civets, however, are not believed to be the origin of SARS.
87 Interestingly, however, the ability of SARS to spread via air ducts meant poorer countries, such as Vietnam, contained the virus more quickly than more developed countries (Gallagher and Garrett 2004: para.75-76).
As “viruses do not carry passports” (Daar 1997: 975) and with xenotourism in Mexico City, XTP highlights the globalisation of infectious risk and the potential need for universal guidelines (Cook 2007; Cook et al. 2005; Daar 1997: 975). As a result, the risk/benefit equilibrium may topple not only between individual benefit (private)/societal risk (public), but also developing/developed nations (see Figure 10). It should also be remembered that universal guidelines and regulations may not fully appreciate the cultural and religious differences that exist throughout the world. Lastly, the lack or weakness of restrictive guidelines in developing countries may expose these nations to an increased infectious risk from “‘expatriate’ experiments” (Daar 1999: 58). These “xeno-havens” might be undeveloped countries with a lack of socio-economic infrastructure, who are already vulnerable through a pre-existing increased infectious risk (Cooper and Lanza 2000: 219; Butler 1998: 322).

![Figure 10 - Balancing Risk/Benefit in Xenotransplantation](image)

**Figure 10 - Balancing Risk/Benefit in Xenotransplantation**
In turn, the protective defence of species differences between pig/human is broken down by GE the source animal. When accompanied with patient immunosuppression, humans may become increasingly more susceptible to porcine infections and viruses (Weiss 2004: 291; Ludwig et al. 2003: 76; Weiss 2000; 1998a: 933; 1998b: 327-328). This increased susceptibility occurs by making humans and pigs more ‘alike’ (GE), suppressing the human immune system (PITs), and by averting the natural physical barriers between pig/human (XTP). This highlights that while the evolutionary relatedness between human/nonhuman primates is closer than human/pig, this does not necessarily mean the infectious risks from porcine XT to humans is less than that of nonhuman primate XT (Bloom et al. 1999: 80).

As a result of infectious possibilities, pigs need to be screened for a variety of potential human pathogens (see Figure 11). In the scientific community, it is believed that SPF environments and selective rearing, breeding and birthing procedures, can overcome these

88 Such considerations are particularly important when considering pigs GE with human complement regulatory proteins (CRPs). In humans, CRPs act as receptors for human diseases. For example, hDAF is the receptor for human Coxsackie B and ECHO (enteric cytopathic human orphan) viruses (relatives of the polio virus), while CD46 is a receptor for measles (Seow and Chew 2003: 1421; Weiss 1998a: 933) and certain strains of herpesvirus and infections of the upper respiratory tract (adenovirus) (Weiss 2004: 291). Thus, pig viruses closely related to these human diseases may adapt to human CRPs, allowing them to survive and replicate in human environs (Andersen 2000: 3). Importantly, this altered viral pathogeneity is a concern for the human and pig population (Bach et al. 1998: 143). In other words, transgenic pigs may develop an increased susceptibility to these human diseases (Andersen 2000: 3), or a patient carrying a new viral pathogen from a porcine human CRP XT could harm the pig husbandry industry (Bach et al. 1998: 141). This highlights the need to protect not only the patient and human society, but also animals (Bach et al. 1998: 143).
pathogens (Fishman and Patience 2004: 1385; Cooper 2003: 558).
Recent work by Mueller et al. (2005: 59, 61), however, reveals that while porcine CMV can be eliminated by caesarean delivery and early weaning of piglets, porcine lymphotropic herpesvirus-1 cannot. Furthermore, unknown, new or emerging viruses cannot be screened (Weiss 2004: 285). This demonstrates additional anxiety in XTP, where testing procedures for infection may be inadequate, or clinical symptoms could be misdiagnosed or not recognised (Fishman and Patience 2004: 1384). In other words, the new infectious agent is unpredictable (Bloom et al. 1999: 79).

Figure 11 - Example Pathogens that Need Screening and Eliminating from Pigs for Xenotransplantation

<table>
<thead>
<tr>
<th>SCREEN FOR:</th>
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<tbody>
<tr>
<td>Porcine circovirus-1 and -2</td>
<td>Porcine rotavirus</td>
</tr>
<tr>
<td>Porcine adenovirus</td>
<td>Rabies</td>
</tr>
<tr>
<td>Porcine reproductive and respiratory syndrome virus</td>
<td>Swine polyomavirus</td>
</tr>
<tr>
<td>Porcine encephalomyocarditis virus</td>
<td>Porcine lymphotropic</td>
</tr>
<tr>
<td>Porcine parasites (i.e. –</td>
<td>herpesvirus-1, -2 and -3</td>
</tr>
<tr>
<td><em>Toxoplasma gondii</em>)</td>
<td>Porcine CMV</td>
</tr>
<tr>
<td>Nipah virus</td>
<td>Swine and human influenza</td>
</tr>
<tr>
<td></td>
<td>Drug-resistant bacteria</td>
</tr>
<tr>
<td></td>
<td>Porcine pneumovirus</td>
</tr>
</tbody>
</table>


89 For a more comprehensive listing, see Kumar et al. (2002).
The risks and mechanisms of emerging and re-emerging infections are complex and should also be considered. These interrelated issues include:

- “Microbial adaptation and change\(^{90}\)
- Human susceptibility to infection\(^{91}\)
- Climate and weather\(^{92}\)
- Changing ecosystems\(^{93}\)
- Human demographics and behaviour\(^{94}\)
- Economic development and land use\(^{95}\)
- International travel and commerce\(^{96}\)
- Technology and industry\(^{97}\)
- Breakdown [or inadequacy, or non-existence] of public health measures\(^{98}\)
- Poverty and social inequality\(^{99}\)
- War and famine
- Lack of political will
- Intent to harm”\(^{100}\). (Morens et al. 2004: 245)\(^{101}\)

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\(^{90}\) For example, viral mutation, developing drug resistance and evolution.

\(^{91}\) For example, immunosuppression, questions on drug potency, quality of food sources and the existing public health system.

\(^{92}\) For example, El Niño.

\(^{93}\) For example, the greenhouse affect and deforestation.

\(^{94}\) For example, such as hygiene practices, syringe use, traditional cultural customs, hunting, butchering, eating of bushmeat, growth of wildlife markets, pet ownership and animal domestication, direct contact with farm and/or wildlife animals, ecotourism, illegal animal trade, laboratory handling of viruses and animal materials, unprotected sex and urban myths. Additionally, animal exportation and migration practices need to be considered.

\(^{95}\) For example, the impact on industry and gross domestic production growth.

\(^{96}\) For example, tourism, quarantine affects on local industry, intellectual property rights and patents.

\(^{97}\) For example, such as Legionnaire’s disease from air-conditioning units, vaccine development, enhanced diagnostic tools and reduced human capacity for employment and work through illness.

\(^{98}\) For example, such as levels of biosecurity, inadequate medical staff and veterinarian training, means of infectious identification, and limited facilities, funding and staff shortages.

\(^{99}\) For example, such as crowding, inadequate hygiene, access to antibiotics and filtered water supplies, and limited health systems to deal with public health crises in the globalisation of infection.

\(^{100}\) For example, bioterrorism.

As stated previously, infectious outbreaks question the balance between individual (human) rights and public health, and subjective and collective human freedoms (Danchin 2003: 335; Fidler 2003: 485, see Figure 10). These factors can also influence viral spread, where “everyone wishes to promote his or her rights, regardless of whether this is at the expense of others” (Danchin 2003: 333). As a result, poorly contagious diseases such as AIDS, can become epidemics due to human lifestyles, egoism and behaviours (Danchin 2003: 333). In turn, the speed of international travel means an individual in the early stages of infection can unknowingly spread virions around the world in a matter of hours, as evidenced by the quick international spread of SARS (Pang and Guindon 2004: 513). These infectious agents may also lead to chronic diseases that, in themselves, may induce organ failure and the need for AT (Morens et al. 2004: 244). Consequently, due to a complex web of microbial, viral, social and environmental factors, complacency towards infectious diseases cannot be afforded (Morens et al. 2004: 242). At the same time, the limited human clinical XTP trials have not evidenced bacterial, viral, fungal or parasitic infectious transmission (Fishman and Patience 2004: 1386; Garkavenko et al. 2004: 5353-5355), though this does not mean they will not happen.

Of major concern are viruses carried in the germ-line, known as endogenous retroviruses (intergenerational-transmitted viruses). Present in all studied vertebrate species (Cunningham et al. 2001: 63, 50-52, 78, 84, 87, 283-286, 299-303, 312, 316, 402).
endogenous retroviruses are carried in each tissue through an integration “in[to] the DNA of the host’s chromosomes” (Weiss 2004: 285). As a result, such viruses cannot be eliminated through current techniques, including SPF environments, and are often ‘invisible’ in the host (Weiss 2004: 285; Perico et al. 2002: 51; Tucker et al. 2002: 192; Loss et al. 2001: 32; Weiss 1998b: 328). This invisibility, afforded by the inactivity of the disease in the host, may become activated and pathogenic (‘visible’) as zoonosis (Weiss 2004: 287; Andersen 2000: 2; Weiss 1998a: 933; Patience et al. 1997b: 116, 119). In pigs, these viruses are called porcine endogenous retroviruses (PERVs).

In 1997, PERV became a major concern in XTP when Patience et al. (1997a) discovered that two strains of PERV (-A and -B), could infect human cells *in vitro*. It was also discovered that PERV has differing levels of expression in various organs with the highest levels in the kidney, followed by the liver, lung, heart and pancreas (Perico et al. 2002: 51). PERV has also been found to be expressed by endothelial cells (Martin et al. 1998: 694) and in porcine bone marrow cells (Buhler 2004b: 6). As a result of such findings, theoretical concerns were raised as to whether PERV or other pathogens could be transmitted from a porcine XT to a human recipient and in turn, from person-to-person (Holzknecht and Platt 2003: 328). Importantly, as endogenous retroviruses are found in all tissue due to genomic
integration, porcine XT recipients will certainly be exposed to PERV (Perico et al. 2002: 51).

Extending the work of Patience et al. (1997a), studies of human cells in vitro have found that α-Gal antibodies prevent PERV infection (McKane et al. in Buhler 2004b: 6; Buhler 2004d: 477; Weiss 2004: 291). This process is supplemented by the complement cascade, which inactivates PERV (Buhler 2004b: 6). Transgenic pigs therefore raise concerns that by being ‘designed’ to reduce the human immune response, the possibility of PERV infectivity will increase. Indeed, recent studies of GT-KO and human CRP pigs have shown decreased sensitivity to the human immune response (Buhler 2004e: 217). This could increase xenozoonotic possibilities by enabling porcine retroviruses, both exogenous and endogenous, to infect human cells more easily than their non-GE counterparts (Buhler 2004d: 478; 2004e: 217). Furthermore, Ericsson et al. (2003: 6764) demonstrate the human receptor (HuPAR-2) for PERV-A is present in most human tissues, though infectivity can occur independently of these receptors (Lavillette and Kabat 2004: 8869). This presents “novel opportunities for such viruses to infect germ cells and to invade a new species” (Lavillette and Kabat 2004: 8875).

In vivo (inside the body), PERV has been transmitted via porcine islet and/or pancreatic tissue XTs into immunodeficient mice (Berney et

\footnote{For more information of the relevance of α-Gal and the importance of the complement cascade, refer to Figure 5 and the glossary.}
al. 2002: 676; Deng et al. 2000: 1010, 1014-1015), and diabetic immunocompromised mice (van der Laan et al. 2000: 90, 92). Other studies in immunodeficient mice and immunosuppressed rats highlight that the existence of PERV DNA (‘microchimerism’) in the blood and vital organs does not necessarily lead to infection (Baertschiger and Buhler 2004: 561).

In addition to human in vitro and animal in vivo studies, scientific research has examined the possibility of PERV infection in existing human recipients of porcine XTs. For example, Paradis et al. (1999) found no evidence of PERV infection in 160 people who received extracorporeal, skin or cellular porcine XTs, though microchimerism was evident in 23 patients who underwent splenic xenoperfusion. Similar results were found by Garkavenko et al. (2004: 5353-5355), where no evidence of viral infections, including porcine lymphotropic herpesvirus, porcine CMV, porcine circovirus-2 and PERV, were found. In turn, two patients who received short-term xenoperfusion through pig kidneys (Patience et al. 1998: 699), and 28 others who had their blood perfused through a bioartificial liver containing porcine hepatocytes (Pitkin and Mullon 1999: 829), showed no evidence of PERV or microchimerism. In addition, Dinsmore et al. (2000) found no evidence of PERV infection in 24 patients exposed to porcine neural cells. Conversely, while Heniene et al. (1998: 694-699) and Tibell et al. (1998: 1390-1391) found no evidence of PERV infection, the recipients tested positive for antibodies against porcine
influenza virus and parovirus\textsuperscript{103}. Furthermore, despite being an endogenous retrovirus, human-tropic PERV in miniature swine has been found to be a recombinant of PERV-A and PERV-C. This means that while PERV-A and PERV-C exist independently in the pig, this recombinant is an exogenous, not endogenous, retrovirus (Wood et al. 2004: 2494-2495). As a result, Oldmixon et al. (2002) and Scobie (2004) were able to selectively breed miniature pigs without human-tropic PERV.

In light of these studies, PERV concerns have been reduced (Cooper 2003: 559). Fishman and Patience (2004: 1388) thus believe the infectious risks are low, and research should focus on other barriers to human clinical trials. In turn, Professor Bernie Tuch\textsuperscript{104} (in Armstrong 2004: 18:16) suggests because the data does not support virion transmission, the community should relax XTP regulations to allow human clinical trials to proceed. Fung et al. (1997: 956) add the real infectious risk and metabolic disparities can only be determined when XTP is routinely successful in humans.

What such assertions underestimate are problems inherent to infectious studies. For example, the shortcomings of Paradis et al.’s (1999) study include:

\textsuperscript{103} In Tibell et al.’s (1998) study, this did not lead to illness (Daar 1999: 57).
\textsuperscript{104} Tuch is a participant in this research project.
the lack of immunosuppressed recipients\textsuperscript{105} (Loss et al. 2001: 35; Blusch et al. 2000: 7687; Takeuchi 2000: 2699; van der Laan et al. 2000: 93);
short-term exposures to pig tissue through xenoperfusion (Boneva et al. 2001: 6; Takeuchi 2000: 2699; Chapman 1999: 1006);
no long-term whole organ XTs (Loss et al. 2001: 35; Blusch et al. 2000: 7687);
no early samples available through retrospective analysis (Boneva et al. 2001: 6; Herring et al. 2001: 26);
possibilities of selection bias (Boneva et al. 2001: 6);
lack of consideration for and examination of differing tissue compartments for viral infections (Binette et al. 2004: 1058; van der Laan et al. 2000: 93);
no transgenic porcine XTS (Loss et al. 2001: 35; Blusch et al. 2000: 7687);
the testing of peripheral blood only, which may not detect latent infections (Boneva et al. 2001: 6), and/or may not be best measure to examine PERV infection (Blusch et al. 2000: 7687; Takeuchi 2000: 2699); and
the difficulties in distinguishing between low level microchimerism and PERV infection with current techniques\textsuperscript{106} (Binette et al. 2004: 1057; Herring et al. 2001: 26).

\textsuperscript{105} Significantly, individuals who were immunosuppressed only received PITs at the equivalent levels of AT (Blusch et al. 2002: 247). PITs use in XTP, however, is expected to be higher than that of AT.
To add to such uncertainties, studies have revealed *in vivo* PERV susceptibility in apes, baboons, rhesus and cynomolgus monkeys (Loss et al. 2001: 35), and gorilla and baboon PERV infection *in vitro* (Blusch et al. 2000: 7687-7688). Therefore, Bach and Ivinson (2002: 129) and Florencio and Weizmann (1999a: 21), assert the lack of comprehensive data means infectious risk remains a debatable issue that should not simply be dismissed as ‘theoretical’. Weiss (2004a: 281) additionally connects PERV to “the Greeks hidden inside the Trojan horse, they may emerge once the pig tissue or organ is taken into the human body”. Such unpredictability is demonstrated by “our experiences with monkey viruses […] it is difficult to predict the outcome when a virus from one animal finds its way to another” (Weiss 2004: 281). As PERV is closely related to leukaemia viruses, one of these difficult-to-predict possibilities includes cancerous malignancy (Ericsson et al. 2003: 6762; Blusch et al. 2002: 243). Consequently, while PERV does not seem to be highly contagious, vigilance is required as other zoonoses such as HIV did not emerge quickly and took time to become an epidemic (Weiss 2004: 290). In this light, “what would we do with a recipient and contacts who harbor an unknown or untreatable virus that is spreading rapidly and killing thousands?” (Daar 1997: 977). At the same time, the human body is

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106 Blusch et al. (2002: 243-245) believe the highly sensitive PCR markers and immunological assays available to distinguish between microchimerism and PERV infectivity are sufficient. Nevertheless, they also note “in all cases careful controls and interpretation of data are critical”, and “screening methods suffer frequently from certain drawbacks” (Blusch et al. 2002: 245). Difficulties are also inherent in the possibility of cross-infections, false positives and expressions of endogenous retroviruses other than PERV (Blusch et al. 2002: 244; Loss et al. 2001: 32).
also a threat to the porcine XT, as it may become infected by and make visible human endogenous retroviruses (Patience et al. 1997b: 119). Thus, “the risk of xenosis will never be zero” (Fishman 1997: 44). This is because “xenotransplantation is a lifelong experiment” (Fishman 1998b: 49, original emphasis), where “you just don’t know what comes with each organ”\(^\text{107}\) (Fano 2001: 35). In sum, the “certain promise” of animal sources to treat human conditions is confronted with “uncertain perils” (Weiss 1999: 1221).

### 3) Main Points

- GE is being used to make pigs more similar to humans.
- Animal welfare and the complexities and ambiguities of human/animal relations are highlighted in the inefficiency and uncertainty of GE, transgenesis and cloning.
- Social concerns of hybridity and risk need to be respected and valued.
- The intimacy between human/pig in XTP means cross-species infections (zoonosis) are a concern.
- XTP could allow known, unknown and/or new infections to cross species barriers and possibly create a new human epidemic.
- Infectious outbreaks are of a global concern. These might be unknowingly encouraged by xeno-havens.
- The risk/benefit equilibrium of XTP is a complicated appraisal of human (and animal) freedoms and rights.
- Protective barriers to disease facilitated by species disparities are challenged by the technosciences employed in XTP to overcome rejection. These make the pig more ‘human-like’.
- PERVs are of major concern, as they are incorporated into the pig’s genome and cannot be bred out.
- PERVs have been shown to infect human cells \textit{in vitro}.
- Existing porcine XT recipients have not shown PERV \textit{in vivo} infection. These studies, including the scientific procedures employed to test for PERV, have been questioned.
- As HIV and SARS highlight, zoonosis remains a constant threat and needs constant vigilance.

\(^{107}\) In turn, as these concerns relate to human and animal health and welfare, there needs to be open communications between physicians and veterinarians in order to understand the transmission of zoonotic viruses (Grant and Olsen 1999: 163).
Sociocultural Research: Quantitative and Qualitative

Despite this extensive knowledge and research on the technoscientific, medical and ethical complications presented by XTP, comparatively little research has specifically focused on the social concerns, anxieties and perceptions surrounding XTP. In turn, the majority of social examinations are survey-based quantitative research. Quantitative and qualitative social research into XTP is examined in more detail below. Notably in Australia, XTP has only been socially studied from a quantitative perspective, highlighting a massive gap in current research and knowledge.

Quantitative Research

Appendices 2.0 to 2.2 provide an overview of quantitative research examining social reactions to XTP. This type of research generally focuses on the acceptability of XTP to the wider public, those waiting to receive or who have received AT, and undergraduate university students. The results generally demonstrate varied cultural opinions, as well as variance within cultures.

Julvez et al. (1999: 726) claim that once individuals are provided with XTP information, their opinion becomes more informed and therefore more positive towards XTP technologies. They demonstrate this
change through their research, where XT acceptance in emergent situations increased with information on the theoretical infectious risk (Julvez et al. 1999: 726). In turn, the work of Ward (1997 in Long et al. 2002: 281; Mohacsi et al. 1999: 40), which provided comprehensive detail on the GE of pig organs, showed a 78% acceptability toward transgenic pig kidneys. The problem with this research is that it devalues social understandings, knowledge-claims and anxieties, by attempting to alter individual opinion with scientific ‘evidence’ and ‘knowledge’. This includes an apparent imperative to ‘educate’ the public, thereby privileging particular points of view and knowledges over others. This may influence public responses, and “may not reflect the views of other patient groups or the wider community” (Mohacsi et al. 1999: 41), as the focus seems to be placed on changing public understandings and perceptions. In comparison to Ward (in Long et al. 2002: 281; Mohacsi et al. 1999: 40) and Julez et al. (1999), other research providing limited detail on XTP (Lundin and Idvall 2003; Levitt 1996 in Mohacsi et al. 1999; Arundell and McKenzie 1997), did not achieve such positive responses (see Appendices 2.0 to 2.2).

At the same time, undecided individuals who are mostly likely to benefit from XTP do desire more information to make an informed positive or negative response (Arundell and McKenzie 1997: 66). Thus, technoscientific and medical information must be balanced with subjective moral and sociocultural ethical concerns, where both
forms of knowledge and understanding are equally valued. Ethically, however, it must be remembered that potential transplant patients often have end-stage organ failure, and may resort to desperate measures for survival\textsuperscript{108} (Arundell and McKenzie 1997: 66).

Desperate means for survival, however, is not necessarily adopted by individuals with organ failure. For example, Arundell et al. (1994 in Mohacsi et al. 1999: 40), Arundell and McKenzie (1997), Mohasci et al. (1997) and Long et al. (2002), did not receive an overwhelming acceptance of XTP from people who were waiting for or had received an AG, ranging from 14\% (Long et al. 2002) to 50\% (Arundell et al. 1994 in Mohacsi et al. 1999). Conversely, the National Kidney Foundation (King 1998) and Schlitt et al. (1999), found the majority of AG recipients would accept a XT, at 74\% and 77\% respectively.

Assumptions therefore cannot be made on who will and who will not accept XTP.

It is not surprising that Appendices 2.0 to 2.2 reveal a range of acceptance-based quantitative public responses to XTs and XTP research, from approximately 34\% (general public, Franti et al. 2001) to 94.3\% (physicians, Julvez et al. 1999). Such ambiguities are also confirmed by comparing the differences between accepting a XT regardless of the situation and accepting a XT in an emergency; and when a human AG has failed and/or is unavailable, ranging from 0\%

\textsuperscript{108} This issue will also be highlighted in the following section ‘Qualitative Research’.
(National Kidney Foundation in King 1998) to 39.4% (Julvez et al. 1999). These differences might be due to the subjects (type and number), provision of background material, and interpretation of the results. Furthermore, some surveys primarily focus on themes other than XTP, such as organ donation and AT (Pfizer Australia and Transplant Australia 2004; Lundin and Idvall 2003; Sanner 1998; Gallup Organization Inc 1993), quality-of-life following AT (Okada-Takagi and Williams 1993) or biotechnology (Yann Campbell Hoare Wheeler 1999; Biotechnology and the European Public Concerted Action Group 1997). Therefore, these surveys may not encompass the complexities of XTP that may influence XT acceptance or rejection.

In Australia, XTP survey research has been conducted with people waiting kidney transplantation for at least one year (Arundell et al. 1994 in Mohacsi et al. 1999), acute care nurses (Mohacsi et al. 1995), people waiting kidney, heart or heart/lung AGs (Arundell and McKenzie 1997), people with renal failure who are waiting AT or are potential AG recipients (Mohacsi et al. 1997), people who have received an AG in the past year (Okada-Takagi and Williams 1993), the general public, teachers and farmers (Yann Campbell Hoare Wheeler 1999), and the general public over sixteen years of age (Pfizer Australia and Transplant Australia 2004). In addition, an honours thesis at the University of Western Sydney by Harold Hanlon (1997), examined the general public's attitudes and acceptance of
XTP. Cumulatively, these survey results are difficult to interpret. For example, while Hanlon (1997) reports a 74% acceptance rate of XTs from the general public, this figure decreases to 47% when the success rate of XTP was cast as significantly lower than AT. Such uncertainty and risk was not encompassed by the other Australian surveys. Pfizer Australia and Transplant Australia (2004), however, demonstrated 70% of the population would accept an organ in a life or death situation. The only other Australian survey focusing on the general public’s reactions to XTP did not include a question of personal XT acceptance, but worthiness (60%) and morally acceptability (55%) (Yann Campbell Hoare Wheeler 1999). On the other hand, other Australian surveys focusing AG recipients and potential AG recipients showed similar levels of self-acceptance for a XT, ranging from 41.6% (Mohacsi et al. 1997) to 50% (Arundell et al. 1994 in Mohacsi et al. 1999: 40). In this research group, however, there was a difference of up to 30.2% on the acceptability of XTP (Mohacsi et al. 1997; Okada-Takagi and Williams 1993). Significant differences were also exhibited between what animal was considered an appropriate XT source, with pig organ acceptability at 41.6% (Mohacsi et al. 1997) and 27% (Arundell and McKenzie 1997), and nonhuman primate organs at 41.6% (Mohacsi et al. 1997) and 13% (Arundell and McKenzie 1997). Furthermore acute care nurses, who have personal contact and experiences with people with organ-failure and their families, exhibited low rates of XT acceptance, with only

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109 It should be noted Hanlon’s (1997: 39) research used a random convenience sample. Chances of research bias therefore cannot be ruled out.
19% accepting a nonhuman primate organ and 18.9% a pig organ (Mohacsi et al. 1995). Lastly, as addressed previously, some of these surveys are not primarily concerned with XTP, but XTP as part of the wider transplantation network (Pfizer Australia and Transplant Australia 2004; Okada-Takagi and Williams 1993), or as a biotechnology (Yann Campbell Hoare Wheeler 1999).

As indicated by the Australian survey results, it is difficult to measure social opinions regarding XTP. Daar (1999: 58) believes survey results on XTP, as reported in Appendices 2.0 to 2.2, “are cumulatively contradictory”. Thus, despite the occasional use of open-ended questions, attitudinal formation and complex emotions such as desperation, anxiety, contradiction, ambiguity and uncertainty, are difficult to understand. These are particularly important in regards to individuals targeted by XTP (Lundin 2001: 150, 153; Michael 2001: 216; Lundin and Widner 2000: 1176). At the same time, the diversity of results suggests these varied emotional reactions do play a significant role in understanding and reacting to XTP. As Sanner indicates:

If xenotransplantation is introduced on a large scale, the public must be offered factual knowledge about the principles and procedures. At the same time, the emotional factors must be addressed. This is more difficult, as no doubt it concerns very subtle and partly unconscious ideas. Therefore, these ideas must be explored by more refined methods than a questionnaire, helping people scrutinize their beliefs and reactions. (Sanner 1998: 536)
The limited qualitative social research examining such negotiations is now examined.

Qualitative Research

The anthropological studies of Lundin (2002; 2001; 1999) and Lundin and Widner (2000)\textsuperscript{110}, focus on the XTP experiences of diabetics in receiving porcine foetal islet cells, and people with Parkinson’s disease who have received human embryonic neural cells. These risk-based studies are mainly concerned with two central issues:

- the process through which cellular XT recipients and potential recipients negotiate medical opportunity and risk with social and personal anxieties, ambivalences, ambiguities and XTP concerns; and
- if and how XTP creates new cultural meanings of human and animal ontology in the quest for a healthy, normal body.

According to Lundin (2002: 336-338), the human/animal hybrid in XTP creates an identity crisis for the interviewees. This crisis is an outcome of emotive and quantitative-based ontological questions on

\textsuperscript{110} The sociocultural context of this research is Sweden.
the biological substance of being human and being animal, which caused feelings of unease and insecurity:

The cells felt okay….But a pig’s heart! The heart is the seat of the personality and with a pig that would make it repulsive. (porcine foetal islet cells recipient in Lundin 2001: 152; Lundin and Widner 2000: 1175)

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. (diabetic reflecting on a pig kidney in Lundin 2002: 337)

As a result, the cultural fears and risks embedded in the biomedical changes of the biological body lead to a redefinition of cultural barriers and/or of what is subjectively acceptable or unacceptable in biotechnological developments (Lundin and Widner 2000: 1175; Lundin 1999: 8). This also questions the consequences of technological interventions on humanness and what it means to be human or animal. In other words, XTP patients or potential patients are worried about how much animal material can be incorporated into their body before their ‘humanness’ is challenged or ceases (Lundin 2002: 337), or when the ‘foreign invader’ takes over (Lundin 2001: 152):

I wonder how much from an animal can be introduced into my body before my humanity vanishes. (porcine cellular XT recipient in Lundin 2001: 150)

The question is how many genes you can change before you are changed as a human being. (unidentified woman in Lundin 1999: 19)
In turn, cultural breakdowns create a cultural integration of the ‘new’
body as ‘normal’, thus resolving self-questioning and identity
Illness thereby becomes a mediator of XTP, despite resonances of
ambivalence and cultural uncertainty:

Before [the illness], I probably couldn’t have considered
such a thing, to cross the species barrier as it were, and
get something animal inside me. But things change. (Peter,
human embryonic neural cells recipient in Lundin 2002:
338)

The illness completely shatters me, and one clutches at
every straw that’s offered, even if this thing with pigs does
seem a little strange. (Unidentified porcine foetal islet cells
recipient in Lundin 2002: 338).

As indicated by Lundin (2002: 338), “the positive view of
xenotransplantation is not just built on medical grounds. There are
also deep social reasons”. In this light, feelings of abnormality result
from social comparisons to the socially acceptable and normal
‘healthy’ body. These redefine the natural and unnatural body,
making the patient’s ‘natural’ body appear unnatural and
unacceptable, and the biomedical xenotransplanted body as a
longed for means to restore the ‘natural’ and ‘real’ healthy self
wish is to become healthy, to be normal again” (Peter, human
towards receiving animal tissue and biotechnological products
thereby gives way to the self-desire for a better life and to reduce self-suffering (Lundin 2001: 151; Lundin and Widner 2000: 338). Thus, individual re-evaluation and negotiation of personal ethical concerns prompts a redefinition of subjective ethics, morals and norms, in a quest for survival (Lundin 2001: 151). In this state, biotechnology becomes a ‘natural’ and ethical opportunity, when faced with the ‘unnatural’ and ‘unnecessary’ possibility of death (Lundin 2001: 151; Lundin and Widner 2000: 1175):

I think I could do anything because I don’t want to die. That’s the last thing I want. (Unidentified porcine foetal islet cells recipient in Lundin 1999: 8)

Anything is better than being so terribly ill, even if you don’t know how well the transplantation will work out. (Birgit, porcine foetal islet cells recipient in Lundin 2002: 338)

Nobody ought to be seriously ill, everyone has to be normal. (Unidentified patient in Lundin 2001: 152)

If a pig organ can help me to be healthy, then I’m ready for it. (Peter, human embryonic neural cells recipient in Lundin 2002: 335)

With cell transplantation, I can maybe become normal again. (Peter, human embryonic neural cells recipient in Lundin 2002: 342)

As a result of these various negotiations, XTP is perceived as a potential opportunity (life) rather than a potential risk (death) (Lundin 2001: 151; Lundin and Widner 2000: 1175). These strong survival desires and death anxieties are also exhibited in relation to receiving
an AG, as revealed by an interviewee in Sanner’s (2001a: 1494) research: “Surviving is most important of all. I would do anything”\textsuperscript{111}.

Simultaneously, as XT recipients negotiate anxieties of the human/animal and natural/unnatural interface (Lundin 2001: 152), the subjective and ambivalent feelings about these boundaries denote not every potential XT recipient would accept the technology: “No, I don’t want a pig’s kidney. I’d rather die than live half-human and half-animal” (Hackney, potential kidney XT recipient, 1996 in Lundin and Widner 2000: 1175). This ambivalency also means individuals can differentiate between biomedical applications, where personal experiences with disease can contrast with general attitudinal feelings towards biotechnology (Lundin 2002: 340; 1999: 8-9). Through such disputes, not only is the border between natural/unnatural again challenged and redefined, but uncertainty is heightened:

But it feels as if there’s a difference between IVF [\textit{in vitro} fertilisation] and xenotransplants. I mean, if you can’t have children, maybe you’re not meant to. But with a sick kidney … you die. (Karin, porcine foetal islet cells recipient in Lundin 2001: 151; 1999: 9)

\textsuperscript{111} This highlights the relevancy of psychosocial experiences in AT to XTP.
Despite subjective moral, ethical and psychological difficulties in accepting a XT (or AG), many AG recipients defend XTP on the following grounds:

- valuing human life over animal life;
- the pre-existing use of animals for food, experiments and sport;
- morals not counting when faced with death;
- the minimising of animal suffering in clinical transplantation;
  and lastly,
- the use of humans as medical ‘guinea-pigs’ in transplant development means animals should also contribute as ‘guinea-pigs’ (Okada-Takagi and Williams 1993: 19)\textsuperscript{112}.

Additionally, Sanner (2001a; 2001b)\textsuperscript{113} interviewed members of the general public in regards to receiving organs from human and animal sources. Like the individuals in Lundin (2002; 2001; 1999) and Lundin and Widner’s (2000) research, the general public were worried about the influence of an animal organ on their human identity and ontology (Sanner 2001a: 1495; 2001b: 22).
Consequently, they questioned whether a porcine XT would alter their behaviour (“What if I would start grunting?”), appearance (“I would perhaps look more piggish with a pig’s kidney”) and

\textsuperscript{112} Many of these themes also emerge in this thesis, though in more complex and ambiguous ways.
\textsuperscript{113} The sociocultural context of this research is Sweden.
personality (“At least 5% of me would become animal”) (interviewees in Sanner 2001a: 1495; 2001b: 22). Ambiguities are again revealed where some felt the consumption of pork did not differ from accepting a pig XT (“You don’t eat people, but you eat pigs so it would be better to have an animal organ”), though others felt this was a disgusting concept (“I use to buy pig liver prepacked at the supermarket. To have it inside me – well, it feels a bit disgusting”) (Sanner 2001a: 1496; 2001b: 23). Other interviewees integrated the technology, relating it to other medicinal animal uses and technological developments: “A pacemaker is totally accepted today. It will probably be the same with other artificial implants or transplants” (Sanner 2001a: 1496). Lastly, in a cost-benefit analysis of XTP, others believed:

- pigs and animals to be no different to humans, therefore accepting a XT was unproblematic;
- XTP was too scientifically risky;
- species boundaries should not be manipulated;
- existing use of animals justifies XTP; and
- all forms of transplantation to be unusual (Sanner 2001a: 1496; 2001b: 23).

The confusing moral-ethical approaches to XTP and biomedical technologies are also evidenced in the contradictory discursive negotiations of human/animal similarity (continuity) and dissimilarity.
(discontinuity) by medical-science and non-scientific, non-governmental animal advocacy organisations (NGAOs). The seemingly contrasting positions of animal/human continuity and discontinuity are mobilised by both groups to substantiate their differing positions, as explored in the work of Birke and Michael (1998), Brown (1999a; 1999b) and Brown and Michael (2001a). These conflicting debates of similarity/dissimilarity of human/animal are summarised in Figure 12. Similarities and dissimilarities are drawn together in different technical and moral interpretations to create tensions in the XTP debate or, in the words of Brown (1999b: 333), “How can we physically mix (natural-technical discourse) if we’re so different (social-moral discourse)?” Importantly, such boundary crossings or “risk identities” (Brown and Michael 2003: 2), are facilitated by XTP processes which, through the use of animals, need to negotiate both scientific and cultural domains. In turn, such debates serve to construct the pig body itself (Brown and Michael 2001a: 4).

According to Brown (1999a: 183), science engages in ‘boundary work’ by privileging its own knowledges in navigating between morality and nature, without confusing the two. This maintains the boundary divisions of science; permitting scientific access, knowledge and authority only to the selected privileged experts and

114 The sociocultural context of these works is the United Kingdom.
115 This is explored further in the chapters ‘The Biological Gaze: Selecting an Animal’ and ‘The Sociozoologic Gaze: Using Animals’.
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<th>EXPERTS AND PUBLICS (MORAL-ETHICAL)</th>
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<tr>
<td>Social/cultural (NGAOs)</td>
<td>Difference-discontinuity: “The pig is different”</td>
</tr>
<tr>
<td>Natural/scientific (medical-science)</td>
<td>Similarity-continuity: “The pig is the same”</td>
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**Figure 12 - Similarity and Dissimilarity in Social/Cultural and Natural/Scientific Debates**

Adapted from Brown (1999b: 332) and Brown and Michael (2001a: 18)

not to others (publics)\(^{116}\). Arguments of human/animal similarity, which reduce pigs to mechanistic Cartesian body metaphors, are often made in the media to alleviate public concerns species dissimilarities and the pollution of human integrity and identity in hybridity (Birke and Michael 1998: 259)\(^{117}\). As a result, the concept of hybridity, and the medical use of animals in general, is unproblematic to science (Birke and Michael 1998: 245). Moreover, the mechanistic reduction of animals allows them to be distinguished from humans, meaning dissimilarity between human/animal and the existing human use of animals, morally justifies using animal organs for human purposes (Brown 1999a: 190; 1999b: 332; Birke and Michael 1998: 248-249)\(^{118}\).

> Rather than taking the pig and making sausages, you could take the cornea, kidney and heart. [A]fter all, many pig organs are remarkably similar in structure to human organs. (Herring 1995 in Brown 1999b: 187)

\(^{116}\) Similar boundary work is undertaken by the sciences in this thesis.

\(^{117}\) This thesis will demonstrate how this is not always successful, where tensions arise between technical and cultural rationalities.

\(^{118}\) Again, similar tensions are uncovered in this thesis, but also feature significant complexity, ambiguity and contradiction.
We have been using pig insulin for generations and pig heart valves for a long time. Morality cannot be tissue specific. (Hamshire 1995 in Birke and Michael 1998: 250)

Thus, scientific discontinuity exists between the social-moral status of humans and animals (Brown and Michael 2001a: 14; Birke and Michael 1998: 249). Simultaneously, arguments of similarity are enhanced through the “production of similarity”, as achieved by technically altering pigs (GE) and suppressing the immune response of humans (Brown 1999a: 186). In this fashion, immunological pig/human dissimilarities and the existing selective animal breeding in farming, are used to publicly defend and negotiate the scientific GE of pigs (Birke and Michael 1998: 249). Additionally, based on scientific-technical awareness, science seeks to justify GE pigs and their usage on the grounds of physiological similarity to humans (Brown and Michael 2001a: 4; Brown 1999b: 187; Birke and Michael 1998: 249).

Scientific arguments consequently switch between two ontological positions - science expert and general public - to deal with human/animal continuity and discontinuity in animal-based medical applications (Brown and Michael 2001a: 3, 10). Through such boundary work, science presents itself as epistemologically different to the publics. Switching between and combining ‘natural-expert’ knowledges with moral-ethical discourses serves to construct a privileged position, where the appropriateness of (pig) similarities is
determined. On the other hand, the similarities/dissimilarities of nonhuman primates make them an unsuitable animal source. This serves to marginalise opposing arguments, as science assumes a position of factuality and authority across natural-social domains to negotiate risk (Brown and Michael 2001a: 4-5, 10, 14; Michael and Brown 2000: 9)\(^{119}\). Hence, “the public are not even invited as they are not considered to be technically competent” (Michael and Brown 2000: 10)\(^{120}\).

Furthermore, science draws parallels to public moral-ethical discourse for it to be seen as the same as the public, but pigs as morally different (Brown and Michael 2001a: 17; Michael and Brown 2000: 7-9; Brown 1999b: 333; Birke and Michael 1998: 251).

Equations of XTP to ‘meat’ thereby allow scientists to identify as members of the public, while also appealing to known public experiences: “One cannot logically criticise the use of pig tissues to save human lives in the therapeutic procedure while at the same time accepting the existence of the ham sandwich” (David White in 'Esquire', February 1994 in Michael and Brown 2000: 9). At the same time, those publics which fall outside of science’s acceptable public (Michael and Brown 2000: 8), namely animal welfare organisations (the ‘militants’), are neutralised by emphasising the care and concern

\(^{119}\) These themes are explored and further developed in the chapter ‘The Biological Gaze: Selecting an Animal’.

\(^{120}\) This is unravelled further in the chapter ‘The Biological Gaze: Selecting an Animal’, which also includes the publics’ negotiations of such scientific decision-making.
shown towards animals in scientific-medical husbandry practices. Thus, scientific ‘expert’ knowledge counters cultural anxieties of animals in medical-human use with historical cultural certainties of other human uses of animals (Brown and Michael 2001a: 282). In such constructions, opposing public arguments are counteracted by painting other more socially familiar husbandry procedures as lesser forms of animal treatment (Brown and Michael 2001a: 15-16): “most of the things that get done to the animal here are infinitely nicer than what happens on your average factory farm or abattoir” (science interviewee in Brown 1999a: 199). In other words, there are publics that are the same and publics that are different, which allows scientists to become the public’s representative (Michael and Brown 2000: 9).

The negotiation of similarity and dissimilarity, however, is problematic for science. According to Brown (1999a: 183), “claims to scientific identity entail certain normative conditions, such as the requirement to maintain the appearance of consistency, thus reducing the capacity of claimants to contradictions when they arise”. Therefore, science as an institution is inflexible, and is concerned “with specific

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121 This is not necessarily the case amongst the publics, as seen in the chapter ‘The Sociozoologic Gaze: Using Animals’.
122 What is particularly missing here is how the publics paint such practices. These themes are explored and further developed in the chapter ‘The Sociozoologic Gaze: Using Animals’.
123 Similar negotiations are undertaken by the research participants in this research particularly in relation to vegetarianism, which will be explored in the chapter ‘The Sociozoologic Gaze: Using Animals’. In this research, however, it is revealed that while the sciences like to present as the public’s representatives, this is incorrect. That is, the sciences do not necessarily accurately ‘speak’ for the publics.
aspects of nature" (Brown and Michael 2004: 209). XTP challenges this scientific identity.

The contradictory and conflicting position adopted by science enables more flexible groupings such as NGAOs to weaken expert scientific claims by drawing upon the technical and moral (Brown 1999a: 183-185). Thus, NGAOs use competing social, moral and scientific arguments to dispute the use of animals in biomedicine, but reverse the similarity/dissimilarity dyad of natural-scientific rationalisation in order to expose scientific contradictions (Brown and Michael 2001a: 17; Brown 1999a: 183-184, 189). By using scientific knowledge, NGAOs highlight that despite physiological similarities, there are significant phylogenetic, physiological and immunological pig/human differences that deny long-term survival (Brown 1999a: 187):

While a pig organ may appear, superficially, to resemble a human organ, once we examine more closely the role that organs play in the workings of the whole body, then subtle dissimilarities will take on major significance. (Uncaged Campaigns, Xenotransplantation Report in Brown 1999a: 188)

These techniques also allow NGAOs to reduce hierarchical and moral discontinuities between humans and animals, meaning rights and privileges cannot be granted to one at the expense of the other (Brown 1999a: 191). NGAOs further use similarity (moral-ethical) to emphasise the pathogenic risks of xenozoonosis, which threaten the
distinctions drawn between human/animal (Brown 1999a: 188). In this fashion, not only does science construct pigs, but NGAOs as well.

Such exposures have forced science to seek continuity in their arguments by creating boundaries within science, such as between virology and immunology (see Figure 13). This done in an attempt to negotiate the “contradictions in the similarity of porcine donors and human hosts” (Brown 1999a: 189)\(^{124}\). At the same time, the flexibility required by science to negotiate the risks of XTP echoes “the object of analysis is itself plastic and open to co-construction” (Brown and Michael 2003: 6).

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<tr>
<th>DISCIPLINE</th>
<th>PIGS AND HUMANS</th>
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<tr>
<td>Virology</td>
<td>Dissimilarity</td>
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<tr>
<td>Immunology</td>
<td>Similarity</td>
<td>Therapeutic benefit</td>
<td>Potentially reduced</td>
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**Figure 13 - Similarity/Dissimilarity in Natural/Scientific Xenotransplantation Debates As Based on Using Genetically-Engineered Pigs**

Furthermore, the hybrid stimulates social fear and risk by violating ontological securities and purity. These anxieties are highlighted by media portrayals, which emphasise the disgust of chimerism and associate XTP with science fiction stories, mutants and the

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\(^{124}\) These contradictions and complexity of constructing animal species by official science, are illustrated in the chapter ‘The Biological Gaze: Selecting an Animal’.
monstrous (Brown 1999b: 337-341). Science attempts to alleviate such anxieties and to normalise transgression by appealing to human morals and emotions in human suffering (Brown and Michael 2003: 6; 2001a: 16; Brown 1999b: 346). Significantly, this anguish is their own in the painful and difficult decision-making they must undertake, as well as that of the potential XT recipient. Such techniques move the XTP argument from a medical innovation of an expect scientific authority (objective; rationality), to the authenticity of and personal interest in human suffering and pain (subjective; emotion) (Brown and Michael 2003: 6; 2002: 260-261, 269). This also dismisses what Birke and Michael (1998: 253) and Brown (1999a: 191) term the “yuk factor” of animal/human hybridity, as a moral imperative is given to XTP. In addition, by employing Cartesian metaphors of the mechanistic body, the possibility of chimerism is cast as scientifically ridiculous, thus devaluing and dismissing public fears and sociocultural values (Birke and Michael 1998: 252-253). Lastly, media reports not only stimulate hybrid fears (social/cultural), but also project the purity of the hybrid (natural/scientific) by connecting humans and the ‘humanness’ of the pig: “[The pig] has a genetically human heart” (‘Daily Express’, 12 March 1993 in Birke and Michael 1998: 254). The pig is therefore not an unfamiliar hybrid monster (‘cross-species’), but a familiar ‘part-human’ pig (‘humanised’) (Birke and Michael 1998: 254).

125 Interestingly, however, the sciences aim to create a chimeric immune system to facilitate the human immunological acceptance of animal parts.
This boundary work is not totally successful, as NGAOs “maintain pressure on the logical contradiction of humans and pigs sharing the same embodiment without risk” (Brown 1999a: 189). Furthermore, the challenge XTP poses to social understandings mean that the publics may hold suspicion towards science and place trust in other sources, such as NGAOs and/or the media (Brown and Michael 2001b: 279). In this fashion, XTP not only challenges modern ontological securities, but also “the divide in which science represents nature and the public represents society” (Brown 1999b: 333). Throughout these discursive negotiations of continuity and discontinuity, the ties between science and mortality can facilitate confusion on what constitutes expert and popular voices (Brown 1999b: 333). What is left unaddressed, however, is how the publics in general and those targeted by xenotechnologies, construct animals and understand hybridity as it relates to XTP.126

More recently, Michael and Brown (2004) have undertaken focus group research into how the public understands and evaluates XTP research. This focuses on cost/benefit analysis, where the public identifies a cycle of XTP pros and cons (Michael and Brown 2004: 382, 386). This involves a series of considerations and ‘buts’ that remain unresolved. At the same time, some regard these cyclic considerations as useless, as the public is rendered powerless and irrelevant in the face of innovation (Michael and Brown 2004: 387):

126 These areas are of specific concern to this thesis.
If they [scientists] see commercial value in it, or if they see fame in it or anything, they will just do it. Not because they should do it but because they could do it. I think that [is the] thing with science at the moment. (interviewee B in Michael and Brown 2004: 387)

Expert knowledges and issues of trust are also relevant in cost/benefit decision-making (Michael and Brown 2004: 386), where both government organisations and NGAOs can and cannot be trusted, rendering their evaluations as questionable (Michael and Brown 2004: 387). Therefore, while the public acknowledges social value in the technology (benefit), this is unimportant as other factors such as economics or status, propel technology (Michael and Brown 2004: 387). Ultimately, however, decisions made on cost/benefit and ethics are useless, as decision-making is finally resolved by one’s position in the life-death cycle. Death avoidance and the survival instinct will drive the subject to any means to achieve the desired ends (Michael and Brown 2004: 387): “But if you’re desperate to live … […] You’d be desperate to get back to normal” (interviewee A in Michael and Brown 2004: 388). Cost/benefit is determined solely by human need in this context.

127 This theme is also important to the research participants in this research, though they focus primarily on quality of life. This is addressed in the chapter ‘Risk and Trust: Science, Infection and Health’. Furthermore, the research participants do not advocate their position as one lacking in power, choosing to focus on other risk evaluations instead. This will be outlined in the chapters ‘Risk and Trust: Science, Infection and Health’ and ‘Risk and Uncertainty: Science and Zoonosis’.
The complexity in assessing the value of XTP is further revealed through metaphorical references to ‘meat’ (Michael and Brown 2004: 389). As shown previously, references to meat allows XTP to be assimilated with known and commonplace understandings and experiences (Michael and Brown 2004: 389; Brown and Michael 2003: 7). Similarly to the work by Macnaghten (2004) on the public responses to the GE of animals, XTP complicates the understandings of and concepts associated with meat, where they “become less familiar, or rather, less secure and more fluid” (Michael and Brown 2004: 389) (Brown and Michael 2003: 6-7)\(^{128}\). Such complexities increase the problems with cost/benefit analysis, both positively and negatively (Michael and Brown 2004: 389). Thus, the:

- benefit of meat-eating to humans equates to the benefit of XTP to humans, be it ‘natural’ or ‘artificial’ (continues existing processes and human choices) (Michael and Brown 2004: 390-392; Brown and Michael 2003: 7);
- processes of XTs and meat entering the body are different, where one involves a barrier and bodily breakdown (meat) and the other does not (XTs) (differentiation) (Michael and Brown 2004: 392; Brown and Michael 2003: 7); and
- XTs and meat allow the body to function via incorporation (no difference) (Michael and Brown 2004: 393).

\(^{128}\) This will be explored and further developed in the chapter ‘The Sociozoologic Gaze: Using Animals’.
In this way, XTP cannot simply be aligned with meat-eating (Michael and Brown 2004: 384), as “cost-benefit thinking is highly contingent” (Michael and Brown 2004: 393). As a result, Brown and Michael (2003: 7) believe “cost-benefit analysis becomes a doubtful value and again threatens the credibility of those institutions who apply and implement such models of decision-making”.

From this quantitative and qualitative research, it is revealed XTP is a new and growing field in sociocultural research. This also exposes, however, the distinct lack of sociocultural research in the Australian context, particularly in relation to qualitative methods. What is also missing is an engagement with those involved at all levels of XTP, from its development (the sciences), to the targets of XTP (humans with various health conditions), to regulatory bodies and committees. Due to the contemporary debates and current five-year moratorium on XTP in Australia, the need to socially engage with and evaluate this technoscience in the Australian context is highly important and needed. Furthermore, as will be explored in the following chapter ‘Entering the Network: Methodology’, significant failures are evident in the Australian XTP public consultations. This thesis is therefore very timely, allowing the sciences and the publics to voice their key concerns and understandings of two key concepts in XTP - animals and risk.
4) Main Points

- Limited social research has examined XTP, with the majority being quantitative.
- Variant results are revealed in quantitative research between and in cultures.
- These variant results are also evident in the collectivities likely to benefit from XTP.
- Some quantitative research focuses on changing public understandings and perceptions of XTP.
- Some quantitative research on XTP does not focus exclusively and/or primarily on XTP. Thus, they might not sufficiently examine the complexities and ambiguities of XT acceptance or rejection.
- Large variance between research results, intent and focus, make quantitative research on XTP difficult to cumulatively interpret.
- Qualitative social research on XTP has been conducted in Sweden by Lundin (2002; 2001; 1999), Lundin and Widner (2000) and Sanner (2001a; 2001b); and in the United Kingdom by Birke and Michael (1998), Brown (1999a; 1999b), Brown and Michael (2003; 2001a) and Michael and Brown (2004; 2000).
- Focus of qualitative research has mainly been on various negotiations of risk, based on:
  - cost-benefit analysis by experts and non-experts (Brown and Michael 2003);
  - public cost-benefit analysis of XTP (Michael and Brown 2004; Brown and Michael 2003);
  - personal uncertainties, ambiguities, ambivalence and concerns towards XTP (Michael and Brown 2004; Lundin 2002, 2001; Sanner 2001a, 2001b; Lundin and Widner 2000; Lundin 1999);
  - subjective cultural redefinitions of animal/human ontology (Lundin 2002, 2001; Sanner 2001a, 2001b; Lundin and Widner 2000; Lundin 1999);
  - the process through which the xenotransplanted body is normalised (Lundin 2001; Lundin and Widner 2000); and
  - ‘risk identities’ of boundary negotiations between the animal/human interface (Brown and Michael 2003).
- Lundin (2002; 2001; 1999) and Lundin and Widner (2000) are specifically concerned with patient experiences of being implanted or potentially implanted with a XT.
- Discourse analysis has focused on:
  - public defences of XTP by science (Brown and Michael 2001a; Brown 1999a, 1999b; Birke and Michael 1998);
  - authority construction of science in the XTP debate (Brown and Michael 2001a; Michael and Brown 2000; Brown 1999a); and
- Michael and Brown (2004) and Brown and Michael (2003) also examine the complexities and ambiguities the public make in understanding the perceived relationship between XTP and ‘meat’.
- Complex themes of meat also emerged in Sanner’s (2001a; 2001b) research.
- No qualitative research has been undertaken in Australia.
- Present debates on XTP in Australia reveal the need to socially engage with and critical analyse XTP.
While this thesis is solidly located in the sociology of science, it is worth briefly considering some of the literature emerging from the sociology of human-animal relations due to the centrality and importance of animals to XTP. With very few exceptions, sociology has traditionally been human-centred or anthropocentric; asserting that what is relevant and important in and for human society and the social world are humans. As a consequence, animals were considered an illegitimate area of research. This approach, however, misses the relationship between human and animals, and visa versa. In the words of Tovey (2003: 197), “to read most sociological texts, one might never know that society is populated by non-human as well as human animals”. Furthermore, the area has been subjected to resistance and defamation (Arluke 2002: 370), with animals depicted in opposition to human qualities, being “mindless, emotionless, self-less, reacting rather than acting, [and] apprehending rather than comprehending” (Sanders 2003: 406).

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This is now being readdressed by the sociology of animals, sometimes referred to as anthrozoology, which acknowledges the significance of human-animal intersubjectivity, the diversity of and integral roles animals play that are often contradictory and ambivalent, and the importance, prevalence and meanings of animals in society. Highly influential to the advancement of this field and to the animal movement have been the differing philosophical accounts of Peter Singer (1991, originally published in 1975) and Tom Regan (1984), who have been attributed with creating a surge of interest in animals and animal claims.

In his work, Singer (1991; 1974) argues for a higher status for animals based upon moral equality. This utilitarian approach is concerned with moral differences that are relevant between humans and animals, and providing equal weight to similar interests. This then determines how humans should treat animals, and what actions are right or wrong. Significantly, Singer (1991; 1974) believes that the interests of humans and animals must be considered equally, and relevant moral differences between the species must also be taken into account. These distinctions mean that variant groups are entitled to differing rights or treatment. For example, “since dogs can’t vote, it is meaningless to talk of their right to vote” (Singer 1991: 2).

However, it does mean that experiences, such as enjoyment, pleasure or suffering, be considered equally “in so far as rough comparisons can be made” (Singer 1991: 8; 1974: 79). By extension,
therefore, “if a being is not capable of suffering, or of experiencing enjoyment or happiness, there is nothing to be taken into account” (Singer 1991: 8; 1974: 79). Thus, equal consideration involves deliberation of the interests and preferences of the human or animal being, which may reveal differing moral rights and forms of treatment. Ethicist Jeremy Bentham (in Daar 1997: 975) thus questions, “what insuperable line prevents us from extending moral regard to animals?” This argument for moral equivalency is not the same as advancing animal rights. For example, if it is fine to experiment on humans or to breed them specifically for the dinner table, then the same can be done with animals. This is not to say that Singer believes we should extend our current treatments of animals to humans, but rather moral equivalency dictates that we treat animals unethically and that this needs to change.

Consequently, Singer’s (1991; 1974) approach focuses on harm to animals caused by immoral actions, but a different approach examines animal rights. There are many works that take this perspective, with one of the most prominent being that of Regan (1984) which, instead of examining moral equivalency, concentrates on how animals have intrinsic value that exists independently of action and is disrespected by humans. This is summed up in the following:
Individuals [human or animal] are subjects of a life if they are able to perceive and remember; if they have beliefs, desires, and preferences; if they are able to act intentionally in pursuit of their desires or goals; if they are sentient and have an emotional life; if they have a sense of the future, including a sense of their own future; if they have a psychophysical identity over time; and if they have an individual experiential welfare that is logically independent of their utility for, and the interests of, others. (Regan 1984: 264)

With this understanding, “no harm done to moral agents or patients can be justified if it is unjust” (Regan 1984: 265), and the “possession of moral rights does not come in degrees. All who possess them possess them equally” (Regan 1984: 268). Consequently, it is not up to humans to decide what rights and levels of respect animals are entitled to, as animals already inherently have value and moral rights. However, due to prejudice and arrogance, humans ignore these rights. In other words, animals have inherent rights because they are sentient. Furthermore, unlike Singer’s (1991; 1974) advocacy of moral equivalency, these rights exist separately of humans and prior to action. This sits in opposition to some scientific approaches to and understandings of animals.

Despite their differences, Singer (1991; 1974) and Regan (1985; 1984) are both concerned with the status of animals in society, and what rights they should be accorded or are entitled to. Under the influence of such work, the sociology of animals has been primarily concerned with the complexity of human-animal relationships, and how humans actively construct animals.
For example, continuing the interest in animal rights, Tester (1991) does not argue for or against the moral status and rights of animals. Rather, he examines how the belief in, evolution and invention of animal rights has occurred and, more specifically, how this has facilitated claims on the moral status of animals. Through this account, Tester (1991) highlights how society has moved from the animal trials and the public execution of animals in the fourteenth century, to anti-cruelty movements in the nineteenth century (including antivivisection), to humane animal killings (euthanasia) and the militancy of the Animal Liberation Front in the twentieth century. According to Tester (1991), these changes were influenced by the modern conflicting episteme of difference and similitude, and an emphasis on the human-animal boundary. Thus, this is a sociological and historical account of human attitudes to animals, and how this has come to inform present understandings of animals in the animal rights movement.

Significantly, Tester (1991: 48) believes that animal rights are created, “a social construction and exclusively a social practice” that operates “to classify and define humanity”. This means that arguments which assert that the status of animals has evolved through time as society has acquired more knowledge, such as asserted by Norbert Elias, are mistaken. Animals are used a tool to define what it means to be human, and the animal rights movement
sustains these boundaries by avoiding contact with animals - “they certainly distance themselves from any relationship with animals and thereby begin to know themselves all the better” (Tester 1991: 178) - and is paradoxical in that animal rights are not applied equally to all animals: “animal rights only wants to talk of the animals with which people are more familiar, and it only talks of animals to the extent that we do something to them” (Tester 1991: 16). As Baker (1993: 213-214) outlines, Tester’s (1991) thesis rests on the idea of humans avoiding contact with animals, though it is selective and ignores that animal rightists may seek contact with animals. Furthermore, as Franklin (1999: 188) indicates, Tester’s (1991) focus on the militancy of the Animal Liberation Front ignores more peaceful animal movements.

Animal rights are only one possible approach to human-animal relations. For example, Baker (1993: 21) believes that by focusing on the development of animal rights and animal rights movements, Tester (1991) ignores visual representations and public understandings of animals, including their popular symbolic value. Baker (1993: 33) is more interested in how the use of animals in visual representations “prompts the kind of meanings and connotations that it does”. There are many ways in which he addresses this popular imagining of animals, such as an analysis of power in political posters and editorial cartoons, whereby animals are used to symbolise human identity, self and nationhood by
distinguishing the superior abilities of ‘us’ (good) from the inferior ‘other’ (bad) (Baker 1993: 33-73). Consequently, animals can unify and undermine human relations. However, this is not always successful, and the symbolic may also communicate and connote meanings that are oppositional to the original intended purpose.

There are further examples of such animal constructions. For example, in the public realm, calling a human an ‘animal’ can be a positive or negative affirmation, referring to sexual prowess, sexual objectification, less-than-human status, or unacceptable, wild and uncontrolled human behaviours that are considered beastly, uncivilised and subhuman. As Arluke and Sanders (1996: 183) and Birke (1994: 17) outline, animalistic name-calling, such as ‘chick’, ‘pussy’, ‘bird’, ‘fox’, or ‘bitch’, is often used in an attempt to infantilise, denigrate, belittle and demonise women. Furthermore, this can refer to parts of a woman’s body (for example, calling a woman’s vagina a ‘beaver’), which links ‘uncontrollable’ and ‘untamed’ animal bodies to ‘uncontrollable’ and ‘untamed’ women’s bodies (and sexuality), and (hu)man domination and control. Franklin (2006: 7) additionally indicates that such name-calling can refer to particular types of good or bad: “to be a lamb is to embody the innocent goodness of childhood, while a mother hen is the attentive good matriarch”.

Animalistic names can also be terms of affection and endearment, such as ‘bug’, ‘bear’ and ‘possum’. Humans additionally construct multiple categories for animals based on constructions of
human/animal relationships, such as ‘livestock’, ‘pets’, ‘wild’, ‘tame’, ‘native’, ‘introduced’, ‘free range’, ‘caged’, ‘game’, ‘vermin’, ‘pests’, and on. This creates divisions between animals within a species (for example, a pig has the possibility of being constructed into many of these categories). This list is by no means exhaustive, but it does demonstrate how human constructions and categorisations of animals operate to create systems of human/animal difference. These understandings are fundamental to the treatment and construction of animals in the XTP network, as will be explored in detail in the chapters ‘The Biological Gaze: Selecting an Animal’ and ‘The Sociozoologic Gaze: Using Animals’.

While these works can be commended for bringing attention and visibility to animals, they primarily examine human-animal relationships as a one-way street, whereby the concern is with how humans construct animals. As a consequence, what is largely missing are animals constructions of and relations with humans (Tovey 2003: 197), as well as of themselves. This is difficult terrain to enter if one fears the cries of anthropomorphism.

However, as Haraway (2003) outlines, the active role of animals - in her case, dogs - in human lives, means that the active role of humans in animal lives must be acknowledged. This involves recognising dogs as ‘real’ dogs that do doggy things, not as ideas, tropes and fantasies that tell us something about humans and
humanity. This doginess - dogs as dogs - needs to be respected in its own right: “Dogs are not alibi for other themes [...]. Dogs are not surrogates for theory; they are not here just to think with. They are here to live with” (Haraway 2003: 5). For Haraway (2003: 53), this is an issue of ethics, not animal rights.

Furthermore, while humans and dogs are different species, we live together and co-evolve through a trans-species relationship. This has changed humans and dogs, and forms shared histories that aid understandings of each other. We are companion species: “If I have a dog, my dog has a human; what that means concretely is at stake” (Haraway 2003: 54). Through such processes, both are domesticating and learning about and from each other; there is “otherness-in-connection” (Haraway 2003: 45). Naturecultures draws attention to the importance of these intersubjectivities and co-constitutions. Haraway (2003) also asserts that we often fail to acknowledge this intersubjectivity and co-constitution by misrecognising dogs. This is specifically achieved by anthromorphising them; subscribing dogs with human qualities. Thus, Haraway (2003: 37, 95-96) refuses to think of her dogs as her children, as it demeans, infantilises and mislabels them. She desires dogs, not children: “My multi-species family is not about surrogacy and substitutes; we are trying to live other tropes, other metaplasms” (Haraway 2003: 96). Thus, dogs and humans are different species who live in multispecies relationships.
Conclusion

The problems inherent to and emerging from XTP are scientifically and socially numerous. These difficulties tend to emerge from the similarities and differences between humans and the animal source (pigs). Scientifically speaking, while pigs are considered to be physiologically similar enough to humans to be used as a XT source, the disparities between humans and pigs cause significant immunological hurdles that ultimately lead to graft rejection. While these rejection phases could potentially be overcome by manipulating the body of the animal (GE) and/or recipient (PITs or antibody depletion), these interventions also pose significant problems. Predominately, they may stimulate infections to emerge in the XT recipient, which could then spread to others as a new epidemic. In addition, physiological differences between pigs and humans may mean pig XTs do not function adequately and appropriately in the human body. Additionally, despite a significant history of XTP failure, the impetus driving this technology is human need and suffering, created by human organ shortages and diseases that impact on quality-of-life.

Lastly, the analysis of quantitative and qualitative sociocultural research reveals a lack of XTP engagement in the Australian context. While quantitative research has occurred across different population collectivities including those who could benefit from the technology,
qualitative research has yet to be undertaken. It was from and with these considerations that this thesis emerged.
3 - Entering the Network: Methodology


Actor (actant)-Network Theory

Influenced by constructionist sociology130, “ANT’s main concern is what actors actually do” (Van Loon 2002: 47, original emphasis). As

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130 Constructionist sociology believes that the interactions between people, and the knowledge and attitudes formed in these interactions, serve to socially construct reality (Neuman 2003: 63). As will be examined in this chapter, ANT also differs from constructionist sociology as it does not place humans in the central position of privilege and analysis. ANT is also influenced by continental philosophy, semiotics, American microsociology, and the work of Simondon and Leroi-Gourham (see Harris 2005).
a ethnomethodological approach that mixes theory, philosophy and
method, ANT is a detailed analysis of how beliefs and knowledge are
collectively composed by people through mutual construction and
reconstruction of social reality and its ‘rules’ (Neuman 2003: 367;
1992: xv). The result is that society is not perceived to be ‘given’, but
constructed through interaction (Strum and Latour 1999: 116). This
co-construction of reality reveals that truth is not absolute, as there
are ambiguous ways of understanding and building the world that
should be valued and respected (Travers 2001: 169-170). Thus, the
ethnomethodological concern of ANT is to contextually examine the
everyday methods and techniques employed by social actors in their
negotiations of social interactions. Traditionally, ANT focused on
science and scientists (which is also continued by this thesis), but is
now exploring a wide range of social institutions, knowledges and
practices.

In regards to science studies, ANT often examines the two opposing
‘Janus’ faces of science; ‘science in the making’ and ‘ready made
science’ (Latour 1987: 4). ‘Science in the making’ refers to the
unknown face of science, where knowledge and truth are uncertain
and ambiguous, and decision-making occurs in an open and
unstable network (Latour 1987: 7). In contrast sits ‘ready made
science’, where knowledge has been rendered unproblematic and
certain, serving to guarantee and secure a stabilised, coherent and
closed scientific network (Latour 1987: 7-8). The aim of science is to move from ‘science in the making’ to form a network of ‘ready made science’, where all controversy and uncertainty is simplified, finished, sealed and forgotten in a ‘black box’. The network thus forms, consisting of a solid, single and indisputable voice, where “many elements are made to act as one” (Latour 1987: 131). While this allows science to present itself as publicly firm, the uncertainty, controversy and debate of ‘science in the making’ (the ‘gray box’) may still occur privately. Science is thereby in a constant state of flux and instability due to its heterogeneity (Webster 1991: 23, 25-26).

ANT’s aim is to open science’s ‘black box’ to reveal the ‘gray box’; the processes behind ‘science in the making’ and the uncertainties that remain in ‘ready made science’:

We will enter facts and machines while they are in the making; we will carry with us no preconceptions of what constitutes knowledge; we will watch the closure of the black boxes and be careful to distinguish between two contradictory explanations of this closure, one uttered when it is finished [‘ready made’ science], the other while it is being attempted [‘science in the making’]. (Latour 1987: 13)

131 A network is “a string of actions where each participant is treated as a full-blown mediator” (Latour 2005: 128). In addition, it “is a concept, not a thing out there. It is a tool to describe something, not what is being described” (Latour 2005: 131). Furthermore, network understandings, their processes and phases, means that ‘network’ is a plural and a verb, not a singular noun (Law 2001: 859). The network is therefore active.

132 Significantly, when it comes to science studies, ANT often examines technoscientific innovations when they have failed or after the event. There still remains behind this ‘science’ to be ‘sciences’. In the case of XTP in the Australian context, this is very much revealed to be and is explicitly science in the making, as human clinical trials have not begun, and XTP is yet to succeed. This will be examined further in this chapter in ‘The Australian Xenotransplantation Network’.
Additionally, ‘science in the making’ involves examining the ways in which actors generate scientific facts and construct a network. It is important to note that this network does not simply include humans. It encompasses dynamic, interlinked and symmetrical relationships between human and nonhuman actors (‘actants’) (Harris 2005: 166; Van Loon 2002: 47; Latour 1993: 4; 1992: 24). An actant can therefore be a scallop (Callon 1986b), atherosclerosis (Mol 2002), an automatic door opener (Latour 1992), a microbe (Latour 1988), an electric vehicle (Callon 1986a), alcoholic liver disease (Law and Singleton 2003), transportation systems (Latour 1996), naval empires (Law 1986), cervical smear tests (Singleton and Michael 1993), and so on. Opening a black box and entering a network thereby reveals stories about actant organisation, social ordering, identity and sense-making (constructions of ‘truth’ and ‘facts’) (Michael 1996: 42; Law 1994: 52). For example:

The smallest AIDS virus takes you from sex to the unconscious, then to Africa, tissue cultures, DNA and San Francisco ['science in the making'], but the analysts, thinkers, journalists and decision-makers will slice the delicate network traced by the virus for you into tidy compartments where you will find only science, only economy, only social phenomena, only local news, only sentiment, only sex ['ready made' science]. (Latour 1993: 2)

Further examples are in Law (1997). This is not to suggest nonhuman actors are ‘active’ in the traditional sense of the term, but rather to highlight their much ignored relevance in sociotechnical-human interrelations. Thus, while they exist in the network and gain power from their associations, nonhumans may have to be explored in slightly different ways. That is, ANT is an analytical approach that is not saying that “we have to treat people in our lives as machines” (Law 2001: 857). To this extent, the object/subject dualism is not totally effaced by ANT.
In this process, facts are revealed to be constructed and fabricated, as humans (H) and nonhumans (NH) form networks (or collectivities) (Latour 1999: 15-16) that feature throughout human relations. These heterogeneous organisations and alliances are the affects of the inability to distinguish between the social and the technical, as “no-one has ever seen a social relation by itself [...] nor a technical relation [...]. Instead we are always faced by chains which look like this H-NH-H-NH-NH-NH-H-H-H-H-NH” (Latour 1991: 110). This means that “what counts as a person is an effect generated by a network of heterogeneous interacting materials” (Law 2001: 857, original emphasis). In other words, a person is a particular kind of person due to the types of knowledges and interpretations produced in H-NH chains. Such dynamic relations mean that “scientists never exist simply as people talking among people about people” (Callon and Latour 1992: 353). These chains link together to create networks, within which humans and nonhumans can also be networked in their own right (Michael 2000: 22). For the actor-network theorist, following these actors and their network construction is all important: “Stick to the actors, my friend, stick to the actors. If they drift, we’ll drift along with them” (Latour 1996: 94).

134 This is also an important point to remember when considering ‘science’. While science may appear, at times, to operate as a single actor, science remains to be a heterogeneous assemblage as ‘sciences’.

135 Of course, this could mean that network expands endlessly and, as a result, data collection would never end. It is therefore important to draw boundaries. This is often done by the research participants themselves (Latour 1996: 18-19). For this research, the network’s boundaries were determined by a document, which will be outlined later in this chapter in ‘Methodological Praxis’.

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Creating heterogeneous networks occurs through the acts of translation, which link actors, networks and intermediaries. Translation also includes the techniques employed to enrol other actants, and assigns their characteristics, roles and identities (Akrich and Latour 1992: 259-260; Callon 1986a: 24-26; 1986b: 203-212). This transpires through three main phases: problematisation, interessement and enrolment.

**Translation**

**Problematisation**

The initial processes of problematisation involves constructing a story, where actants defining the problem at hand (the ‘what’ and ‘why’) and the potential solution (the ‘how’), through the use and production of intermediaries. This implicates a set of H and NH actants with pre-defined desires, roles and identities, who need to accept how the problem at hand has been defined in order to enrol into the network (Callon 1986b: 203-205). Furthermore, as the initial actants have identified the problem, how to find the answer, and

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136 Intermediaries are actants that define the relationship between actants, and persuade other actants to join the network (Callon 1991: 134-141). They are the language of the network, “transport[ing] meaning or force without transformation” (Latour 2005: 39) and “are resistant to alternative interpretations and thus can shape the understandings [and identities] of relevant publics” (Irwin and Michael 2003: 116).
mobilised the intermediaries, they become the obligatory passage points (OPP) who will solve the moulded desires of the network. OPP are nodes through which all actants must pass, or what Michael (1996: 54) and Singleton and Michael (1993: 229) call “narrative bottlenecks”. This allows the founding actants to become irreplaceable and indispensable to the network (Irwin and Michael 2003: 116; Michael 2000: 33; Latour 1987: 108-109, 120; Callon 1986a: 24, 26-27; 1986b: 205-206).

In this research, problematisation is highly significant, as the actant stories often attempt to unify, simplify, and reduce to singularity a multiplicity of narratives, problematisations and viewpoints on XTP. This is particularly the case for that narrated by official science, which focuses on forming the illusion of a stable network of alliances.

**Interessement**

Interessement is a triangulation method designed to lock the alliances emerging from problematisation in place. While a variety of strategies can be used, the process typically involves one actant enrolling a second actant by coming between this actant and its links or associations with a third actant (Michael 1996: 53; Singleton and Michael 1993: 229; Latour 1988: 172; 1987: 114; Callon 1986a: 27). The aim is to create disassociation, allowing the first actant to redefine the second actant’s identity. This process determines the
role of the second and subsequent actants. In the words of Callon (1991: 143), “A translates B’. To say that is to say that A defines B”.

**Enrolment**

Network alliance, or enrolment, is the direct outcome of successful interessement. Actants disassociate from other associations, and accept the problematisations, roles and interests defined by the first actant (Michael 1996: 54; Callon 1986a: 25; 1986b: 211-212; Callon and Law 1982: 619-620). In other words, they grant consent to and align with the network. This means that “enrolment is not a unilateral process of imposition; it entails both the ‘capturing’ of the other and the other’s ‘yielding’” (Singleton and Michael 1993: 229).

These translation processes can also occur over distances, which make network enrolment problematic. By using immutable mobiles, such distances can be combated and potentially overcome. In simple terms, immutable mobiles (or inscriptions) are texts such as graphs, tables, figures, calculations, writing, maps, models, statistics and on, which are relational and connect actants in and to the network (Latour 2005: 223-226; 1999: 306-307; Michael 1996: 55; Law 1994: 102; Callon 1991: 135; Latour 1987: 227). They are most successful at translation when they combine and circulate, as it gives them the strength to operate as the network’s “mobile actants’ that cannot be silenced (muted), nor transformed (mutated), [… and] do all the work
of silencing and transforming” (Van Loon 2002: 51). Immutable mobiles are particularly important for science (Callon 1991: 135; 1986a), as they mediate actant relationships and enable “‘acting at a distance’” (Van Loon 2002: 51). When these materials and processes are unproblematic and invisible, the network is established, simplified and black boxed (‘ready made science’) (Law 2001: 58; Michael 1996: 54; Latour 1987: 3).

However, translation is not necessarily permanent. As discussed previously in relation to ‘science in the making’ and ‘ready made science’, networks are fragile and precarious, and can become unstable if not subjected to ongoing processes of translation (Van Loon 2002: 50; Latour 1988: 222; 1987: 122). A network is therefore constantly in process and requires maintenance; as actants depart, alliances change and new actants enter (Callon 1986b: 196). To achieve these examinations of translations and networks, ANT has three basic tenets: generalised agnosticism, generalised symmetry and free association (Callon 1986b).

**The Three Basic Tenets: Generalised Agnosticism, Generalised Symmetry and Free Association**

Generalised agnosticism refers to an impartial commitment and approach to actants and their stories. This includes valuing all technoscientific and social stories equally, and abstaining from
censorship (Callon 1986b: 200). Consequently, no story or point of view is privileged, and no interpretation is suppressed. When exploring these stories, it is also important to understand conflicting viewpoints in the same neutral language and terms. This is known as generalised symmetry (Michael 1996: 53; Latour 1987: 144; Callon 1986b: 200, 221).

Generalised symmetry continues the principle of agnosticism through its equivalence of all actants, which equally refers to – and does not distinguish between - human and nonhuman actants. As a result, “everything deserves explanation and, more particularly, that everything that you seek to explain or describe should be approached in the same way” (Law 1994: 9-10, original emphasis). This can cause a flattening effect on the network that, by breaking down boundaries, aids to expose the blending of humans and nonhumans in everyday life (Star 1991: 43).

Lastly, free association involves rejecting the traditional boundaries between the social, natural and technological. Such distinctions are not a priori; they are defined by and emerge from actant stories (Law 2001: 856; Michael 1996: 53; Singleton and Michael 1993: 229; Latour 1987: 202-205; Callon 1986b: 200-201, 222). This transgression of disciplinary boundaries involves an interdisciplinary approach to studying science. As a result,
Instead of imposing a pre-established grid of analysis upon these [the actants and their relationships], the observer follows the actors in order to identify the manner in which these define and associate the different elements by which they build and explain their world, whether it be social or natural. (Callon 1986b: 201)

Therefore, ANT rejects the idea that specialist scientific knowledge is beyond sociological inquiry, which distinguishes this approach from other SSK and SST constructionist methodologies. An example of these other approaches is employed by Collins and Yearley (1992; 1992a), where a solid *a priori* foundation is assumed, as based on ontologically-fixed and human-centred asymmetrical relations between nature (science) and the social (sociology) (Boyne 2001: 30, 33; Callon and Latour 1992: 348; Callon 1986b: 197)\(^{137}\). This means SSK and SST traditionally assert science and scientist accounts are separate from, beyond the understanding of, and impractical for, social analyses. By equally embracing humans, nonhumans, the natural and the technological, ANT therefore goes beyond constructionist sociology in asserting all of these elements interactively influence social construction, and are an intimate part of

\(^{137}\) This is the social realist position of SSK advocated by Collins and Yearley (1992a: 308, 310-311; 1992b), which allows privileges and ‘expert knowledge’ to be assigned to scientists and their accounts, and therefore beyond sociological inquiry. Such associations facilitate the desire to discover “the relationship... between the [social] world and our representational [natural] devices” (Collins and Yearley 1992a: 310). As a consequence, Collin and Yearley’s (1992a: 314-317) SSK focuses on the social construction and *modus operandi* of expert scientific knowledge as sociologists cannot, through a lack of scientific understanding, address or examine the constructed sequences of scientific processes. In this vein, they play a double-edged sword by recognising the expert and specialist knowledge of science, but refuse scientific accounts of the natural world by seeking “to account for the findings of natural science” (Collins and Yearley 1992b: 377).
social relations and knowledges (Callon and Latour 1992: 348; Latour 1992: 23-24; Callon 1986a: 20). As a result, ANT creates a dynamic, hybrid, and cyclic bond between nature, technology and society, as well as various traditionally distinct disciplines, where neither nature nor the social is privileged in the “sociotechnological network” (Latour 1993: 5). Furthermore, this means non-scientists can also engage with and speak about ‘sciences’ (Latour 1999: 17). ANT is neither technological determinism nor social determinism.

ANT’s position on network construction requires a slight adaptation to the ethnomethodological approach, as worldly construction should not be limited to human actors nor focus exclusively on the micro. Rather nonhuman actors, including technological components and nature, are important elements in the hybridised network. This dynamism creates a rhizomatic network of relational assemblages between interlocking autonomous actants, in preference to human privileges and linear centrality (Boyne 2001: 23, 25; Latour 1992: 23-24). As a result, nothing is placed in the central position of analysis, since all actants are assigned an equal and symmetrical status in a non-hierarchical structure regardless of their ontological ‘type’ (Boyne 2001: 23; Latour 1992: 24). As a consequence, “it is not

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138 In the words of Latour (1999: 84, original emphasis), “science studies [...] rejects the idea of a science disconnected from the rest of society, but this rejection does not mean that it embraces the opposite position, that of a ‘social construction’ of reality, or that it ends up in some intermediary position, trying to sort out ‘purely’ scientific factors from ‘merely’ social ones. […] What science studies rejects is the entire research program that would try to divide the story [...] into two parts”.

139 Latour (1996: 46) asserts a commonality between networks and Deleuze and Guattari’s concept of ‘rhizomes’: “Our terrains aren’t territories. They have weird borders. They’re networks, rhizomes”. 
possible to distinguish for long between those actants that are going to play the role of ‘words’ and those that will play to the role of ‘things’” (Latour 1988: 184). In this light, micro and macro social structures are not socially given, but constructed through network relations that shift and change (Neuman 2003: 460; Strum and Latour 1999: 119). Additionally, actants are no longer distinct entities in a network, but hybridised “compound realities, the product of a process of composition” (Callon and Law 1997: 170), where interrelationships and shared knowledges allow “Mr Anybody… [to] become Mr Manybodies!” (Latour 1987: 31). This is an important element of the network – it speaks as one, but it also contains multiple actants that give it force and strength (Van Loon 2002: 49; Latour 1988: 160).

By blurring distinctions between humans and nonhumans, ANT has been criticised for attributing animals with human qualities (anthropomorphism), such as intention, thought and action. However, while anything can potentially be an actant, this status can only be achieved when the actant is defined by others in the network as acting; “imbued with the capacity to change the unfolding of events” (Blok 2007: 73). For example, in regards to Callon’s (1986b) scallops, Blok (2007: 73) outlines: “as scallops are deemed capable of either attaching or detaching - by scientists and fishermen - they do in fact act”. Thus, it is important how the scallops are perceived and treated, and the consequent implications for actant identities
within the network. This approach to understanding nonhumans has been embraced in and is central to the chapters ‘The Biological Gaze: Selecting an Animal’ and ‘The Sociozoologic Gaze: Using Animals’.

In sum, modernistic and hierarchical distinctions between actant (agency/individual), networks (structure/collective), the micro/macro, and nature/society, are unnecessary in ANT, as the actant’s dynamic role in the collective network constructs definitions that impact upon and create identity and reality (Callon and Law 1997: 167; Callon and Latour 1992: 356). Hence “one is not born a scallop; one becomes one” (Callon and Latour 1992: 356).

The Australian Xenotransplantation Network

Before I explore the relevance and application of ANT in this project, it is worth noting the existing status of XTP as ‘science in the making’ in Australia. Animal-to-animal forms of XTP have occurred in Australia for some time. In 2001, however, Professor Bernie Tuch¹⁴¹, the Head of the Diabetes Transplant Unit at the Prince of Wales Hospital in Sydney, planned to conduct clinical trials of XTP, where porcine islet cells would be implanted into people with Type-1

¹⁴⁰ There are many more concepts in ANT that I have not addressed here. For sake of clarity, I have only chosen to examine the most major ones, and those of relevance to this thesis.
¹⁴¹ Tuch is one of the research participants in this project. His stories will be explored in the following chapters.
diabetes. The NHMRC prevented this trial from going ahead, based on the need for nonhuman primate experimental trials prior to human clinical trials (personal communication with Tuch 2003), and fears of cross-species viral transmission (Tuch in Armstrong 2004: 18:16). In the same year, the NHMRC formed the Xenotransplantation Working Party (XWP):

to provide advice on the scientific, ethical and technical issues relating to xenotransplantation research, produce guidelines for the assessment of animal-to-human transplantation trial proposals, and consult widely with the community about these issues. (Xenotransplantation Working Party 2003a: iii)

XTP is consequently problematised. Namely, what is needed to progress with XTP and what regulation is required, are problems that are defined by the NHMRC and necessitate a solution. In this process, the NHMRC becomes an OPP through which, in the Australian context, XTP and its associated networks such as scientists and clinicians, must pass. In aligning individuals into a new network - that of the XWP - the problematisation of XTP by the NHMRC is accepted and delegated to a new actant. Interessement has occurred through the XWP’s acceptance of the problem, both as individuals and as a networked collectivity. It has now fallen to the XWP to expand the XTP network and to initiate a new process (or processes) of translation. This means the ‘what’, ‘why’ and ‘how’ (the

142 Various types of XT are outlined in the chapter ‘Xeno-what? A Literature Review’. 
problematisation) of XTP, needs to be (re)defined and mobilised. Thus, the XWP becomes an intermediary who represents the NHMRC to the publics, and the publics to the NHMRC. In this process, the XWP also assign roles and identities to the publics. This makes the XWP a very significant OPP to XTP.

The first XWP enrolled seven committee members, mostly from clinical and medical health backgrounds (see Figure 14). The initial consultation document produced in July 2002 titled ‘Draft Guidelines and Discussion Paper on Xenotransplantation’ (Xenotransplantation Working Party 2002), was designed to elicit community feedback on particular issues surrounding XTP as predetermined by the XWP, and for seeking public comments on the proposed regulatory controls and guidelines (Xenotransplantation Working Party 2002: xv). This problematisation of XTP and the mobilisation of this document solidified the XWP’s position as an OPP. Furthermore, as the documents produced by the XWP define the problem and its limits, then these documents become actants in their own right – immutable mobiles - and an additional OPP. The desire to fulfil network alignment and successful translation lead to community discussions and consultations from August to October 2002 in Sydney, Melbourne and Perth, which attracted 116 participants (Xenotransplantation Working Party 2004: 2; 2003b: 7). These consultations and the 97 written public submissions (inscriptions)
received raised a number of significant public concerns, including:

- xenozoonotic fears (for the recipient and the community) and issues of responsibility if such an event did occur;
- regulation issues;
- animal welfare and rights;
- questions regarding health and medical research funding priorities;
- whether recipients would actually benefit from the XT;
- the ethicality of animal GE;
- the inability to infer results of animal-to-animal experimental trials to animal-to-human clinical applications; and
- potential communal reactions to XT recipients, amongst other concerns (Xenotransplantation Working Party 2004: 2; 2003a: iii; 2003b: 8-9).

Furthermore, “some respondents felt that much of the information provided was in a format that did not facilitate community understanding of the complex issues involved” (Xenotransplantation Working Party 2003a: iii). Therefore, the XTP network was not stabilised. Rather, it faced significant opposition in its mobilisation that reflected in failed network enrolment. In addition, the XWP’s problematisation was not resolved, and was further expanded by the publics in oppositional or counter directions.
<table>
<thead>
<tr>
<th>MEMBERSHIP CATEGORY</th>
<th>NAME</th>
<th>COMMITTEE MEMBERSHIP</th>
<th>DATE/S</th>
<th>EXPERTISE/AFFILIATION (AT TIME OF COMMITTEE MEMBERSHIP)</th>
<th>VOLUNTEER IN THIS RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>Dr Kerry Breen</td>
<td>XWP</td>
<td>2001-2002</td>
<td>Clinical medicine and medical ethics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dr Jack Sparrow</td>
<td>XWP</td>
<td>2003-2004</td>
<td>Medical administration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ms Elizabeth Grant</td>
<td>AIS</td>
<td>2003-2004</td>
<td>Pharmacist; Research Committee Chair; Animal Welfare Committee</td>
<td></td>
</tr>
<tr>
<td>Australian Health Ethics Committee</td>
<td>Dr Kerry Breen</td>
<td>XWP</td>
<td>2001-2004</td>
<td>Clinical medicine and medical ethics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A/Prof. Bernadette Tobin</td>
<td>XWP</td>
<td>2001-2004</td>
<td>Animal Welfare Committee</td>
<td></td>
</tr>
<tr>
<td>Gene and Related Therapies Research Advisory Panel (GTRAP)</td>
<td>Dr Dominic Dwyer</td>
<td>XWP</td>
<td>2001-2004</td>
<td>Clinical virology and infectious disease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prof. Philip O’Connell</td>
<td>XWP</td>
<td>2001-2004</td>
<td>Clinical and experimental transplantation (including XTP)</td>
<td></td>
</tr>
<tr>
<td>Therapeutic Goods Administration</td>
<td>Dr Leonie Hunt</td>
<td>XWP</td>
<td>2003-2004</td>
<td>Assistant Secretary, Drug Safety and Evaluation Branch, Therapeutic Goods Administration</td>
<td></td>
</tr>
<tr>
<td>Clinician with AT background</td>
<td>Dr Simone Strasser</td>
<td>XWP</td>
<td>2003-2004</td>
<td>Clinical transplantation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prof. Mauro Sandrin</td>
<td>XWP</td>
<td>2003-2004</td>
<td>Clinical and experimental transplantation (including XTP)</td>
<td>✓</td>
</tr>
<tr>
<td>Infectious disease/public health</td>
<td>Prof. Aileen Plant</td>
<td>XWP</td>
<td>2003-2004</td>
<td>Medical epidemiology and international health</td>
<td></td>
</tr>
<tr>
<td>Community Views</td>
<td>Ms Michele Kosky</td>
<td>XWP</td>
<td>2001-2004</td>
<td>NHMRC member with expertise in consumer issues</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Mr Twanny Farrugia</td>
<td>XWP</td>
<td>2001-2004</td>
<td>Counsellor (general, loss and grief); long-term transplant recipient</td>
<td>✓</td>
</tr>
<tr>
<td>Animal Welfare Committee</td>
<td>Ms Elizabeth Grant</td>
<td>XWP; AIS</td>
<td>2001-2004</td>
<td>Pharmacist; Research Committee Chair; Animal Welfare Committee</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A/Prof. Graham Jenkin</td>
<td>AIS</td>
<td>2003-2004</td>
<td>Stem cell research</td>
<td></td>
</tr>
<tr>
<td>Animal welfare (not in the scientific environment)</td>
<td>Dr Bidda Jones</td>
<td>XWP; AIS</td>
<td>2003-2004</td>
<td>Scientific Officer, RSPCA Australia with expertise in animal welfare issues</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Ms Glenys Oogjes</td>
<td>XWP</td>
<td>2003-2004</td>
<td>Executive Director, Animals Australia</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Ms Helen Rosser</td>
<td>AIS</td>
<td>2003-2004</td>
<td>Assistant to Executive Director, Animals Australia; Co-founder and National Coordinator, Human Charities Australia Inc.</td>
<td>✓</td>
</tr>
<tr>
<td>Animal welfare (in scientific environment/research)</td>
<td>Dr Robert Dixon</td>
<td>AIS</td>
<td>2003-2004</td>
<td>Faculty of Veterinary Science, University of Sydney; Subdean Animal Welfare; Member of several research institutional animal ethics committees; transplant recipient</td>
<td>✓</td>
</tr>
<tr>
<td>Veterinary and animal husbandry</td>
<td>Dr Lyndy Scott</td>
<td>AIS</td>
<td>2003-2004</td>
<td>The Australian Veterinary Association</td>
<td>✓</td>
</tr>
<tr>
<td>Observer</td>
<td>Dr Bruce Scoggins</td>
<td>XWP</td>
<td>2003-2004</td>
<td>Health Research Council of New Zealand</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Figure 14 - Membership of the Xenotransplantation Working Party (XWP) and the Animal Issues Subcommittee (AIS)**

While the XWP believed the 97 first-round submissions indicated “a high level of community engagement and provided considerable information to the NHMRC about community views on animal-to-human transplantation” (Xenotransplantation Working Party 2003a: iii; 2003b: 2), they were somewhat disappointed as to the origin of the public submissions (see Figure 15). Namely, it was noted “few submissions were received from potential patients, past recipients of human organ transplants or groups representing such people. The views of these groups will therefore be sought in this [second] round of consultation” (Xenotransplantation Working Party 2003b: 25). Additionally, few submissions were received from medical professionals who could potentially treat and monitor XT recipients (Xenotransplantation Working Party 2003b: 3). The XWP also suggested and presumed:

> the limited data available on public opinion indicate that people’s views are usually influenced by whether a person or loved one needs a transplant: people for whom an animal-to-human transplant is a potential therapy are more likely to support the technology.\(^\text{143}\) (Xenotransplantation Working Party 2003b: 25)

What this means is that the actants that the XWP expected to accept their problematisation of identifies, roles and XTP, and to subsequently enrol in the network and perhaps persuade others to

\(^{143}\) Of course, this negative statement is somewhat ironic, given the XWP’s positive reaction to receiving 97 public submissions (Xenotransplantation Working Party 2003a: ii; 2003b: 3). Moreover, this statement by the XWP presumes people who could potentially benefit from the technology will simply accept XTP. As will be revealed in this thesis, this is not necessarily the case.
join, did not. Such presumptions are based on the XWP’s assignment of roles and identities to selected human collectivities of interest. The desire to draw these actants into interessement is based on network expansion, which would increase the network’s power. This would also involve, on behalf of the enrolled actants, accepting a particular pre-determined version of XTP problematisation.

Based on the issues raised by the publics and in conjunction with the NHMRC, the XWP decided a second-round of public consultations was necessary. Therefore, the XWP and their problematisation of XTP was successfully resisted by the publics, and this exercise of power deemed that, for the XTP network to continue, adaptations needed to be made. This was additionally demonstrated in identifying a lack of expertise in the XWP to address all of the public’s concerns, particularly in relation to animal welfare. As a result, the XWP was expanded to fifteen members to encompass new ‘expertise’ from “animal welfare, infectious disease control, clinical transplantation, experimental transplantation (including animal-to-human transplantation) and the regulation of clinical trials” (Xenotransplantation Working Party 2004: 2) (refer to Figure 14). Furthermore, an Animal Issues Subcommittee (AIS) of six members was formed, some of which also sat on the XWP, to specifically examine and advise the XWP on animal ethics, welfare and

144 Significantly, the existing XWP already had expertise in this area. It is therefore interesting that the expansion of the XWP included reinforcing the existing status quo.

<table>
<thead>
<tr>
<th>SUBMISSION SOURCE/ORGANISATION</th>
<th>FIRST-ROUND</th>
<th>SECOND-ROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government agencies</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Animal Welfare</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Medical</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Religious</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Universities</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Hospitals</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Consumer</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other organisations</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Medical professionals</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Ethicists</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Transplant researchers</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Individuals</td>
<td>44</td>
<td>283</td>
</tr>
<tr>
<td>TOTAL</td>
<td>97</td>
<td>343</td>
</tr>
</tbody>
</table>

**Figure 15 - Australian Public Submissions on Xenotransplantation**


Therefore, the XWP increased its alliances, and sought further knowledges to increase its power and to mobilise its own version of XTP problematisation. This network expansion does not challenge the existing network, as consistent interests and immutable mobiles remain. At the same time, the network should not be conceptualised as a 'super actor'. Rather, the alignment of numerous actants to the network highlights it does not have a single author which, due to this multiplicity, can lead to contradiction and conflict in the network.

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145 Some of the first-round submissions were from organisations from which future members of the XWP were sourced (namely, Helen Rosser, Dr. Bidda Jones, Prof. Mauro Sandrin, Glenys Oogjes, and Dr. Bruce Scoggins) (see Xenotransplantation Working Party 2003b: 170-172).
Therefore, it can be expected that tensions existed in the XWP and AIS, and also between them.\footnote{This is revealed in more detail throughout the thesis and particularly in the chapter ‘Risk and Uncertainty: Science and Zoonosis’.
}

The second-round consultation was preceded by two more documents (actants), one being the response paper for public debate and community consultation, ‘Animal-to-Human Transplantation Research: How Should Australia Proceed?’ (Xenotransplantation Working Party 2003b), and a community guide titled ‘Animal-to-Human Transplantation Research: A Guide for the Community’ (Xenotransplantation Working Party 2003a). This community guide was designed “to complement and introduce the reader to […] the Response Paper’ (Xenotransplantation Working Party 2003a: iii, original emphasis), and to provide a concise and easy to read introduction to XTP and its surrounding issues something which, for the publics, was missing from the first-round of public consultations (Xenotransplantation Working Party 2004: 3; 2003a: iii; 2003b: 3). This previously missing intermediary perhaps facilitated the lack of network enrolment. The desire to expand the network thereby continued, and the problematisations of XTP reviewed in light of resistance.

Public meetings were held in every Australian capital city in February 2004, which drew 377 attendees (Xenotransplantation Working Party 2004: 56). They also received 343 inscriptions in the form of written

While “the majority of respondents to the public consultation and attendees at the public meetings were opposed to animal-to-human transplantation” (Xenotransplantation Working Party 2004: 13), the XWP subsequently recommended to the NHMRC that clinical trials of xenoperfusion and cellular XTP to proceed in Australian under strict guidelines and monitoring (Xenotransplantation Working Party 2004: 31). This continued to reflect the previous positions held by the XWP (2003b: 145; 2002: xxxv), which were formed prior to public consultation. Further, they asserted nonhuman primates should not be used as the XTP source animal, and that whole organ clinical XT trials should be banned for five years (Xenotransplantation Working Party 2004: vii-viii, 31). As a result, the XWP network asserted its own problematisation to be correct, and opposing voices to the network’s interests were externalised and silenced. Therefore, the XWP and the enrolled actants continued to exercise their networked power at the expense of competing stories.

In September 2004, the XWP (2004) forwarded these proposals and the projected regulatory framework for XTP in the form of a document actant to the NHMRC; the original OPP. The NHMRC subsequently supported the XWP’s recommendations to ban clinical

147 Prior to public consultation, “the working party was of the opinion that the best option for Australia is to allow research to proceed under guidelines that take account of ethical issues, protect the interests of research participants, ensure that animal welfare concerns are met and safeguard public safety” (Xenotransplantation Working Party 2002: xxxv).
trials of whole organ XTs for five years and the use of nonhuman primates as the source animal for clinical XTP indefinitely\footnote{In contrast, the USA has not banned the nonhuman primate-to-human XTP model (U.S. Food and Drug Administration 2001: 7-8, 23).} \footnote{In contrast, the USA has not banned the nonhuman primate-to-human XTP model (U.S. Food and Drug Administration 2001: 7-8, 23).} \footnote{These restrictions do not apply to experimental animal-to-human trials.} (National Health and Medical Research Council 2004a: para.2; Pettigrew 2004: para.4). This means that the NHMRC accepted this problematisation of XTP by the XWP, and allowed the XWP’s network enrolment to remain unchallenged.

Further deliberation occurred before the NHMRC (2004b: para.2) decided in December 2004 not to endorse the XWP’s position on human clinical trials of xenoperfusion and cellular XTP, as based on xenozoonotic concerns and a belief that “xenotransplantation is at an early stage and clinical trials in the foreseeable future are unlikely to be of significant benefit to the research participants” (National Health and Medical Research Council 2005: para.3)\footnote{These restrictions do not apply to experimental animal-to-human trials.}. Therefore, a moratorium has been placed on all forms of clinical XTP in Australia, which will expire in December 2009. At this time, the NHMRC’s problematisation of XTP could lead to a ban on XTP; allow the moratorium to continue; or allow XTP human clinical trials. Meanwhile, the NHMRC is receiving information on the safety and efficacy of XTP research, as based on clinical and scientific research, from a new member of the network, the Gene and Related Therapies...
Research Advisory Panel (GTRAP)\textsuperscript{150} (National Health and Medical Research Council 2005: para. 6-8). As a result, the NHMRC did not accept the total problematisation of XTP by the XWP. This can be seen as contradictions and tensions that can - and do - exist in networks. Furthermore, the NHMRC continued to expand the network through its own specific problematisation and aligning GTRAP as a new OPP that replaces the XWP, which then generates new problematisations. Hence, the fluidity of the network and its heterogeneity is exposed.

Significantly, despite their recommendations to the NHMRC, the XWP also acknowledged that they were still unable to effectively understand and deal with all the issues and public concerns raised in the second-round of consultation and, as such, their problematisation was incomplete and unresolved. This effectively supports and heightens the relevance of this research:

Some respondents noted that the [second-round] public document lacked analysis of the psychosocial issues relating to animal-to-human transplantation. For example, the attitudes of people towards using animals as medical therapies for humans (compared to attitudes towards using animals for food)\textsuperscript{151}, and the psychological impact of mixing animal and human tissues\textsuperscript{152}, were not explored. The way in which people balance decisions about extending life and the allocation of limited health

\textsuperscript{150} It has not evaded my attention that some of the members of the XWP, who are clinicians working on and towards XTP, are also - or have been - members of GTRAP.
\textsuperscript{151} This has been addressed in this thesis. Refer to the chapter ‘The Sociozoologic Gaze: Using Animals’.
\textsuperscript{152} To a certain extent, this has been explored in the work of Lundin (2002), and Lundin and Widner (2000).
care resources among increasingly complex and expensive health care technologies, was also not explored in much detail in the reports. The XWP agreed that, in retrospect, a sociologist would have been a useful addition to the group to help understand these issues. (Xenotransplantation Working Party 2004: 14, emphasis added)

The lack of qualitative social research on XTP in Australia and these recent developments in regulation and public consultation, presents a myriad of sociological research possibilities in this unstable network. This also highlights the need for critical social analysis, particularly given that XTP remains in Australia to be ‘science in the making’. Influenced by ANT, this research examines XTP in Australia, with a concern for the various actants enrolled therein and their problematisations. Specifically, this research concentrates on the XTP network created by the XWP’s community document (2003a), a significant OPP, and enters this ‘science in the making’ by engaging with selected actants. This document actant reveals who are considered the main and important actants, and what their roles and identities should be. As Latour states, (1988: 9), “if we open the scientific literature of the time, we find stories that define for us who are the main actors, what happens to them, what trials they undergo”.

153 As will be detailed later in this chapter in ‘Document Analysis’, not all actants in the network could be mobilised in this research.
Therefore, the main research questions to this thesis are:

- What is the xenotransplantation network, as conceived by the document actant ‘Animal-to-Human Transplantation Research: A Guide for the Community’ (Xenotransplantation Working Party 2003a)?
- How do the enrolled actants negotiate the social and technological complexities of xenotransplantation?

While these questions could imply an opening of the XTP network’s black box, this is not the case. Due to the rejection of the XWP’s recommendations by the NHMRC and the current five-year moratorium on all forms of human XTP, XTP remains, at least in Australia, gray boxed as ‘science in the making’. Therefore, while the community document attempts to create a black box, its construction has been challenged and (temporarily) halted. At the same time, scientific networks existing within this delicate network (networks within networks), are attempting to make the black box a reality. The tensions and conflicts between the XWP’s problematisation of XTP and that of the publics, adds to the instability and fragility of the network. These issues are of major concern in this thesis.

As noted by the XWP (2003a: iii; 2003b: 2-3, 25) and as previously addressed, while the XWP was pleased by the public’s response, not all actant views were encompassed or revealed in the consultative
rounds, particularly that from which the XWP believed would facilitate translation and network stabilisation. Furthermore, I would contend that 97 (first-round) and 343 (second-round) public submissions do not effectively or adequately reflect the Australian population and their opinion. It could also be argued that because the XWP formulated their own position on XTP external and prior to public consultation and subsequently recommended this position to the NHMRC (which largely contrasted to the public’s view), that public consultation and discussion did not actually occur. This can be seen as an attempt by the XWP, in the vein of ANT and network translation and heterogeneity, “to persuade others, to shape them as particular sorts of being with particular sorts of interests, properties and knowledges” (Michael 1996: 49). It is not, however, the intent of this thesis to critique this public consultation process in further detail. Rather, it is clear that the problem with XTP and public consultation is that not all the actants have been included, and it is this which is currently of more pressing concern to this research.

By entering the XTP network through the community document, an opportunity is equally provided for the ‘vocal’, ‘included’, ‘silenced’ and ‘excluded’ actants, including those who may resist their assigned roles and identities, to speak. Importantly, this community

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154 That is to say, I am very interested in and disappointed by the public consultation process and would like to examine and critique this further in the future.
155 This is not to imply the ‘silenced’ and ‘excluded’ are passive actants in any simple sense. Their textual identification in the XTP network does mobilise them,
document should also be considered an actant; an immutable mobile that defines relationships, roles and identities, and attempts to enrol particular (desirable) actants into this network. All of these H and NH actants tell stories that construct and reconstruct the realities and truths of XTP as ‘science in the making’.

Calling these actant accounts ‘stories’ is by no means an attempt to fictionalise, infantilise, belittle, devalue or denigrate them. Rather, as indicated earlier, stories circulate those problematisations which are the most desirable; operating as “ordering resources for working on and making sense of the networks of the social” (Law 1994: 71). Throughout their stories, the actants are seeking to understand, produce, and problematise XTP:

as we create and recreate our stories we make and remake both the facts of which they tell, and ourselves. So it is that we seek to order, and re-order, our surroundings. So it is that we formulate, we try to sum up. (Law 1994: 52)

As previously stated, this research identifies and enters the XTP network outlined in the community document actant, and ‘follows the

but not in a physically embodied sense that humans typically conceptualise and expect.

156 In ‘Aramis’, Latour (1996) allows this failed French transportation to ‘speak’. As XTP and Aramis are both ‘science in the making’, the following story from Aramis could equally apply to XTP (if ‘engineer’s’ is substituted with ‘scientists and clinicians’, and ‘Aramis’ with ‘XTP’): “I am not yet among the powers that be. I am only a light breath, a feather drifting with the winds, a murmur in an engineer’s ear, a wasp to be flicked impatiently away, an attractive idea that flits from seminar to colloquium to investigatory body to research report. ‘Aramis’ is an argument, a story that grownup children tell themselves” (Latour 1996: 122-123).
actants' in order to reveal their stories. These stories are highly important to ‘science in the making’ (sciences) and the potentialities of ‘ready made science’ (science); revealing the complexities of actant uncertainties and ambiguities. This approach is advocated in Latourian ANT:

The fact that we do not know in advance what the world is made up of is not a reason for refusing to make a start, because other storytellers seem to know and are constantly defining the actors that surround them - what they want, what causes them, and the ways in which they can be weakened or linked together. These storytellers attribute causes, date events, endow entities with qualities, classify actors. The analyst does not need to know more than they; he has only to being at any point, by recording what each actor says of others. [...] The task of the analyst is to follow the transformations that the actors convened in the stories are undergoing. (Latour 1988: 10)

While any documents generated by the XWP could have been chosen to identify and enter the network, the community document actant was chosen as it was designed to inform the ‘lay’ person, and presents a significantly smaller network than the other documents. As will be discussed in later in this chapter in ‘Document Analysis', the process of “network mapping” (Brown and Michael 2003: 3) revealed a large XTP network in the community document, which needed to be further modified for temporal and practical constraints.

This research also modifies and softens the ANT approach, or ‘translates’ it in two ways: (i) by considering the importance of various
subject positions, including the silenced, marginalised or less privileged, and (ii) identifies and mobilises another network that overlays the XTP network: the conceptual network\textsuperscript{157}.

Firstly, ANT has been criticised for privileging science and scientific ‘expertise’ with the one way operation of OPP and interessement. This has been labelled the ‘citadel model’ (Martin 1998 in Irwin and Michael 2003: 117) or ‘executive approach’, which assumes top-down power relations by privileging experts, design and innovation, and disempowering and marginalising the publics and other voices from less privileged positions, including that of women (Oudshoorn and Pinch 2005: 7). Indeed, this is potential problem with ANT, where those in positions of authority - the ‘experts’ - might be considered the central and most important source of information. At the same time, there is no coherent ANT approach, as it can be used in a variety of ways and with consideration of the subject at hand. Therefore, many others have adapted and translated ANT, which are sometimes labelled as ‘after ANT’ approaches. An example of one such development is Irwin and Michael’s (2003) ‘ethno-epistemic assemblages’ (EEA). EEA seek to confront and overcome the traditional contrasts between science (experts) and society (the lay publics) by demonstrating how they come together and merge; emphasising heterogeneity and fluidity (Irwin 2008: 592-593). This approach also includes exposing “how it is that the separations between science and society are reproduced” (Irwin and Michael 2003: 17). Furthermore, these knowledges and their production are locally situated, highlighting the significance of context.

\textsuperscript{157} Significantly, there are several commonalities between my translation of ANT and EEA, such as heterogeneity, symmetry, context, complexity, controversy, and “explanatory potential” (Irwin 2008: 593, original emphasis). In addition, they are “admixtures of ethical, experiential, scientific and regulatory discourses” (Irwin and Michael 2003: 112), and seek to overcome the social privilege of technoscience. In this research, however, it is also important to, at times, distinguish between different actant collectivities to show tensions that emerge between or within them. Furthermore, I have restricted my research to a network predetermined by an important OPP, a community document actant, as mobilised by another OPP, the XWP. Lastly, this exposes another difference between my approach and that of EEA - I have mobilised and used ANT terminology when and where appropriate to explain what is happening in the XTP network.
time, whether such criticisms are valid are dependent on how ANT is mobilised with regard to the phenomena under examination.

In respect to XTP, it is a scientific endeavour that, in the Australian context, is largely determined by regulatory organisations that primarily listen to and seek advice from scientific bodies. Furthermore, these scientific associations actively promote their powerful position of expertise through a wide variety of professional and public sources, including the media. Through such approaches, these actants demonstrate an executive approach. This research, however, examines the co-construction of XTP, and avoids privileging the stories of the ‘experts’ over the publics. Therefore, the aim is “to avoid silencing invisible actors and actants and to include power relations explicitly in the analysis of user-expert relations” (Oudshoorn and Pinch 2005: 7), which also includes, as XTP is ‘science in the making’, potential users. To make these potential users more visible, it is important to emphasise their significance in XTP development. By embracing both publics and experts as active, this challenges the privileging of scientific knowledge on XTP in Australia. The use of ANT in this thesis, therefore, overcomes the divides that are based on ‘types’ and ‘forms’, and to highlight how these might be resisted and contested, particularly by the publics. As stated by Akrich (1992 in Oudshoorn and Pinch 2005: 11), “we have to go back and forth continually between the designer and the user, between the designer’s projected users and the real users”.

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It is because of this marginalisation and silencing of the users and potential users that this thesis primarily focuses on the subjectivities and stories of human actant collectivities - those involved with the science and regulation of XTP (the visible) and those targeted by xenotechnologies (the invisible). The stories and problematisations of all these human actants are important, particularly those who have been obscured. Moreover, the nonhuman actant in the form of texts (immutable mobiles) is also essential to this thesis, as will be outlined and explored later in this chapter in ‘Document Analysis’. What this then exposes is a lack of engagement with animal actants. This is not because animal actants are irrelevant; rather animal actants are central and highly important to XTP and the success of this network. However, the nonalignment of animals to the XTP network is self-evident. I will return to this soon.

In regards to the conceptual network, it identifies the main concepts or OPP which the (potentially) enrolled actants must negotiate and resolve. Consequently, the XTP network must not be regarded as flat and one-dimensional; it is three-dimensional and rhizomatic. The concepts which overlay the network feature throughout the community document actant, and include surveillance, monitoring, risk, animals, research funding, trust, faith, healthcare priorities, ill health, AT, and so on. These concepts can also break down further into sub-concepts, highlighting how many networks can exist within a larger network. As will be further articulated later in this chapter in
‘Document Analysis’, the XTP network is large and potentially difficult to manage. The conceptual three-dimensional elements of this network do not make the task any easier. In addition, the actants also introduce a variety of concepts that are not identified in the pre-existing network/s, which serves to intensify problematisation. Furthermore, while the research participants were introduced to a variety of concepts found in the XTP network, only two (and their associated sub-networks, as narrated and assembled by the research participants), are examined in this thesis. These concepts, animals and risk, feature throughout and underlie many other concepts in the XTP network. There are not necessarily any underlying coherent patterns in official science’s and the research participant’s negotiations of these concepts, as XTP and the conceptual network are characterised by often conflicting similarities and differences.

The second research question can thereby be further modified:

- How do the enrolled actants negotiate the social and technological complexities of xenotransplantation in relation to risk and animals?

I will now turn to how the network was mapped, and how the actant stories were collected.
Methodological Praxis

Three empirical research methods were used to explore the XTP network and actant stories. These are document analysis, focus groups, and semi-structured interviews.

*Document Analysis*

An important component of ethnomethodology is how the textual production of language constructs an everyday social reality (Watson 1992: xv-xvi). Document analysis is a non-obtrusive and ‘nonreactive’ qualitative research method, and facilitates description and interpretation of people’s values and beliefs in particular setting without their direct participation, or as an alternative perspective (Marshall and Rossman 1999: 116-117, 128-129).

Documents are of great interest to ANT, as these actants attempt to manufacture a coherent scientific truth (Watson 1992: xviii). Significantly, documents can act as intermediaries and immutable mobiles, enabling consistent stories and networks to form over great distances. In this research, document analysis allows an identification of how the community (document) actant creates and assigns various roles, identities and knowledges to a network of selected actants and conceptual actants. This also reveals what is important to the scientific regulatory construction of XTP in Australia,
as according to the XWP. Document analysis of the community actant does not require the direct involvement of the XWP, as these documents are publicly available for perusal and act independently of the XWP. Therefore, documents take on ‘a life of their own’, which is why documents become actants in and of themselves.

The ANT methodology for documentary analysis also involves what Brown and Michael (2003: 3) refer to as “network mapping”. This process identifies the key actants required for focus groups and interviews. Network mapping of the community actant, however, reveals significant problematisations in translation. That is, it exposes who the actants of interest are, their identities and roles, and their need to (still) pass through the OPP of the community actant if they wish to grant enrolment and be translated into the network. Network mapping of the community actant reveals secondary and subsequent actants (see Figure 16). This process preceded further data collection and actant enrolment in this research project.

As revealed in Figure 16, the community actant exposes a large XTP network ‘in the making’, and contains many varied actants, including the conceptual actants. The size of this network is beyond the realistic scope and manageability of this research project, and therefore decisions needed to be made regarding how to narrow this network to a manageable size. This decision was partly guided by the other document actants produced by the XWP (2004; 2003b),
and issues regarding actant access. Namely, as the XWP identified the lack of involvement from XTP’s targeted human actants (namely, the potential patients of XTP), then these actants became relevant for this research in their ‘invisibility’ and ‘silence’. This lack of involvement (or enrolment) also suggested it was unknown if these actants would accept or reject the XWP’s position of intermediary and their problematisations. These actants include people on dialysis and people with Parkinson’s disease, Huntington’s disease, Type-1 diabetes and pre- and post-AT; as well as their supportive networks.\textsuperscript{158}

Furthermore, it is important to consider the ‘vocal’ and ‘visible’ actants, as their stories are integral and influential to the formulation of other actant stories and the network itself. As a result, the XWP, AIS and ‘science’ were also targeted for this research. The XWP and AIS are intimately connected to the community actant which, through networked associations, are both additionally tied to the governmental regulatory decision-making and oversight of XTP in Australia. In addition, science is identified in this research as both human and nonhuman. Scientists form human actor-networks with the assistance of nonhuman document actants. It is these latter document actants, in the form of science books, popular scientific

\textsuperscript{158} Unfortunately, only three AT recipients were involved in this research, and they were also implicated in other research participant networks. This was the result of difficulties in enrolling AT actants without the complex, lengthy, and sometimes financially expensive negotiations of clinical institutions.
Figure 16 - The Community Actant's (2003a) Australian Xenotransplantation Network

Actants mobilised in this research network are highlighted in red.
magazines and peer reviewed journals, which act as immutable mobiles; stretching, linking and forming the Australian XTP network beyond the national boundaries. For sake of clarity, I refer to these scientific immutable mobiles throughout the thesis as ‘official science’. How the various human actants were enrolled in this research will be addressed later in this chapter in ‘Enrolling the Research Participants (Actants)’. Additionally, the overwhelming response of the human actants to this research presented dilemmas on data collection, which were partly circumvented by the use of focus groups. I will address this soon.

Lastly, the NHMRC retained all the community submissions (actants) made to the XWP during the first and second-rounds of public consultation. These consultative document actants were identified as a secondary data source that would complement the other document actants and primary sources of data gathered through focus groups and interviews. While access to many of the second-round consultative document actants was granted, they have not been used in this research. This is because, as outlined in the following sections, the actant network in this research was growing too large and unmanageable and, as such, these secondary sources of data

159 Initially, the NHMRC did not grant access to these documents for privacy concerns. After months of negotiation and ethics approval by the Australian Health Ethic Committee (AHEC), the NHMRC did agree to send informed consent information packages on this research to all human actants who submitted these consultative document actants. These human actants were mostly located in, but not restricted to, Australia. The information package contained the full information on this research project, requested access to second-round submissions, and provided the option to participate in interviews or focus group sessions.
were not needed\textsuperscript{160}. In any case, some of the human actants who enrolled these document actants were included in focus groups or interviews at their request.

**Focus Groups**

Focus groups are informal collective interviews that generate large amounts of data from various people (Morgan 1997: 2, 14, 31, 47), which can improve qualitative sample size by interviewing several people at one time (Marshall and Rossman 1999: 115). Notably, this research uses semi-structured focus groups to facilitate discussion between group participants. This allowed conversations to develop with participant interests, while also permitting guidance of the conversation towards the pertinent areas for this research or return to previous concepts (Morgan 1997: 48, 51, 63). Consequently, it was important to minimise the number of topics to be covered in order to balance the research focus with open group discussion (Neuman 2003: 396; Morgan 1997: 47), hence highlighting the need to modify the conceptual network of the larger XTP network.

In this research, focus groups lasted for approximately two hours, and consisted of three to eight human actants. Homogeneous groups were formed to avoid the ethical dilemma of uncomfortable or

\textsuperscript{160} This is not to say these actants are irrelevant, as they can be used for data analysis at a later stage.
conflict-ridden conversations between potentially opposing groupings (Morgan 1997: 37). The actants selected for the focus groups were therefore based on the similar or shared experiences (Neuman 2003: 396; Berg 2001: 111; Marshall and Rossman 1999: 115; Morgan 1997: 35), namely medical conditions that they shared or had sympathies towards. At the same time, not all research participants were able to attend focus groups based on their health condition; mobility and transportation problems; location of and distance between research participants; personal sensitivities; participant preference for an interview; and personal temporal constraints. As such, flexibility of the research methods was integral. For example, no focus groups were formed for scientists due to their disparate locations and time restrictions. While these considerations significantly narrowed the scope for focus groups in this research, some focus groups were still formed, which included:

- one ‘Parkinson’s disease’ focus group (seven actants)\(^{161}\), and
- one ‘Type-1 diabetes’ focus group (three actants).

Importantly, focus groups have successfully been used in XTP social research by Brown and Michael (2003: 4-5, 16-26). In their studies, they utilised eleven focus groups of patients and non-patients, who

\(^{161}\) It should be noted that five Parkinson’s disease focus groups were conducted in total. The other four Parkinson’s disease focus groups consisted of nineteen actants in total. These focus groups have not been included in this analysis due the overwhelming amount of data. Furthermore, some recording problems were experienced in a very small number of these sessions. The selected focus group, however, is representative of these other focus groups.
met twice over two hour sessions. The first session used textual and visual stimuli to motivate discussion, while the second session involved fictional biographical scenarios. Between the two sessions, informants were given an information package on the current medical and research stakes in XTP (Brown and Michael 2003: 20-23).

In contrast, this research used one session per focus group, though Brown and Michael’s (2003) method still informed the study. Information charts were generated from the community actant and used to facilitate conversation on pertinent topics; namely the conceptual XTP network. A pilot trial encompassing ten general members of the public was used to test these resources prior to conducting the formal focus group sessions. This revealed that some charts did not need to be used, and some stimulated more conversation than others. These charts were also used in the interviews. The final charts used can be found in Appendices 3.0 to 3.4.

**Semi-Structured Interviews**

In this research, semi-structured interviews were used to gather data from all human actant collectivities. As influenced by constructionist approaches and ANT, how the interviewee actively constructed meaning with respect to the conceptual network and the data subsequently generated is of interest (Silverman 2001: 95).
Qualitative interviews are characteristically “a conversation with a purpose” (Kahn and Cannell 1957 in Marshall and Rossman 1999: 108), designed with a series of questioned-based or topical prompts (McCracken 1988: 24). The semi-structured approach adopted by this research allowed the conceptual network to be addressed, while still providing flexibility for the interviewee to explore and elaborate (Bryman 2001: 314). Through this technique, the phenomenon unfolded as it was viewed by the interviewee/s (Marshall and Rossman 1999: 108; McCracken 1988: 22). Finally, as the gestalt of the interview is important, interviews were conducted in an environment in which the interviewee was comfortable, such as their workplace, home or in a public place. In addition, it was difficult to gain one-on-one access to some participants, so telephone interviews were also conducted.

Interviews were carried out with all actant groups (with the exception of official science), which encompassed\(^{162}\):

- One ‘Parkinson’s disease’\(^{163}\) interview;
- Three dual\(^{164}\) ‘Parkinson’s disease’ interviews\(^{165}\);

\(^{162}\) It should be noted that some research participants fitted into multiple categories, particularly members of the XWP and AIS. As outlined previously, all AT recipients fitted into other actant groups. The participation of particular actants in various research methods is outlined in the ‘List of Research Participants’ on page xi to xii.

\(^{163}\) This is not to objectify the research participants according to their health condition or affiliation. Rather, it is simply done to identify which homogeneous collective the actants align with according to their chosen enrolment in this research. Furthermore, this also highlights how humans form networks within networks.
- Three ‘Huntington’s disease’ interviews;
- One dual ‘Huntington’s disease’ interview;
- Five ‘Type-1 diabetes’ interviews;
- Two ‘dialysis’ interviews (one of who is also an AT recipient);
- Four ‘scientist’ interviews;
- One dual ‘scientist’ interview;
- Four ‘XWP’ interviews (including one AT recipient); and
- Two ‘AIS’ interviews (including one AT recipient).

Interviews have previously been used in this context by Brown and Michael (2003), who used a flexible, semi-structured approach designed to target several XTP interests based upon risk negotiation. Interviews in this research are also flexible, informal, and semi-structured, allowing the issues raised by interviewees to be explored and/or clarified. Similarly in this research, no a priori knowledge of XTP was assumed, though human actants were guided through the XTP network and conceptual network through the use of charts (see Appendices 3.0 to 3.4).
Enrolling the Research Participants (Actants)

In total, 40 human actants (generally referred to as ‘research participants’) and numerous document actants are included in this research project. These 40 human actants are a small portion of a much larger data set. That is 128 human actants in total, excluding those in the pilot trial, participated in focus groups or interviews during the period of August 2005 to April 2006. Some of the earlier data are excluded, as the research focus was still being refined. The data presented, however, are representative of the actant collectivities (for example, Parkinson’s disease). Other actant collectivities who were interviewed or participated in focus group sessions, such as antivivisectionists, people with lung conditions, people with general health conditions and carers for people with various health problems and disabilities, were excluded from the final data analysis. This was because they did not explicitly fit into the XTP network, as determined by the community actant (Xenotransplantation Working Party 2003a)\textsuperscript{166}. In addition, transplant coordinators and transplant staff, who are important to the XTP network, are not included. This is not to say that these collectivities and their stories are not important; they are as relevant as and equal to any another story. Indeed, one critique of ANT is that it does not consider those excluded from the network and their stories. It cannot be denied, however, that regulatory and policy decision-making regarding science and technology is often reliant on and undertaken within pre-defined networks. Furthermore, while this research adheres to the network in the community actant (Xenotransplantation Working Party 2003a), this network still remains very unstable and frail, highlighting that the network could fall and fail. Indeed, it could be argued that this is the case, given the NHMRC’s rejection of the XWP recommendations. As a result, those external voices could become extremely important as time passes.

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network, were interviewed\textsuperscript{167}. However, only three of these actants were involved in the research project and therefore not included in the final data analysis. Lastly, it was planned to undertake observational studies of pigs in the laboratory conditions considered mandatory for XTP. These environments are notoriously difficult for those external to the scientific XTP network to access, as I discovered\textsuperscript{168}. Consequently, observational studies were eliminated from the data set. In any case, large amounts of data were gathered and generated through the other research methods, and therefore the quality of the research and the stories gathered is not compromised.

Before moving on, it is worth exploring in more detail the relative marginalisation of the animal actant in this thesis. The aforementioned problems with accessing XTP laboratory facilities certainly aided this situation. However, animals also do not subscribe

\textsuperscript{167} These research participants were recruited through the Transplant Nurses’ Association (TNA).
\textsuperscript{168} I did, however, gain access to the biosecure facilities of the Australian Animal Health Laboratory at CSIRO Geelong (Victoria, Australia). This facility has the highest level of biosecurity in Australia, and is where many highly infectious diseases to animals and humans are studied. As a result, my observations were restricted to the interactions between pigs infected with the Nipah virus and the scientists who were studying them. This virus alters the animal’s behaviour, and is also highly infectious to humans, which serves to alter human behaviours towards and interactions with infected animals. Consequently, pigs infected with the Nipah virus and pigs destined for XTP are different, and observations gathered from one do not accurately reflect on the other.

While I have a long and interesting personal story regarding this experience - such as wearing biosecure clothing (including underwear), entering and exiting airlocks, and ‘showering down’ - it is largely irrelevant for this thesis. Furthermore, CSIRO has no official position on XTP and is currently not performing any XTP research. In addition, this level of biosecurity is higher than that required for XTP. In any case, it is ironically fortunate for the animals that I could not access XTP environs, as any animal that I would have had direct and personal contact with would need to be sacrificed in order to preserve human needs for biosecurity.
to the XTP network for understandable reasons. Firstly, the
objectivity of the animal actant is visible through the human
construction of the XTP network, yet their subjectivity is obscured. In
other words, human actants wish to enrol animals into the XTP as
based on how their roles and identities have been constructed by
humans and human interests, but this ignores how animals may
create and understand their own needs and identities. At the same
time, the subjectivity of animals is evidenced through their rejection
of network enrolment and refusal to yield power. This is shown by the
inability to successfully transplant their organs, tissues and/or cells
into humans, as well as the significant failure rate of GE and cloning.
In other words, the animal body is not subscribing to being carved
into pieces (XTP) or to being created (GE and cloning). It is
additionally doubtful that animals would agree to be created and bred
specifically to be killed, regardless of the designated human purpose.
This also allows XTP to remain a gray box; opened and operating as
'science in the making' over being closed and black boxed as 'ready
made science'. Furthermore, the facts of XTP are still under
development because of the counter position occupied by animals.
These counter identities and roles renders XTP a visible and
unstable network, one which is prone to fracturing. While this non-
subscription and failure to enrol an actant can result in the actant's
marginalisation and network exclusion, the centrality of animals to
XTP means they are cannot and will not. XTP is ultimately impossible
while this translation remains incomplete. Translation therefore
becomes an ongoing process that occurs in the hope of modifying the position of animals and enrolling them into this network. This is demonstrated by attempts to discipline the animal body through SPF environments and GE. Animals might eventually accept this translation and enrol into the network (and perhaps to varying degrees). On the other hand, this may lead animals to further modify their existing counter identities and roles. As such, there is constant resistance and nonconformity on the part of animals, but they still remain in a (forced) relationship with XTP and its network/s.

In sum, the nonalignment of animals to the XTP network exposes their rejection of their roles and identities in attempt to define it for themselves, and to set their own limits on XTP. In addition, it also highlights the XTP network’s persistence to enrol animals, particularly pigs. This is not addressed in further detail because of this obvious and straightforward (though not necessarily uncomplicated) activity.

The human actants were enrolled in a variety of ways, which was dependent on the actant network into which they were initially identified and enrolled by the XWP and community actant. This alignment with particular actant networks determined the forms of research participation that were possible (for example, focus groups and/or interviews), and whether the actants could choose to be personally represented by a pseudonym or not. That is, particular
actant networks were unable to participate in focus groups and were limited to interviews, due to their health condition (Huntington’s disease), disparity of location (scientists and dialysis), and/or work and temporal constraints (scientists, XWP and AIS). All other research collectivities were given a choice between focus groups and/or interviews. Most research participants in focus groups noted that they were happy to participate in either research method, which allowed for further research flexibility.

In regards to the use of pseudonyms, some research participants indicated their desire to be explicitly identified, while the anonymity of particular research participants could not be guaranteed due to their public XTP involvement and/or profile. In regards to this latter category, scientists, the XWP and AIS, were made aware that guarantees of anonymity would be impossible. All other research actant collectivities were given the option of a pseudonym or personal identification, as indicated in the ‘List of Research Participants’ on pages xi to xii.

Based on these actant differences and their differing levels of enrolment in the XTP network, different informed consent information packages were provided. For example, informed consent information packages sent to human actants who submitted second-

169 While ANT does not distinguish between actants, it was important in the research to do so prior to engaging with the actants for ethical reasons, particularly given that some actant networks experience vulnerability due to their health condition/s.
round documents to the XWP required permission to access their
document and the option to participate further in this research. Ethics
approval was received from the Australian Health Ethics Committee
(AHEC) of the NHMRC, and the Queensland University of
Technology’s Human Research Ethics Committee (Level 3 Ethical
Clearance).

How the research participants were recruited depended on their
actant collectivity. To enrol people with Parkinson’s disease, Type-1
diabetes and Huntington’s disease (and their partner/spouse/carer),
support organisations and community groups were directly
approached. As a result, this research project received administrative
support from Parkinson’s Disease Queensland, Diabetes Australia –
Queensland, the Australian Huntington’s Disease Association
(Queensland), and Dynamic Intent. The involvement of these
organisations involved sending a brief synopsis about this research
project to various support groups, and/or in newsletters. This resulted
in presenting the research project to a large number of support
groups throughout south-east Queensland\textsuperscript{170}, and the consequent
enrolment of a large number of research participants. Some
individuals also forwarded the information about the research onto
others that they thought could be interested. In regards to people on

\begin{flushright}
\textsuperscript{170} For the reader familiar with this geographical area, this involved travelling from Bundaberg in the north to Broadbeach/Southport in the south, and Toowoomba/Stanthorpe in the west.
\end{flushright}
dialysis or AT recipients, they were recruited through word-of-mouth and the NHMRC (that is, they made second-round submissions).

As outlined previously in ‘Document Analysis’, the NHMRC also provided administrative assistance for this research. This involved sending informed consent information packages to people who made second-round submissions to the XWP on XTP. This provided access not only to these document actants, but also a diversity of human actants who indicated their wish to be involved in focus groups and/or interviews, including AT recipients, people on dialysis, and very high profile and important Australian scientists. Different informed consent information packages were additionally sent to the XWP and AIS, some of which who agreed to participate. Furthermore, other scientists/clinicians important to XTP were directly recruited following the presentation of my work at the Transplantation Society of Australia and New Zealand (TSANZ) 24th Annual Scientific Meeting, March 2006\textsuperscript{171}.

To rearticulate, this thesis presents problematisations and stories about XTP, as mediated through various human and nonhuman actants, and the conceptual XTP network and OPP of animals and risk. These are articulated in a variety of complementary and conflicting ways. Furthermore, these stories are called many things, such as narratives, the comparative continuum, scale, classification, and

\textsuperscript{171} This was held in Canberra, Australia. TSANZ also provided administrative assistance to this project by advertising it in their online newsletter.
frameworks, constructions and ‘gaze’, but they all tell and negotiate the same thing - XTP and the XTP network - albeit with differing problematisations. Importantly, as the network is precarious and fragile and, as XTP is science in the making, network enrolment beyond official science to the publics is yet to be achieved.

Furthermore, while official science displays strong XTP alliances and representation, ambiguities still exist. As a result, this thesis primarily focuses on problematisations surrounding two important concepts and OPP in XTP; animals and risk. What this reveals is official science’s problematisation seeks interressement and enrolment above and beyond itself. At times this is achieved and, at other times, it is not. Consequently, the problematisation of the OPP of animals and risk can stimulate conflict between and in stories. Through this process, sciences’ use of social arguments and attempts to represent the publics - at times successful and at other times, not - is exposed.

We now begin our journey.
4 - The Biological Gaze: Selecting an Animal

Introduction

XTP is a story; a process through which official science and other actants attribute different levels of agency to humans and animals, and determine the relationship between them. Integral to XTP as a definition, network, and acting as OPP, are three central actants – animals, humans and transplantation. The last of these – transplantation – is a complex network that implicates humans (living and dead), drugs, surgical tools, body parts, telephones, waiting lists, and so on, and which functions external, but is highly important, to XTP. The former actants, animals and humans, are the focus of this and the following chapter, ‘The Sociozoologic Gaze: Using Animals’. Significantly, the role of these actants is heterogeneous and socially composed, as the relationship between humans and animals is problematised on perceived levels of species similarities and differences. This social construction of similarity and difference is vital for the development and progression of XTP. By relying on and problematising existing social arrangements and associations between humans and animals, XTP acts as a metaphor of these relationships. The success of XTP involves both humans and

172 A heavily edited version of this chapter has been published (see Cook 2006). Sections have also been presented at several national and international conferences and seminars.
animals accepting these roles via interressement. Rejection problems inherent to XTP, however, mean network adherence is yet to be fully realised. This is particularly an issue when it comes to animals, who are an important OPP and intermediary in the XTP network.

In turn, like all nonhumans, animals are usually invisible in human-nonhuman networks. That is, in everyday activities and relationships, humans are usually unaware of the important role nonhumans play in creating, recreating and sustaining what is understood as ‘human society’, ‘human life’ and ‘human relationships’. The needed relation between humans and animals in XTP changes the invisible role of animals to visibility, while also rendering them visible in other relations, such as the human consumption of ‘meat’.

This chapter explores the visible role of animals and species selection in XTP, as narrated by official science and other actants, which creates tensions between humans, animals and official science. These tensions result from how official science - a heterogeneous network in and of itself - problematises animals as either suitable or unsuitable for XTP based on complicated stories of animal/human similarity and dissimilarity. To understand this problematisation and the network construction of human/animal relationships, I have designed the comparative continuum to visually demonstrate these difficult and sometimes conflicting stories. These official scientific stories attempt to externalise competing knowledges
and narratives from the network to create the appearance of scientific coherency and authority. Ultimately, what it means to be a particular animal intermediary to XTP is not straightforward, and is subject to tension and subjective interpretations. These stories, however, are influential to the research participants and their trust in official science, though important differences exist between these stories. Problematisation by official science, therefore, is not always successful and does not necessarily lead to the enrolment of others in the official scientific network or the publics.

Each of these stories - official science and the research participants - will be explored in turn. There will also be some consideration given to animal stories. For official science, their stories centralise on stabilising the selection of an animal species as a source animal, and justifying this problematisation as unquestionable. As these stories by official science are highly important for those which emanate from the research participants, I will begin the sociological story at this point.
Animal Choice by Official Science

ALL ANIMALS ARE CREATED EQUAL BUT SOME ANIMALS ARE MORE EQUAL THAN OTHERS (Revised Seventh Commandment of Animalism in Orwell 1945: 114, original emphasis).  

There are two types of XTs; concordant and discordant. Both of these grafts refer to the evolutionary relatedness between the host and recipient as based on DNA structures and organisation. This is known as phylogenetics. Concordant XTs occur between closely-related species, such as Old World primates, Great Apes, and humans.  

Species similarity is verified by a DNA sequence difference of approximately 2% between Great Apes and humans (Cooper and Lanza 2000: 45). On the other hand, discordant XTs occur between dissimilar or distantly-related species, such as pigs and humans (Hoffman 2000: 375; Bach 1998: 302).  

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173 Significantly, this quote regards animals constructing their own identity, rather than humans constructing animal identity for and onto them. It simultaneously highlights the selectivity and greed of human attitudes and approaches to animals.  

174 For example, baboons, mangabeys and macaques.  

175 For example, gorillas, gibbons, chimpanzees and orang-utans.  

176 At this stage, I would like to remind the reader of the relevance of textual changes. As outlined in ‘Constructing and Fracturing Alliances: An Introduction’, this text is polymorphic (or polyfontic), containing various stories and voices. To differentiate between them, different texts are used: official science, research participants, and the sociological. Once again, if this involves direct quotes from official science, the appropriate academic conventions are followed. In the case of research participants, all stories are direct quotes. The only exceptions to this rule are when an author uses italics to emphasis a point, or where Latin is used (for example, in vivo).

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Figure 17 highlights the animal species that have been of focus for official science in XTP. In addition, as indicated by the definitional stabilisation of XTP by the XWP\textsuperscript{177}, XTP is a restricted technoscience that moves only in one direction. That is, while XTP could involve transplants between disparate animal species, in reality only humans can be XT recipients, and only animals can be the XT source and used as experimental models. Hence, the construction of XTP by official science problematises and reinforces the wider asymmetrical social, networked relationships between humans and animals. This binary structure is integral to current understandings of XTP, and acts as an intermediary that positively favours humans and negatively impacts animals.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>BETWEEN</th>
<th>EXAMPLE</th>
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<tbody>
<tr>
<td>Concordant</td>
<td>Closely-related/similar species</td>
<td>Baboon to Human</td>
</tr>
<tr>
<td>Discordant</td>
<td>Distantly related/dissimilar species</td>
<td>Pig to Human</td>
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\textbf{Figure 17 - Concordant and Discordant Xenotransplantation}

\textsuperscript{177} This is “\textit{any procedure that involves transplantation, implantation or infusion into a human recipient of cells, tissues or organs from a nonhuman animal source}” (Xenotransplantation Working Party 2003b: 22, original emphasis). Refer to the glossary and ‘Xeno-what? A Literature Review’ for more information.
Concordance and discordance equates to the levels of difficulty in achieving success when transplanting across species barriers, as influenced by the severity of immunological responses. As phylogenetic discordance between the human recipient and animal source increases, so does the severity of immunological rejection and the difficulty of successful XTP. When the human recipient and animal source share genetic similarities, compatibility is increased and immunological rejection is decreased. Thus, the survival of concordant XTs is easier to achieve than discordant XTs. While the definition of ‘success’ in XTP is variable and contingent depending on who is speaking and where and when, there have been some limited scientific developments (‘successes’) in concordant XTP.

*Reemtsma et al. (1964c) report a human recipient of a chimpanzee renal xenotransplant achieved graft survival for six and a half months, and died from an unknown cause after nine months. More recently, Starzl et al. (1993) report a 70-day survival of a baboon-to-human liver xenotransplant.*

Based on this scientific experimental knowledge, nonhuman primates seem the obvious choice as the XT host for humans. Nonhuman primates, however, are constructed by official science to be an inappropriate XT source. Despite significant barriers to successful XTP, miniature pigs have generally been accepted as the source animal. This decision-making by official science allows tension to arise between when an animal species is desirable as a source animal and why, and when an animal species is not. Therefore,
official science draws on numerous practical and moral-ethical ‘truth claims’ to construct stories as to why pigs, rather than nonhuman primates, are the best choice for XTP. This process can be understood as problematisation, as official science defines what is appropriate and why, and seeks to establish itself as an OPP that must be negotiated to realise XTP. The ultimate aim is to establish a position of expertise in the eyes of other actants; which also enables official science to solidify its position as an OPP. To understand how official science constructs these complex and conflicting stories and problematisations, and how they seek to provide the appearance of stable scientific knowledge amongst heterogeneity, I have designed the comparative continuum.

**The Comparative Continuum**

The comparative continuum is a diagrammatical exploration and explanation of the stories and problematisations by official science about the selection of a particular animal species and their potential use in XTP. This scientific measurement of an animal species relies upon hierarchical boundary distinctions between humans and animals, where species comparisons are based on dynamic and interrelated factors. These are the increasing and decreasing degrees of desirability, undesirability, similarity and dissimilarity of an animal species to humans in XTP, as predetermined by official
Influenced by these numerous and interdependent factors, the comparative continuum can be visualised as a fixed and hinged see-saw. On one end, the see-saw permanently sits in a fixed, horizontal position that denotes the unreachable superiority of humans. The other end of the see-saw is hinged, and rests on the ground in a mutable and inferior position, which signifies animals (see Figure 18). In official science’s stories of finding a suitable animal XTP source for humans, the animal end of the comparative continuum needs to move towards the more superior human end. This movement is achieved by the perceived scientific (or technical) suitability of an animal, and decreases the angle of animal/human difference. In addition, this movement on the comparative continuum provides an intermediary for animal suitability or unsuitability in XTP. Again, this is based on complex combinations of desirability, undesirability, similarity and dissimilarity. The numerous possible combinations of these four factors, as mobilised by official science, mean that species dissimilarities can be constructed as either desirable or undesirable. Therefore, similarity does not necessarily equate to XT desirability. In sum, the comparative continuum functions to demonstrate official science’s stories and problematisations between a particular animal species and humans in relation to XTP utility.
Figure 18 - The Comparative Continuum

Significantly, the comparative continuum can never result in species equality between animals and humans. Rather, the comparative continuum exists only because the inferior bodies of animals - “that which is not human” (Birke et al. 2004: 169) - are compared to the superior human body. XTP can only exist if stories are told and circulated of animals being a resource that can be harvested and exploited for human use. This problematisation of species relationships constructs the value of animal life as significantly different to the value of human life. This needs to be accepted to formalise the heterogeneous XTP network and, in turn, solidify the position of science as an OPP.
This process allows the immutable mobile of official science to tell and present a story that, as demonstrated in the comparative continuum, reduces the angle of difference/s between a particular animal species and humans. Any comparisons made to humans, however, are shallow. As previously stated, human superiority means there will always be an angle of difference between humans and animals, as the value of human life is always beyond animals. This means that despite official science’s stories of reduced degrees of difference between humans and animals, animals will never achieve equality (equilibrium) with humans. The comparative continuum thus operates on an unbalanced equilibrium, where a necessary oppositional relationship exists between animals and humans.

While official science seeks to reduce its disparate stories of animals to provide the appearance of cohesive scientific truth, the comparative continuum reveals that these stories remain highly complex and problematic. For official science, these hierarchical oppositions are considered ‘natural’, thus rendering the story - superficially, at best - fixed, indisputable, unquestionable and unchallengeable. As exposed by the comparative continuum, however, scientific truth is fluid and can (and does) change overtime.

Taken as a whole, the comparative continuum is a visual summary of official science’s key points in selecting a ‘suitable’ animal XT source for humans. It demonstrates how official science builds the story of
an animal being suitable, unsuitable, desirable and undesirable, based on criteria predetermined by official science. This story provides common understandings and definitions (problematisations) for official science, which serve to coordinate and bind the scientific community together as an OPP. While this process aims to create the illusion of a common scientific narrative by reducing plural ‘sciences’ to a singular ‘science’ (the black boxed network), this process paradoxically occurs by retaining complex narratives within the cohesive story. To create the façade of comparative continuum stability and to keep the official science network in tact, official science continuously reproduces, reasserts and circulates these claims internally and externally to the network. By employing the comparative continuum in this chapter, I will demonstrate how the truth claims (or stories) of official science involve increasing problematisation rather than simplicity, which is culturally and historically specific. While these stories can be challenged, many research participants believe in and reinforce the networked authority and expertise of official science, and accept their problematisations. At the same time, tension and conflict emerges with official science’s problematisation, which must also be negotiated.

I will now examine how official science’s stories of the suitability of nonhuman primates and pigs as a human XT source, as evidenced in and on the comparative continuum, are problematised.
The Problematisation of Nonhuman Primates

For official science,

The close, phylogenetic relationship between humans and nonhuman primates could increase the likelihood of cross-species viral transmission (zoonosis), as viral pathogens between the two species are comparable. Many nonhuman primate viruses have been known to infect humans (for example, see Boneva and Folks 2004: 505; Wolfe et al. 2004: 2094; Allan 1998: 89-92; Palmer et al. 1998: 353, 387, 417-418; Allan 1996: 18-19). This pathogeneity renders nonhuman primates an unsuitable XT source.

Furthermore, it means catching wild baboons, which are considered pests in some parts of the world (Daar 1997: 976), is not a viable option (Hammer et al. 1998: 7). Discrepancies in anatomical size also exist between nonhuman primates and humans, with baboons only reaching approximate weights of between 10 to 30 kilograms (Chiche et al. 1993: 1418). This is generally considered too small for adult humans (Appel III et al. 2000: 219; Buhler et al. 1999: 421; French et al. 1998: 684-685). Such anatomical discrepancies mean that baboon or nonhuman primate organs may not function or cope with human physiological demands. For example, Hardy et al. (1964: 120) found that a chimpanzee’s heart cannot manage human circulatory demands.

Initially, the comparative continuum achieves an apparent desirable similarity between humans and nonhuman primates, as the close

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178 In addition, refer to the chapter ‘Xeno-what? A Literature Review’.
phylogenetic relationship determines concordant XTP (nonhuman primate-to-human) is more likely to succeed over discordant XTP (pig-to-human). This similarity, however, is now rendered as undesirable based on zoonosis and physiology, revealing contradiction and tensions within these problematisations (see Figure 19). As a result, official science’s stories begin to demonstrate a complexity in negotiating the comparative continuum. Species similarities can determine nonhuman primates to be both an appropriate (phylogenetic) and inappropriate (physiology and virology) XTP source animal. Therefore, combinations of similarity and dissimilarity are simultaneously used to increase the angles of difference on the comparative continuum and, for official science, eliminate nonhuman primates as the XT source.

These tense deliberations of phylogenetics, anatomical and physiological function are not the only practical (technical) concerns of official science. They also arise from moral-ethical (cultural) considerations, which focus on species characteristics or ontology – as perceived by official science - and their correlation with XTP requirements.
Nonhuman primates reach sexual maturity between three to five years of age, and reach full grown adult size at nine years. The duration of pregnancy is six months long, and typically produces singular births (Cooper and Lanza 2000: 47-48). These offspring require intensive parental care, and in turn, extensive socialisation with other nonhuman primates for behavioural development (Hammer et al. 1998: 7; Weiss 1998a: 931), and exercise (Fishman 1997: S43). Thus, the need to create large colonies of captive nonhuman primates for xenotransplantation is resource and time intensive. The cost of breeding and maintaining nonhuman primates, as based on their long maturation and species needs, is difficult, economically prohibitive and time consuming (Cooper et al. 2002: 136; Cooper and
Lanza 2000: 45-48). At the present time, nonhuman primates are not available in large enough quantities for scientific and medical applications (Boneva and Folks 2004: 505; Tibell and Lundgren 2002: 20; Cooper and Lanza 2000: 45-48), and there “is a lack of experience in genetically modifying them” (Cooper et al. 2002: 136). Such shortages and financial expense could be the reason nonhuman primates are commonly reused in multiple experiments (Carlsson et al. 2004: 234), which is not possible in xenotransplantation.

It is also argued that animals used for XTP would need to be bred and kept in SPF environments. These are barren, biosecure settings are designed to eliminate, prevent, or minimise infection and disease in order to produce germ-free (gnotobiotic) animals. Again, human needs are seen to conflict with the species needs of nonhuman primates.

To guarantee a SPF environment, animals need to be delivered by hysterectomy and/or caesarean section, and reared in isolation with little or no social contact. While it might be possible to breed nonhuman primates in SPF conditions to minimise infectious risk, some pathogens are persistent and latent, making them difficult to eliminate (Boneva and Folks 2004: 505; Weiss 2004: 284). Although SPF nonhuman primate colonies exist, these are small in number with rudimentary husbandry methods (Boneva et al. 2001: 3). Furthermore, the species needs of nonhuman primates would be

179 Some use the term qualified pathogen free (QPF) instead of SPF in order to differentiate these stringent bioexclusion laboratory conditions from the SPF environments often used in commercial piggeries to eliminate limited pathogens (Tucker et al. 2002: 203).
difficult to achieve in SPF conditions. In addition, the public would vocally oppose the use of nonhuman primates (Cooper and Lanza 2000: 49; Buhler et al. 1999: 421).

Breeding and raising nonhuman primates in isolation for XTP is seen by official science to be logistically complex. Most significantly, it is considered unethical and immoral to deny nonhuman primates social contact with their own species and to raise them in the biosecure environments required for XTP. However, we also witness official science placing itself in the role of intermediary and mobilising interessement; attempting to act on behalf of and to speak for the publics, and disassociating the publics from other alliances (for example, those which would contest or resist official science’s problematisations).

These stories of similarity and dissimilarity between the bodies of nonhuman primates and humans – a comparison that is never reversed by official science - are now expanded. Initially, the biology of nonhuman primates was examined by official science through the scientific lenses of phylogenetics, anatomy and physiology. This bodily concern now turns to social understandings and constructions of species being as defined and created by official science. In other words, official science seeks to substantiate and expand its practical and technical stories and problematisations through the sociocultural. The result is that the ontological species needs of nonhuman primates are narrated as unacceptable for XT requirements and
demands. Thus, how species characteristics are understood by official science is applied to rationalise their selection or deselection of an animal species for XTP. Claiming to speak for the publics and asserting that the publics would reject the use of nonhuman primates further substantiates official science’s problematisations of nonhuman primates. Official science takes on a self-appointed authority to represent and to speak for science and the social. Other moral-ethical reasons mobilised by official science include fears of ‘humanisation’ and species annihilation, thereby heightening the problematisations and exclusion of nonhuman primates as a source animal.

Some Great Apes such as chimpanzees, bonobos (pygmy chimpanzees), orang-utans, gorillas and various forms of gibbon, are endangered (Cooper et al. 2002: 136; Cooper and Lanza 2000: 45; Daar 1997: 975). Xenotransplantation would place pressure species survival. Furthermore, gathering male baboons from wild tribes “would destroy the social life of a baboon gang and lead to their extinction within a short time” (Hammer et al. 1998: 7).

XTP would thus place pressure on species survival due to the large numbers of animals required, which would exasperate and compromise the endangered status of nonhuman primates (see Figure 20). This reinforces the moral-ethical unacceptability of the species for XTP. In these problematisations, captive nonhuman primates become intimately connected to their wild counterparts, with
humans taking responsibility and accountability for species preservation. This complements the technical problematisations of official science, eliminating nonhuman primates as an entire species from clinical XTP. These narrations are interesting given any nonhuman primates used in XTP would be specifically bred in SPF environments. Furthermore, the elimination of the entire nonhuman primate species on environmental grounds includes some nonhuman primates, particularly Old World Primates, which are not endangered. This suggests that while environmental concerns might preclude certain nonhuman primates as an XTP source, it remains unethical to use nonhuman primates even if a species is not endangered. Therefore, the individual bodies of nonhuman primates are connected to the preservational ‘good’ of the species. The loss of one nonhuman primate has impacts beyond the individual, as it influences the survival and integrity of the entire species.

*Should our closely related relatives be used as a “tissue and organ farm”* (Weiss 1998a: 931)? Nonhuman primates, particularly chimpanzees, display a physical appearance and intellectual, emotional and social natures, that are analogous to humans (Takeuchi et al. 2005: 324; Magre et al. 2003: 313; French et al. 1998: 685).
Even if the great apes were available in the necessary numbers, because of their physical and behavioural similarity to humans many people oppose their use as sources of organs for transplantation. This would almost certainly jeopardize any xenotransplantation program that was initiated. (Cooper and Lanza 2000: 45)

Additionally, the public reaction to the use of baboons as organ donors has to be considered. Although baboons are a little further removed phylogenetically from humans than are chimpanzees, they still have many human characteristics. A significant and vociferous segment of the public would oppose the planned killing of large numbers of baboons even if their organs would be life-saving to dying humans. (Cooper and Lanza 2000: 49)
These stories from official science highlight that it is not simply species needs and preservation that precludes nonhuman primates on moral-ethical grounds as the XTP source animal. Rather, nonhuman primates are too close to humans phylogenetically, which is also visually demonstrated, to be used as source animals. This closeness includes emotional capacities, and an awareness and development of complex relationships. Nonhuman primates “are the most prominent inhabitants of the borderland between humans and beast in Western imagination. They are the animals perceived to be the closest to humans” (Corbey 2001: 163). Such similarities problematise the human/nonhuman primate boundary (Corbey 2001: 172), and allow some moral concerns usually afforded only to humans to be extended to nonhuman primates. Nonhuman primates are rendered like humans or as pseudo-humans - not quite human, but close\(^{180}\). The sentimental ties that connect humans to nonhuman primates are maintained and preserved by official science’s problematisations. Furthermore, these heighten the construction of nonhuman primates as a species rather than individual bodies, where the sacrifice of one body has consequences on other bodies, as based on intimate social ties. Hence, phylogenetic concordance to humans allows the status and value of nonhuman primates to be elevated above other animals, further reinforcing their undesirable similarity. Again, official science also appears to speak for the publics and, in particular, these who would oppose the use of nonhuman

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\(^{180}\) In the words of Haraway (1992: 2), “monkeys and apes have been subjected to sustained, culturally specific interrogations of what it means to be ‘almost human’".
primates. These invisible actants thereby perpetuate and reinforce the visible role of official science.

The “humanization of primates” (Fung et al. 1997: 957) in xenotransplantation is inappropriate and subjects them to too much suffering.

Paradoxically, the story of ‘humanising’ nonhuman primates plays on similarity and difference to humans. A close phylogenetic relationship and shared ontological characteristics with humans means nonhuman primates are an unsuitable source animal in their pseudo-human status. At the same time, the fear of ‘humanising primates’ preserves important differentiations between the two species by retaining a clear physical separation between ‘us’ and ‘them’. Similarities between humans and nonhuman primates are therefore mobilised to reinforce species differences, preserving the existing security and safety of species boundaries.

Despite these considerations,

The pig-to-nonhuman primate model is generally accepted as a preclinical experimental assessment for human clinical trials (Schuurman et al. 2003: 293; Xenotransplantation Working Party 2003b: 29-30, 47, 90; 2002: xlii, 11, 71, 87; Lambrigts et al. 1998: 547). Therefore, these large animal models are considered to be “more relevant to clinical xenotransplantation” (Zhang et al. 2000: 2051) than smaller animal models. Nonhuman primates
are required “to test the procedures in animals that are as closely related to humans as possible. This stage is needed in order to assess whether the procedure is likely to work in humans before an application for a clinical trial is made” (Xenotransplantation Working Party 2003b: 47).

Therefore, despite technical and cultural problematisations for not using nonhuman primates as the XTP source animal and distancing their bodies from that of humans, official science differentiates clinical applications from experimental procedures. In this process, tensions arise over the boundaries of what constitutes the humanisation of nonhuman primates given their stand-in, pseudo-human status. The discomfort of humanising nonhuman primates thereby operates with reference to specific contexts.

In these problematisations by official science, phylogenetic similarity becomes desirable to ensure human safety (that is, as a concordant XT host), though on virological (phylogenetic) and moral-ethical grounds, this similarity renders nonhuman primates as an undesirable source animal. In turn, while nonhuman primate ‘parts’ are believed insufficient to operate in the human body, whole nonhuman primate bodies are considered sufficient enough to act as pseudo-humans. Yet, on moral-ethical grounds, this use of nonhuman primates as pseudo-humans reduces, downplays and compromises their sentience and intelligence. Simultaneously, official science only labels using nonhuman primates as a source animal in XTP as a ‘humanisation’ process, and differentiates this from
nonhuman primates as an experimental pseudo-human. While the end-point is the same for nonhuman primates - it is sacrificed for human XTP purposes - official science differentiates between the processes. The separation of ‘they can stand in for us but they cannot be inside of us’, preserves an extremely complex and tense similarity/dissimilarity and desirable/undesirable duality.

In summary, the problematisation of nonhuman primates by official science on the comparative continuum is as follows (see Figure 20):

- Phylogenetics - nonhuman primates are desirable and undesirable in their similarity to humans
- Physiology - nonhuman primates are undesirable in their similarity and dissimilarity to humans
- Moral-ethical considerations make nonhuman primates an unacceptable XTP source for humans

These numerous narratives of desirability/undesirability render nonhuman primates as both too dissimilar and similar to humans for XTP. The stories about pigs, however, determine that pigs are more suitable as a XTP source animal. Again, this is based on official science’s complicated problematisations of desirability/undesirability and similarity/dissimilarity, which come together in intricate and rigid ways to designate species identities. Therefore, in the case of selecting an animal species for XTP, interessement involves
distancing nonhuman primates from clinical applications of XTP, while inscribing pigs. In other words, pigs are problematised to be the solution while nonhuman primates are not. I will now explore how official science mobilises its stories and problematisations of pigs.

The Problematisation of Pigs

So far, official science has problematised nonhuman primates as technically and culturally inappropriate as a XTP source animal. With the same considerations, official science problematises pigs very differently:

Practically and medically, the anatomy and physiology of the internal organs of pigs are moderately similar to humans. Differences between particular breeds of pigs and humans, however, eliminate particular porcine breeds. Domestic pigs are inappropriate, as they reach weights up to 450 kilograms (Appel III et al. 2000: 219; Sachs 1994: 186). On the other hand, miniature swine are ideal, reaching maximum weights of between 100 to 135 kilograms, a size viewed to be consistent with adult humans (Appel III et al. 2000: 220; Buhler et al. 1999: 421; Sachs 1994: 186). At approximately thirty years, the life expectancy of these adult porcine organs is comparable to humans (Magre et al. 2003: 313). The results are organs similar to those of adult humans in both size and function. Furthermore, piglets could be used for neonates and children (Perico et al. 2002: 46; Cooper et al. 1991: 482).
If the immunological problems could be overcome, the ideal animal organ donor for man would be an animal that is readily available throughout the world in large numbers and grows to an adequate size. This would immediately exclude nonhuman primates […]. (Cooper et al. 1991: 481)

These initial stories of the pig as a XTP source animal thereby revolve around perceived desirable physiological similarities to humans, which aligns pigs and humans favourably on a comparative continuum. This alleviates the undesirability of species dissimilarity, as determined by species phylogenetic discordance, which has a negative comparative impact. Simultaneously, physiological and anatomical similarities do not necessarily mean a porcine organ will function effectively or efficiently in a human environment. Tensions thereby arise in official science’s justifications of using pigs, as expected and unexpected functional deficiencies (dissimilarities) of porcine organs may have problematic and harmful effects to the human recipient, which would render these XTs undesirable (see Figure 21). In this process, official science additionally differentiates between pigs, where only particular breeds are suitable on practical (technical) arguments. This contrasts to their approach to nonhuman primates, where no differences are drawn between breeds and species-types on neither technical nor cultural grounds. Furthermore, an animal’s availability and accessibility to humans becomes a determining factor of species desirability and suitability, which has nothing to do with the animal’s body.
It is unknown whether pig organs can cope with different physiological requirements, such as an adequacy to pump blood vertically to the brain (Weiss 1998: 932). Other problems could manifest in the pulmonary circulation between the heart and lungs, which is important for the body’s respiration and blood oxygenation (Morris 1997: 257; Sherwood 1993: 259). Complex biochemical and metabolic functions that create physiological signals between human functions are also important. For example, the human kidneys produce ninety percent of the body’s erythropoietin (Guyton 1992: 250), which is required for the production and maturation of the red blood cells (Weiss 1998a: 932). Porcine erythropoietin is not recognised by the human receptor and as a consequence, it will not be recognised by other human functions (Magre et al. 2003: 313; Seow and

Thus, while pigs and humans share physiological commonalities, there remain official science stories that tell of physiological incompatibilities. This poses problems for the cohesive official science story of selecting pigs as the source animal in XTP over nonhuman primates, which serves to compromise the problematisation of pigs. To be specific, physiological similarity and desirability between pigs and humans becomes disrupted by dissimilarities and undesirability, both of which are inconvenient for reducing the angle of difference on the comparative continuum. These potential problems, however, do not eliminate pigs as the source animal of choice - desirable similarities are narrated as dominating undesirable dissimilarities. Additionally, to confront such
undesirabilities, official science proposes to further mobilise its expertise to intervene with the bodies of pigs through scientific techniques, such as GE and cloning, thereby not compromising their problematisations. In contrast, while the close phylogenetic relationship and anatomical similarities between nonhuman primates and humans increases XT success, this desirable similarity is overridden by undesirable dissimilarity, as outlined earlier.

These problematisations by official science reveal the comparative continuum to be increasingly complex. Namely, to provide the appearance of a cohesive official science story on the problematisations of pigs and to continue to reduce the angles of difference on the comparative continuum, the considerations of desirable similarity have altered to considerations of desirable dissimilarity. This demonstrates the complex mobilisation of similarity, dissimilarity, desirability and undesirability which can, according to the problematisations translated by official science, increase or decrease the suitability of using a particular species and breed for XTP. Consequently, seemingly contradictory combinations of physiological similarity, dissimilarity, and phylogenetic disparity, can all occur simultaneously and yet not compromise the animal (pig) of choice.

\[181\] This is particularly the case between humans and chimpanzees.
At the same time, such stories are yet to fully resolve the choice of pigs as the XTP source animal. As nonhuman primates were eliminated on zoonotic grounds, this also becomes important when analysing pigs. Problematisation is increasingly complex.

_A history of domesticity and extensive knowledge of pigs is believed to reduce infectious risk_ (Weiss 2004: 284), _as human proximity to pigs has not resulted in any major infections_ (Daar 1997: 976).

_In view of the close association of humans and pigs, and attempts at transplantation and accidental contamination of humans, especially butchers, with pig blood, if there was a severe danger, one would have expected it to have made its appearance, but this is not the case._ (Calne 2005: 6)

Existing close relationships between humans and pigs are therefore taken as proof that pigs pose less of a zoonotic risk to humans in XTP than nonhuman primates. Phylogenetic distance therefore becomes a _desirable dissimilarity_, as it provides protection against possible pathogenic transfer (see Figure 22). Thus, pig/human difference is favourable for virology, but conflicts with the desire of phylogenetic concordance for immunology. As a result, the sciences conflict with each other over the selection of pigs. At the same time, however, the comparative continuum continues to favour pigs as a human XT source. Such complex problematisations also allow official science to distance itself from competing stories and the publics by asserting a selective, specialised expertise.
As outlined previously, the biological (technical) debates made by official science regarding the elimination of nonhuman primates as a source animal were not enough. Rather, official science also mobilised social moral-ethical concerns. The same tactic of switching between the biological (technical) and the social (cultural) is also employed when arguing the selection of pigs as the source animal of choice. In contrast to nonhuman primates, the species characteristics and needs of pigs are believed to make them a suitable XT host, and can be adequately catered for in SPF environments.
Pigs produce large litters of between three to sixteen piglets after a short pregnancy of approximately four months. After reaching sexual maturity at between four to nine months, pigs have a regular mating cycle of three weeks (Cooper et al. 2002: 137; Cooper and Lanza 2000: 47, 50; Dorling et al. 1997: 868; Sachs 1994: 187). As pigs are already used and studied extensively in scientific and medical experimentation, large numbers are currently available for use. Furthermore, their short gestation and large litter production would allow herds with desirable characteristics to be created relatively quickly. This could include pigs that are selectively bred through techniques such as inbreeding (Cooper et al. 2002: 136; Cooper and Lanza 2000: 53; Sachs 1994: 187-188), genetic engineering, and/or cloning, which would reduce XT rejection in the recipient (Boneva and Folks 2004: 506; Cooper and Lanza 2000: 51; Buhler et al. 1999: 421-422).

Significantly, “there is considerable experience with techniques of transgenesis in pigs” (Cooper et al. 2002: 136). Pigs have minimal space requirements, are easily fed, and can be separated from their mother immediately after birth and reared in SPF facilities (Cooper and Lanza 2000: 49-50; Weiss 1998a: 931; Cooper et al. 1991: 481). The widespread use and knowledge of pigs indicates husbandry methods are well developed and in active use, including the monitoring of SPF colonies and gnotobiotic pigs (Boneva et al. 2001: 4; Cooper et al. 1991: 482). The existing social uses of pigs also reduces social controversies and ethical concerns (Cooper and Lanza 2000: 49-50).

The official scientific story of pigs is one involving ease of maintenance, raising and breeding in large numbers. This is reinforced with pigs being labelled as logistically and economically
feasible. Moreover, pigs can be 'created'. Therefore, the ontology of pigs designates them as an acceptable source animal for XTP (see Figure 23). In contrast, the species characteristics of nonhuman primates eliminate them as a suitable human XT source, though they were considered appropriate until recently\textsuperscript{182}. With these considerations, the selection of pigs can be partially viewed in light of economic rationalism: the fast reproduction of pigs and existing husbandry practices allows larger numbers of suitable organs, tissues or cells for humans in need to be produced. Hence, the product can be produced relatively quickly, easily and cheaply. As pigs are constructed as easily raised and maintained in SPF conditions, the product can also be standardised. This creates pig parts that are more pure and superior to 'average' pig parts, thereby serving to differentiate between pigs. Furthermore, the short gestation and regular mating cycle of pigs means pigs (the machinery), can maintain an efficient turn over of product in a controlled environment (the laboratory). The entitlement of the (human) consumer to acquire an (animal) product quickly and on demand is met. In such problematisations, pigs are scientifically constructed, manufactured and consumed. Therefore, the ease of handling and producing the XTP (animal) product becomes a determining factor in species suitability and desirability, rather than the pig’s needs or potential for XTP success. A similar argument was

\textsuperscript{182} For example, see Starzl et al. (1993), Bailey et al. (1985), Barnard et al. (1977), Hardy et al. (1964), Hitchcock et al. (1964), Reemtsma et al. (1964c), Starzl et al. (1964) and Voronoff (1925).
mobilised in relation to nonhuman primates, though with very differing outcomes.

Figure 23 - The Comparative Continuum (Pigs, Part 3)

Hence, the official science story of pig ontology narrates pigs as dispensable, and quickly and easily replaceable as a ‘renewable’ source. Furthermore, unlike nonhuman primates, pigs are problematised as not having a worldly awareness of self or other, meaning tight social networks and bonds do not form in the species. Official science thereby designates that there are no differences between pigs – one pig can be replaced by another without
compromising the ontology of pigs or their species networks. The sacrifice of one pig means little. As a result, pigs are not viewed as a species with complex relationships and interdependency, and are symbolised as inanimate; ‘a pig is a pig is a pig’. Again, this contrasts to the problematisations of nonhuman primates, who are narrated to have complex species needs and interrelationships that would be compromised in and by clinical – but not experimental – XTP.

By lacking qualities reminiscent of humans, pigs also become impersonal objects of science. That is, while nonhuman primates were identified to be ‘like’ humans, no such connections are made between humans and pigs. Therefore, pigs are noted to display marked differences to humans in appearance and behaviour. The consequence is a perception that pigs share fewer cognitive and emotional capacities with humans when compared to nonhuman primates. The intrinsic value of pigs is resultantly diminished, implying that they do not suffer, or their suffering is diminished. The story of humans and pigs rendered as one of dissimilarity. Yet, at the same time, pigs are similar enough to humans to be the XTP source animal.

“[…] pigs […] are not sentient animals” (Fung et al. 1997: 956).

These species differences mean that any possibilities of humans identifying with pigs are rendered impossible by official science.
Therefore, it is ethically acceptable to deny pigs contexts in which they can explore their ‘natural’ behaviours, and to breed and raise them in SPF environments. This strongly contrasts to official science’s problematisation of nonhuman primates, who should not be treated to such unethical treatment. In the comparative continuum between humans and pigs, therefore, pigs as a human XT source are narrated as ethically unproblematic, though are still subject to the same processes that are ethically problematic for nonhuman primates. This further ignores the pig’s counter identities and roles that marginalise them from the XTP network. I will return to this soon.

The distant phylogenetic relationship, a perceived difference of species being and a (scientific) comfort with “‘humanized’ pigs” (Cooper and Lanza 2000: 44), both breaks down and maintains the human/pig divide by both exploiting pigs and intimately combining pig/human bodies. This means that because pigs are dissimilar (‘them’), they are culturally acceptable to use in XTP. This again involves science acting as an intermediary for the publics. At the same time, this use breaks down the ‘us’ and ‘them’ divide by combining human/pig, though it maintains pigs as ‘them’ through exploitative human XTP use. Standards and problematisations are therefore fluid and flexible; recognised and applied differently between nonhuman primates and pigs. Official science controls how these animals are constructed, understood and viewed to suit human XTP purposes, and imposes these viewed through the XTP network.
This ‘humanisation’ further brings an increased status to the pig; one that does not compromise its use in XTP, but ironically intensifies and justifies its use. Thus, pigs are low in the order of nature, but high in the order of science:

No longer the lowly farmyard hog wallowing in mud and eating slop discarded from the human table, and considered by some groups to be too unclean to be eaten, the pig has become the center of a growing scientific and biotechnological endeavour. Its status has been elevated to that of a research source of the highest order. And plans are afoot to raise its status even higher by further sophisticated inbreeding, by genetic engineering and cloning to ‘humanize’ it, and by ultimately rendering it disease free. [...] And if xenotransplantation proves ultimately successful, the expression ‘pearls before swine’ may come to be used not as a way of characterizing wastefulness but as an expression of thanksgiving. (Cooper and Lanza 2000: 54)

The final comparative continuum and problematisation on pigs by official science (refer to Figure 23) can be summarised as follows:

- Phylogenetics - pigs are **desirable** and **undesirable** in their dissimilarity to humans
- Physiology - pigs are **desirable** in their similarity and **undesirable** in their dissimilarity to humans
- Moral-ethical considerations render pigs an **acceptable** XTP source for humans

The final comparative continuum, involving complex and at times, contradictory problematisations of nonhuman primates and pigs, as according to official science, looks like this (see Figure 24):
Importantly, when considering the ethics of animal use (acceptability and unacceptability), official science frames this from a perspective of humans and human desires for XTP. Animal welfare in SPF environments and XTP appears only to be important in relation to the production of XTP products for humans, or the instrumental value of the animal XT source. Inevitably, the values and biases of official science are used when assessing what is thought to be important for animal welfare, which differ depending on the animal species under examination. The animal body itself and its own problematisation of its own species being are somewhat irrelevant. To be precise, if the
animal product needs to be kept and bred in certain conditions that will meet the needs of the human, then this procedure ensures wellbeing. In the case of XTP and the use of pigs, the human useability and quality of the end-point animal product is used to measure animal wellbeing. Included in such criteria is ease of handling, rearing, breeding, and existing human exploitations. For nonhuman primates, their pseudo-human status of human stand-in but not as human XT source, complicates the wellbeing narrative, and highlights the complications and conflicts within official science’s problematisations. In other words, nonhuman primates can (experimental) and cannot (clinical) be used, while pigs can be used regardless (experimental and clinical).

**Animals by Animals?**

Official science’s problematisations ignore that, for the animals involved in XTP in the experimental (nonhuman primates and pigs) and clinical (pigs) phases, the outcomes from their use matters; it matters to them. Both involve their sacrifice - death - for no personal or species benefit. For example, the cross-species transplants performed by Imutran (a subsidiary of Novatis, a large multinational pharmaceutical company) in the late 1990s alone, involved the sacrifice of over 420 monkeys and nearly 60 baboons (Mani et al. 2003: 59). In addition, “an estimated 10 000 pigs and nearly five
hundred primates have been [used] in the UK” (Ho and Cummins n.d.: para.4).

Objectifying animals as an end-source for subjective, human medical needs raises many ethical issues, since multiple animal lives are sacrificed for the survival of one human life (Clark 1999: 142; Lehrman 1995b: 8). Once again, this occurs in both the experimental and clinical phases. In turn, a XT may involve several animals in one or multiple treatment phrases. For example, in porcine foetal islet transplantation, three to eight pigs would be required for one XT (Cooper and Lanza 2000: 245), a process which may need to be repeated a number of times. In this objectification, and as demonstrated by the comparative continuum, animals are simultaneously considered to be different and similar enough to humans to be used for human means and ends.

Furthermore, while certain physiological and behavioural signs can measure animal welfare scientifically, how these are understood as animal welfare is a value-based judgement (Fraser 1993: 38). This means animal wellbeing, including what is acceptable and what is not, is variable and contingent. This has significant outcomes for animals - particularly for pigs in the case of XTP - as this approach clearly delineates between the value of humans and animals. In turn, from the animal’s point of view, it marginalises, demeans and
devalues their species needs and desires; their own problematisations of themselves.

By attributing a low level of value to animal life, humans cast their own value at a level which animals cannot achieve. This feeds into the comparative continuum, where the possibility of species equality cannot be achieved. For example, a concern with animal welfare would consider the environment that pigs will be and are kept in, and how this complements or deviates from what their behaviours would be in a ‘natural’ environment. This might be limited or impossible in a SPF environment. Human rights, needs and wants are consequently privileged over the animal’s right and need to a “good animal life”, including the animal’s normal behaviours and physiological needs (British Union Anti-Vivisection (BUAV) Organisation 2000; Olsson 2000: 1172-1173). This denial occurs by not only subjecting animals to intrusive and often deadly experimentations, but also denying them natural environments in the scientific demand for SPF animals (Gold and Adams 2002: 41). Such environs are, for humans, economically expensive and labour intensive. For pigs, SPF laboratories pose much large problems.

By designating pigs as tools, the scientific model ignores how animals are complex, communicative, self-aware, intelligent, and emotional subjects that experience life and feel pain, and intentionally seek avoid situations of sufferance (Mani et al. 2003: 56-
In the case of pigs, they are inquisitive and exploratory, and require environments that enrich and stimulate their species-specific behaviours. These contexts should allow them to “acquire experience which enables it to collect information and analyse it, to build up cognitive picture of the world in which it lives and to act on this knowledge” (Poole 1992 in Van de Weerd and Day 2008: 2-3). For example, pigs spend much of their time rooting, grazing, foraging, chewing, browsing and sniffing, which facilitates their search for food, to find a suitable spot to rest, and to explore and become familiar with their surroundings (Studnitz et al. 2007: 184-185; Olsson 2000: 1173). This sense of environmental curiosity may also motivate the pig to seek new surroundings or novelty, or to examine something unusual. This new stimuli is preferable to pigs over familiar objects, which also helps to overcome boredom (Studnitz et al. 2007: 186-187). Furthermore, Jensen and Pedersen (2007) highlight that pigs prefer compound and complex rooting materials of high quality, such as maize silage with straw, spruce chips and compost, that extend and stimulate their curiosity and cater for many of their interests, “by being ingestible, destructible, deformable, chewable, odorous and to some extent rootable” (Jensen and Pedersen 2007: 42) (Van de Weerd and Day 2008: 17; Studnitz et al. 2007: 191, 193). In addition, pigs are highly sociable animals, where contact with other pigs in small stable groups, most often familial, is important for their welfare (Bollen and Ritskes-Hoitinga 2004: 281; Langley and D'Silva 1998: 57).
Relocation, regrouping and mixing with unfamiliar animals can create stress and anxiety for pigs, resulting in negative outcomes in behaviour, physiology, health and performance, which can be further exasperated by confined environments (Coutellier et al. 2007). Significantly, this contrasts with official science’s problematisation of pigs, whereby they are designated as lacking worldly awareness, complex relationships, and sentience.

Boredom is a problem in barren settings such as that required for XTP. SPF environments are confined, contained areas that have specific cleaning procedures and cleaning agents; backup ventilation fans; filtrated water supplies; continuous human observation; backup electrical supplies; and consistent humidity, air temperature, and air pressure (Tucker et al. 2002: 193). These laboratory settings need to also be enriched to cater for the behavioural, psychological, and social activities of pigs, including freedom of contextual choice and various and changing exploratory activities and materials (Tucker et al. 2002: 195). This is particularly important in barren environments, as pigs living in such conditions “have elevated levels of exploratory motivation in comparison to pigs reared in enriched environments” (Van de Weerd and Day 2008: 11). However, this is difficult for XTP, as the desire is not for healthy pigs for the pig’s sake, but for pig ‘parts’ that are safe, clean and healthy for humans. Consequently, the absences of provisions for pig welfare mean that SPF contexts have the potential to produce psychological distress (such as chronic
stress and depression), and harmful, abnormal behaviours, including head thrusting, inactivity and unresponsiveness, and various forging behaviours and exploratory behaviours being redirected to pen fittings and other pigs, such as ‘nosing’, stereotypies (repeated sequences of movements with no apparent purpose), and bar, ear, leg and tail-biting (Van de Weerd and Day 2008: 3-5, 8, 13-14, 17; Studnitz et al. 2007: 188; Bollen and Ritskes-Hoitinga 2004: 281; Langley and D’Silva 1998: 57). Additionally, stress is not only bad for the pig’s welfare but also for the quality of the XTP, as stress-related diseases in pigs “affect the cardiovascular system” (Olsson 2000: 1173).

XTP SPF facilities have attempted to circumvent these animal welfare concerns “by providing pigs with separated sleeping areas, feeding areas and loitering areas […, and] sterile objects, such as sterile water bags […] as enrichment” (Bollen and Ritskes-Hoitinga 2004: 286). Clearly, however, this contradict pig’s welfare by separating them; offering limited possibilities for rooting behaviours; denying novel situations and new stimuli; the inability to have access to complex and compound rooting materials; and maintaining a barren environment of limited space with no possibility or ability to explore new surroundings. Thus, they are designed to meet the needs of scientists and patients, not that of the pig. The problematisation of pigs by official science, and the roles and identities assumed by pigs, thereby clash. At the same time, “the patient has the right to know
that the transplant is of the best possible quality, which can only be achieved if it has come from a healthy, nonstressed animal” (Olsson 2000: 1173).

The sacrifice required from pigs is great. As outlined previously, pigs clearly do not subscribe to this network – their organs, tissues and cells are rejected and the failure rate of GE and cloning are high - yet the force of the XTP network continually attempts to enrol them through continued modifications and changes to the pig’s subscribed identity and role. It is these types of debates and understandings of pigs that are being subverted, ignored and silenced in the XTP network and the comparative continuum; much to the benefit of human actants within the network.

Animal Choice by the Research Participants

From these many problematisations, it can be seen that in regards to the practicality and rationality of selecting a source animal for XTP, official science assumes an authoritative position as an OPP, and instigator of enrolment to the XTP network. This authoritative positioning occurs despite the relationships and experiences that people socially experience with animals, and how animals construct themselves. Selecting an animal is based on scientific comparisons of similarities and dissimilarities, desirability and undesirability, which cannot be made by the publics (or the research participant or animal
actant in general). Official science is the holder of technical expertise, the bearer of privileged knowledge, and should be trusted and unquestioned to make this decision. Through their complex and tense problematisations of nonhuman primates and pigs, they reinforce their expertise by distancing this knowledge from the publics. At the same time, official science speaks for the publics by crossing into the social domain to advance their problematisations on moral-ethical (cultural) grounds; acting as an intermediary to public views. As a result, the decision by official science should be viewed as truthful, well informed and just, as it takes into account technical and cultural parameters. Indeed, much trust is placed in science by the research participants to make the right choice of animal source. The research participants thereby accept the problematisations of pigs by official science, sometimes without question, and enrol into the XTP network:

I believe wholeheartedly in this because I honestly don’t believe that any of this would be done unless there is so much research that is done that is viable and sort of getting back to the ethical side of this as well. (Kevin Robins)

DM*: So, hang on a minute, so nonhuman primate, OK, so we’re talking about pigs then. They’re not monkeys, they don’t want monkeys.
I: They’re not monkeys.
DM*: No, that’s fair enough. (Doug Mason*)

I think you leave that to the practitioners who know this, what animals would be best, would be suitable. (Fay Eisenhauer)

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It is again worth emphasising that all stories from the research participants are direct quotes.
I'd leave that [animal choice] to the scientists because I don’t have that knowledge. (Fay Eisenhauer)

They just know more about the pigs, but genetically it’s more suitable. (Adrian Evans)

Now I suppose you chose the one that is, has the cells most like human, that’s why they use a pig isn’t it? Because they’re the closest. (Darla Kent*)

Pigs are more like humans than cows though, so I would imagine they would use pigs. (Jeremy Batt*)

Apparently the pig is and their organs are so close, more compatible towards the human form. [...] but also if those neural cells are looking at being transplanted, the brain cells, we’re basically saying because the organs are so compatible to humans, how far off the mark is the brain? The pig brain to a human brain? You know we, we can look at transplanting full organs from, from the likes of a pig because they’re fairly compatible, so what’s the difference between their brain to our brain? (Kevin Robins)

Trust and faith are social realities that are built on emotive and cognitive factors (Lewis and Weigert 1985: 972-973). It is also a relation between people and institutions that creates solidarity. In this case, the research participants place trust in a body of scientific problematisations and knowledges, as well as the scientists and practitioners that represent this knowledge. Furthermore, as the research participants believe that they lack the expertise and knowledge (rationality) to make a decision on a suitable XTP source animal, they invest high levels of emotional trust and faith in those that they profess and perceive to have the required knowledge and expertise; above and beyond which they hold as the publics. Thus,
the investment of faith equates to the perceived superior cognitive capacities of science/scientists and, as a result, an acceptance of their problematisations of source animal selection. Official science expects and relies on this emotional trust, faith and hope, to facilitate and uphold their networked social position of authority. Therefore, emotional trust reinforces the expertise of science and affirms their position as an OPP. The decision on animal XTP source can only be made by those who have or are perceived, claim or assert to have, specialist knowledge and insight, as backed by a network that enrolls both official science and its varying supporters.\(^{184}\) Therefore, official science is an OPP to animal source selection in XTP and for XTP itself.

Official science is at pains to justify and problematise the choice of pigs over nonhuman primates as the XTP animal source. As previously outlined, in cultural problematisations, as substantiated by technical narratives, nonhuman primates are morally and ethically unacceptable. Part of this story is the perspective that the public will not accept nonhuman primates as the XT source based on species commonalities to humans, such as similar cognitive and emotional capacities and a shared history. Again, this contrasts to the problematisations of pigs. In this light, official science constructs a position of authority whereby they speak for the scientific XTP

\(^{184}\) These supporters include many of the research participants, but also consist of those bodies funding XTP research and the tools scientists use. The complications associated with trust will be explored in further in the chapter ‘Risk and Trust: Science, Infection and Health’.
network and for society. By mixing science and the social together, official science (almost) seemingly traverses the two, creating a large network of enrolled actants. While the research participants have indicated trust and faith in science, the assumptions made by official science regarding social reactions to selecting nonhuman primates as the XT source are incorrect; they presume too much about the publics. Therefore, there is a conflict between what official science asserts the publics will believe, and what the publics actually believe. As a result, the publics have their own problematisations on animal desirability and undesirability, thereby constructing their own version of the comparative continuum that conflict with the roles and identites prescribed onto nonhuman primates by official science:

**DT:** Oh, I’m with everybody else. I’ve got no objection to using any animal. It’s best to leave that up to the people who know best. (Derek Taylor)

It’s just that it happens to be the pig. If there was another animal, I don’t think the conversation would be any different. (Scott Trapp*)

**I:** Is there some kinds of animals that you’d be fine with and others you wouldn’t be happy with or don’t mind?

**PK**: I don’t mind.

**BK**: I don’t mind.

**PK**: Nah. I don’t mind. If it’s going to help you, then. (Pippa and Bob Kearns*)

I would think, nah, any other animal [besides a pig], it wouldn’t worry me. It would be fine. (Bill Kent*)

I’ve played with cars all my life and I’m a mechanic, maintenance fitter by trade, so you can take one part out of that machine and put it in that machine, if that one’s more... as long as they work, who cares where they come from? (Jeremy Batt*)
Thus, the research participants are open to animal choice without restrictions - at least at this stage - on any species. This comfort with all animals as a XTP source is possibly a reflection of the faith and trust the research participants invest in official science’s expertise in choosing a source animal. Furthermore, it could be faith and trust in a perceived thoroughness of scientific research, and a desire to benefit from its potential outcomes. On the other hand, while official science may restrict animal species on practical grounds (that is, based on phylogenetics and physiology), any restriction on moral-ethical concerns, such as physical similarities between the species, is unfounded. To understand such social perceptions, therefore, official science needs to engage with the publics and not speak for them. This is particularly illustrated in the following stories by Ian Douglas.

Ian Douglas is an animal carer for injured wildlife such as fruit bats and birds. He is also in the early stages of Huntington’s disease. Therefore, Douglas brings his own social experiences into his negotiations of XTP; experiences with the health conditions of humans and animals, as well as human/animal relationships. Specifically, in his experiences with animals, Douglas has identified several beneficial qualities that animals possess, but humans lack, such as fast healing times for broken bones and regenerative limb growth. As a result, he would like to see official science examine these species characteristics with the aim of using them for human
benefit. Through such considerations, Douglas alters the
comparative continuum of official science, and reveals a contrasting
social position. That is, while humans are above and cannot be
compared to animals on the comparative continuum, for Douglas
humans as a species could be improved by incorporating beneficial
qualities of animals into human bodies. As humans lack these
qualities, animals are thereby seen as ‘better than humans’ on
specific criteria. Therefore, the comparative continuum for Douglas is
not as simple as that constructed by official science. Rather, Douglas
views the comparative continuum as more dynamic, involving a third
dimension where animals can possess qualities superior to those
possessed by humans. Once again, however, Douglas asserts the
superiority of humans by advocating the exploitative use of animals
for human benefit. Even in his dynamic comparative continuum,
therefore, animals remain inferior to humans even though they
possess desirable qualities that are beyond human ontology.

If a bird breaks a leg or whatever, it can heal in 10 days. Wouldn’t it be
great if humans who have broken legs and arms could heal in that
short time? Is it because we’re so much bigger and it takes so much
longer or does the bird possess something that we don’t? Okay…
now if you don’t know and I don’t know, the scientists have to find out
so, yep, not a problem. Get some lizards, have a look at them. […]
Yeah, so... all sorts of things. (Ian Douglas)

And it wouldn’t matter, like I said before, it doesn’t have to be a pig,
doesn’t have to be a pig. Why do they always, well you’re using a pig,
monkeys you know, apes, monkeys... whatever. I said to Joanne the
other day, or yesterday, I said listen... you’ve got lizards that can drop
their tails and then the next day or the following week, they’ve grown
a new tail. Now I would imagine that somewhere out there, there’s
probably a group of scientists studying how the lizards can regrow a
limb and if a lizard can do it, can’t that be applied to, you know like if we had a finger cut off. (Ian Douglas)

So no, doesn’t have to be a pig. Animal, bird, you know? No reason why birds can’t be included there too. And I mean the sky’s the limit isn’t it? (laughs). (Ian Douglas)

Conclusion

The stories and problematisations in this chapter centre on selecting an animal species for XTP. To explore the stories told by official science, I designed the comparative continuum. The comparative continuum is a visual demonstration of official science’s justification of selecting a particular animal species for XTP - pigs over nonhuman primates - as based on complex and dynamic combinations of species similarity, dissimilarity, desirability and undesirability. While the aim of these stories is to reduce the difficulties of animal source selection, this can only paradoxically occur by increasing complexity. This process marginalises other understandings that may be mobilised by external networks and/or the publics.

Through these arguments, official science places themselves in a position of authority, where they switch between natural (technical) and social (cultural) arguments to justify their position and affirm their expertise. This also serves to simplistically construct the relationship between humans and animals. That is, animals are used as
experimental resources and tools for research. Animals are therefore no different from other nonhuman objects, such as pipettes, fume hoods, petri dishes, cells, freezers, safety glasses, computers, microscopes, and on. All these objects are manipulated and maintained in the interests of achieving research outcomes. Through such problemisations, the ontology of animals is defined in particular ways. What scientists find acceptable and morally-permissible, however, does not necessarily equate to what other publics find acceptable and morally-permissible. Furthermore, by making these stories difficult to negotiate and understand by those external to the scientific network, they become difficult to combat, confront, challenge, deny or reject.

Yet faith and trust is shown in these stories by the research participants, who officially operate externally to the scientific XTP network. This is not simply guided by feelings of network exclusion and powerlessness. Rather, these research participants acknowledge the ‘rightful’ position of the scientific XTP network’s authority, placing their trust and faith in the scientific ‘expertise’ and ‘cognitive abilities’. As a result, by accepting official science’s problematisations of animals, these research participants become enrolled. Again, however, this does not mean that official science accurately portrays the stories of the research participants. Rather, tensions arise in differences between technical and cultural problematisations. Thus, while official science asserts nonhuman
primates are an unacceptable XTP animal source on moral-ethical grounds, the research participants tell a different story. They move their gaze from selecting an animal species to the relevance and importance of humans using animals for human purposes and outcomes. Of course, all these stories operate on a construction of power, whereby assumptions are made about human/animal ontology in order to maintain and reinforce a human-centred hierarchy. Animals are rendered a passive commodity, and the roles and identities that they construct for themselves are overwhelmed by the network’s relentless power. This begins to highlight a new concern - the utility of animals.
5 - The Sociozoologic Gaze: Using Animals

Introduction

“We are all matter, and we all matter” (Birke et al. 2004: 167, 178).

In ‘The Biological Gaze: Selecting an Animal’, it was shown that official science problematises animals to justify selecting pigs over nonhuman primates as a XTP source. These arguments primarily focus on the technical practicalities of using a particular animal species over another. At the same time, these stories do not go far enough. To expand these narratives and problematisations, official science crosses into the social domain. This allows official science to substantiate its practical (technical, natural) claims by drawing on moral-ethical (sociocultural) debates. As a result, official science positions itself to represent the sciences and the publics. This not without tension, as it should not be presumed that official science’s narratives are consistent. Different and complex problematisations emerge, whereby particular animal species can be simultaneously narrated as similar and dissimilar to humans. Furthermore, while the research participants may align with many of official science’s problematisations, there are also important differences. This means official science cannot, and does not, represent the publics.
As narrated, designated and designed by official science, animals are classified, judged and measured according to their structural characteristics (nature) and ontology (social) in relation to humans. The result on the comparative continuum is that pigs are problematised to be a lower form of animal life than nonhuman primates, which clarifies and justifies their selection as a human XTP source. In this process, official science marginalises opposing voices and stories - they define, determine and control XTP and the animal intermediaries implicated in this story, through various predetermined, scientific classificatory frameworks.

Significantly these stories and problematisations, or human classificatory frameworks on and about animals, reveal the meaning of ‘animal’ is by no means straightforward and clear. Western society uses the concept of ‘animal’ or ‘animals’ in a multiplicity of positive and negative ways with differing connotations and implications. Humans, and our understanding of being human, are a standard by which all species are judged and measured. This ontological problematisation of difference provides distance between ‘us’ and ‘them’, acting as “an ideological justification of human behaviors towards [animals]” (Corbey 2001: 174). This chapter explores how a sociozoological scale of animal categorisation is used to explain and explore human use of animals in XTP, which largely complements the previously explored biological gaze of official science. At the same time, however, this sociozoologic scale displays ambiguity that
challenges the model of official science. That is, the sociozoologic
gaze involves conflicts between how different actants view animals
and their use in XTP. These conflicts also occur within individual
actant accounts. Problematisations are not consistent, and therefore
contradictions will and do emerge in networks.

**The Sociozoologic Scale**

According to Arluke and Sanders (1996: 186), “the sociozoologic
scale is a type of story that humans - with the help of animals - tell
themselves and each other about the meaning of ‘place’ in modern
societies”. The aim of these stories is to “explain and rationalize
certain relationships that are expected” (Arluke and Sanders 1996:
186). Hence, the sociozoologic scale (and gaze) is an indisputable
hierarchy, where animals are judged on “how well they seem to ‘fit in’
and play the roles they are expected to play in [human] society”
(Arluke and Sanders 1996: 169). For example, whether an animal is
explained or rationalised by humans as ‘good’ or ‘bad’ depends on
the animal’s subscription to occupying a subordinate position in
human society. If classified as a ‘good’ animal, the animal will
achieve a higher moral status than one constructed as ‘bad’. The
limitation of animals to ‘good’ or ‘bad’ categories operates on “a
fundamental master-servant relationship where the place of the
animals is clearly subordinate to that of humans” (Arluke and
Sanders 1996: 171). Therefore, being labelled a ‘good’ or ‘bad’
animal has nothing to do with the animal itself or its behaviour, but rather how humans distinguish and understand that animal, and use it as an intermediary to understand the comparative status of humans. The sociozoologic scale therefore problematises animals and their relationships to humans (and each other).

This chapter examines three sociozoologic scales in XTP undertaken by official science and the research participants. These construct animals as: tools in the meat and science industries; tools as determined by their breeding; and pets. For Arluke and Sanders (1996: 170), these animals can be understood as ‘good’ animals, as their role is valuable and productive for human society. To be more specific, animals in these categories are problematised as a utility (tools) which humans can use, or provide humans with friendship and companionship (pets). These then breakdown further, with the actants creating subcategories that differentiate animals by their breeding, relationships to humans, and environmental context. These sociozoologic categories and problematisations are extremely important to how the research participants mobilise animals as intermediaries to XTP, and how they perceive, negotiate, understand, and construct animal use. At the same time the sociozoologic scale, like the comparative continuum, is not consistent\textsuperscript{185}. Animals function as an OPP to XTP, meaning the way problematisations are constructed and mobilised are crucial to XTP and its networks.

\textsuperscript{185} The comparative continuum is explored in the previous chapter ‘The Biological Gaze: Selecting an Animal’.
Significantly, tensions and conflicts arise over changing perceptions of and attitudes towards perceived similarities (commonality) and dissimilarities (difference) between humans and animals. As a consequence, concerns are raised by research participants over the treatment and moral status of animals in general, and in XTP. Such problematisation and ambivalence over animals impacts on the XTP network by producing complicated and contradictory discourses, which need to be considered in their full richness and ambiguity.

To start scrutinising these problematisations of animals, the assertions of official science and the uncertainties and discomforts expressed by the research participants over animals-as-tools in the meat and livestock industries (MLI) and its relevance to XTP, will be explored.

**Animal Use by Official Science and the Research Participants**

Science might be able to tell us about the body functions of a cat but it cannot say anything about its moral standing or value to humans. […] Science might choose a classificatory framework to distinguish animals but it cannot control how these same animals enter into our language as metaphors, or metonyms, the ways in which the animals come to represent something other than themselves. (Franklin 2006: 5)
To rationalise the exploitations of pigs in XTP, official science consistently draws upon existing social exploitations of pigs by humans. These exploitations are problematised in two ways in order to justify XTP: equivalence of process; and differentiations of purpose.

**Problematisation - Equivalence of Process: Official Science**

The equivalence of process uses existing human exploitations of animals to justify the use of animals in XTP. This problematisation by official science is complicated, breaking down into two subcategories - pigs and humans.

According to official science, the equivalence of the process for pigs means that because it is killed for human purposes, it does not matter to the pig what purpose it is used for. Therefore, the pig is unconcerned as to whether it is used in the MLI or for XTP, as the end-point is the same - it is sacrificed for human use. The processes of the MLI and XTP thus are equivalent. Furthermore, official science designates a passive role for the pig, where it is powerless in the exploitative relationship. As the pig has no control, it will therefore not
care about the reason for its death. In this problematisation, official science speaks for the pigs that are destined for slaughter.

In regards to the equivalence of process for humans, official science focuses on existing exploitations (and more specifically, slaughters) of animals by humans. Ethically, the human use of pigs as experimental tools, food and clothing, are viewed as sufficient evidence and justification for using pigs as the XTP source. Thus, pigs raised and killed for XTP are problematised as no different from other historical and contemporary exploitations of pigs by humans. As society accepts the sacrifice of pigs for existing human products, then it makes sense to official science that society accepts, or will accept, the sacrifice of pigs for XTP. For official science therefore, XTP is simply extending these existing (human) social practices into a new medical application. As a result, in the equivalence of process for humans, XTP is no different to any other animal industry, and to single it out would be unfair and nonsensical. The MLI consequently functions as an intermediary to animal use in XTP for official science. XTP then becomes ethical, morally defensible and by default, indisputable.

The controversy of animal sacrifice is thus overwhelmed by the intermediaries of ‘practical’ social facts. The purpose of slaughtering pigs is rendered irrelevant, as the act and outcome is the same for both pigs and humans.
While official science asserts the processes of XTP are equivalent to existing human exploitations of animals (more specifically pigs), the purpose of XTP is viewed differently. Namely, the purpose of XTP is differentiated and separated from other kinds of animal industries. This specifically relates to the MLI and human consumption of meat. The problematisation by official science is as follows - humans eat meat despite the availability of non-animal, vegetarian food sources. This means humans do not need to slaughter animals (and in particular pigs), but they continue to do so. If pigs were additionally used for XTP, the status of pigs would socially increase. For official science, this is principally the case if XTP provides the only possible opportunity to treat certain human diseases. In contrast, meat is not seen as saving human lives - it simply fulfils human hunger and dietary preferences. While the possible rise of the pig’s social status through XTP could ethically compromise their use as a XTP source, any elevation of social status does not equate to questioning the exploitative use of pigs in any animal industry. Like the problematisations of equivalence of process, the MLI is again used as an intermediary to animal use in XTP, though mobilised in conflicting ways. That is, the MLI are similar (process) and different (purpose) to XTP, which are both problematised to justify XTP.
Based on official science’s problematisations of equivalence of process and differentiations of purpose, those who vocally oppose XTP on the grounds of animal slaughter are cast as illogical, irrational, and hypocritical. The aim is to marginalise those stories viewed as adversarial to the network and official science’s expertise, thereby guaranteeing network cohesion and strength. The step from ‘pigs-as-food’ to ‘pigs-as-medical-tools’ is expected to be socially deemed as unproblematic.

Significantly, these justifications and the expertise of official science are not practically (scientifically) informed. Official science’s problematisations of equivalence of process and differentiations of purpose involve using sociocultural exploitations of animals to advance XTP. This highlights that, like the selection of pigs as a source animal, they cannot use the sciences alone to expand the XTP network. Rather, the social is an integral element to their arguments and problematisations. The publics are thereby become very important to the XTP network.

The problematisations of equivalence of processes and differentiations of purpose are frequently argued by official science:

With regard to animal rights, the ‘bottom line’ as far as the pig is concerned is that in order to provide us with food, insulin, or heart valves, the pig has to be killed. Those who do not object to slaughtering pigs for these purposes should surely have no objection to using the pig’s organs or tissues for transplantation. And if we can employ pig heart valves in
large numbers, then surely we should be able to make use of the animal’s entire heart. (Cooper and Lanza 2000: 194)

Whatever the moral claim of animals may be, I would be shocked if it allowed leather wallets and shoes, but disallowed organs for transplant. (Bramstedt 2000: 634)

The risk of controversy with regard to the use of animals as organ donors for man [sic] would be greatly minimized if the animal were already being killed in large numbers on a daily basis to provide food for human consumption. (Cooper et al. 1991: 481)

Arguably, because society allows the use of animals for food, the use of animals as a source of organs or tissues is morally acceptable. It would be difficult to argue against the use of pigs for xenotransplantation, which might be the only option for the treatment of life threatening diseases, and simultaneously countenance the use of pigs for food when nonanimal sources exist. (Samstein and Platt 2001: 189)

The ethical challenge is diminished but not eliminated by turning to farm animals, which are produced and used by humans […]. If, in addition to their agricultural use, such animals also produced life-saving organs for humans, the morality of their use by and for humans might actually be increased. (Bollinger and Sugarman 2003: 410)

As 100 million pigs are killed in the United States each year for foot, it seems unlikely that there will be widespread ethical reservations about using them as a source of life-saving organs. (Cooper et al. 2002: 144)

[…] I argue that death is implicit in many non-medicinal uses of animals (e.g. as a food source), making the organ’s destination ethically insignificant. (Bramstedt 1999: 428)

Ethical concerns over the use of pig organ are modest given that millions of pigs are slaughtered worldwide each year for consumption and for medical products such as insulin and heart valves. (Pham et al. 2004: 100)

If it is acceptable to kill pigs to make sausages, surely it is acceptable to kill them to save lives. (Lanza in Cooper et al. 2002: 144)
The widespread societal acceptance of the use of pigs for food and other products presages a broad social acceptance of their use for medical purposes. (Boneva et al. 2001: 4)

Our ethical qualms relating to the use of the pigs as a donor animal are very much reduced in view of the fact that the pig is already purpose-bred as a source of food. (Cooper and Lanza 2000: 194)

Physicians have used heart valves from pigs, animal products, such as insulin, and animal tissue, such as skin grafts for burnt patients, for many years. The use of animals for these forms of treatment has generally been accepted by the public. (Smetanka and Cooper 2005: 338)

Problematisation - Equivalence of Process: Research Participants

These sociozoologic stories from official science highlight their problematisations are based on the existing social uses of pigs. These social exploitations of pigs are important intermediaries to XTP, which render their use in XTP as suitable and appropriate.

While official science justifies selecting pigs as the XTP source on biological and ontological grounds, as shown in the previous chapter, the movement to the sociozoological scale concentrates on existing social exploitations of and human relationships to pigs. The next logical step for official science’s argument is that these sociozoologic uses are socially acceptable because humans commodify and consume the animal (porcine) goods produced. These justifications, however, are not simply employed by official science. The research participants establish continuity in these problematisations by expressing similar beliefs in regards to the equivalence of process.
Again, this operates as an intermediary to substantiate continued research and human exploitations of animals in various forms, including XTP. That is, because animals are killed for other human purposes and, in particular for their flesh (meat), then the means of the MLI and XTP are equivalent:

But you’ve got to kill them to eat them, so it’s the same. (Julia Robins)

We know them for food and we don’t think twice getting stuck into a nice, juicy steak. I have no real objection to it. (Rod Logan*)

But I mean and, and I think as first said, we, we don’t have, we don’t have any, the majority of us don’t have any conscience when they’re, when they’re killed for the table. So, what is the difference? (Fay Eisenhauer)

Whether it’s for meat consumption or research what’s the real difference? I mean you’re still using the animals for something aren’t you? (Kevin Robins)

One is something that you’re eating, and the other one is something that is saving your life. Nah, just no difference. (Bill Kent*)

Well we eat them don’t we? So you know, that side of it doesn’t really worry me. (Colin Bruce)

Well, I guess because I’m happy to kill another animal for food, I would have no problem killing another animal for survival in another way. So, I personally don’t have a problem with it and I have no religious restraints that stop me from thinking that is unethical. So, it’s only for those reasons that there’s nothing in particular stopping me from thinking it’s unethical. (Daniel Layton)

[…] personally [I] do not exclude any reasonable use of animals for food, fibre and recreation. Provided the animal’s fundamental needs are catered for, use is OK. (Chris Moran)

AM*: As much as I don’t like to see the animals being exploited, animals have been exploited all along for, for the purposes of –
DM*: They have been, but in a different way.
AM*: It, it still ends in the same sort of result (laughs). It still, I don’t see much [difference].
(Adele and Doug Mason*)

I think, say, animals for the food industry. They’re being raised to be killed to feed the population and that’s to keep them [humans] alive and also the animals that are being raised for research are doing the same thing so there’s no difference between them. (Lyn Robertson)

They, they get eaten by humans. The donkey gets, he becomes a slave to human, you know. He just works and works and works for to make life easier for the human. You know, they’re, it’s just one of those things where animals are exploited. (Adele Mason*)

Both [meat and xenotransplantation] are going to keep you alive. You eat the meat, that’s good for your health. The animals also, they’re using for all the things they are, that’s also good for you. Now, that’s my opinion. (Pippa Kearns*)

Thus, the research participants primarily focus on equivalence of process to substantiate animal use in XTP. As existing human applications of animals often involve animal slaughter, XTP is simply another way humans exploit animals. The extension of animal use into XTP is unquestionable, with the slaughter of animals for food a particularly salient intermediary. This affirms and continues the social arguments made by official science in regards to the problematisations of equivalence of process. Interestingly, Rod Logan* and Fay Eisenhauer are the only two research participants who explicitly indicate a lack of thought or consciousness involved with consuming animal flesh. This lack of social awareness regarding the methods and processes of the MLI, translates to an acceptance
of XTP methods and processes, which may also involve a lack of consciousness and awareness of methods and processes\textsuperscript{186}.

This is not to say the research participants do not think about or reflect on the practices employed in the MLI. Rather, the shift of discussion from everyday relations with these industries (in the form of meat) to production, elicited concern and discomfort. This specifically relates to the practices and processes employed by these industries, whereby animals are viewed and treated as products. While such discomfort may exist, the research participants remain a safe distance between the act of consumption and the act of production. This distance is not simply physical. Rather, when confrontation over animal exploitation occurs, some research participants admit to a conscious decision to remain psychologically distant and physically inactive. For example:

Well I think we, I tend to, I must admit I switch off because I, I find when I see a picture of battery chickens, it makes me feel really sort of, I don’t know. I just feel really bad about it, but I must eat eggs from a battery chicken. I probably, I’ve eaten, I’ve eaten chickens that have

\textsuperscript{186} We can perhaps understand this unconscious consumption of animals, both in the MLI and XTP, through the active separation of such animals from the everyday experiences of the urban consumer. This separation occurs at the level of rearing of animals and the processes through which these animals are slaughtered. For example, in regards to meat production, livestock slaughter once occurred as a solemn public event in the middle of an urban township (Vialles 1994: 5, 77). The process is now, however, invisible through its removal to windowless and rural industrial environments. Similarly, animals for XTP are removed from sight, being bred, raised, slaughtered and used in highly sterile laboratories of restricted scientific access, which includes SPF environments. This removal from consumer awareness of the ‘natural’ (living) animal from its slaughter and conversion into a ‘cultural’ object (meat), renders the practices and processes of the MLI and XTP invisible, and thus more socially acceptable. The dead animal carcass is never seen by the consumer.
been bred in a battery setup. So we’re, I tend to, I must admit, I switch off, but if I see it on television, I feel very revolted by it all. (Scott Trapp*)

I will return to themes of discomfort soon. At this stage, it is suffice to say that increasing public awareness of farming production is largely critical, demonstrating a clear social concern over animal welfare (Lassen et al. 2006: 222). For the research participants, however, such awareness does not result in acts of protest at any level to the MLI or XTP. At the same time, this facilitates a conflict with the use of the MLI as an intermediary to animal use in XTP. That is, while official science believes that one form of animal exploitation simply translates to and mobilises another, the research participants do not view this so simplistically or straightforwardly. Rather, they have their own problematisations that introduce uncertainty. At the same time, this does not compromise the XTP network, but it does demonstrate the potential for contradiction and tension to exist within networks. In contrast to official sciences’ primary focus on technical issues in animal selection187, the research participants are clearly concerned over the social treatment of animals and the outcome for the animal in being part of a particular animal industry. These social problematisations can therefore be distinguished from the social narrations on animal use employed by official science.

187 Refer to the previous chapter, ‘The Biological Gaze: Selecting an Animal’.
Problematisation - Differentiations of Process and Purpose:

Research Participants

As noted, the research participants’ employment of the MLI to justify XTP occurs in a problematic fashion. The first reaction of the research participants to animal use in XTP is an equivalence of process to other animal industries. This is soon problematised by comparing XTP to the MLI to demonstrate what the research participants consider to be important differences. In this shift, the sociozoologic gaze continues to examine processes and mobilises the MLI as an intermediary to XTP, though the focus is now on the differences in both process and purpose, with most of their concern on process. This differs to official science, which centres on differentiations of purpose only. For the research participants, this is problematised in four interrelated ways: animal treatment (process), animal welfare (process), animal slaughter (process), and animal-product use (purpose).

Firstly, there are perceived differentials in animal treatment between animal industries. The MLI are particularly targeted by the research participants for animal welfare concerns, based on: housing animals en masse; using various methods to alter the animal (for example, the GE of animals for improved product presentation, and the use of drugs for faster animal growth); and denying animals freedom of movement. The profit motive of the MLI leads to animal treatment
and conditions that the research participants view as unnecessary, unethical and/or cruel, which they strongly differentiate from XTP\textsuperscript{188}. Discomfort about animal treatment in the MLI, however, does not correlate with a rejection of animal exploitation in MLI, altering or changing their diet (for example, vegetarianism), or rejecting XTP. I will return to the significance of vegetarianism to the XTP debate soon.

This connects to the second reason why XTP is viewed as different from other animal industries: the research participants perceive a need to treat the animal with respect in science and XTP, leading to the assumption that scientists do not treat and view animals as mere products. To ensure a good scientific, medical and XTP outcome, the animals are valued in themselves, and must be cared and catered for. Thus, the research participants perceive scientists as ethical, and capable of evaluating animal welfare objectively without the motives of production and profit. This is not considered the case in the MLI, where product and profit overrule animal welfare. Therefore, science is more responsible, ethical and humane in its treatment of animals when compared to other animal industries. As a result, the research participants view scientific animal environments, such as SPF laboratories, in a favourable light and as positively different to animal environments in the MLI.

\textsuperscript{188} In particular, the research participants focus on the exploitative use of chickens. Undoubtedly, this connects to the extensive media attention given to chicken industries, such as the extensive use of hormones and steroids and battery-cage setups.
The third problematisation of difference in process and purpose for the research participants relates to methods of animal slaughter. They narrate that the MLI view and treat animals as products from birth to death\(^\text{189}\). The consequence for the animals is a life that entails deprivation and suffering. In addition, animal slaughter occurs through means which are less than ideal, and results in a prolonged death for the animal. For the research participants, animals in these scenarios clearly express their fear, discomfort, distress and pain. In other words, they believe animals to be sentient beings that do not deserve such harsh and cruel treatment. This does not mean animals cannot be exploited and used by humans, including in XTP. Rather, they indicate there are other methods humans can use to avoid unnecessary levels of animal distress. By consequence, as XTP involves using anaesthesia to slaughter (or ‘harvest’) the animal, it is viewed as more humane and compassionate in comparison to methods of slaughter in the MLI.

Lastly, connecting to all these points on the problematisations of differences in process and purpose, the morality of the designated use of the end-product differs between the MLI and XTP. For the research participants, the MLI are viewed as purely motivated by profit. Animals are then products that, if produced in the most effective (but not necessarily ethical or humane) manner, will create increased profit margins for the MLI. The research participants

\(^{189}\) To quote Vialles (1994: 28-29), “the fate of animals raised ‘for slaughter’ is sealed from the moment of their birth. They are fed and sold to be killed”. 
believe XTP is different as its motivations diverge. That is, XTP and the XTP network are driven by the quest for human health and wellbeing. The research participants view this as altruistic, where scientists are not viewed as motivated by profit, and are ethical in their usages of animals. Furthermore, there is a positive outcome for human health in animal slaughter. This further permits a scientific license to modify animals as necessary, such as the use of GE and transgenics, though such standards and permissibility does not translate to food-producing industries (for example, agriculture and the MLI).

Importantly, these four problematisations of differentiations of process and purpose function to alleviate the research participants’ uncertainties and tensions surrounding XTP, while also complicating XTP’s acceptability. This means other animal industries can be used as an intermediary to justify XTP, though they simultaneously can be used to illustrate XTP as different. In other words, the research participants perceive significant differences in animal treatment between the MLI and scientific applications, particularly those employed in XTP. Therefore, if humans accept animal industries that show minimal or no respect for animals, then XTP should be permitted as it shows more respect to animals and their vulnerable, exploited position. Furthermore, the motivations of science are viewed as different and of higher and worthier value than that of other animal industries. In turn, the ethics of the MLI and science
(and scientists) differ as influenced by divergent rationales. Through a perceived combination of professional ethics and practice, therefore, the research participants cast XTP as more ethically sound than ‘other’ animal industries. This allows them to reject and/or show discomfort towards animal treatment in the MLI, yet support XTP and its development.

These four problematisations are extremely important to the research participants when thinking about animal industries and XTP. The context of animal exploitation and use is concurrently irrelevant and relevant for the research participants when problematising XTP:

BS*: Well, the slaughter yards, they just get them in and bang, bang, and, cut them up, and this, this is more humane.
SR*: That’s the only thing I’m against is actual cruelty. People actually just being cruel. See this [xenotransplantation] wouldn’t be cruel.
BS*: This is not cruel.
SR*: No.
BS*: This is more humane. [...] BS*: Three days there [in the abattoir] and not even a drink of water. That’s where the animal rights ought to be. This [xenotransplantation], they’re given a needle and they’re out to it. It’s more humane.
(Sue Reilly* and Bethany Smart*)

With the sheep, they smell the, the smell of death and they, they know. They know what’s coming and they’re scared, scared shitless. There’s no other way of putting it. They’re absolutely terrified of what’s going to happen, and they know what’s going to happen and when it comes, I suppose it’s a bloody relief for them. It’s all over. And every time I drive, where we use to live, the slaughter yard in Gosford where we use to live at one stage and you’d drive past it and, to be quite honest, you’d think of the Holocaust and, and the people were herded together and mass slaughter and they knew it was coming, you know. Nothing they can do about it. And that’s what I object about for, (pause)... But these, these animals [for xenotransplantation] will be, anaesthetised I think is the word, is it? (Frank Smart*)
ST*: If we use medical research the person is doing, as we say, is doing medical research and so there’s a sort of, a good outcome, in theory, to it. But when you get a farmer walking up and down and see all these poor chickens going wa, wa, wa, and they’ve got no fur on them or no feathers on them ‘cause they’re in these tiny cages, sometimes it looks, it’s the actual, there’s a cruelty aspect to me which is, is not present in the actual experimentation side of it, and ‘cause we know they actually can or they, they do it in volume, but they can actually grow those chickens in free, in the free range setup, so it’s a profit motive behind it. Purely profit motive. And so to me there’s a slight moral difference there. That worries me is the actual sight of seeing another human being can do that to all those chickens or those pigs in that, in those confined spaces, and it’s different in someway to the laboratory where they’re actually working for the good of something. To me, there’s a difference. That’s how, that’s my gut feeling.

DT: Yeah, that’s a good point Scott*.

FE: Also injecting chickens with growth hormones so that they’re ready for the table in 6 months. I, I don’t agree with that. I don’t agree with any, I only agree with medical, medical experimentation or medical genetic. I don’t think we should be playing around with ourselves by injecting an animal with growth hormone, which we then eat.

(Scott Trapp*, Derek Taylor and Fay Eisenhauer)

I agree with the animal rights but in relation to the ethical way the research is being done, I’ve got no hassle with animal rights. (Kevin Robins)

JR: Because I love animals, don’t I?

KR: I never would have guessed. How do you feel about a little monkey down there being slaughtered to help you with your Parkinson’s?

JR: Well it wouldn’t be slaughtered, it’d be put to sleep properly and I’d be very grateful. I really would.

(Julia and Kevin Robins)

Well obviously the, in certain areas of food production like chicken, I’ve seen the chicken farms and they’re not very nice places to be for the chicken and they don’t get well looked after. I actually had a mate who had one and I used to go out there and do bits of work for him and chickens get all the water they want but they’re scratching around in their own manure and all that sort of stuff and I think that’s rather cruel to keep 5 thousand chickens in one hut and that’s not my idea of a good way for a chicken to live. [...] I actually watched a show the other night and they showed two chickens, one that was fed the steroids and one that wasn’t and in a matter of, I think 3 weeks, the
one that was on the steroids was twice the size of the normal fed chicken. (Jeremy Batt*; talking about differences in animal industries)

Well you see this animal would, would wander along in a, probably in a generally blissful state. Every, his every requirement would be catered to. He'd be kept warm, he'd be kept well fed, he'd be free, totally free of any infection or disease and if he did happen to pick up the flu or something or the variant equivalent, he would receive absolutely the best treatment, I would imagine, 'cause there would be so much investment. Either that, or they would slaughter him on the spot to stop it from spreading, transferring disease to the rest of the crew. So it would be a fairly benign, but it could be a fairly brutal environment, but he would, I don’t think they’d know too much about it. (pause) And when it went to the full scope, to the actual transplantation, under general anaesthetic. You’ve had general anaesthetics in the past, haven’t you? You know what it’s like. You just go to sleep and don’t wake up. (Frank Smart*)

On a personal level, I’m much more probably interested in human rights and humans not being mistreated. Having said that, if I’ve got the option of buying a product that hadn’t been tested on animals for example, then I would buy that as opposed to the other [...]. (Susan Greenbank)

Chicken farms have been one where, due to profit, animals have been put under stress. I, I think for me that’s the thing where animal welfare is compromised for profit. I would never tolerate that, and in a scientific setting, all, like I’ve never come across any particular situation where I thought an animal was being treated unfairly, so... (Daniel Layton)

I saw a program on television where they had these pigs and the farmer went into the pen and all this sort of thing, and he just picked all the little piglets up and cut their tails off, ‘cause they cut their tails off. You know, it’s just the actual act of doing that. Something to do with the fact that they’re confined in confined spaces so they won’t bite each other’s tails ‘cause they’re all pushed together, so they cut their tails off. And it was just the actual vision of this man doing this, and when you knew the end result was just to make more money, and the actual, the act of doing that seemed extremely cruel to me. And it’s purely for the profit motive, and that, that sort of made me feel really sad. I actually couldn’t watch it. It was a documentary. I had to turn over. I couldn’t watch it after that. That was, that is just my feeling. I maybe hypocritical because I can, like I quite like bacon (laughs). (Scott Trapp*)

FE: I think that a lot of conditions in our society now is because there’s so many chemicals going into the food that we’re eating.
RL*: Yeah I, I disagree with them being cooped up and fed six times a day just to make them fat and not allowed to run around and run some of the fat off.

FE: It’s not only chooks though. It’s, it’s a, it’s all our. It’s, it’s our vegetables and our, and our food. It’s in our meat. It’s in everything at this stage unless you buy, unless you buy freshly farmed or organic or something. So yeah, I’m against this progress that we’ve made to make the food look better for our table, but I don’t necessarily think it’s better for our insides. I’m happy to have the [animal genetic] engineering for, for research, but not –

(Fay Eisenhauer and Rod Logan*)

ST*: It’s the way the human race is being lead down this profit or this path of actually doing, resourcing into cruelty to actually make money and that sort of doesn’t sit very good with me.

KR: I agree.

ST*: And the world is overproducing food anyway. I mean, we throw away as much as eat anyway, so we’re actually overproducing.

(Scott Trapp* and Kevin Robins)

I don’t want to take, ingest it or you know [genetically engineered animal], but when it comes to (laughs) lifestyle, I’m quite happy to have genetic engineering on animals to sort to, to improve lifestyle. See, that’s double standards (laughs). (Fay Eisenhauer)

XTP therefore occupies and enjoys an elevated status above other animal industries, as the research participants perceive it to operate in a respectful and ethical manner. This makes XTP humane and operating in the interests of human ‘good’. Furthermore, all animal industries are viewed as the same in their animal usage by both official science and the research participants, but simultaneously distinctive. By perceiving differences, official science and the research participants separate XTP from other animal industries that they believe violate or exploit animals through cruel or unjust means for unjust ends. At the same time, these problematisations of differentiations of process and purpose by the research participants,
narrate animals to be sentient beings that should not be subject to unfair and cruel treatment. These understandings should not be viewed in light of previous arguments by official science, where in selecting a source animal sentience is bestowed to nonhuman primates and denied to pigs\(^{190}\). Significantly, while the research participants place their trust and faith in the sciences to show respect for and to behave ethically towards animals, the views of official science and the research participants on animal categories and animal sentience substantially differ. As a result, problematisations on animal pain and suffering also part ways.

These stories from the research participants also demonstrate that discomfort and uncertainty over the MLI does not equate to an act of protest against the act of production or against consuming animal products. Critiques of animal industries on animal welfare grounds, particularly in regards to cruelty, are separated from the act of consumption. Despite the assertions of official science, the social consumption of meat is therefore not an intermediary that indicates comfort and support of the MLI and, in turn, XTP. Thus, while the research participants are content to negatively reflect on the act of producing meat, the actual act of consuming meat still occurs without much reflection or criticism, and does not simply reflect their

\(^{190}\) Refer to the previous chapter ‘The Biological Gaze: Selecting an Animal’.
standpoint on XTP\textsuperscript{191}. In other words, the research participant’s tensions over the MLI and the act of consuming meat, does not extend into the XTP debate. As outlined, these negotiations operate as a way to think about how animals are used in human society, what is and is not permissible, and how this impacts on the XTP network.

\textit{Vegetarianism}

As “food reveals who we are, where we come from, and what we want to be” (Belasco 1999: 27), vegetarianism sits in opposition to meat-eating. Significantly, as Australians are one of the largest meat consumers in the world (Franklin 2006: 221; 1999: 148, 151), vegetarianism differs from the dominant Australian identity and culinary preference\textsuperscript{192}. For the research participants, eating meat - or not - matters in XTP. Vegetarianism reminds them of, or brings to their awareness, the reality of animal exploitation in a variety of

\textsuperscript{191} These apprehensions over the permissible use of animals are perhaps due to recent developments of strong emotional ties between animals and humans (Franklin 1999: 35).

\textsuperscript{192} Traditional Australian iconography and nationalism heavily draws upon symbolism of the rural countryside and farming. As Franklin (2006: 4) states, “animals are tied into narratives about nation and Australianess”, though these positions are often contradictory. Historical narratives of Australian identity being tied to these non-urban rural settings continue to persist (Phillips and Smith 2000: 214-216). Eating meat and ‘supporting farmers’ are therefore important for traditional views on Australia and Australian identity. Indeed, opponents to the previous Australian federal government’s financial assistance packages for livestock and dairy farmers affected by the national drought, have been portrayed as “un-Australian” (Nationals MP Bruce Scott in ‘Drought assistance injection fires up viability debate’ 2006: para.7), speaking with their “back passage” (Liberal Senator Bill Heffernan in ‘Drought assistance injection fires up viability debate’ 2006: para.5), “outrageous” (Nationals Leader Mark Vaile in ‘Drought relief criticism “agrarian genocide”, say Nationals’ 2006: para.7), and as fostering “agrarian genocide” (Nationals MP John Cobb in ‘Drought relief criticism “agrarian genocide”, say Nationals’ 2006: para.3). Federal government policy is clearly affected by traditional views on Australia and Australian identity.
animal industries. This leads to an expectation that because vegetarians do not eat meat (a refusal to be enrolled in and to align with the MLI network), they will universally oppose animal exploitation in all of its forms. In contrast, those who eat meat have not made an ethical lifestyle choice on which to launch their opposition to XTP. It is therefore expected that they will – or should align - with the XTP network. Social limitations and expectations are thereby placed on who can reasonably raise objections to XTP, as based solely on an individual’s dietary habits:

I mean what’s the difference between eating them, I know there’s vegetarians, but for those, the majority of us, what’s the difference between eating them and using them for, for medical science? I, I can’t see, I can’t honestly see the difference. (Fay Eisenhauer)

After we saw 'Babe' [an Australian movie about a pig] it was a bit hard to think about slaughtering pigs and things but, you know, it’s, it’s not reality and that’s the world we live in and, and I’m not a vegetarian, and I eat chicken and I eat meat and you know, if the animals are bred for medical reasons, then to me it’s no different to being bred for food reasons, and doesn’t really, it’s just how the world is. (Cecilia Breau*)

So as I say, when I went along [to a public meeting on xenotransplantation], I was amazed at the depth of [negative] feeling that came across. Now I don’t know if all these people are vegetarians, that wasn’t mentioned... (Kevin Green; on the reactions against xenotransplantation based on animal advocacy grounds)

*We would suggest that only the strictest vegetarians, who do not eat any form of animal tissue, do not wear leather shoes, and so on, can reasonably raise objections to the use of the pig in xenotransplantation. (Cooper and Lanza 2000: 194)

Although it is not necessary for humans to eat meat in order to survive, ethical concerns do not override desire and do not prevent most people from eating meat. Therefore, most non-vegetarians will consider a life-saving organ or tissue...
As a result, it is expected that the only rational, opposing voice to XTP is that of vegetarians. The act of rejecting one animal product and network – meat and the MLI – is an intermediary to rejecting another animal network and product - XTP. The results of these problematisations are value-judgements on those who can reasonably object to XTP, whereby only vegetarians are considered to have sensible and sufficient ethical grounding to launch resistance. In official science, Cooper and Lanza (2000: 194) take this one step further - this opposing voice to XTP additionally must be a ‘strict’ vegetarian, presumably a vegan who avoids all animal products\textsuperscript{193}. In other words, food consumption is symbolically important for official science and the research participants as an intermediary to problematisations of XTP – be they negative or positive – and possible subsequent alignment to the XTP network.

Significantly, by grouping all opposing voices together into a category labelled ‘vegetarian’, it is expected that vegetarians are the same; universally consistent in their ethics and world views. This also assumes vegetarians are altruistic, standing in opposition to any

\textsuperscript{193} There are of course, significant differences in how animal products are produced in the dairy and meat industries. At a very basic level, one industry involves animal slaughter (meat), while the other does not (dairy). For official science, however, animal exploitation is animal exploitation regardless of the outcome for the animal - at least, in this case.
animal exploitation networks, particularly that which involves animal sacrifice. Opposing voices to XTP that consume animal products are questionable, irrational, flimsy and hypocritical. As a consequence, vegetarians are also treated with suspicion, caution and integration\textsuperscript{194}. Simultaneously and as already explored, however, ambiguity towards the MLI and its networks can be shown regardless of one’s dietary preferences and alliances. Furthermore, this also ignores that resistance to XTP networks can be launched on numerous grounds other than animal exploitation\textsuperscript{195}.

Despite the assumptions of official science and the research participants on the opposition of vegetarians to XTP, vegetarians differ in their understandings and approaches to diet and in their views on animal industries\textsuperscript{196}. This has particular affects on enrolment to the XTP network, and is evident in the stories from three research participants who self-identified as being vegetarian: Glenys Oogjes, Helen Rosser and Julia Robins. Both Oogjes (a member of the XWP), and Rosser (a member of the AIS)\textsuperscript{197}, are associated with animal welfare or rights-based organisations: Oogjes

\textsuperscript{194} Significantly, the desire of vegetarians not to eat particular foods threatens the dominant Australian social order on two levels: they do not subscribe to traditional images of Australian identity, and challenge the absolute dominance of culture (humans) over nature (animals).
\textsuperscript{195} For example, XTP can be opposed on the grounds of potential cross-species viral transfer (zoonosis). This will be explored in the following chapters.
\textsuperscript{196} As Munro (2004: 63) states, “many people see environmentalists, animal activists and vegetarians as kindred spirits; however, these groups are characterised by important ideological differences in the way they view lab animals, farm animals and especially wild animals”.
\textsuperscript{197} XWP refers to the Xenotransplantation Working Party. AIS refers to the Animal Issues Subcommittee. For more information, refer to the glossary for the chapter ‘Entering the Network: Methodology’.
as the Executive Director of Animals Australia, and Rosser as the Chief Executive Officer of the Australian Association for Humane Research. Robins was the only vegetarian not explicitly aligned with an animal welfare or rights-based organisation, and living with a health condition targeted by XTP (namely, Parkinson’s disease). It is not unexpected that, like all the other research participants, the views of XTP from Oogjes, Rosser and Robins, differ and are ambiguous. For example, while Robins will not eat meat and does not support the MLI, she feels very differently about XTP and scientific research involving animals. A rejection of one type of animal network, therefore, does not automatically translate to a rejection of other types of animal networks. In other words, other social factors can act as intermediaries to network enrolment or disassociation.

For Robins, she identifies with official science’s problematisations of equivalence of process and differentiations of purpose. That is, while she does not support the MLI and will not align to its networks, she recognises that regardless of her lack of enrolment, animal slaughter in the MLI occurs. Therefore, even though Robins is a vegetarian, she acknowledges the end result for the animal is the same, regardless of whether it is used in the MLI or XTP. The value of the MLI and XTP, however, diverges substantially. The problematisations of differentiations of purpose are highly significant for Robins, as she clearly separates the motivations of the MLI and XTP - one she considers unnecessary (MLI) and the other as necessary (XTP). As a
result, Robins shows no support for the MLI, and noticeably differentiates between animal industries and uses. This technique allows her to show support for XTP and align to its network, but not the MLI:

I’m a vegetarian. People kill pigs to eat them now what’s the difference? I think it’s a great idea, I really do. (Julia Robins)

I mean, I’m against that [the meat and livestock industries] because I suppose ‘cause I’m a vegetarian. But to save someone’s life, gee. (Julia Robins)

You can, I don’t expect everyone to be a vegetarian. You don’t have to eat that meat. But something like that, saving a life. (Julia Robins)

This contrasts to the positions taken by Oogjes and Rosser. Where Robins mobilises the problematisations of equivalence of process and differentiation of purpose as intermediaries to XTP despite her aversion to the MLI and meat consumption, Oogjes and Rosser focus on and do not problematise the differences between the equivalence of process and purpose. In saying this, however, this is not to say their narratives are the same as mobilised by official science and other research participants. Rather, like all other actants, theirs are subjective and culturally informed.

For official science and the majority of the research participants, problematisations of equivalence of process are positive for XTP. That is, the negative and damaging processes of animal exploitation
in the MLI justifies the comparatively favourable and ethically-justified exploitation of animals in XTP – an acceptance of one form of animal problematisation (MLI) justifies the other (XTP), yet both function differently. For Oogjes and Rosser, their negative problematisations of the MLI and rejection of its products, translates to a rejection of XTP and its processes. As a result, the problematisations of one animal industry act as an intermediary to another, and their rejections are equally produced in both. Therefore, for Oogjes and Rosser, animal exploitation is animal exploitation, and cannot be justified. This means there is no point of differentiating between the processes or purposes of the MLI and XTP (and their networks), as they are both unethical and unacceptable. In other words, the means does not justify the ends, as the means is not justified in itself:

[…] I do believe in animal rights. I don’t think we should be exploiting them to fix our own problems. I mean for that reason I’ve been vegetarian and vegan for many years […] (Helen Rosser)

I mean I don’t eat animals because I think that it’s unnecessary. It’s exactly the same position I take into this xenotransplantation debate because I don’t think it’s acceptable and I don’t think it’s necessary because you’re doing it because they’re available [pigs]. It’s almost like they’re cheap and expendable but I think we’re going down the wrong track. (Glenys Oogjes)

In any case, the objections from Oogjes and Rosser are irrelevant. The voices of those who oppose which, according to official science and many of the research participants are vegetarians, are
considered the minority, and conflictual to the processes of network translation.

In the Australian culture of meat-eating, vegetarianism is marginal and a counterculture; an antithesis to mainstream Australia. Opposing voices in their entirety are therefore ‘put in their place’ as a minority, and rendered marginal. This is particularly the case from official science who, specifically when it comes to animal use, strongly marginalise any opposing problematisations on the basis of ‘strict vegetarianism’, or as being hypocritical through the acceptance of other animal use/s. This also occurs despite the uncertainties and discomforts expressed by the research participants regarding the MLI. As a result, reactions to XTP should be considered culturally, historically and locally specific, and heavily related to existing social exploitations of, and social and individual views on, animals.

**Tools – Breeding**

So far, the MLI have been mobilised as an intermediary to largely justify XTP through problematisations on the similarities and differences between the two industries. Through these stories, the problematisation of XTP involves linking it to the MLI as equivalent in process, but distinguishing the purpose of XTP to be of higher and worthier value. Simultaneously, both the purpose and process of XTP are different, as animals are perceived not to be simply treated as
products for a profit motive, like the MLI. These seemingly conflicting sociozoologic stories enable XTP to be warranted, even if similar but different animal industries cannot. The XTP network thereby expands. Additionally, in the previous chapter, ‘The Biological Gaze: Selecting an Animal’, official science is at pains to problematise why pigs are chosen over nonhuman primates as the animal source for XTP. While the research participants placed faith and trust in official science to make such a decision, they problematised this further by being open to exploring animal species other than pigs and nonhuman primates. The restrictions official science placed on source animal selection, as influenced by what they perceived to be social arguments, were thus unfounded. The research participants placed no restrictions on using any animal species. It is this point to which I now return.

When problematising animal use, the research participants make it clear that animals are bred for a purpose. Humans translate specific intentions to specially-bred animals and define the value of an animal’s life, meaning animals are bred for differing reasons and for varying outcomes. For example, animals produced for MLI and for scientific research, are bred to be used and killed by those specific industries and for specific purposes. Other animals bred for a purpose are not necessarily and should not be sacrificed, such as pets. I will return to pets and their relevance to the problematisations of XTP later. For the research participants, the intimacy people
experience with animals is vitally important in their translations and problematisations of animal use in XTP, and for the choice of a human XT animal source. This heavily contrasts with the overwhelming biological considerations employed by official science. In other words, the research participants draw and rely upon social knowledges to negotiate animal use, and do not simply seek out scientific (natural) expertise.

For the research participants, it is permissible to create animals specifically for XTP as it becomes the animal’s ‘purpose’ or specialist ‘skill’. For example, animals bred in the MLI are products and machines that manufacture flesh (Vialles 1994: 51), while animals bred for the science and medical industries are products that manufacture knowledge and outcomes. In the case of XTP, this ideally leads to a better quality or prolonging of human life. Furthermore, while the research participants’ reactions indicated that any animal species is fine to use for XTP, it should not just be any animal from the animal species of interest. Here, the research participants further problematise animal use. That is, there is a clear desire that the animals used in XTP must be different from and special as compared to other animals within the same species. A pig in a free-range farming environment, for example, is different from a pig in a sterile, scientific laboratory environment. In turn, both of these pigs are different from pigs raised as pets, and each have a differing value and purpose as attributed by humans. What a pig is
and its suitability for particular purposes is therefore dependent on a variety of variables, including environmental context, how the animal has been bred, and any pre-existing human/animal intimacies. Inequities that exist between human/animal and animal/animal are relationally embedded in and problematised by the research participants through place, time and space.

Therefore, differences in breeding and environment determine only certain kinds of pigs can be used for XTP. Animals not specifically bred for XTP should not be used for XTP purposes, and are externalised from the XTP network. Context and breeding (content) become intermediaries for drawing distinctions on the sociozoologic scale, and are problematised between animal species and also within an animal species. These sociozoologic scales determine whether a pig is wild or domesticated, and whether the domesticated pig is to be used as meat, as an experimental tool, as a source for human body parts, as a pet, or something ‘other’. Simply put, a pig is not a pig. What an animal is, is determined by humans (see Figure 25). In turn, for the research participants, there is a dynamic interrelationship between environmental context and animal breeding. This suggests the context in which the animal ‘lives’ is verified by its breeding which, in turn, becomes the animal’s natural ‘home’. For example, a laboratory environment becomes the ‘natural’ environment for a laboratory- created and raised pig to reside. As a result, the research participants believe the meaning and value of an animal and an
Figure 25 - Sociozoologic Scale: Gazing on Pigs
animal’s ontology differ depending on the context and the content of the animal:

And as I say, the animals are bred specially for things like this [xenotransplantation], so they don’t go and, what will I say, have a normal life. You know what I mean? ‘Cause they’re all bred specially for this. It’s not as if they get out in the sty and run in the fields and everything else. (Pippa Kearns*)

You can’t consider the animal. As I say, if you look at him, he’s there for a purpose. That pig’s marked to take stem cells from, or that pig is marked for whatever. All thoughts for the animal are past. (Bob Kearns*)

If animals are bred for a purpose, then it doesn’t really matter. They’re not going to be there unless they’re bred for that purpose, and yeah. (Cecilia Breau*)

These would be specially bred and they’d probably be a special strain of pig eventually bred for the job [xenotransplantation]. (Frank Smart*)

You see, they’ll be bred for that [xenotransplantation]. They’ll be looked after. They’ll be treated pretty well. (Sue Reilly*)

And look, I would imagine that you’re not just going up to a farmer’s pig pen and taking one of his pigs, these would be specially bred for that very purpose so they’d be very clean and hygienic I should imagine so I don’t have a problem. (Ian Douglas)

I guess if that’s what they’re bred for, that’s what they’re there for […] (Darla Kent*)

I personally think they’re not going to be there if they’re not being bred specifically for this purpose, and I’m sure the little piggy would be quite happy to keep me alive if I told him that he just wasn’t going to somebody’s dinner. (Cecilia Breau*)

As long as it’s bred, if it’s especially bred for that, then I don’t have a problem. (Steven Clarke*)
I mean, animals now are bred purely for a specific purpose. I mean, quality of meats. Sheep they’re bred for either their wool or their meat, to the point that it’s even getting back to the vegetables and everything nowadays. (Kevin Robins)

For the research participants, the context in which a pig is bred and raised therefore determines the value of the pig’s life and how a particular pig should be used by humans. This marginalises some pigs from the XTP, while others become embedded into the network. Similarly, in ‘The Biological Gaze: Selecting an Animal’, official science also differentiated between pigs to marginalise domestic swine and to select miniature pigs as the XTP host. Significantly, however, official science bases these problematisations on biological (natural) grounds. The research participants did not simply accept official science’s determinations of animal selection. Here, the research participants elaborate on and mobilise their social understandings of animals, outlining their own complicated problematisations and differentiations.

While the research participants differentiate animals based on their purpose, content and context, being an animal establishes an inferior ontology to humans. At the most basic level, XTP involves euthanising – or slaughtering and killing – animals for humans. This process needs to be accepted by humans (and the research participants) through the processes of translation. Ultimately, it needs to also be accepted by animals to finalise the network. Furthermore, as the sociozoological scale highlights, humans need to problematise
animals in particular ways that separate human and animal lives and ontologies. Regardless of whether the research participants react to XTP and its network in a positive or negative fashion - that is, whether they adhere to the network or not - many research participants adhere to the belief that human beings are ontologically superior to animals. The ‘naturally’ inferior status of animals justifies their use by humans in various ways, and provides the viability for continued exploitations. Furthermore, the inferior status also justifies the various problematisations of animals on the sociozoologic scale, which serves humans in various ways. In other words, the value of human and animal life is hierarchically problematised - human and animal lives are not seen as equal. This provides privilege to humans and their unquestionable access to animals, animal lives, and bodies. Animal use by humans thus becomes natural and unquestionable for the research participants. Additionally, these boundaries between human and animal life largely complement the comparative continuum, where animal life can never truly compare to or match the high value of human life.

There is no question about the order of things. Man, as far as I’m concerned, is the highest order, full stop. You can do anything you like as far as animals go, but I’m not into animal cruelty either, so. (Bill Kent*)

I think animals are less important than people […]. (Peter Collignon)

I, I see the sustaining of life as being of, human life as being of high importance. […] In relation to regenerative or replacement cells in a human body, if we have few alternative sources, then it seems to me
on, even on a higher ethical plain, it would be practical to utilise animal sources as a course. (Bernie Tuch)

I do believe that human life is far more important than animal life, so for me the justification is there. (David Strom)

I would put human life above any of the animals. (Ian Douglas)

Like I said, the human’s life is above the animals or the birds. (Ian Douglas)

[…] I do respect animal life but I still place human life in a hierarchy as being more important. (Robert Dixon)

I’ve got no objection to killing animals if it can assist the human beings in their life. […] Maybe I think of them as lower level of life. I might be right, I might be wrong. (Rod Logan*)

Animals have a right to life as much as us, but natural progression of things says, well I feel we in the past have taken those lives, so it’s still a natural progression for me to take that life and infringe on that right. (Daniel Layton)

The treatment of animals-as-tools demonstrates the power of humans in problematising and translating the social value of animals. In the sociozoologic system (and the comparative continuum), animals are problematised to be lesser beings than humans, and can be used and manipulated according to human will and desire, which includes XTP. These negotiations by the research participants share similarities and differences with their views of animals-as-pets.

198 This will be explored further in the chapter ‘Risk and Trust: Science, Infection and Health’.
Pets

Animals-as-tools highlights how official science and the research participants problematise exploiting animals throughout their lifecycle for the benefit of humans. Importantly, animals-as-tools justifies using animals in XTP. When thinking about animals-as-pets, this story changes. Like animals-as-tools, animals-as-pets serve a purpose for humans. The problematisation between animals-as-tools and animals-as-pets, however, means human purposes have differing outcomes for certain animals, as based on their sociozoologic categorisation. For official science, animals categorised as pets are eliminated as a XTP source, suggesting existing human/animal relations are (partly) considered in their practical (natural/scientific) animal evaluations:

*It would be clearly preferable for the animal not to be generally known as a pet, thus excluding the dog, which would in any case be too small in most cases. (Cooper et al. 1991: 481)*

For the research participants, the level of intimate contact between humans and animals is highly important when problematising an

199 This is very rarely addressed in the literature from official science. I suggest this is because of official science’s overwhelming focus on pigs and nonhuman primates. As explored in ‘The Biological Gaze: Selecting an Animal’, official science goes to extreme lengths to justify the selection of pigs as a human XTP source. The position of expertise that science constructs and assumes means their scientific focus should go unquestioned. As a result, animals that act as pets are infrequently mentioned. In addition, animals-as-pets involves a strong and obvious crossover to the social.
animal source for XTP. In conceptualising these relationships, the research participants displayed fondness towards animal species commonly kept by humans as pets, particularly dogs and cats. The thought of using pets as sources for human parts was clearly unacceptable or discomforting. This highlights the importance of the sociozoologic scale, where differences are problematised between animals within a species on the basis of both content and context:

You know, if the pigs are bred specifically for the purpose and they’re not somebody’s pet […] (Cecilia Breau*)

FE: I wouldn’t like to see domestic animals, no. I mean, our dogs can’t be touched, can they! (laughs)
RL*: Well, anybody else’s but yours.
(Fay Eisenhauer and Rod Logan*)

I don’t have any, I don’t have any animals that for serious medical research, that I would exclude, because obviously you’re not going to come and get the family pets. (Fay Eisenhauer)

But I wouldn’t like them to do it to my pet dog because I’m an animal lover or a pet lover. (Colin Bruce)

I mean if it was a dog I guess I’d be really upset about that because I love dogs, but I’m not personally fond of pigs or things like that so I guess it really does depend on the animal […]. (Susan Greenbank)

I don’t know what my reaction would be if I found out they were using poor little cats for things, ‘cause they’re your friends. Be like using you! (laughs) But, but the, see you don’t think of pigs and cows. They’re all out in the paddock and you’re not patting them on the head and cuddling them. So I guess that’s different from having a dog or a cat that comes and sits on your knee. (Pearle Giddins)

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200 Dogs are the most frequent pet cited by the research participants. Research by Franklin and Crook (in Franklin 2006: 203) suggests this is unsurprising, with almost half of Australian households owning a dog.
The close proximity and interaction between humans and pets clearly allows personal associations and intimate cross-species relationships to form. Significantly, however, these intimate relationships do not mean an animal species commonly used as a pet cannot be used in XTP. Pets are problematised to be a special breed within an animal species\textsuperscript{201}, separated and entitled to differing considerations to the animal species en masse. Therefore, animals-as-pets are ontologically different to animals-as-tools, and should be viewed and treated as such, even within the same animal species. This means that while an animal’s breeding and environmental context are significant intermediaries to an animal’s value and use, the levels of intimacy in the human/animal relationship are also highly important.

For the research participants, the close social relationships formed in pet ownership creates fondness and companionship\textsuperscript{202}, something which XTP and its network cannot ethically encroach. Pets become too familiar and similar to humans to use in XTP. This contrasts to the problematisations made by official science in the previous chapter, where the only animal/human similarities that were considered relevant were biological (natural). The research

\textsuperscript{201} Pets are different from other animals because of the way humans integrate them into human spaces. Pets have a subhuman status, as they are adopted by humans and are allowed in human households, given personal names, and are never eaten (Franklin 1999: 87). Animals that are not pets, despite being from the same species, are not entitled to the same treatment. In some cases, they might be considered vermin (for example, feral cats). This sociozooologic scale was examined in relation to pigs in Figure 25.

\textsuperscript{202} This should be considered a two-way relationship. That is, just as humans form close bonds with animals, it is reasonable that animals form a close bond with humans. In the words of Franklin (1999: 85), “they [pets] make long-term bonds with their human companions; they rarely run off with others; they are almost always pleased to see ‘their’ humans; their apparent love is unconditional (and therefore secured) and they give the strong impression that they need humans as much as humans need them”.

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participants also draw distinctions between different kinds of domesticated animals. These sociozoologic problematisations are filtered by personal human/animal relations, and operate as intermediaries to measure the suitability of using particular kinds and breeds of domestic animals in XTP.

The strong importance of the intimacy experienced between humans and pets is potently narrated by Pearle Giddins. Giddins likes to spoil her grandchildren, or has fond memories of her grandchildren who have passed away, all of which who are her children’s pets. For Pippa and Bob Kearns*, their animals are members of the family that share intimate spaces traditionally thought of as ‘human’ territory, such as bedrooms\(^{203}\). Significantly, these animals-as-pets are also identified as possessing personalities and special qualities that are not identified in animals-as-tools or other domesticated animals. This serves to further differentiate between animals within a species and the level/s of animal/human engagement and intimacy:

\[\text{Like my daughter’s Thomas. He’s the only children I get from children. The only grandchildren I get are dogs and cats, so. I’m having big problems buying Thomas a Christmas present because the liver sparkles that the pet shops put out, they don’t seem to be getting this}\]

\(^{203}\) As Birke et al. (2004: 175) highlight, the companionship between animals and humans involves an interactive dynamic. These relations, or ‘performativity’, can change all that are involved in the relationship. Viewing the human/animal relationship as solely determined and experienced by humans is narrow, and ignores the independent influence of animals. In addition, pets and pet-keeping is trivialised when this dynamic is considered a substitute for ‘real’ human relationships (Serpell 1996: 24). Pets and humans therefore co-produce the human-animal relationship, where each contributes time and effort (Franklin 2006: 196).
year. But he, he, you know, it’s intriguing. Little animals and what they know, and their sense of hearing. Maggie Cat, she was 17 when she died. She could hear my, say, Marie lived in Sydney at Hurstville, and that cat could hear her car coming, and she’d be up on the balcony waiting for her to turn out the heavy traffic road there into the street where the lived. She’d be up there on the balcony, waiting, watching, ‘cause she could hear her coming. Their abilities are such that people, humans just don’t give them credit for it. Maggie Cat I use to, when I was going to be down there and they had budgies, so I’d go along with Steve and I’d be picking up these, the seeds on the weeds which the budgies loved, and Maggie got very angry. She wanted the green bits thanks! (laughs). (Pearle Giddins)

PK*: If you’ve got an animal, then you care for it. It’s like a member of the family. That’s my opinion of animals. You’ve got them, you care for them. Look after them.

BK*: That’s my opinion.

PK*: Yep. I must. This [bird] is our baby. Grandmother one that was on my shoulder, and I’ve got another one up there, and one that’s on my bed no doubt. Yeah, a cat on the bed. Yeah, if you’ve got an animal, you look after it. Don’t abuse them. Don’t ill treat them. No. As you can see, they’re so spoilt. (Pippa and Bob Kearns*)

Pet ownership places animals and humans in close proximity, allowing each to form perceptions and knowledge of one another and to form mutually strong and shared animal/human relationships204. For the research participants, these strong bonds create sociozoologic categories and separations within an animal species, providing pets with a higher social value and worth than other animals in the same species. This entitles pets to some human rights that are not usually accorded to animals. Such problematisations are

204 The way the research participants articulate the position of pets in their family is also significant. The intimate relation and role of pets means this is not simply humans owning an animal. If this was the case, pets would not be articulated in human, familial terms - they would remain separate from humans, their spaces, and their lives in general. Additionally, this is not anthromorphicism. Rather, the human/animal family is a hybrid, involving a dynamic relationship of “co-residence, enduring ties, emotional interdependence, friendship, company and shared activities” (Franklin 2006: 207).
not considered by official science, which only attributes limited human rights to nonhuman primates in their pseudo-human status, though is based on entirely different considerations and circumstances. As highlighted in ‘The Biological Gaze: Selecting an Animal’, however, the research participants did not agree with these social problematisations.

For some research participants, contemplating the use of animals in XTP and with considerations for their fondness for their pets, leads them to reflect on human and animal psychology. This reveals animal categorisations to be flexible and ambiguous. That is, while animals operate as a parallel community to human society, which propels animal exploitation and animal use in XTP, there is also a social erosion of such boundaries\(^{205}\). Human utilisation of animals-as-tools and animals-as-pets distinguishes animals as different (dividing human/animal), while also forming intimate interspecies bonds (merging human/animal). The closeness of and connections between the human and animal worlds allows the research participants to emotionally reflect on and identify with animals and their exploitations by humans. As a result, the ambiguity of the animal/human bond poses challenges to the XTP network:

Far as I’m concerned, animals have all got brains and they’re not given any credit for it. Man thinks he’s the kingpin and knows everything, but he doesn’t. You have a dog or a cat and soon find out that it’s got as much brain as you have. So people, well white, the

\(^{205}\) This argument is explored in more detail by Franklin (1999: 36).
white man seems to be worse than anybody else. He seems to think anyone that’s not a white man, he treats the black man like an animal. Think about the American slaves. They were just treated like animals. So, it’s just this, white man’s problem I think. He’s, he just thinks he’s smarter than most and mostly he’s not. (Pearle Giddins)

I think as we get older we seem to, I feel a lot of people seem to cherish other forms of life. When you’re kids you don’t worry about animals. But when you get older, you start to appreciate all the other animals in life [...]. (Kevin Robins)

Like I said, I have very little concern or regard for the human side of things because we’re supposed to be at the top of the chain, (pause) the other poor little sods are at our beck and call. They’re herded, they’re killed for food and (pause), but on the whole, I still say that it’s a worthwhile thing to do. (Frank Smart*)

Animals are probably better than humans (laughs). They’re... I like animals, I love animals. They’re... they never let you down. (Lyn Robertson)

I’m generally quite sympathetic to animals and I wouldn’t like to think animals just being harvested for the wellbeing of humans. (Doug Mason*)

We’re very good at destroying everything around us just for our own purposes, and when it comes to animals, you know, I, I don’t believe in animal rights as far as animal rights people are concerned. I wouldn’t join any organisation. But I believe in animal rights as far as that animals have a right to coexist without being destroyed or imposed upon in an artificial way by humans, just because humans have the power to do it, you know. (Doug Mason*)

We’re not a nice race of people really. We destroy (laughs) all these things around you, and people get on their high horses and say how dreadful it is and everything, but if you compare everything and take everything into account, well, you know, there’s too many not nice things that if we got rid of all of them we’d probably just have to, you know sit on a rock and do nothing because there’s too much not nice things in the world. It’s just the way the world is. (Cecilia Breau*)

In the human/animal relationship, these research participants view humans as a destructive species that impinge their own desires and...
wants on the surrounding (animal) world with careless abandon. Contrastingly, animals are viewed as dependable, reliable and ‘good’. The research participants thereby express compassion towards the plight of animals, which are considered victims of uncaring, thoughtless humans. Franklin (1999: 54) calls this misanthropy\textsuperscript{206}. As already witnessed, however, contradictory approaches and opinions continuously surface in regards to animals and their use in XTP. Therefore, despite these expressions of misanthropy and other types of ambiguity, the research participants can still continue to support XTP and align in with its network. At the same time, these problematisations show that this does not occur unquestionably and not without significant concerns.

**Conclusion**

It is obviously very important to understand Australian attitudes to and practices with animals because these matter and they are going to matter more. (Franklin 2006: 198)

Animals mirror human desires and wants. They come to be problematised in relation to human needs and purposes. This chapter explored the ways humans talk and gaze upon animals, the relevance of these narratives and problematisations to XTP, and the

\textsuperscript{206} Misanthropy “refers to a general antipathy to humanity as a species, rather than an individual dislike or hatred of people or others. Specifically, it refers to those who see humanity as disordered” (Franklin 1999: 54).
consequent classification of animals on the human-determined sociozoologic scale. This determines the place and functionality of animals in human society, and is influenced by whether humans diagnose particular animals or an animal species as 'good' or 'bad'. Ultimately, this chapter focused on 'good' animals; animals that serve useful purposes to humans as tools or as pets. The utility of animals is highly important to this process. For example, by connecting XTP to the MLI, actant stories construct complex problematisations of animals based on the equivalence of process (official science and the research participants), differentiations of purpose (official science and the research participants), and differentiations of process (research participants). This renders XTP as similar to but different from the MLI, all of which sustains and justifies XTP and its networks. At the same time, animal industries are strongly differentiated and separated – one cannot simply justify the other.

The use and suitability of the animal is additionally problematised by its parts, which determine the whole. Ontology is problematised by the animal's content and the context in which it resides, and provides meaning and value. In other words, a pig bred and raised in a laboratory is different from a pig bred and raised in an intensive farming environment or in open farm setting. Such problematisations highlight that the sociozoologic scale not only problematises the differences between human/animal-animal species, but also between animals in the same species. Therefore a pig is not simply a pig, as
what a pig is is determined by how it is raised and bred (content), where it is kept (context), and why it has been raised and kept (purpose).

The existence of animals-as-pets challenges and complicates these problematisations, as the dynamic affinity between humans and pets (and pets and humans), renders animals-as-tools difficult. Again, the animal’s content and context, as designated and narrated by humans, is important. Animal species commonly conceived by humans as pets can therefore be used in XTP, as long as the individual animal has been bred and raised - and here again is the relevance of content and context - for that purpose. Affinity with the individual animal is more important than the animal species as a whole. Therefore, animal/human intimacy brings new and important considerations to the XTP network and its problematisations, including risks surrounding the heightened intimacy between humans and animals in XTP hybridity.

Perhaps some of this anxiety, difficulty and contentiousness are summed up by Kim Dodwell:

It’s a lot of pigs for one person isn’t it? Four pigs just to get a couple of islet cells. But then I eat meat so it’s very hypocritical. I don’t really... I can’t stand on a cockroach, I can’t do anything to animals that’s mean... I can spray spiders if they’re near me but I’d rather shoo them out the door, which is not really anything to do with the pig. Gee... (pause). Small pigs are cute, big pigs they’re not so cute (laughs). Oh dear. I guess it would just take a while to get used to the thought of it and you know, then is it easier to know that a pig died rather than like, a human died for that as well? I guess... that’s
actually quite confronting isn’t it? To think of them just grown for your own... but I suppose so. I suppose it is a good thing in a way, it does help people. I suppose we all just died before didn’t we? We didn’t really, we just... (laughs). Yeah, we did, didn’t we? (laughs) I think some people can take it to the extreme and I guess... no I guess that’s fine, growing animals for health and all that sort of stuff. Yes, that was a long answer, sorry (laughs). I had to workshop that didn’t I? (Kim Dodwell)
6 - Risk and Trust: Science, Infection and Health

Introduction

So far, actant stories have problematised animal selection (‘The Biological Gaze: Selecting an Animal’) and use (‘The Sociozoologic Gaze: Using Animals’). These lead to considering networks outside of, but socially relevant to, the XTP network, as well as the formation of new networks. That is, networks within networks emerged, presenting new intermediaries and increasingly complex and ambiguous problematisations and stories surrounding animals and their application/s in XTP. ‘Facts’ are thereby temporary; subject to flux, other internal and external network associations, and altering and competing problematisations.

In this chapter, the actants turn their gaze to risk. While risk is often conceptualised in sociological theory as bad and to be avoided, the actants’ stories of risk in XTP challenge such assumptions. These problematisations reveal that risk can be something desirable, and can function as both a positive and negative experience. For example, risk-taking as positive is based on personal expectations, and the potential benefits it could bring. These risk stories again stress how networks can emerge in networks (and then inside these networks and on), which challenge scientific attempts to simplify and
black box the XTP network. Complexity, tension and contradiction reign.

Actant problematisations of risk revolve around various conceptual networks that overlap the XTP network, as well as pre-existing networks of association. Memberships of these networks are largely determined by subjective knowledges and experiences that then determine the network collectivities, such as living with Parkinson’s disease. For example, working in XTP links many of the scientists into a scientific XTP network, where they centre their risk stories on xenozoonosis\textsuperscript{207}, and almost exclusively on porcine endogenous retroviruses (PERV). Other actants, however, choose to focus on a wider array of XTP risk possibilities, and draw connections between their existing social problematisations of tangible risks to facilitate and bring understanding to the abstract concept of risk in XTP. For instance, risk experiences with health problem/s can influence subjective understandings of XTP, and reveal identity to be an important element of risk assessment. Therefore, actant stories about xenozoonotic risk differ depending on the ‘network within the network’ to which they are enrolled and subscribed. This means multiple risk networks can simultaneously exist that all revolve around one risk concept in XTP – xenozoonosis - albeit with slightly distinctive problematisations. Amongst actants, therefore, differing

\textsuperscript{207} Xenozoonosis refers to cross-species viral transfer that occurs due to XTP. For more information, refer to the glossary and the chapter ‘Xeno-what? A Literature Review’.

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risk networks that can contradict are revealed between scientists and other research participants. At times, however, these risk networks also overlap. As a result, this chapter and the following chapter (‘Risk and Uncertainty: Science and Zoonosis’), largely separate various actant collectivities – primarily scientist actants and other research participant actants - to expose their distinctions and commonalities in risk problematisation. Science is, however, not always separate, as it features throughout these risk stories and can mobilise social arguments. Consequently, science continues to aim to be an OPP; attempting to create and control a network where science is permitted to cross from science to the social – and back again. As explored in the previous chapters, this aids science to affirm its own expertise while attempting to marginalise those problematisations and stories that differ.

Science and Xenozoonosis

For science, the viability of XTP is - and can only be - tested through scientific processes, methods and materials. Many of the research participants who identified as a scientist (and part of the scientific XTP network) believed that, in addition to science’s ability to test the viability of XTs, it can also provide safety and security in regards to xenozoonosis. This is a technical understanding of risk, which suggests that science can objectively and correctly measure the possibility of xenozoonosis, and prove or disprove the viability and
probability of xenozoonotic threats. Risk certainty can thus be gained through rational assessments that provide the basis for objective decision-making. Therefore, science positions itself to be an OPP through which XTP and xenozooonosis must pass. Furthermore, their ownership, control of, and privileged access to the resources needed to test and diagnose any xenozooonotic threats, make them indispensable to the network. At the present time, scientists in the XTP network assert that scientific methods have not revealed or produced any potential xenozooonotic threats to humans, and therefore it is highly unlikely - if not improbable - that xenozooonosis and/or a xenozooonotic event will eventuate.

So really there’s just no evidence of any in vivo cases of further transmissions of any virus. (Denbigh Simond)

But to say that this person is carrying a pig heart or a pig tissue is more likely to come down with an infectious disease, I don’t believe. I don’t accept. I mean, that needs to be investigated but I... I’d need to be convinced of that and at this stage I don’t think there’s any information or evidence to say that would be the case. (David Strom)

Above, David Strom addressed what he perceives as a lack of scientific evidence relating to any xenozooonosis specifically from pig implants. This focus on xenozooonosis from pigs features throughout the opinions of the research participants who are enrolled into the
scientific XTP network, and reflects an acceptance of the problematisation of pigs as the source animal for XTP\textsuperscript{208}.

While xenozoonotic risks could relate to a number of known and unknown infectious possibilities, as well as contemporary and historical zoonotic events occurring in humans\textsuperscript{209}, scientists choose to almost exclusively problematise, reflect on and examine one xenozoonotic possibility - that of PERV. As a result, a wide and innumerable range of xenozoonotic potentials is reduced to one possibility and PERV, by operating as an intermediary to xenozoonotic risk, makes it easier for science to rationalise risk and to address and counter any risk concerns. This serves to narrow the scope of problematisation and network translation.

**PERV and the PERV Network**

As explored in ‘Xeno-what? A Literature Review’, PERV is carried in the pig’s genome and cannot be bred out with existing techniques\textsuperscript{210}. PERV became a major concern for XTP in 1997 when Patience et al.

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\textsuperscript{208} As addressed in the chapters ‘Xeno-what? A Literature Review’ and ‘The Biological Gaze: Selecting an Animal’, pigs have been selected as the source animal by official science due to evolutionary, physiological (scientific/natural), and ethical (social) reasons.

\textsuperscript{209} A number of zoonotic events that have occurred in humans, such as the Nipah virus (pig-to-human), are outlined in the chapter ‘Xeno-what? A Literature Review’.

\textsuperscript{210} There are, however, strains of pigs that do not carry PERV, as outlined in the chapter ‘Xeno-what? A Literature Review’.
found that while PERV did not infect pigs, it could infect human cells in vitro. This resulted in a new problematisation for XTP; namely it raised concerns regarding possible cross-species transmission and human in vivo infectivity from PERV. The result was that PERV became to be considered a potential human pathogen that contests the XTP network. This research also challenged the existing problematisations, whereby the only significant hurdles for XTP were considered to be the various stages and forms of immunological rejection. Due to this new and challenging problematisation, further scientific research has investigated PERV in vivo infectivity which revealed, for official science and the scientific XTP network, PERV does not infect humans in vivo and does not create new human disease/s.

As a result of this scientific research, the original problematisation of PERV has altered for the scientific XTP network. Namely, these latest results are viewed as objective and unquestionable, proving the xenozoontotic (PERV) safety of XTs. It also creates new problematisations, and supersedes those previously held about PERV. The result for XTP translation is that current scientific findings and knowledges are more factual and relevant than the scientific findings and knowledges previously generated by Patience et al. (1997a). The PERV network is thus formed.

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211 As this research occurred in the laboratory of Professor Robin Weiss, he is often credited with this work amongst the scientific community.

212 Refer to the chapter ‘Xeno-what? A Literature Review’.
The diminishing scientific concern over PERV demonstrates fluidity in regards to risk problematisation; the way in which conceptualisations and understandings move and alter over time (and within networks). This mutability of PERV risk means it has shifted from a dangerous threat to a benign topic. Consequently, PERV research that demonstrates a lack of PERV-xenozoonotic threat has a presumed authenticity and superiority, which allows XTP research to continue. This also illustrates the fluidity of science knowledge and truth, which is subject to change and contestation.

There’s no, to be honest there’s not actually even any concrete data that PERV actually caused disease in pigs so on that basis, you know, you could perhaps surmise there’s not a huge risk. […] Viruses do jump species though so you still have to consider that as a possibility and as Denbigh [Simond] said, no evidence at all in people who have directly been involved in xenotransplantation related events like these, so blood perfusion through pigs and things like that. So the evidence of it actually causing disease is non-existent in humans and non-existent in pigs. (Chris Moran)

We’ve, I don’t think we should be blasé and say oh it’s not going to happen but also studies that are overseas where they took purified PERV you know, grams of it and injected it into a number of different species of primates that were heavily immunosuppressed and followed them for two years and there was no evidence of infection at all. (Mauro Sandrin)

Really, there’s no convincing data to say that those [retro]viruses can actually go from pigs or pig cells to human cells. With all the research that’s been done and all the times it’s been tested and tried and evaluated as to whether those viruses can jump out of a genome of pig cells and bring certain cells into human cells, there is no evidence whatsoever. (David Strom)

There are animals, pigs in particular that have been diagnosed or tested for these viruses inserted in genome and there are breeds of pigs now without them that don’t have them so if you’re talking about
using those animals as a source of organs for xenotransplantation, well that risk has now been eliminated. (David Strom)

[...] to date, no evidence could be found for the transmission of PERV to humans. (Laconi 2006: 656)

The risk of PERV infection is now felt to be manageable, in large part because of the establishment of [...] safety procedures. (Sykes et al. 2007: 662)

However, several studies in humans and non-human primate xenograft recipients have failed to provide any evidence that PERVs can spread to humans from porcine tissue ‘in vivo’. (Yong-Guang and Sykes 2007: 522)

These observations further support previous studies that did not find evidence of PERV transmission in xenotransplantation recipients and suggest that risk of human inflection may be low. (Levy et al. 2007: 314)

[...] the transplantation of pig tissues to human has, so far, not resulted in the transmission of PERV. (Groth 2006: 180)

For PERVs to exhibit pathogenic potential, they must infect transplant recipients, and, although microbiologic monitoring of the patients has become a crucial component of properly regulated trials, there is no evidence of PERV transmission to patients treated with porcine xenografts. (Patience and Stoye 2004: 178)

An element of this scientific assurance, objectivity and problematisation of XT safety, is alleviating or confronting the risk-based fears of merging the self and other. The resulting problematisation is that PERV and xenozoons pose no issue to human safety, which indicates that the human/animal hybrid is safe – the animal ‘other’ is no longer a threat. Difference is not frightening. These problematisations also link with existing relations between
humans and pigs which, according to the translations of the PERV and scientific XTP networks, have not resulted in viral transfer. As a result, many of the scientist actants believe XTP poses little or nil zoonotic threat.

You have to monitor for PERV’s and other infectious organisms although the PERV issue is becoming less and less of an issue because there’s more and more studies being done but there’s a point you can never, ever say never but I mean we argued years ago that if PERV’s had really been a problem you probably would have seen it already. (Mauro Sandrin)

[…] I don’t think it’s [cross-species infection] as big an issue as people make it out to be. I think we’ve got to be careful, yes there’s the potential of PERV’s jumping species, and as I said before, if it was going to happen I think we would have seen it […]. (Mauro Sandrin)

The scientific XTP network has therefore reached agreement on human susceptibilities to xenozoonosis and PERV, namely that there is no or very little risk. This high level of consensus formalises the norms of scientific behaviour in thinking and communicating about xenozoonosis and PERV risk by black boxing it (‘ready made science’). A coherent narrative of the truth is resultanty stabilised within specific nodes of the XTP network, and an alignment of human and nonhuman actants to a ‘new’ sub-network - the PERV network - is realised. In this process, knowledges that advocate different opinions on PERV and xenozoonosis – both historically and currently - are marginalised from the PERV network. This establishes boundaries between what is internally accepted in the PERV network
and what is not. In other words, non-adherence to the PERV network involves an externalisation from the scientific communal norms of network behaviour and problematisation. The PERV network therefore privileges the knowledge that is acceptable and permissible to the internal coherency and truth of the network, while rendering external knowledges as erroneous. The black boxing in the PERV network provides an impression of certain knowledge and control, where the unknown possibility of xenozoonotic and PERV transmission to humans becomes known\(^{213}\). The further result is that risk becomes objectified by being reduced to technical, scientific measurements.

For Bernie Tuch and Chris Moran, knowledges and problematisations external to what is acceptable in the PERV network, or counter rhetorics, have slowed scientific progress and hindered the development of XTP. To be specific, Tuch believes if it was not for the research by Patience et al. (1997a) and the subsequent reactions (fear of xenozoonosis from PERV), XTP research would have progressed much further than its present state and possibly have provided human therapies. In Tuch’s and Moran’s views, knowledges external to and opposing the PERV network have thereby slowed the growth of science and the positive outcomes it could bring. As a result, Patience et al. (1997a) and the knowledge

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\(^{213}\) This is not to say that those externalised from the PERV network are also externalised from the XTP network. Rather, the PERV network operates within the XTP network. As stated previously, the XTP network is characterised by tension and contradiction.
they generated on PERV become unwanted blockages to XTP problematisation and development, and unwelcomed challenges.

The rational objectivity of science and the scientific method is thereby fluid, as emotion and a selectivity of research outcomes, is revealed to be an integral part of the scientific debate. Significantly, this also involves understanding and interpreting scientific results in ways that favourably continue the PERV network.

In the case of xenotransplantation we’ve got this absolutely unmeasured but presumably and I think we can quite reasonably assume it’s a miniscule risk, which is completely obstructing real tangible benefit that could be presented if the technology was allowed to mature and develop. (Chris Moran)

If Robin Weiss hadn’t ‘basically’ alerted the world to the potential risk of pig endogenous retroviruses in the late 90s, the potential use of pig cells would be that much further advanced. I’m not arguing what he did was wrong. I’m not saying that. If it hadn’t have occurred then the, the role of pig cells as a therapy for diabetes and other treatments, would be, many more experiments would have been done between then and now, and we would have a better understanding of their potential role. (Bernie Tuch)

Bear in mind history says that pig tissue in particular was transplanted in the 1990s, and it was only at the end of the 1990s when Robin Weiss in London highlighted the possibility that there could be pig viruses. Sorry, that there were pig endogenous retroviruses which could infect human cells in vitro. It raised the ante, and, and as a result, pig trials have been that much harder to carry out because of this fear. (Bernie Tuch)

Therefore, not all scientific research into xenozoonosis and PERV is equally valued in or inclusive to the PERV network. The scientific coherence in the PERV network does, however, involve a concession that zoonosis does occur in human society and could
happen - at least theoretically - in XTP\textsuperscript{214}. Past social experiences therefore become important to technical risk assessments. This is also contradictory. Namely, while the PERV network believes xenozoonosis to be unlikely, this will be guaranteed through appropriate scientific procedures and monitoring. As a result, science problematises and mobilises the risk of xenozoonosis and PERV through the selection of pigs as a source animal\textsuperscript{215}, continued XTP research and potential XTP therapies, yet science can simultaneously overcome and manage these risks. Science becomes the giver and provider. This management can occur through scientific knowledge in general (Moran) or more specifically, by the use of GE animals (Sandrin) and/or implementing appropriate screening strategies (Tuch). Risk is objectified, with scientific procedures possessing the ability to measure, control, and monitor xenozoonosis and PERV. For the PERV network, these scientific approaches ensure xenozoonosis and PERV will not happen or, if they do, will not be a common occurrence. Furthermore, they could be predicted, discovered, known, controlled and handled by science. Thus, the problematisation of xenozoonosis and PERV transmission to humans involves identifying that it is unlikely to happen, but if it did, it can be managed. As a result, science reinforces its position as an OPP by asserting its own abilities to deal with the theoretical, unpredictable and unknown. At the same time, objective risk measurements are

\textsuperscript{214} The challenges this can bring will be explored in more detail in the next chapter ‘Risk and Uncertainty: Science and Zoonosis’.

\textsuperscript{215} How source animal selection is problematised was detailed in the chapter ‘The Biological Gaze: Selecting an Animal’.
influenced by subjective risk measures and experiences, as revealed by Sandrin’s linkages between PERV and HERV (human endogenous retroviruses).

I see that, well yes it [infection] can be a problem, so it can be when you transplant human tissue. Animal tissue may have a slightly greater risk, but there should be appropriate checks and balances that one can put into play. (Bernie Tuch)

[… in regards to cross-species infection] people say oh yeah but patients are going to be immunosuppressed, well we’ve been immunosuppressing patients for allotransplants and we haven’t seen HERVs come out and infect people and you can breed these things out so there are pigs that are low in PERV or have no PERV so you can genetically engineer it out so that’s why I don’t think it’ll be an issue. (Mauro Sandrin)

If… it’s not no risk, it’s a risk that requires evaluation and rational appraisal is probably the best… the way I describe my attitude towards it. (Chris Moran)

Despite science acting as an OPP, and attempting to blackbox xenozoonotic and PERV risk through the coherence of the PERV network, the quantitative possibility of xenozoonosis remains unknown. This lack exposes a deficiency of knowledge, which aids to further problematise the unwanted challenges of xenozoonotic uncertainty and risk anxiety. As a result, the PERV network continuously attempts to provide risk certainty and to quell risk anxiety through apparent coherency and objectivity. This alone, however, does not achieve the desired outcome – the ability to proceed with XTP research and human clinical trials without public and scientific fears of xenozoonosis and PERV. This would also
require the successful enrolment of animals into the larger XTP network. In a further attempt to achieve this outcome, Sandrin and Moran employ quantitative language to provide the appearance of xenozoonosis and PERV risk measurement. This statistical employment allows xenozoonotic risk to be stabilised, aiding to provide risk assurance and to facilitate human feelings of safety and security. In other words, quantification attempts to counter and diminish differing perceptions of xenozoonotic risk by moving the unknown and abstract to the known and tangible. This connects to the idea that acceptable risk is guided by statistical analysis. At the same time, technical rationalities are strongly influenced by cultural rationalities\(^2\).  

The estimates provided by Sandrin and Moran reaffirm the PERV network, reinforcing xenozoonotic transmission to be an unlikely scenario. For Sandrin, this risk is in the negative, noting it is highly unlikely and improbable. Moran, however, crosses the nature/social divide by employing a comparative approach, contrasting PERV risk to everyday social acceptances of risk. In this scenario, PERV risk is compared to the risk of a domestic aeroplane flight crashing - the risk of crashing is present, but is so low that is should not warrant

\(^2\) Traditionally, the separation between science (expert)/publics (lay knowledges) is accompanied with a division between rationality (objectivity)/irrationality (emotion). In all of these dualisms, the publics lose. Science studies, however, highlights that emotion is used by both the publics and the sciences, and that emotion itself is a form of rationality. Plough and Krimsky (in Fischer 2005: 55) label these different forms of rationality as cultural (the social, personal and familiar), and technical (the scientific, depersonal and quantitative).
conscious reflection or effort. In contrasting this to PERV risk, Moran believes PERV risk to be significantly statistically lower and should not warrant concern. Once again, however, xenozoanosis and risk transmission is not ruled out by Sandrin and Moran, though it still remains quantitatively irrelevant. In this way, they aim to make the incalculable risk of xenozoanosis calculable in order to stabilise and reinforce xenozoanotic risk knowledges and the PERV network. Furthermore, in this process, Sandrin and Moran abandon objective risk assessments based on scientific method for subjective risk assessments. That is, they no longer use scientific evidence to discuss risk. Rather, to further problematise the PERV network’s risk assessments, they draw upon their own personal beliefs and experiences. In the case of Moran, the example of an aeroplane crashing is additionally mobilised to illustrate the irrationality of xenozoanotic fear.

So you know, never ever say never because there might be one in ten to the minus 15 or something chance that it might happen but I think routinely it probably won’t. (Mauro Sandrin)

So we know that viruses can cross species boundaries, we know that recombinant viruses in particular have greater potential to cause harm than non recombinant viruses and on that basis you need to be careful for making sure that you’re not introducing a problem via these endogenous viruses. But I don’t think it’s a serious problem, it’s kind of like... asking a question of you know, when you go on an aeroplane flight from Sydney to Melbourne, should you be really,

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217 Another research participant, Peter Collignon, challenges the quantitative analysis by Sandrin and Moran, questioning the use of such estimates, while using measurements in a different fashion. This is explored in the chapter ‘Risk and Uncertainty: Science and Uncertainty’.

218 Interestingly, a similar scenario is used by Fischer (2005: 54) to illustrate the separation of risk rationalities and irrationalities in risk assessments: “Towards this end, the concept of ‘acceptable risk’ has been advanced to help people see the irrationality of their anxieties about flying in a plane”.

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really worried about the plane crashing. Well clearly you shouldn’t be and I’d say the risk of PERV transmission in a xenotransplant recipient is of that sort of order of risk except probably divided by you know, a thousand or more. You know, it’s a very, very, very low risk thing but it’s always something you need to keep in mind because it can happen and there are historical, biological precedents for this type of thing happening and therefore we need to be careful to ensure that it doesn’t happen and try and manage the situation so that it doesn’t happen. (Chris Moran)

An important aspect of Moran’s justification of low PERV risk, and one to which I now return, is crossing the science/society divide. Previously, scientific research on PERV was used to argue that it does not pose a human xenozoonotic risk. This alleged rational and objective approach gives away to sociocultural experiences and understandings of risk. The logical problematisation between the two is that irrational fears of the everyday equate to irrational fears of the novel. This is also demonstrated by David Strom, who believes the current numerous avian influenza meetings, summits and conferences demonstrate the accepted, everyday, real possibility of a human-topic avian influenza outbreak. While this could be mobilised to argue the threat of xenozoonosis, Strom uses these current social zoonotic anxieties of avian influenza to narrate the comparative xenozoonotic safety of XTP. So while avian influenza is perceived by Strom to be a real and current threat to humans, xenozoonosis is not. As a result, like the cases of Moran and Strom, social scenarios, understandings and experiences of risk are used to illustrate, problematise and reinforce a perceived xenozoonotic safety of XTs.
It’s a real risk, it’s out there, it’s right now... and will always be around, well for the foreseeable future to say that there’s an increased risk of another pandemic because someone’s got a, carrying a pig organ, I find rather ridiculous because the real risks that we face every day right now are, I believe are high. I mean, worldwide they’re having summits and meetings and conferences regarding avian flu outbreaks. That I see as a far more greater risk than anything else. (David Strom)

**Risk, Trust and the Everyday**

Clearly for the PERV network and the scientist actants therein, the risk of xenozoonosis and more specifically PERV, is disproportionate to the benefits which XTP is expected to deliver. In many cases, these infectious risk events are vague estimations. Cohesiveness of the XTP scientific community in a negative-risk model creates specific problematisations that align scientists together as an authoritative voice in the black boxed PERV network. The resulting problematisation is that the pig body and the animal/human hybrid are not threats in XTP. Stories and problematisations that differ from the PERV network are externalised\(^\text{219}\).

The successful scientific problematisations and alliances forged in the PERV network and amongst the scientific community in general, impacts on the social perspectives and perceptions of xenozoonotic risk and scientific ethical practices. The research participants – as part of the social milieu – consequently invest their faith and trust in

\(^{219}\text{These challenges will be explored in the following chapter ‘Risk and Uncertainty: Science and Zoonosis’}.\)
science ‘experts’. Such investment is valuable to the scientific community in furthering and deepening their perceived value and trustworthy social status, advancing their problematisations of PERV and XTP, and subsequently expanding enrolment to their networks. At the same time, this privileged social status and designation as an OPP comes with heavy social expectations and moral obligations.

For example, Steven Clarke* believes scientists are only proceeding with and researching XTP because they understand it and, by consequence, understand what they are doing (including the implications of their actions). This means, as Colin Bruce, Kevin Green and Kevin Robins assert, scientists are expected to have been thorough in their XTP research, which includes accepting, analysing and eliminating any xenozoonotic risk. This places a great onus and trust in science to fully appreciate and manage any possible consequences of XTP during the research process and prior to implanting pig parts into humans. These expectations mean that, for the research participants, science would not proceed in XTP without a full understanding and knowledge. Scientists are expected to know an event and its possibility before the event occurs. Thus, the research participants believe that scientists are inherently ethical

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220 The research participants also invest their trust and faith in science by trusting in their appropriate selection of an animal XT source, as explored in the chapter ‘The Biological Gaze: Selecting an Animal’.

221 This is perhaps unsurprising, as many of the research participants rely on medical research and developments to manage their own health or that of a loved one. As a result, significant amounts of trust, emotion and faith are invested in scientific and medical research, as well as those who facilitate this research and provide its outcomes directly to the consumer. Interestingly, and unexplored in this thesis, the research participants do not always trust their network of medical specialists. This development of trust extends from how comfortable the research participants feel with their healthcare professional.
and transparent in scientific problematisations, processes and practises.

Similarly for Bill Kent*, any negative consequences or problems that could eventuate from XTP would be circumvented by the plethora of scientific knowledge that exists. This encompasses the ability to effectively and efficiently deal with any xenozoonotic events that could surface or develop. Like the stories and problematisations of the PERV network and in particular, the quantitative approaches undertaken by Moran and Sandrin, Kent* also seeks a quantitative definition. His story, which is based on and defined by cultural rationalities (social knowledges and experiences), is one that complements the scientific problematisations. Given Kent’s* trust in science, this is hardly surprising. To be specific, Kent* views the scenario of consecutively winning the lottery for three weeks in a row to be a more likely scenario than a xenozoonotic event. In other words, the risk is so quantitatively low that it is not worth contemplating or even addressing. In contrast to Moran and Strom, however, Kent’s* quantitative social analysis draws upon a fortuitous yet improbable event, rather than comparing the likelihood of two negative risk scenarios – an aeroplane crashing (Moran) and an avian influenza epidemic (Strom). Despite these differences, both problematisations of risk reach the same conclusion - the highly unlikely scenario of xenozoonosis and the highly improbable event of a human epidemic (or epidemics) via a faith and trust in science.
I think they’re, the scientists know what they’re doing, otherwise they
wouldn’t be doing it. (Steven Clarke*)

I believe whole heartedly in this because I honestly don’t believe that
any of this would be done unless there is so much research that is
done that is viable and sort of getting back to the ethical side of this
as well. (Kevin Robins)

I don’t think the doctors would be talking about xenotransplantation
unless they see some quality coming out of it. (Rod Logan*)

I would have to rely on the people, on the researchers and the
clinicians to eliminate as far as possible that sort of risk and press on
from there. (Kevin Green)

Well that’s, you know that’s why they’re confident that nothing is
going to go wrong because they’ve you know, crossed the t’s and
dotted the i’s and making sure nothing can go wrong. (Colin Bruce)

You know, at least now in this day and age, anything that does
happen, well, at least we have a reasonable amount of science that’s
current and up-to-date and able to work on those sorts of problems.
So, so that’s a big, big no problem. (Bill Kent*)

Yeah, I don’t really have a problem with the infection thing because
the chance is, okay, say they find this, a proper cure for diabetes and
they can stop rejection and all that sort of stuff, but then they’re going
to have to come up with, and these people that are doing the research
probably will, come up with a drug that will stop infection and that.
[…] It’ll also be, I would imagine, people working on technology to
stop all these things happening, so the chances are that they’re all
done their job right and they’re all come out correct. (Jeremy Batt*)

Well, I would actually say that if there is a, a (pause) risk, it would be
minimalised, you know. (Frank Smart*)

[…] I’m sure that there is, like they know all the diseases now, what
they’re doing with the bird flu and all of that, like they’re right on top
of that. I can’t see why, like if something did happen, they wouldn’t
know it straight away. I can’t see a problem there. (Colin Bruce)

Oh, they’re hard onto this mad cow disease and this chicken thing,
aren’t they. They’re quick on the uptake there and they’re learning fast
[…]. (Pippa Kearns*)
I mean, you’re looking at they’re not going to do these sorts of transplantations unless they had covered all the risks to the best of their ability, so the risks, and I’m saying risks, they are in my opinion minor. (Kevin Robins)

I, if you create a whole new disease, then somebody else will create a means of suppressing it or killing it or whatever. But I think that, well, I think in the overall scheme of things you’re probably more likely to win Tatts lotto three weeks in a row. [...] It’s just way out there in the, in the zillions, zillions to one, the chances of it happening. And I think that, you know, a risk that’s worth it as far as I’m concerned. [...] It’s just way out there in the, in the zillions, zillions to one, the chances of it happening. And I think that, you know, a risk that’s worth it as far as I’m concerned. (Bill Kent*)

Dwelling on what might happen down the track is as useful as sitting here pondering what you might do if you win Tatts lotto. It’s just a waste of time to me, so. (Bill Kent*)

Significantly, these problematisations reveal that, for the research participants and the PERV network, risk can be controlled and contained. Such measures are achieved through technical approaches and knowledges, which allow for objective judgement. This dependency of the research participants on scientific knowledge to provide security against xenozoonosis, or to quickly manage it if it does eventuate, extends into a trust of XTP scientific environments. Steven Clarke* and Ian Douglas perceive these environments to involve stringent conditions, where the source animals for XTP are painstakingly screened and monitored for potential infections and viruses. This thorough approach of science also extends into the source animals being specifically bred for XTP. Therefore, these research participants believe that animals destined to be source animals for human XT therapies are special and different to other
animals within the same species\textsuperscript{222}. As a result, the perceived technicality and rationality of science is highly important. This is particularly the case for the apparent meticulousness of science, where specially bred animals are subjected to rigorous scientific screening. These procedures are considered by Clarke\textsuperscript{*} and Douglas to provide xenozoonotic safety and security, as they entail careful and methodological scientific monitoring and control. As a consequence, they become part of the PERV network, reaffirming the problematisations of PERV by science, as well as reinforcing the expertise of science and its role as an OPP to XTP and XTP safety.

When it’s human-to-human, animal-to-human I think, they’d have special animals bred aside, kept sterile, etc. It’d be fine. (Steven Clarke\textsuperscript{*})

I don’t really see a problem. I really don’t because the animal that you’re getting the tissue from is under control clinically okay, so I can’t see how that animal could be coming in with any form of disease, right? If there’s going to be a problem I don’t think it’ll be a viral problem. It would probably be more to do with tissues not being compatible. [...] I think you’ve got a bigger risk in that area than getting some kind of infection from that animal because I think the number one priority is to have a pool of specially bred animals, birds or lizards (laughs). (Ian Douglas)

Medical and Infectious Risks

At this point, many of the research participants have invested their trust in the science, scientists, and scientific methods, to guard

\textsuperscript{222} This view of animals is addressed in detail in ‘Tools - Breeding’, found in the chapter ‘The Sociozoologic Gaze: Using Animals’.
against xenozoonosis. This reflects an adherence to the PERV network and its problematisations. At the same time, a faith in science and the PERV network does not secure and stabilise the research participants’ risk anxieties. As social actants, their everyday social experiences and cultural rationalities of risk are highly significant in their xenozoonotic risk assessments. This means that some flexibility on problematisation remains within networks, which allows actants to apply their own risk assessments even though network adherence is seemingly achieved. In other words, while this brings new narrations into the PERV and XTP networks, this does not necessarily lead to destabilisation. Rather, tensions can be used to reinvigorate and extend the reach of the network. Such contradiction, hesitancy and complexity do not necessarily compromise a willingness to pursue potentially risky situations.

In this section, it is revealed that the research participants often relate or connect the unknown, new, and unfamiliar medical procedures of XTP, to known and familiar medical procedures and techniques. Thus, medical scenarios allow them to negotiate the infectious possibilities of XTP in a general manner that goes beyond – and does not necessarily consider - xenozoonosis. These familiar risks may not have been personally experienced by the research participant or, on the other hand, the research participant might currently be, or have, experienced such medical risks. In any case, the medical situations provide the contextualisation and
problematisations that the research participants seek to deal with and understand the potential risks of XTP, bringing unknown and the unfamiliar (XTP and xenozoonosis) into their comfort zone. This also reveals that the research participants feel the infectious risks of XTP are of a medical nature, rather than drawing correlations between XTP infection and xenozoonoses. As a result, infectious risks are further problematised by relegating XTP and its risks to being another everyday medical risk in a swag of potential, everyday medical risks.

Specifically, the research participants use a variety of medical situations to reveal that they view XTP as a medical procedure that, like other invasive medical procedures, carries a risk of infection. This connects the infectious risk of XTP to surgical procedures, in preference to attaching it to dangerous, pathogenic pig implants and xenozoonosis. By drawing distinctions between these different and possible infectious risks, the research participants eliminate the xenozoonotic threat from their XTP risk assessments. In addition, XTP is not distinguished as novel or different from other medical interventions, as they all involve the same or similar infectious risks and no guarantees of success. An acceptance of medical risk/s thereby involves an additional acceptance and acknowledgement of the possible failure or other negative consequences that can result from risk-taking. It is these cultural forms of risk analysis that technical assessments fail by ignoring how risk is personally
experienced and judged on past incidences. This allows XTP to become an everyday medicalised event and social experience that as manageable as cutting your finger (Robins) or foot (Batt*), having haemorrhoids removed (Kent*), or experiencing a blood clot (Douglas). The strangeness of XTP becomes familiar, rendering it a banal medical procedure.

This problematisation of risk additionally separates the potential XTP recipient from communal anxieties of xenozoonosis. Importantly, the infectious risk of surgery is embodied; experienced in and by an individual. Xenozoonosis, however, involves the possibility of animal-to-human infection and a possible human-to-human spread. This connects individual risk to epidemics, pandemics, and public health on a national and international scale. In contrast, the research participants align infection with standardised risks experienced in other medical procedures, which serves to neutralise the risk of xenozoonosis or at the very least, dialogically avoid it. In other words, xenozoonosis is separated from XTP by perceiving the infectious risks not to be associated with mixing the self (human) and the other (pig), but with human vulnerabilities that are exposed when the protective boundaries of the skin are violated through surgery. This is not to say that the research participants perceive infectious risks to be an evil ‘external other’ to the pristine ‘internalised self’. As expressed by Jeremy Batt* and Ian Douglas, these infectious events result from the active dynamics between the internal self (which
implicates pre-existing medical ailments such as Type-1 diabetes (Batt*), and heart problems (Douglas*), and the external environment of everyday living and medical interventions. Therefore infectious events, including those possibly associated with XTP, are problematised to be an intimate result of this interrelationship. This self/other connection stands apart from the hybrid threat of XTP. Furthermore these problematisations of infectious XTP threat, while substantially different from the PERV network by placing medical procedures in the centre of analysis over xenozoonosis and PERV, still reaffirm the XTP network. This occurs by drawing on differing yet complementary knowledges and rationalities – science (PERV network; primarily technical rationality) and the social (the research participants; primarily cultural rationality).

It would be no different to having haemorrhoids removed. It’s still a medical procedure, isn’t it? I mean it’s… (Bill Kent*)

Whatever… even if there is some medical procedures that are 100% these days, they’re not 100%. There is always a risk. (Scott Trapp*)

So they have to tell you the worst scenario. It’s like when you have an operation, they have to tell you that you might die, yes you might, but you might live too. (Adrian Evans)

Number one, any operation, you cut your finger you’re liable to infection for a start, so okay it’s not animal to human but it’s still an infection. An infection is an infection as far as I’m concerned, whether it be staf or something else. (Kevin Robins)

I’m prone to infection anyway, purely by being diabetic. [...] I’ve always got to wear covered in shoes because if I cut my feet, that’s the worst place you can cut yourself because that’s the poorest
circulation point in your body they tell me. So infection is something I’m used to anyway. (Jeremy Batt*)

Yes, three risks. What are the three? Infection, bleed-out, die. And the doctors look at me and I always, cut the crap, I’ve said what you wanted to say but I’ve said it in three words instead of five hundred words (laughs). Because that’s basically the risk with any operation. (Kevin Robins)

I think you’ve got to take a risk in life and I think if there’s a risk in it, I mean there’s a risk every time they operate there’s a risk of infection. (Sinah Hoskings)

I don’t think it is too much of a risk. Just like when they put the first heart in. The person died off in a few hours, a few days, but they got better as they went along. (Steven Clarke*)

When I had open-heart surgery, they explained it’s risky. You could die. So you’ve got to stop the heart and connect it to a heart-lung machine, okay? That’s a bit of a shocker when you wake up and a couple of days later you think… my heart wasn’t working. [...] Now anything could have happened. Something could have gone wrong when they stitched one of the arteries in there, there could have been a blockage later, I could have got a clot you know? Anything. Clots are a risk. (Ian Douglas)

Despite these problematisations of infectious risk which eliminate the xenozoonotic threat, some research participants believe the possible health and medical risks of xenozoonosis are evident through current social experiences and anxieties encasing zoonoses. This approach suggests that the research participants have a belief in zoonotic inevitability, which distinguishes them from the PERV network. These problematisations thus appear to challenge the PERV network; namely xenozoonosis will happen because zoonosis does. This might imply the research participants feel powerless in the face of and towards zoonotic threats, and therefore cannot do anything to
manage, control or confront such risks - what is the point of opposing XTP on xenozoonotic grounds given that zoonosis is already happening? At the same time, these assumptions are perhaps too simplistic and deterministic.

For the research participants, zoonosis is already socially experienced, similar to but different from xenozoonosis. Significantly, this is accepted as part of their everyday social reality. As a result, xenozoonosis is problematised not to be any worse than, or necessarily different from, existing zoonotic threats. While this could exasperate personal feelings of powerlessness and zoonotic and xenozoonotic potential, they are narrated as part of the banality of everyday life and are not to be feared, embraced or celebrated. Xenozoonosis is simply another everyday social risk that need not elicit serious concern or political and social blockages to further scientific development/s in XTP. The familiarity of dealing with one (zoonosis), thereby translates to another similar yet different scenario (XTP). For the research participants, current zoonotic concerns surrounding avian influenza are the prime example of everyday zoonotic threats that simply need to be accepted and managed\textsuperscript{223}.

So I mean have a look at this bloody bird flu, come from a chook. And it’s killing people but then look at HIV, that’s supposed to have come from monkeys in Africa and now it’s worldwide. So all those sort of things are happening anyway. It may be because of something man’s

\textsuperscript{223} This could, again, connect to the faith and trust many research participants invest in science and scientific research, as previously explored in this chapter.
done wrong, I don’t know but I don’t think that’s really a concern, because you’ve already got HIV and we’ve got the bird flu and regardless of what happens, because of the way man is treating this planet, those sort of things are going to happen anyway so... (Jeremy Batt*)

The issue of perceived risk of a pandemic from an animal disease being transferred from animals to humans, that happens in reality anyway but I don’t see that xenotransplantation will be the source of that infection. (David Strom)

Well, it would be no worse I think than having to deal with this bird pandemic, bird flu pandemic that everybody is talking about. (Bill Kent*)

First thing I thought of that it won’t happen, it wouldn’t happen [a new human epidemic]. And there’s always new diseases or something cropping up in the public anyhow. So... yeah. (Lyn Robertson)

Well, I think there is always a risk in everything that you do. You go out, there’s a risk, but I don’t think it’s a bigger risk. [...] It’s just like a flu epidemic in, chicken flu or whatever it’s called, poultry epidemic in China and that. And when it gets to humans, there’s no stopping it apparently. It’s a risk we have to take, isn’t it. (Steven Clarke*)

This form of xenozoonotic problematisation could pose difficulties for the PERV network. That is, while the PERV network asserts ‘nil PERV risk’ and ‘if xenozoonosis were to happen, science could deal with it’, these problematisations contradict this position. The research participants now assert that science cannot necessarily control or contain xenozoonosis. As a result, technical processes do not overcome or prevent cultural and personal risk anxieties. At the same time, this does not compromise the XTP network as, in the words of Clarke*, it’s a risk we have to take. Risk is thus inevitable and desirable.
These associations between zoonosis and everyday risk enable the research participants to gain an insight into and understanding of xenozoonosis by linking it to familiar knowledges and experiences. Abstract possibilities are thus understood through current events. Like XTP as a medical procedure, xenozoonosis becomes trivial. While this problematisation differs to that of the PERV network, it still retains a favourable outcome for the network.

Inherent to these risk stories is hybridity. By accepting zoonosis, xenozoonosis, and connecting them to everyday experiences and risks, the human/animal hybrid of zoonosis and xenozoonosis is rendered unproblematic – there is no desire to separate them. At the same time, these problematisations heavily rely on the perceived differences between humans and animals. Namely, the research participants problematise the value and worthiness of animal life to distinguish it from human life. It is these considerations which I will now explore.

Risk, Altruism and the Value of Life

As the research participants’ risk negotiations and cultural rationalities reveal, they problematise the risks of XTP by connecting it to the known, daily experiences of risk, such as existing medical conditions and everyday infectious threats of medical and zoonotic nature. Throughout these problematisations, the implication is that
risk and risk-taking is already an inevitable and acceptable feature of their lives, something which technical risk assessments and rationalities cannot measure. This renders XTP as another risk in a suite of social risks, rather than a special case or negative experience that requires different considerations. Risk can be desirable in that it can bring positive and productive results for an individual. Through these problematisations, the research participants challenge the risk constructions of the PERV network, but do not underwrite it. There remains room for contestation and contradiction.

For many of the research participants, XTP is problematised as a potential medical procedure that may positively alter their current or possible future states of health. It provides expectation. Thus, in addition to medical risks and zoonosis being part of daily life, the research participants also assert a necessity and inevitability of risk-taking for health. The possible gains for health thus render the risks of XTP as acceptable, as any risk is worth it for an improvement in health. In some cases, the risk becomes zero. Therefore, an acceptance or rejection of risk-taking is dependent on identity construction. There are two ways in which the research participants problematise these potential health-related outcomes of XTP, which become intermediaries to XTP – quality of life and life itself. Again, this process reveals how risk is a personal experience that cannot be technically measured or rationalised.
On an individual basis, some research participants (for example, Dodwell and Trapp*) narrate that in their current state of health and associated quality of life, they would not accept a XT and its related risks. Therefore, an individual's experience and perception of their health and quality of life becomes an intermediary to what kind of medical interventions and levels of risk they would accept. As their disease progresses and quality of life diminishes, this may alter the level of risk that they are willing to accept and undertake.

Consequently, the risk/benefit problematisation of XTP is not based solely on scientific expertise, technological development and perceived xenozoonotic possibility/ies. Rather, the personal experiences of health and quality of life are integral intermediaries to risk/benefit assessment. The larger the deficit in their perceived quality of life, the larger the perceived benefit from XTP becomes. In turn, a compromised quality of life and the risks of continued health deterioration are a greater risk and personal burden than those perceived to be associated with XTP.

Similarly, the research participants assert that if an individual has exhausted their quality of life or if they will inevitably die as a result of their health condition, then the risks of XTP are nullified and/or the potential benefit/s heightened. The risk of death or a seriously compromised quality of life is so high that any possible and remote
chance of improvement is highly desirable and sought after\textsuperscript{224}. The XTP risks are not as bad as inevitable death and, at the very least, XTP provides hope and possibility. This also problematises the potentialities and expectations of XTP, as an extension to and quality of human life are given high priority and importance as an intermediary to XTP. Again, the risks of xenozoonosis are thereby nullified if human choice is limited.

\begin{quote}
If you’re a good citizen and you do everything right, you’ve got a good chance, and you’re fairly sick, there’s a chance to improve your quality of life, you’d have a go at it. (Adrian Evans)
\end{quote}

\begin{quote}
If it’s going to make you better or a chance of making you better, what are you risking? (Rod Logan*)
\end{quote}

\begin{quote}
It’s a risk you’ve got to take. (Bob Kearns*)
\end{quote}

\begin{quote}
If I did have, if I did start having eye issues or kidney issues and losing toes and things like that, then I would be I suppose, starting to wonder what sort of... it just depends on what my quality of life became. (Kim Dodwell)
\end{quote}

\begin{quote}
JR: It would... if I get worse it’d be great [a xenotransplant].  
KR: What could it do for you though?  
JR: I could keep on doing good. (Kevin and Julia Robins)
\end{quote}

\begin{quote}
If you believe that you are going to get a 50 percent or better chance of increasing your quality of life, that risk is worth it, even though there’s that minor possibility [of xenozoonosis]. (Kevin Robins)
\end{quote}

\textsuperscript{224} This is not to suggest the research participants believe in the continual extension of life. While this point is not addressed in this thesis, it is worthwhile indicating that many research participants did not believe and expressed disgust in an infinite extension to human life. Some also espoused the merits of euthanasia when quality of life has disappeared. Consequently, while we should do everything we can to extend human life and improve the quality of human life, there is also a point when ‘enough is enough’. The point at which this time comes would be debatable, controversial, and very personal.
RL*: I think I would be prepared to run the risk.
FE: Well, as I’m saying, I think you’d probably run the risk if it was going to help.
KR: If it was going to help and give you a quality of life.
FE: Yeah that’s right […] (Rod Logan*, Fay Eisenhauer and Kevin Robins)

I reckon that if it can help the person and either improve their quality of life or give them a few more years of a good life, go for it. (Rod Logan*)

It would be easy, the worse you are, the easier to make the decision. Yeah. (Fay Eisenhauer)

I’d say, I wouldn’t risk it at this stage. I’ll carry on with my medication, but I, depending on how I feel in 2, 3 years times, if I’ve deteriorated, I might take it then. (Scott Trapp*)

FS*: Well, there is no such thing as a sure thing, but I dare say if you’re on the edge of the hole and someone’s treading on your fingers alternatively –
SR*: You’d say give it a go.
FS*: I would say, yes. I’ll try it. Whatever the risk. (Frank Smart* and Sue Reilly*)

I would say that if by the time I got to replacing an organ and you were going to die if you didn’t have piggy wiggy, then I would say go the pig, you know, to at least give you some chance of… and just see what sort of quality of life you get. (Kim Dodwell)

Like I’m thinking more about my wife but say people who can’t get a heart or can’t, like I think it should be happening if the people agree to it and you know, it’s their last chance, why not try it? […] So I’d be, in severe cases, I’d be for doing it if the people you know, if they said yeah go ahead and do it. (Colin Bruce)

There may be an increased risk of an infection coming across and causing problems but again, mostly the people going to be looking at this sort of therapy, you know, xenotransplantation, those sort of people are going to be at a point that they’re fairly advanced into a particular disease, so their quality of life is going down the tubes, in my opinion. (Kevin Robins)

ST*: I think that if I was told (pause) if, if the situation was now where they could transplant something into me which would cure my Parkinson’s and they said there was a 1% I could get some other infection from that animal, I would definitely take
that risk. I, I’m, the way I feel at this moment, I’m prepared to go quite a long way to actually, to take quite a lot of risks to actually, to actually get rid of a feeling which I have in me at this particular moment now, ‘cause I’m going through an off period at the moment, and I really wouldn’t wish this on anyone. (laughs)

RL*: I would think a lot of Parkinson’s people would feel the same. Give it a go. I think this is what influences a lot of the deep brain stimulators. It’s almost the end of the road, they don’t know if it’s going to work, although they’re pretty good at it, but I think they put up with all sorts of things up to that point in time. This is just another risk and if they’re given a better quality of life, be in it. (Scott Trapp* and Rod Logan*)

SR*: No, I wouldn’t like to develop some animal disease, no. But, then again, if you get sick enough and you want to have a shot at anything to get better, I suppose. (pause)

BS*: Well if it’s the last resort, you’ll try it. (Sue Reilly* and Bethany Smart*)

I think it would be a risk that you would take if you’re either going to die or you can have a transplant. He’ll have the transplant. (Bill Kent*)

And I mean if you don’t have it and you’re going to die, well who cares? You might as well have it. (Sinah Hoskings)

The potential impacts on quality of life and longevity are intermediaries to XTP that are strongly linked to the research participants’ problematisations of risk/benefit. Even though this pursuit for health and life is shared with loved ones, this is largely an individualised pursuit. This may suggest supporting XTP and

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225 Deep brain stimulators (DBS) are a neurosurgical medical device used to treat the chronic symptoms of neurological disorders, most commonly those associated with Parkinson’s disease. DBS electrodes (or leads) are implanted in the subthalamic nucleus of the brain, and connected to a pacemaker (or neurostimulator), which generates a continuous high frequency electronic pulse. Importantly, DBS is not a cure for Parkinson’s disease, and can sometimes make the symptoms worse. These devices are usually only used as a last resort; often for patients with debilitating symptoms that medication cannot control. The prohibitive cost of DBS, however, places it beyond the reach of many people with Parkinson’s disease. For more information, see Song (2006) and Benabid (2003).
accepting its risks is a selfish pursuit when faced with the possibilities of communal xenozoonosis. For the research participants, however, their possible and potential receipt of a XT, as based on the intermediaries of quality of life and life itself, is stimulated by alturism. Therefore, while facing their own mortality and experiencing a diminishing quality of life could motivate the research participants to accept a XT regardless of the level of risk, they are also propelled by a desire to minimise the risks of XTP and xenozoonosis for current and future generations. This provides them with the possibility of empowerment over particular health conditions and concerns. This would also enable future generations to maximise their own health, wellbeing, and life expectancy. In other words, the research participants are willing to accept the technically-informed risks of XTP and undergo clinical trials to contribute to the risk minimisation of XTP and ill-health for future generations. This also encompasses any continued and invasive monitoring and surveillance required after receiving XTP. Monitoring is therefore not a negative, dystrophic, and Orwellian ‘Big Brother’ technique, but a positive facilitation of health outcomes for the recipient and for scientific research and knowledge/s.

The research participants’ projections for XTP thus differ and involve contradiction. Risk/benefit problematisations on the health benefits of XTP are both personal (quality of life and life expectancy) and communal (a desire to make XTP safer for future generations). In this
latter story, there is also an admission that XTP does involve risk, and that further knowledge needs to be developed to reduce it.

Inherent in all these negotiations is a continuing faith and trust in clinicians, scientists, scientific testing methods, and scientific research, which ultimately supports the problematisations of the PERV network. The research participants’ desire to participate in XTP (pre)clinical trials for future generations underlies their desire to be part of and to contribute towards scientific research into XTP, as well as that geared towards particular diseases and illnesses of personal interest. Therefore, while their risk problematisations may differ from the PERV and scientific XTP networks via a focus on cultural rationality and personal experience in preference to technical rationality, they do not necessarily compromise it.

FE: I think the older ones are more inclined to take the risk for the younger ones future. Barry [her husband] said he would, he would take the risk regardless and because, because he’d be looking to see if it worked so the young, the younger might benefit.

ST*: You might also get a few more years.

RL*: You might be doing them a good turn.

KR: [...] as Fay just mentioned then, being a bit older I think they’d be more prepared to take those risks.

FE: To help the younger, yeah. (Fay Eisenhauer, Scott Trapp*, Rod Logan* and Kevin Robins)

ST*: And when they do have a cure or supposed cure for Parkinson’s, they will, before it’s released, try it on humans. A small percentage of humans.

FE: Yeah, that’s right.

RL*: Oh yeah, clinical trials.

FE: So I think it’s better for the older ones, sorry about this darling [to her husband, Barry Eisenhauer], I think it’s better for the older ones to be that guinea pig if you like, rather than the young.
But as you said [to Scott Trapp*], there is some benefit for the old ones. (Scott Trapp*, Fay Eisenhauer and Rod Logan*)

Barry [her husband] would make himself available now. Barry’s 78 this year, so he’d be happy to make it himself available to as a guinea pig if you like, you know sort of, to try it, but for, for the young that are coming through it. (Fay Eisenhauer)

And even if it doesn’t help me or if it doesn’t help you, it might help someone else along the line. It all has to start somewhere. (Sue Reilly*)

JR: Then again if they said... like if they keep checking up on me [after receiving a xenotransplant], because if it helps the research well...
KR: Oh yeah, yeah.
JR: I would. It’s important to do that too. (Kevin and Julia Robins)

I mean if you feel lousy, you might as well have it done and at least you’d be doing something for somebody else. (Julia Robins)

BK*: I haven’t got long to live. I’m 80 now, so what the hell?
PK*: But you’ve got to think of a person that’s 30.
BK*: Yeah, it might help them, you see. What they do to me could help them.
PK*: What they find out from you.
BK*: Yeah.
PK*: Yeah.
BK*: OK. I, I might keel over soon after that, but you know, if they gave me something like that and, even if for a short time, then that’s science for you. I think.
PK*: And they’re going to learn from it, aren’t they.
BK*: Yeah. (Pippa and Bob Kearns*)

I’ve had my life. I mean, they can experiment on me and transplant kidneys and whatever they want to. It wouldn’t make a great deal of difference to me, you know. (Frank Smart*)

FS*: I mean if you had someone, if you had an uncle or, or your grandfather was 83 and he was dying of kidney failure, and he was prepared to go on this. All he’s doing is being a guinea pig for science.
SR*: Oh, guinea pig for science, for the future, yes. Fair enough, yeah.
FS*: And so an 89 year old, he probably wouldn’t have much life anyhow, and if he lived for 12 months, that would be a good show. Right? And out of the 12 months of his life, extended life, the information that would be gained, and this is doing it from
a clinical, cold hard point of view, the information we’d option out of his last 12 months of his life, would be invaluable, you know. (Frank Smart* and Sue Reilly*)

So I don’t have a problem being a guinea pig or whatever. So you feel like you’re giving something back and you’re trying to help, you know? (Ian Douglas)

[…] let progress, let medicine progress the way it needs to be done. Not only for our generation but generations to come. (Kevin Robins)

I would volunteer my body to be done. Injections into the brain, anything, just to see how it works. (Steven Clarke*)

For those research participants who volunteer their body/life (or at least, support such an idea) to the scientific networks of XTP, this is a necessary risk for their health and wellbeing, as well of that of current and future generations. For Pippa and Bob Kearns*, Fay Eisenhauer, Kevin Robins and Frank Smart*, these volunteers are more likely to be the elderly or should be sourced from the elderly population. They expect that, by being closer to or beyond life expectancy, coupled with the longevity experienced by the individual, equates to a reduced fear of illness or death from XTP, and a desire to altruistically self-sacrifice for younger and future generations and the scientific XTP network. Age-based identity is therefore a determinant of a willingness to take risks and the acceptability of having a XT.

Employed by the research participants in these risk/benefit problematisations is also the metaphor of ‘guinea pig’, which
highlights the exploitative role of animals in scientific research and XTP. The reference to humans as ‘guinea pigs’ further continues the research participants’ problematisations that there is a continued risk inherent to XTP beyond animal experimental trials, and a need to experiment on both animals and humans. The volunteer’s body in these initial risk stages is likened to that of the animal’s body - a tool for scientific knowledge – a guinea pig for science (Sue Reilly). Furthermore, this also demonstrates that both animal and human bodies are vulnerable to risk.

The alturistic focus of the research participants explicitly connects to human health, life and quality of life. Human need propels XTP research into animal experiments and onto human trials. What underlies these processes is a belief in, and differentiation between, human desires and the lives of animals, which reinforces the sociozoologic scales and problematisations of human and animal categories. At the same time, continuity is drawn between humans and animals, where both sacrifice their bodies as ‘guinea pigs’ for the health of the (human) other. As continuously explored throughout this thesis, the problematisation of XTP involves sacrificing animals – an OPP – for human health. Therefore, any level of XTP problematisation and network alliance by the research participants involves accepting these sacrificial processes. The result is that the value of human life is separated, differentiated from and elevated

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226 This is explored in more detail in the chapter ‘The Sociozoologic Gaze: Using Animals’.
above animals. This is further highlighted by the problematisations on which animal and human bodies can be used for particular levels of XTP experimentation and those which cannot.

Importantly, the metaphorical deployment of guinea pigs by the research participants should not be mistaken for an equal value of human and animal life and their roles in scientific experimentation. Neither should it be considered advocacy for experimenting on humans, not animals, for human health conditions. Rather, the appropriate and proper scientific experimental model for XTP remains to be the OPP of animals. Furthermore, whether XTP experimentation occurs on animal or human bodies is determined by perceived levels of risk. The research participants do not believe it is ethical or right to subject humans to the heightened levels of XTP risk found in experimental stages. In the name of human health and life, however, it is right and ethical to subject animals to this risk. The need for human health and imperative of XTP equates to a need to sacrifice animals.

You can’t experiment on humans, can you? (Rod Logan*)

Ethically, you can’t do it directly on humans so you’ve got to do trials on mice and lambs and pigs and all those sorts of things beforehand. (Kevin Robins)

But going back to quality of life, if you’re going to get quality of life how are you going to get it? Are they going to inject you into something straight away and send you like a bloody zombie or wait to
try and get the statistics of all their research and get it right first of all? (Kevin Robins)

Given the only realistic alternative [to experimenting on animals] is experimentation on humans, I strongly support carefully controlled and regulated experimentation on animals, which avoids or minimises pain and discomfort, and which has a realistic chance of providing useful results or outcomes. (Chris Moran)

[…] I think if we’re going to do this, we should experiment on people, on animals I mean. (Peter Collignon)

The value and priority of human life over animal life is therefore clearly expressed by the research participants when problematising risk in, and experimental trials of, XTP. There is no question who should be experimented on (animals), and who should benefit from the reduced risks of XTP and its potential positive health outcomes (humans). Thus, there are acceptable and unacceptable human risks. These risk assessments are based on the problematisations on the value of animal and human life, where animals are a human resource and tool that are mobilised in XTP for the benefit of human health and life. The overwhelming need to improve human health and quality of life leads to a scientific and social imperative for XTP and, by consequence, animal exploitation. Therefore, when animal lives can be used by science to improve human health, the quality of human life, and to reduce the levels of clinical risks to which humans are exposed, then the means (exploiting and sacrificing animals, and/or exposing animals to high levels of personal risk), justifies the means (happy, healthy humans exposed to a minimised risk and
subsequently benefiting from XTP). In other words, unacceptable levels of risk to humans are acceptable for animals, as this operates to facilitate acceptable levels of human risk. XTP risk is problematised as something that animals should primarily experience for the safety of humans. For the research participants, the result is that the value of animal life, regardless of the level of human/animal intimacies, is significantly diminished when humans can derive potential personal benefits from animal lives and bodies.

These problematisations occasionally rely on emotive appeals, where choice is presented between animal or human life. Denying scientific development and research into XTP is seen to imply an unfair and unjust prioritisation of animal life over human life. In contrast, prioritising human life and health over animal life implies supporting and aligning to the XTP network, and accepting the resultant sacrifice of animal bodies. This again connects to the privileging and valuing of human life and health over animals. Additionally, this emotive tactic focuses on a need to choose between two lives and bodies - it is either ‘us’ (humans) or ‘them’ (animals). Of course, such scenarios ignore that while the human’s life is already in jeopardy, the animal’s life is only placed at risk as a result of human desires. In this process, risk is also problematised to be relative to species type, whereby risk assessments prioritise the risk to humans if XTP is not pursued:

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227 This relates to reactions towards vegetarianism and vegetarians, as explored in ‘The Sociozoologic Gaze: Using Animals’.
I am an animal lover but if (pause), we’re talking about sort of sacrificing the animal to aid (pause) the human and I, I honestly can’t see anything wrong with it. (Fay Eisenhauer)

FE: When it comes to medical science, I don’t (pause). Has to be, it has to be done in, in the most humane way. Yeah.

RL*: And, and the message got over well and truly, that it’s to help humans.

FE: And to help humans. (Fay Eisenhauer and Rod Logan*)

[…] in the overall term, if it was my wife that was going to live or die for the sake of half a dozen pigs, so what? I wouldn’t care. I really wouldn’t. Or my son, or my stepson in this case. My stepson has a serious complaint, and if the life of 200 pigs was going to save him, it wouldn’t worry me. I’d be quite happy to pay for the 200 pigs. And that’s, that’s a honest answer. (Frank Smart*)

I don’t know if I’m answering this right, but I don’t think they’ve [animals] got any rights when they’re going to be used to save the lives of humans, I don’t think they’ve got any rights. (Lyn Robertson)

It’d be great to be able to access organs or tissues or whatever from an animal to help you know, people in need. People with negative problems. (Colin Bruce)

In a case like this we’re talking about medical things that are going to help sick people and you know, people are going to die, I just wouldn’t have any qualms about using animals. (Colin Bruce)

In terms of welfare of a human versus an animal, I am quite happy. Happy is the wrong word… I am able to justify to myself that sacrificing an animal’s life to take an organ to transplant into a human for their survival is justified, is an appropriate process. And in particular if it was one of my relatives or my son that I was sacrificing that animal, I wouldn’t give it a second thought. At all. (David Strom)

My personal thoughts are that animal welfare must always be maintained. However, I don’t have a problem using them to further human wellbeing as long as we do not treat the animals cruelly. (Twanny Farrugia)

Well I… it doesn’t upset me. If you’re saying am I upset because you’re going to slaughter a pig to help a human, no. Doesn’t upset me. (Ian Douglas)

If there was a chance that this was going to work for me, and it meant a pig’s life, take that pig’s life and give it to me, just the way I look at
it. I wouldn’t say be cruel when you’re killing the pig but put it out of its misery in a humane manner and as long as it don’t feel no pain and I get the organ I need, someone else can get the meat from the pig. (Jeremy Batt*)

Therefore, the ‘us’ and ‘them’ scenario is fictionalised; an emotive story that establishes and maintains animal/human boundaries, and justifies animal exploitation. At the same time, this complicates and contradicts previous risk problematisations. Specifically, the research participants previously asserted different levels of appropriate risk for animal (high) and human (low) life. Here they alter the evaluation, where risk is only connected to human bodies. That is, there are unacceptable risks to humans if XTP does not proceed and if animal bodies are not sacrificed therein. The problematisation of risk therefore exposes that when discussing risk, the context and phenomena are highly important. Risk is implicated at varying levels on human and animal bodies, as aligned by and dependent on the scientific progress of XTP. On the other hand, when discussing the health and value of XTP, risk is associated with not helping humans and allowing their health to deteriorate.

**Conclusion**

This chapter examined how various actants problematise and black box risk in XTP. While risk in XTP remains uncertain and subject to contestation both inside and outside of science, we also witness
science attempting to stabilise competing ‘sciences’ by focusing risk and xenozoonotic anxieties on one specific concern - PERV. By narrowing xenozoonotic risk to one foci and problematisation, a diversity of possibilities are marginalised. The PERV network is thus formed, which operates within the larger XTP network. The problematisations of PERV risk by this network are influenced by selective and discerning understandings of scientific research, which are mobilised to suggest xenozoonotic risk either does not exist or is so low that risk anxieties are unwarranted. However, while PERV is of no concern to the PERV network, these ‘low’ and ‘no’ risk stories are consistently narrated in order to stabilise the PERV network, to provide ‘truth’, and to establish new alliances.

An important element of these stories is crossing from nature (technical/scientific) to the social (personal/cultural). This is done to try and establish risk certainty. As xenozoonotic risk is unquantifiable, assertions of ‘low’ and ‘no’ risk have no measurable and numerical basis. This lack of scientific knowledge could potentially compromise the PERV network. By crossing into the social, however, science mobilises tangible and everyday forms of risk to provide favourable measures and problematisations on xenozoonosis and XTP, thereby securing the PERV network.

This process, however, places significant pressures on science and the PERV network, as the publics resultanty expect them to have full
and comprehensive understandings of XTP and its risk possibilities prior to, during and following XTP experiments and trials. As a result, science’s crossing into the social domain - and back again - brings heavy social expectations and obligations that they may or may not be able to fulfil.

While many research participants place their faith and trust in the PERV network and science in general, they continue to problematise risk through personal familiarities and cultural rationalities. Like the PERV network, they seek to stabilise their risk uncertainties by mobilising more familiar social experiences of risk. Therefore, subjective knowledges of medical risks and current zoonotic social anxieties are used to understand the potential medical and xenozoonotic risks in XTP. These existing vulnerabilities mean XTP risks are not new or novel, as these risks already exist. In any case, the enrolment of these research participants in the PERV network highlights a strong belief in and expectation of science to deal with any negative possibilities from XTP.

In sum, XTP risk is part of a package of everyday risks. These everyday risks are best understood as low, but not as low as XTP risk. Furthermore, these risks are not necessarily good or bad, but present. Additionally, risk can be good in that it provides expectation, hope and possibility; the possibility of improved human health and prolonged human life. This continues the sociozoologic scales and
problematisations, reinforcing the superiority and priority of human life and human health over animal life (and lives).

These understandings of risk are not complete. They are a set of risk problematisations in a larger network. Those operating external to the PERV network but internal to the XTP network, have conflicting problematisations and stories. Interestingly, these mobilise the same scientific research and the social anxieties, though with differing outcomes. Furthermore, the same actants may mobilise contradictory problematisations while still operating in both networks. XTP risk is therefore flexible.
7 - Risk and Uncertainty: Science and Zoonosis

Introduction

As explored in the previous chapter ‘Risk and Trust: Science, Infection and Health’, the scientific XTP network has used technical rationalities to stabilise the problematisations of xenozoonotic risk and more specifically, PERV risk. The PERV network is resultantly formed, which asserts that PERV poses no risk in XTP and to humans. Knowledge that differs from the network and its communal norms of behaviour are marginalised. As a consequence, conflicting stories and problematisations are rendered incorrect, irrational and/or invalid. This reinforces the internal story and logic of the PERV network.

Networks and their problematisations can thus be deceptive, full of contradiction, conflict and paradox. In addition, external truths and the mobilisation of differing intermediaries can challenge network appearances of ‘ready made science’, and render the story open and fluid as ‘science in the making’. Furthermore, despite the research participant’s apparent acceptance of risk and adherence to the PERV network, they also exhibit a number of concerns regarding infection that connect to cultural rationalities, zoonosis, and the uncertainty of scientific knowledge/s.
This chapter further explores the problematisations of animals and humans by focusing on the consequences and risks of merging the two. These uncertainties remain in the sciences and amongst the research participants despite the PERV network, which serves to further problematise the risks of XTP and xenozoonosis. These perspectives challenge and weaken the authoritative position and technical rationality of science, and challenge its stories on XTP and xenozoonosis.

**Scientific Uncertainty**

The need for the sciences to provide a cohesive story of ‘ready made science’ often disguises heterogeneity and uncertainties within the XTP network. This includes the multiple problematisations that may exist therein. While science may advocate the xenozoonotic safety of XTP, organised scepticism still remains. Therefore, while the PERV network presents a cohesive and communal belief in ‘no PERV risk’, externally to the network, scientists may display fluidity and flexibility on PERV and/or xenozoonotic risk. Consequently, the communal, networked position of science on PERV risk can differ from the subjectivity of scientists who can, paradoxically, also adhere to and operate within these frameworks. Simultaneously, other actants may continue to problematise externally to the PERV network, and
mobilise different truths to continually challenge the apparent ‘science’ of the PERV network with conflicting ‘sciences’. 

While some scientists inside the PERV network do not adhere strictly to its problematisations, they do not compromise its stability and their network enrolment. This occurs by reinforcing science’s belief of nil-PERV risk while still acknowledging that more research needs to be done. Technical rationality, in other words, is incomplete and PERV risk is still present. This admission of PERV-possibility and the need for more research challenges the PERV network’s problematisations of ‘no PERV risk’. Furthermore, this continues to facilitate the role of science as an OPP to PERV and xenozoonotic risk assessments.

For Daniel Layton, there is additionally a need to calculate and understand risk before proceeding with human clinical trials of XTP. This scientific knowledge, which continues to retain its position as an OPP to XTP, needs to go beyond examining the level of risk and to understand the outcomes and consequences of risk, namely the hazards. Accordingly, XTP should not proceed until these risks and hazards are certain and can be scientifically calculated. For Layton, controlling risk is central.

In contrast, David Strom believes PERV risk and hazards can be circumvented, or have been averted. Simultaneously, however, he feels that total guarantees against risk cannot be provided, as all the
potentials cannot be known. As human error or other events can occur are not predictable and/or controllable, risk will remain. In other words, technical rationality can be compromised. Importantly, Strom does not explicitly attach this risk to a lack of scientific research or rigour.

There is limitless possibilities and we don’t yet have 100% knowledge about the porcine endogenous retroviruses and they’re the big worry. Until we have 100% knowledge, then I think there’s a plethora of potential problems. Now having said that, we know enough that it’s not likely to crossover to humans [...]. So I think that before any transplants should be actually undertaken then, at least into humans, then I think it’s really important that we become certain about these things. We know exactly how those PERVs work and so, at the moment the risk is minimal, but the potential is high because it’s the unknown. Once we know the potential of it, and we still believe the risk is low, then transplants should go ahead. (Daniel Layton)

So should it happen [PERV transmission], I don’t know what the outcome will be. Again, I don’t think, I think it would be manageable, but who knows because we don’t know enough yet about the retrovirus. (Daniel Layton)

You can’t say it’s [PERV risk] permanently eliminated, it might be accidents, it might be things happen. (David Strom)

This focus by Layton and Strom on PERV complements the main scientific stories on xenozoonosis. As seen in the previous chapter ‘Risk and Trust: Science, Infection and Trust’, scientists have focused their xenozoonic problematisations almost exclusively on PERV. This occurs despite opposing problematisations that tell of the possibility of numerous and unknown xenozoonic possibilities in
XTP\textsuperscript{228}. While the coherent PERV network does not effectively address xenozoanoses as a generalised risk, some scientists both internal and external to this network acknowledge xenozoanotic possibilities include and exceed PERV risk.

For Robert Dixon, a member of the AIS, the predominant xenozoanotic problematisation of PERV means that other xenozoanotic threats are being ignored. Risk problematisations of xenozoanoses entail looking at known zoonotic events that have resulted from other similar medical interventions, namely AT. While Dixon acknowledges his story of an AT zoonotic event happened many years ago and prior to tighter screening of AG donors, it nonetheless demonstrates the unpredictability and uncertainty of viral transfer. History reveals zoonotic potential, which cannot be predicted or controlled, and signals what could occur in XTP. Furthermore, even though viral testing procedures are now more advanced, they cannot test for the unknown or unexpected. In addition, for Layton, the lack of knowledge on PERV infectivity to humans thereby translates to a further lack of knowledge on xenozoanotic risk in general.

[...] we focus on PERV's but there are possibilities of other latent viruses that have either been, that may be introduced accidentally into

\textsuperscript{228} This concern was particularly raised as a result of research by Patience et al. (1997a). This research and the consequent scientific reactions are more fully addressed in the chapters ‘Xeno-what? A Literature Review’, and ‘Risk and Trust: Science, Infection and Health’.
the pig and that we don’t recognise until it’s too late. A rather bizarre example is that, and I’m talking many, many years ago in the United States, a corneal transplant recipient died of rabies and that caused a bit of concern of course. So they had to go back and look at the donor and the donor had died of unknown, had got sick and died, but he is a hunter. And without knowing his history, they went and investigated him further and discovered he’d become infected. He’d been bitten by a racoon and he’d got infected and the screening is, obviously a lot better nowadays, but that’s just an example of something that you wouldn’t expect that you know, that would be something (Robert Dixon)

I just don’t think that without full knowledge about the viruses, we can be performing xenotransplantation on a regular basis. (Daniel Layton)

Continued study of the potential infectious risk of xenotransplantation is necessary. (Levy et al. 2007: 314)

Strom, however, problematises zoonotic events and their relevance to XTP and xenozoonosis somewhat differently. He asserts that close animal/human relations enable viruses to change and cross species boundaries; transmitting from animal-to-animal and animal-to-human. This is examined through past and present interspecies relations, whereby zoonotic potential features throughout and a part of everyday life\textsuperscript{229}. While this existence of zoonosis could lead towards negative uncertainties surrounding xenozoonosis, Strom separates zoonosis from xenozoonosis. That is, zoonosis is an everyday event that occurs in everyday circumstances, but XTP is a procedure that occurs in specific and highly scientific contexts. This protects the animals (pigs) from any viruses and/or infections, which

\textsuperscript{229} This echoes the belief of the research participants in dealing with risk, as outlined in the previous chapter ‘Risk and Trust: Science, Infection and Health’.
is very different to normal social contexts. As a result, Strom separates viruses from the pig’s body and XTP, and recasts them as threats external to scientific contexts and the source animal’s (pig’s) body. Thus, as long as the source animal is bred in controlled scientific environments – an important and significant intermediary for the PERV network - then xenozoontosis is not an issue. As a result, the PERV network’s belief is reiterated - technical rationality facilitates risk assessments and protects against risk. Strom does admit, however, that this story is not finished, as it still warrants further technical investigations. Therefore, while he believes scientific contexts provide xenozoontotic safety and security, certainty on xenozoontotic safety is not guaranteed.

Once it [a virus] mutates and is able to transfer to another animal, it’s likely to be able to transfer to humans. But that’s going to be anywhere that you have animals. That’s not a problem associated with xenotransplantation. And one of the ways of trying to help that perceived problem is to raise the pigs in an environment where they’re not exposed to those types of viruses. But I don’t see it as a real problem. And it, it also needs to be investigated thoroughly but that’s not been done. (David Strom)

Importantly, such scientific uncertainty allows room for counter-rationalities, both technical and cultural. Uncertainty breeds tension. There is one scientist who strongly challenges the problematisations of current xenozoontotic research and the PERV network. Professor Peter Collignon, a leading Australian microbiologist and infectious diseases physician at the Australian National University Medical School and Director of Microbiology and Infectious Diseases at
Canberra Hospital, has been publicly outspoken\(^{230}\) in his criticism of XTP and, in particular, the possibilities of xenozoonosis.

**Peter Collignon**

And you know, I don’t know how you can look at that in an unbiased way but I think the pro-camp is using emotion to sell this as life saving but equally there’s some life threatening threats. (Peter Collignon)\(^{231}\)

Collignon agrees with the scientists internal to the PERV network who argue xenozoonotic knowledge is still uncertain and incomplete, though his uncertainty runs much deeper. Importantly, Collignon operates externally to the PERV network, contesting its scientific ‘truth’ with counter narratives. As a consequence, he challenges how xenozoonotic research has been problematised and mobilised by the PERV network to advance favourable, internal stories at the expense of external, competing stories. Where the PERV network asserts current scientific research affirms the xenozoonotic safety of XTP, Collignon problematises this research in contradictory ways, which highlights the continued possibility of xenozoonosis. In other words, the same or similar data can be mobilised, interpreted and assessed with paradoxical outcomes. For example, Collignon points to

\(^{230}\) For example, see Collignon (in Armstrong 2004), Collignon (2002; 1999; 1998a; 1998b), and Collignon and Purdy (2001).

\(^{231}\) This presents tensions between technical and cultural rationalities. At the same time, the use of emotion from the sciences draws upon cultural understandings and experiences. This therefore shows the difficulty and futility of separating the two.
scientific studies into PERV and xenozoonosis that have unexpectedly discovered persistent live pig cells in a XTP recipient after XT removal. For him, these unexpected findings do not affirm the safety of XTP. Resultantly, Collignon narrates that these outcomes could lead to other undesirable or negative effects. Unknown and/or unintended consequences are certain for him in XTP. Knowledge of PERV and xenozoonosis also become fluid and flexible in such problematisations; permitting the existence of competing scientific knowledges and rival technical rationalities. As such, the risk uncertainty that eventuates from unexpected findings exasperates risk uncertainties, serving to challenge the PERV network with counter rhetorics.

And even one of the safety experiments that were put up by, essentially a drug company sponsored thing, which looked at all the people who had been exposed to pig cells and said look, we didn’t find any live virus in these but something like a third of those people still had live pig cells circulating in their blood even though they were exposed two years before and the organ had been taken away so to me that actually showed that it’s not, you know… out of the question that you get unexpected results in persisting pig tissue. I think there’s enough worry to say we shouldn’t do it. (Peter Collignon)

And they get all those unexpected results you know, the argument is that we can predict what’s going to happen. Well, the Mayo clinic recently did some experiment looking at human embryos I think and… oh no, pig embryos and human cells and they found these reformed sort of cell type, I’ll have to look up that, but it was an unexpected finding basically of a persistent pig virus in human cells that wasn’t thought to occur. So they do get unexpected findings even now. (Peter Collignon)
These unexpected findings highlight the PERV network’s apparent consistency and stabilisation of ‘science’ to be an illusion in the face of diverse and challenging ‘sciences’. Therefore, not only is scientific knowledge fluid and flexible, but so is the problematisation of scientific research and results. The same research can be mobilised within networks and competing networks with a multiplicity of problematisations that are conflicting and complementary.

Collignon’s problematisations of what he sees as the failures of current PERV and xenozoonotic research, however, are not enough. Rather, he extends these technical problematisations of zoonosis to cultural rationalities, which are strongly influenced by and connected to three interrelated themes: historical and contemporary zoonotic events in humans; how humans have managed zoonotic events; and human knowledge and zoonoses. Significantly, some research participants agree with Collignon’s views and identify the uncertainties of sciences. This contrasts with the trust other research participants placed in the PERV network’s problematisations and scientific certainties, as explored in the previous chapter, ‘Risk and Trust: Science, Infection and Health’. These three problematisations, zoonoses: history and the present; zoonoses: management by humans; and zoonoses: human knowledge, demonstrate the multidimensionality of risk. These are now examined through the complementary stories of Collignon and the research participants.
Zoonoses and Avian Influenza

Problematisation - Zoonoses: History and the Present

For Collignon, the history of zoonosis demonstrates that a significant amount of existing chronic diseases and illnesses in humans are zoonotic in origin\textsuperscript{232}. In addition, some zoonoses have mutated, enabling their transfer from animal-to-human to human-to-human. Collignon asserts such potential negative consequences are evidenced in the current social anxieties surrounding avian influenza (bird flu). The corroboration of historical and contemporary zoonotic events means Collignon problematises that a xenozoonotic event will occur in XTP, with possible subsequent transmission from human-to-human. Furthermore, Collignon views XTP as a process that facilitates zoonotic possibilities. That is, if a virus is present in the XT, it will inevitably be transferred to humans as a live virus, because XTP as a process and procedure that requires living transplants. The accompanying pharmaceutical modifications (PITs) made to the human recipient as well as the GE to the animal source, only serve to heighten xenozoonosis potentiality by dampening the protective responses of the human immune system. This strongly contrasts to the PERV network, which problematises xenozoonosis as unlikely.

\textsuperscript{232} The prevalence of human diseases with zoonotic origin was explored previously in the chapter ‘Xeno-what? A Literature Review’.
As both avian influenza and XTP are known to be potentially harmful (and in the case of avian influenza, fatal) to humans, Collignon’s problematisations suggest there is no difference in their threat levels to humans. The consequence is that the xenozoonotic threats of XTP and the zoonotic threats of avian influenza are equivalent. He also extends this story to include the scientific processes, research and technical rationalities that are seeking to understand xenozoonoses and avian influenza. Namely, there should be no differences between these scientific procedures and approaches. For Collignon, his problematisations mean that if it is unethical to conduct an experiment or clinical trial in one, then it is equally unethical to conduct it in the other. Thus, there is an equivalency between the risks of avian influenza and XTP.

So you know, to me the risks are there, everything from HIV to Hep B to measles to TB, you name it, it’s come from animals and then adapted and stayed in people so why do this experiment to effectively make that, well... do an experiment that makes it more likely that that might happen? It may not, but to me you know, a reasonable likelihood that it might occur. (Peter Collignon)

Well the main problem is just about every major disease in man starts in animals and it’s human-to-human transmission. And the concern about this is that I think the benefits are not going to be flash yet I think the risks are there and the risks are worse in this because like the bird flu and stuff for instance, you know we’re worried it’ll humanise and go from person to person but with this particular thing we’re taking live virus inevitably, if a tissue is alive it’ll have live virus in it because it’s part of the genome. You’ll be putting it into people and you’ll be heavily immunosupressing them and you’ve altered the genetic makeup of it [the porcine xenotransplant] to make it less likely to be rejected by the body. Now if you wanted to do that experiment with bird flu you’d be locked up. I’d like to take this bird flu, alter the cells its in so they look human, put it into the most immunosuppressed people we’ve got, it’s sort of... you know... and it’s the same probability. (Peter Collignon)
Similarly, the research participants' concerns over zoonosis and xenozoonosis are problematised by their existing social knowledges of zoonoses. While Collignon draws upon historical and contemporary zoonotic events, the research participants’ focus exclusively on current zoonotic concerns. This connects to the research participants in the previous chapter, ‘Risk and Trust: Science, Infection and Health’, as they identify zoonoses that have recently been or are currently being experienced by humans, namely SARS and avian influenza. At the same time, in contrast to these previous problematisations by the research participants, zoonosis and xenozoonosis are now not seen as everyday and banal. Rather, the research participants identify zoonosis as a threat and something humans should be or are concerned with. Therefore, humans already have significant zoonotic events and possibilities that need attention, management and confrontation, and xenozoonosis is an unneeded additional burden. They do not identify, however, if zoonosis can be tamed or controlled by humans. As a result, what these stories and problematisations of zoonosis reveal are serious worries and concerns surrounding existing zoonotic threats, and a reluctance to introduce and add new ones to the existing battles. Therefore, mixing animals and humans promotes risk anxiety and uncertainty over outcomes and consequences; a fear of the unknown and of creating the animal/human hybrid. This again contrasts to the previous problematisations of the research participants and the PERV network, where nil or low xenozoonotic risk translated to an
acceptance of the animal/human hybrid. As a result, risk assessments are cultural rationalities that are largely influenced by subjective belief systems and experiences, rather than technical rationalities.

DM*: But, I think the main reason I would have, I am seriously worried about, you know, the, the, the bird flu situation where they've seriously concerned about the prospects of it jumping to humans and then human-to-humans.
AM*: From human-to-human.
DM*: Like, they know humans can get it from fowls, or animals, birds, but at the moment they're stopping it and people are dying yes, but they haven’t transmitted human-to-human. (Doug and Adele Mason*)

If you start introducing new unknown, previously unheard of viruses when we've already got more than we can handle, you know, what's this new one? Chicken flu? SARS not so long ago and this new one we've all got to be scared of, it's being passed on from the chickens, you know. (Cecilia Breau*)

‘Cause if you start spreading, we've got enough problems with things being spread like this bird flu that we haven’t got yet, without giving people transplants and then they’re going to start spreading germs, some new thing. (Pearle Giddins)

Problematisation - Zoonoses: Management by Humans

While the research participants do not explicitly address the capabilities of humans to manage zoonoses, Collignon believes historical and contemporary human experiences of zoonosis are not only relevant in regards to the possibilities of xenozoonosis, but also in consideration of how humans have managed such events.

Namely, human (scientific) behaviour and technical management of
zoonoses is a reflection on how science can and will cope with current and future zoonoses. Collignon’s narration highlights that because humans have not effectively managed and dealt with existing zoonoses, then it stands to reason that humans (science and technical rationality), cannot manage and deal with xenozoonoses\textsuperscript{233}. XTP, as a zoonotic opportunity, should be avoided regardless of the scientifically predicted (or estimated) low risk level; something which Collignon goes on to later question.

So that’s my view is, that if you look at a track record, we know animal virus, we’re not very good once they’re established in the population. So you just need to not establish it in the first place. (Peter Collignon)

\textit{Problematisation - Zoonoses: Human Knowledge}

As seen in the previous chapter ‘Risk and Trust: Science, Infection and Health’, science mobilises the uncertainty surrounding xenozoonosis and PERV to create xenozoonotic certainty and XTP safety. This quantification is done to make the incalculable calculable through the illusion of technical rationality, and to solidify and reinforce the xenozoonotic risk problematisations of the PERV network.

In contrast, Collignon uses the ambiguity and lack of knowledge about xenozoonosis and xenozoonotic risk to narrate the uncertain

\textsuperscript{233} A similar argument was made earlier in this chapter by Robert Dixon.
dangers and clear perils of XTP. The conundrum between risk uncertainty and certainty, and how this can be mobilised in conflicting ways through technical and cultural rationalities, thus exposes the tensions and competition that uncertainty creates.\textsuperscript{234}

In this problematisation by Collignon, the ambiguity of zoonotic and xenozoonotic knowledge guarantees xenozoonotic risk. Collignon advances this problematisation by highlighting that viral testing and screening is limited by current understandings. These restrictions emphasise that humans are yet to identify the majority of existing viruses and bacteria, let alone what could emerge through XTP and xenozoonoses. The logical extension of this problematisation is that humans do not yet know all the potential viruses in pigs that could unknowingly transfer to humans and, as a result, the potential hazardous consequences and outcomes of viral transfer.

I mean we can only test for the viruses we know, well it’s thought in the world we know, have probably identified one or two percent of all the viruses and bacteria because you look what we know now that we didn’t know 10 years ago so we’ll be putting a lot of unknowns in [xenotransplantation] and sometimes that [zoonosis] happens […]. (Peter Collignon)

Whereas Collignon believes that the lack of human knowledge on zoonosis and xenozoonosis is a result of insufficient testing

\textsuperscript{234} In the words of Fischer (2005: 56), “uncertainty opens the door for competing interests to emphasize different interpretations of the findings”.
procedures (in other words, insufficient technical rationalities)\textsuperscript{235}, the research participants focus more specifically on a general lack of human knowledge. These problematisations suggest that zoonoses cannot be controlled and the consequences cannot be known and quantified. In other words, the unknown is unknown. Furthermore, zoonosis and other cross-species threats might simply be too difficult for humans to grapple with. The result of these stories is that the research participants are very uncomfortable with the potential unleashing of xenozoonoses, as it could be communally devastating. Lack of knowledge also means that humans cannot deal with and treat any xenozoonotic events. Consequently, the faith and trust previously placed in scientific capabilities and knowledges are challenged, as this expertise is now not seen as complete and comprehensive. For Doug Mason*, this is the outcome of combining two different species, stressing the danger and threat of hybrid bodies and their border pollution.

I guess it’s just that whole, I keep referring to stupid movies but you know like \textit{Jurassic Park} and that, once it gets out then what happens? Like can you actually then... like that old crazy chicken virus that’s popping around at the moment and things like that where once it’s done, there is no going back. Like that whole genie out of the bottle thing and everything, I guess they just don’t know do they? It is a risk. (Kim Dodwell)

\textbf{But once a virus does that} [mutates from animal-to-human to human-to-human], you know, \textit{there’s a bit of a horrific situation and I’m a bit concerned about the same thing happening here which they wouldn’t}

\textsuperscript{235} This contrasts to the story told by Strom, which suggests that events external to and beyond scientific rigour and procedures could lead to xenozoonotic possibilities.
know about, you know. Prions and viruses are just too, too small and
too difficult to predict what they can do, you know. Even bacteria, you
know. (Doug Mason*)

If you start doing things like this and you do open up this can of
worms, they can’t be prepared for it. They can’t be prepared for it if
it’s unknown. (Cecilia Breau*)

So, the worry I have is that there is, humans and animals are different
and you know, we’ve got a situation with bird flu at the moment and
that sort of thing so, that worries me that, you know, when the case of
a prion, which I don’t think is treatable at the moment and is a totally
new piece of protein or whatever you want to call it. That was known
before mad cow disease come along and I don’t know the
corresponding human disease [variant Creutzfeldt-Jakob disease]. I, I
know the name of it, but it’s too complicated for me to remember
(laughs), so that’s caused by a prion which to me was a unknown
quantity ten years ago. Totally unknown. (Doug Mason*)

What diseases do the animals have that can be transmitted to
humans? Are you going to be susceptible with these animal parts or
animal properties, are you going to be susceptible to animal
diseases? Are you going to be running around distempered, or are
you going to get swine fever, or a variation thereof? (Frank Smart*)

These uncertainties further exacerbate the ambiguities surrounding
xenozoonotic risk. In dealing with such uncertainties and doubt,
Collignon considers that human lives other than that of the XT
recipient are put at risk and made vulnerable. While he draws upon
quantitative assessments in his analysis, this should not be seen in
the same light as those undertaken by Sandrin, Moran and Bill Kent*.
Rather, Collignon’s problematisation is illustrating the difficulty and
fallacy of quantifying xenozoonotic risk when it is unknown and/or
unpredictable. Therefore, calculations can be used to affirm
xenozoonotic safety or declare its risks. Acceptance of xenozoonosis
is thus rendered impossible by Collignon, due to the inability to know
the potential (yet for Collignon, real and tangible) individual and communal threats. The difficulty of quantifying risk, however, does not mean that it is low or nil. Rather, if a virus is alive in the genome, such as PERV, then the risk of xenozoonoses can never be zero. Risk becomes omnipresent.

In further opposition to the PERV network, he problematises that even if the possibility of xenozoonoses is low this does not guarantee human safety. This is because if XTP becomes an acceptable and commonplace medical procedure that numerous humans undergo, then a low level of risk would result in a numerous cross-species transmissions. When accompanied with uncertain knowledge, it is not clear what these outcomes could be, meaning a low risk can equal high hazards. If this low level risk also involves the possibility of fatal human-to-human transmission, then it has serious ramifications.

You actually, it depends what you count as low but let’s just say the risk is one in a thousand, most people would count that as low. You do ten thousand transplants, that’s ten people with an infection. So I mean, by necessity it has to be low to nil but when you’re doing this on a scale where this is planned, I mean if you read the ‘Scientific American’ and all that, they’re talking about doing tens of thousands of this just in the US. So a risk as low as .1 percent translates into a number of events per year. So that’s you know, so they’re probably right, it is low. But in my view, it’s not zero and if it’s not zero it’s a problem. (Peter Collignon)

You know, would you be willing to do this if there was a 1 in 100 chance that you know, not only your daughter might die but so might her brother and the nurse down the corridor. You know, if there was a 1 in 10 chance people would say no, well what if it was 1 in 100? What about 1 in 1 thousand? You know, at what level of risk are you willing
to take and then if you’re willing to take 1 in a thousand risk or 1 in 10 thousand, what if you do 10 thousand of these so you know it will happen once, are you willing to do it, do you think it’s reasonable? (Peter Collignon)

What about if you give it to your daughter and there’s a chance that she might do okay but she might get an infection that might kill her a year later and not only that, two of your other children might get an infection and die from that. Would you be willing to take that risk? And the answer is almost everybody says no. And to me that is in fact the real issue but the question is never put that way. […] Like, well what happens if your son gets the pig liver but his mother dies and two of the nurses and two of their children die? Is that reasonable to do? (Peter Collignon)

The trouble is you can’t quantify the risk but there’s no doubt there’s a risk. It’s not a zero risk. There are genomes of viruses in there, so it’s not zero. Now whether it’s 1 in 10 million or 1 in 100 or 1 in 50, well may even be higher. (Peter Collignon)

For Kim Dodwell, quantification has differing considerations. For her, it is subjective, based on personal interpretations of what constitutes high and low risk\textsuperscript{236}. To make her point, Dodwell draws upon her own anxieties surrounding the possibilities of having a child with Type-1 diabetes\textsuperscript{237}. As a person living with Type-1 diabetes, she narrates her chances of genetically passing this on (intergenerational transmission), at five percent. She believes this to be high risk while her husband, with his own subjective view, believes this to be low risk\textsuperscript{238}. In order to have a child, however, both need to negotiate the

\textsuperscript{236} While a similar point was made by Collignon in one of the proceeding quotes, he used the low possibility to demonstrate that a low risk can still translate into a number of xenozoonotic events, thus highlighting even a low risk can result in high hazard/s. As a result, this is technical not cultural rationality.

\textsuperscript{237} Since this time, Dodwell has given birth to her first child.

\textsuperscript{238} It is not clear whether these risk analyses are influenced by intimate and embodied experiences of Type-1 diabetes or not. In other words, Dodwell’s perception of high risk could be influenced by her desire of not wanting her child to
other’s problematisations. Therefore, the PERV network’s assertion of xenozoonotic ‘low’ risk and as quantified by Bill Kent*, Sandrin and Moran, would mean little to Dodwell, as her low risk stories could dramatically differ from that of the PERV network (which, in any case, lacks definitive quantitative measures). Significantly, these analyses of risk are problematised with differing cultural rationalities, as based on divergent social experiences, understandings, and experiences of risk. Importantly, however, Dodwell’s subjective risk assessments of passing on Type-1 diabetes additionally differ from her analysis of xenozoonotic risk. That is, a transmissive event of Type-1 diabetes between Dodwell and her child ceases with this one-off human-to-human event. In contrast, she indicates that xenozoonosis has differing risk considerations, as it could go beyond this intergenerational transmission and spread amongst other people in her family (and the community). In other words, xenozoonotic contagion is problematised to be different to intergenerational genetic diseases, as it has the ability to spread in a communal, rhizomatic fashion where there is little control and containment. As a result, she has some control over the risks of passing on Type-1 diabetes, but not xenozoonosis. In turn, she is able to quantify one health risk and face Type-1 diabetes, like she has. On the other hand, Dodwell’s husband does not have Type-1 diabetes, meaning his perception of low risk is external to this embodied experience and knowledge. This could also potentially apply to other research participants, though was only expressed explicitly by Dodwell. Of course, if Dodwell’s child decides to have children of their own, this child could pass on Type-1 diabetes in an intergenerational transmission. A similar scenario could occur with xenozoonosis, but it is not this type of xenozoonotic event that Dodwell focuses on.
not the other. This inability to quantify risk leads to tension and, as a result, opens up risk analysis to these types of cultural rationalities.

So if it got, you know if I ended up having a family and then you know later on like maybe 15, 20 years down the track and all hell broke loose and you know, however long that took it all went terrible, then let’s look at having this treatment. It would have to be, I’d have to know... it just depends how high the risk is doesn’t it? Because I mean we’re going, you take a risk every day but with just, I know I keep talking about having a baby, it sounds like I’m fixated I’m not really, it’s just that it’s going to probably be in the near future that’s all... there’s a 5% chance that I’ll have a diabetic child. If B* [her husband] was diabetic, he’d have a 5% chance, together we’ve got a 10% chance. I said I saw 5% as massive whereas he sees it as nothing. So I suppose it’s just a sit down and have a look at the risk factors. That there, causing an epidemic and things like that, that’s quite… you wouldn’t really want to wish that on your family would you? (Kim Dodwell)

Like Collignon, Dodwell problematises that one transmissive event can result in xenozoonotic deaths beyond the XT recipient. This means, once again, a low level of risk can still translate to high hazards that may detrimentally affect many people. Dodwell thus questions if it is really worth going ahead with XTP if xenozoonotic risk can threaten so many lives for the potential benefit of one\textsuperscript{241}.

Do you put that one person and give them a pig kidney and say there you go and then everyone around them gets sick and all their family die and then all of their friends get some sort of crazy old disease, is that really worth it? And what if that person with the pig kidney dies anyway? (Kim Dodwell)

\textsuperscript{241} I will return to this point later in the chapter in ‘Safety and Future Generations’.
For both of the focus groups included in this research, the lack of human knowledge on xenozoonosis presents a conundrum. The research participants indicate they want the uncertainty of xenozoonotic risk to be made more certain through technical rationality. This would lead to what they perceive to be a solidity of knowledge and xenozoonotic risk. To gain such stability, the research participants thereby identify that XTP must proceed. At the same time, however, they do not want a xenozoonotic threat to be revealed and unleashed. They therefore identify that their desire for xenozoonotic safety can only be met through the possibility of xenozoonotic exposure. This contradiction leads the research participants to waiver, refraining from asserting whether they actually want XTP to proceed or not. The uncertainty and ambiguity of the sciences on xenozoonoses, and the inability to measure and quantify xenozoonotic risk without creating the conditions for it to emerge, facilitate continuing doubts and reservations on part of the research participants. Consequently, there is a desire to control and contain risk, while also emphasising a need to take risks. Resultantly, the PERV network’s problematisations are rejected.

In addition, Rod Logan* questions the PERV network’s quantification of low xenozoonotic risk. Namely, he asserts that this risk is only problematised and presumed as low because of the lack of scientific knowledge and the failures of technical rationality, not because of the presence of any risk certainty. As a result, the assurances of the
PERV network are narrated by Logan* as tentative, ambiguous and unnerving. Consequently, risk remains but it is unknown and unstable; fluid and flexible in the ambiguity of sciences, belief systems, and competing knowledges and rationalities.

SR*: Well, until they start experimenting, they can’t –

FS*: Well until they start, they can’t go any further, you know.

SR*: Yeah.

FS*: So in, I mean that’s only, I’m not looking to change your opinion. You keep your opinion.

SR*: Yeah but I want them to clear this up before they start, but they can’t clear that up until after they do that, yeah.

BS*: That’s right. It’s a catch 22. (Sue Reilly*, Frank and Bethany Smart*)

FE: Well, as you sort of said, there may be, and to me that’s sort of a small risk factor. They’re not saying there’s 50% chance that this is going to happen.

KR: But there’s a small chance.

RL*: But you know they’re saying a small amount because they don’t know.

FE: And until they try, they don’t know. (Fay Eisenhauer, Kevin Robins, Rod Logan*)

These uncertainties and conflicting knowledges from the sciences are reflected in the uncertainties of some members of the XWP and AIS.

242 On the other hand Mauro Sandrin, a member of the XWP, demonstrated certainty on XTP and xenozoonotic risk and strongly adheres to stories of the PERV network. His views are explored in the chapter ‘Risk and Trust: Science, Infection and Health’. 
Xenotransplantation Working Party and Animal Issues

Subcommittee\textsuperscript{243}

Despite the attempts of the PERV network to stabilise risk problematisations on XTP and xenozoonoses, knowledges external to the network continue to challenge its stories. These conflicting narratives and the heterogeneity of the sciences impact upon the XWP and AIS by creating doubt and insecurity. Uncertainty compels uncertainty. Sciences are viewed as having a lack of knowledge and as a result, they cannot provide risk analysis, certainty, and guarantees of xenozoonotic safety. Clear technical knowledge and definite and known levels of risk become highly integral and influential to decision-making and regulation\textsuperscript{244}. The responsibility and considerations of the XWP and AIS are thereby seen as a weighty duty that could result in disastrous consequences if the doubts and the instabilities internal and external to the PERV network are not taken seriously. As a result, cultural rationalities are integral to XTP for the XWP and AIS.

\textbf{Even you know, many people within the medical fraternity, the nursing and doctors and others that are not in the research area, were really concerned and they have a good understanding of disease.} (Glenys Oogjes)

\textsuperscript{243} The Xenotransplantation Working Party (XWP) led the public consultation on XTP in Australia between 2001-2004. For more information on the XWP and its offshoot, the Animal Issues Subcommittee (AIS), refer to ‘The Australian Xenotransplantation Network’ in the chapter ‘Entering the Network: Methodology’. \textsuperscript{244} Hence, the effort exerted by the PERV network to assert the certainties of science and coherency is unsurprising.
It’s a very weighty responsibility on our shoulders and it’s very frightening, especially then when you also get, even when you’re not involved, like listening to the various scientists, virologists talking on television at the moment, with this [avian influenza] pandemic as I said, it’s a good example. It’s really frightening because there are so many concepts and ideas, no one seems to be agreeing. (Twanny Farrugia)

The difference with something like this, xenotransplantation [when compared to allotransplantation], if we stuff it up, the whole community is going to pay the price. If not the whole world and I think that’s the big difference. (Twanny Farrugia)

What my biggest fear, and I wouldn’t say I’m really against it but I think at this point in time, we don’t have enough knowledge and that’s why I was glad when they said they’d review in 5 years because my biggest fear is cross-species viruses and not so much the cross species but we don’t know what’s likely to happen. […] We really just don’t know and from that point of view I guess it scares me as a human being. […] But I don’t think as a world yet we have enough knowledge to really go down that road. (Twanny Farrugia)

Uncertainty and the ‘sciences’ jeopardise the stories of the PERV network. In addition, the existence and effects of historical and current zoonoses on humans influence the xenozoonotic problematisations of the XWP and AIS. Like Collignon’s problematisations of historical and current zoonotic events, the XWP and AIS emphasise that zoonotic episodes are presently being experienced, or have been experienced, by humans. In these stories, strong emphasis is placed on the communal risks and anxieties surrounding a potential new zoonosis. Links are therefore drawn between XTP, HIV and avian influenza, all of which have (or in the case of xenozoonosis, could have) serious social consequences. In

245 This is a reference to the current five year moratorium on human clinical trials of XTP in Australia, which expires December 2009.
such assessments, technical and cultural rationalities entwine.

Furthermore, connecting to Collignon’s problematisations of human knowledge and zoonoses, Michele Kosky highlights that a lack of human knowledge on zoonoses suggests a strong uncertainty of xenozoonotic possibilities and consequences. In addition, she proposes that zoonosis can take time to emerge. Zoonosis is thus a transcendental spatial and temporal actant; it can materialise at a particular time and place, and have effects on other places and at other times. As a result, human applications of XTP may have xenozoonotic implications for current and/or future generations.

It’s complex. I think it’s quite complex. I think currently the risks are not worth the benefit, and I think it brings up very big questions about public health and public policy. Peta, I also have a background in HIV, so I’m very conscious of the issues around infectious disease, and have a broad interest in public health. (Michele Kosky)

[…] I learnt so much about xenotransplantation and I was just absolutely shocked that they would even contemplate doing it. Because it was such a danger and I think a perfect example is the bird flu at the moment they’re talking about pandemic and I think there’s a lot of panic going on, people are really getting excited about it. That’s exactly what could happen with xenotransplantation that was just kept so quiet. But I mean I think you know, just seeing what the reactions to bird flu is just an indication of what I believe would happen if they went ahead with xenotransplantation and if there was a slightest chance that some virus got out and mutated. (Helen Rosser)

I don’t know, maybe bird flu can be an example of showing, well this is what happens if we go ahead with xenotransplantation and maybe that will make people realise the serious consequences of it. (Helen Rosser)

[…] I think there’s quite a lot of evidence that suggests that HIV moved from an animal population, probably chimpanzees, into the human population, probably over hundreds of years. But, nevertheless, it seems that we think we know everything about viruses and bacteria
and prions but we don’t, and it seemed to me from a public health point of view, weighing up the risks and benefits, the risks were exposing the population to a new virus that came from pig parts. You know, tissue, organ, whatever. (Michele Kosky)

It is this final point of Kosky on the effects of zoonosis on current and future generations, and the problematisations this facilitates for xenozoonosis and XTP, which concerns many of the research participants.

Safety and Future Generations

The possibility of xenozoonosis means risk is viewed as inherent to XTP by the research participants, regardless of who is problematising risk or whether risk and hazard are narrated as ‘low’ or ‘high’. Due to the uncertainty of technical reasoning, risk can only be quantified through cultural rationalities. At the same time, the research participants seek to find a resolution on what level of xenozoonotic risk is acceptable, particularly given the communal risks. As a consequence, their problematisations produce two distinct levels of risk; individual and community.

In regards to individual risk, the research participants problematise it to be a subjective choice. Previously, Kim Dodwell related this to quantitative risk assessments, where the analysis of low risk differed depending on the subjective understandings and experiences of both
health and risk. In these cases, however, subjective choice relates to the individual accepting the risks of XTP, including xenozoonosis, where the negative outcomes are restricted to the individual. If this individual's risk-taking encompasses a communal risk, however, the research participants apply a different risk analysis. This is when communal considerations become relevant. The problematisation by the research participants is as follows - it is acceptable to take XTP risks to benefit one’s own health and wellbeing, but if XTP risk-taking compromises the health and wellbeing of other people, then any potential individual benefit is outweighed by the communal risk. In other words, the community is more important than the individual. The risk of exposing people beyond the XT recipient to xenozoonosis elicits anxieties from the research participants, and is therefore unacceptable. This means that xenozoonotic risk is only significant to the research participants in relation to the community. As an extension to these problematisations, any human who proceeds with receiving a XT with the existing xenozoonotic possibilities is selfish and unthoughtful. These concerns surrounding the potential of a new, communal zoonotic pathogen is enough to make some research participants question the validity of technical rationalities and proceeding with XTP\textsuperscript{246}. Thus, while the research participants previously showed a faith and trust in science to measure and control xenozoonotic risk, any potential risks posed beyond the individual are too much.

\textsuperscript{246} Collignon also questions whether informed consent can truly be given by the recipient before receiving an XT.
FS*: Contamination would be a risk that you’d be happy to take yourself, for yourself, but not for anyone else.

BS*: You’d take it for yourself.

SR*: I don’t want to take it, oh I would for myself, but not –

FS*: I can tell you right now. All three of us came in here today fully supporting this 155%. (pause) I think it would be safe to say you were that way?

SR*: Yeah. And I’ve got poor little grandchildren, 4 and under, and I, I would hate to do anything to them. I really would. (Frank and Bethany Smart*, Sue Reilly*)

DT: But then again, there’s no guarantees is there. Nobody can say if you get (pause) any type of disease because of this transplant that you’ve had that you’re not going pass it onto other people. There’s no guarantees on that.

FE: Yeah. Barry just said he’d risk if for himself, but not for the community. (Derek Taylor and Fay Eisenhauer)

So, I just think well, we live in a democracy, people have been free to go and have idiotic treatments for cancer and for arthritis wherever they like in the world. The difference with this is that if we get an infectious agent then it could be many other people who are affected. (Michele Kosky)

If it where just going to affect the person who wanted the transplant that’s one thing, but if it’s going to be likely to affect other people, well they need to be more careful don’t they. They’re really got to be more careful about it. (Pearle Giddins)

If the only risk was the person getting the transplant, you know if I received a kidney transplant from a pig and I died from that infection and I was truly informed about it beforehand which I don’t think they ever are so I don’t think there’s ever true consent but if I was, if I was prepared to take that risk and it was one in a thousand well that’s my bad luck. But if a risk is one in a thousand and not only will I get infected but a whole lot of other people might who didn’t consent to it because they weren’t, they’re contacts, I don’t think that’s reasonable and I think that’s the problem. It’s just not a risk for the person receiving the transplant. (Peter Collignon)

I mean in some ways if it’s just the individual that dies, that’s bad luck. It’s the rest of society issue to me. (Peter Collignon)

SR*: Well I don’t like that at all because if I don’t have it, I can’t affect my family, but somebody else can. They can have it, and it can come back on my family. They might live next door, you might work with them, they could be in the same class at school with them or, you know.

BS*: That’s right.
But if this cross-contamination turns out to be a real problem, and it could be, you know, I think the whole bit, the whole idea, needs to be binned. (Sue Reilly*, Frank and Bethany Smart*)

Consequently, the research participants clearly separate their problematisations on individual and communal xenozoonotic risk, each with its own specific and differing implications. At the same time, they acknowledge an intimate connection between the two, where one (individual) facilitates the other (communal). This is further extended into the genetic implications of XTP and xenozoonosis, which also complicates their individual xenozoonotic risk problematisations. Namely, as xenozoonotic safety cannot be guaranteed for the individual or for the community, it cannot be guaranteed for future human generations. The research participants thereby believe that it could take time for xenozoonosis or xenozoonoses to appear. As a result, humans may or may not be able to identify a xenozoonotic event from animal-to-human, and the full consequences of a transmissive event (namely human-to-human), might yet come. Their problematisations therefore illuminate a belief that it only takes one XT to make a xenozoonotic event possible and, by extension, this xenozoonosis could be passed through the generations by genetic reproduction. As a consequence, even if an individual accepts the risk for themselves, this could still have lasting effects on their family and future human societies. In such stories, individual and communal risks are interlaced. This therefore contradicts the previous stories by the research
participants, whereby individual xenozoonotic risk was differentiated from that of the community. Furthermore, risk also becomes spatially and historically fluid, moving between contexts and timeframes. Consequently, even if the PERV network and technical rationalities can narrow down the ‘sciences’ to the appearance of ‘science’ and stabilise xenozoonotic risk anxieties, this still remains fluid; subject to flux and change, as evidenced by the reactions to Patience et al.’s (1997a) research247. The possibilities of xenozoonoses thus remain.

I mean, it might not affect us in our generations, but ten down. (Bethany Smart*)

I have a problem about transmitting animal tissues into humans because it’s, it’s situations like mad cow disease and that sort of thing, and sometimes you might not find until a generation down the track that these things are happening […].. (Doug Mason*)

It may not be an immediate thing. It would only show say after 2, 3, 4, 6 months. So you wouldn’t really know where it had come from in the first place. (Pearle Giddins)

I mean if the virus actually got through, I think that’s one of the major issues that the people should be aware of. Not the fact that, I mean people might think okay, well if he has a pig heart or pig cells or tissue, he might get a cross species virus, well they might think well that’s their problem, they want to take the risk but they don’t realise the risk goes out to the whole community and I think the whole community needs to know that. That by allowing something to happen to that sick child over there, it might in fact kill thousands of children in the future and so they certainly don’t see any of that. (Helen Rosser)

247 For information on this research and the reactions of the PERV network, refer to chapter ‘Risk and Trust: Science, Infection and Health'.

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Conclusion

In the previous chapter ‘Risk and Trust: Science, Infection and Health’, the scientific XTP network attempted to stabilise risk anxieties by narrating ‘ready made science’. Simultaneously to this network, however, the enrolled science actants demonstrate varying degrees of risk ambiguity, while still adhering to the existing technical rationalities of the PERV network. Therefore, they affirm the network’s stories, but also acknowledge that XTP remains to be ‘science in the making’. This risk ambiguity is highlighted by a lack of scientific knowledge on xenozoonoses. Furthermore, these science actants suggest there cannot be guarantees, thus risk certainty is impossible. This internal network scrutiny is additionally accompanied by external scrutiny which, although also advocating the need for xenozaonosis research, is far more conflictual.

If the sciences cannot provide the answers and if there are competing technical rationalities, then sociocultural assessments cannot be considered irrational. Uncertainty and the incompleteness of technical rationality, for both the sciences and the research participants, compels the turn towards cultural rationalities and a consideration of social experiences, understandings and knowledges. In any case, the social is an essential and integral component to any risk assessment.
The stories and problematisations external to the scientific networks mobilise the same stories of those internal to the network to create new and differing stories. Risks in these problematisations, however, are not simply accepted. Rather, risk is seen as something that should be managed and avoided. Social anxieties surrounding zoonosis thereby change, moving from xenozoonosis being considered another everyday event, to xenozoonosis as an undesirable risk that can be avoided. These narrations advance the need to consider existing human knowledges and capabilities, which are limited, and with temporal considerations. Hence, today’s risk negotiations not only have consequences for current human populations, but for the future/s of human society. Risk in XTP thereby becomes spatial and temporal. Therefore, the attempts to create ‘ready made science’ are exposed; highlighting the continued risk ambiguities of XTP as ‘science in the making’.
8 - A Story in Progress: A Conclusion

This thesis is about the sciences, publics, networks, problematisations and stories surrounding XTP in Australia. It has explored the continuities and disparities between different and conflicting perspectives when seemingly divergent actants examine XTP. Significantly, these are not definite or clear. As the actants speak, ambiguities, uncertainties and contingencies emerge through their construction, reconstruction and deconstruction of varying beliefs, knowledges, truths and realities. By operating internally and externally to networks, their problematisations generate intense forces that are sustained not only by these problematisations, but are intensified and expanded by their circulation. This allows new actants to be enrolled into the expanding network, and the further reproduction of its truth claims. Stories and networks thus have the possibility of being endless; difficult to contain and control.

For the sciences, problematisations emanate from a discipline with specific approaches, procedures, techniques and rationalities. The institution of science aligns select ‘experts’ together under common methods of inquiry and knowledges. This network creates coherency and power, which sustains their stories and privileged social position. In turn, this privileged social status and scientific certainty are continued by other social institutions and practices, such as political and regulatory decision-making. This can be understood as the
manufacturing of ‘ready made science’, or simply ‘science’. That is, all diversity and ambiguity of scientific practices are sealed off (or disguised) in the black boxed ‘network’.

Science mobilises stories to reduce difficulties, complexities and uncertainties. Paradoxically, reducing complexity and creating the illusion of simplicity can occur by increasing complexity. This is seen in ‘The Biological Gaze: Selecting an Animal’, where official science uses complex and sometimes contradictory problematisations on nonhuman primates and pigs to justify source animal selection in XTP. These difficult stories were then narrated further with my mobilisation of the comparative continuum; a story that tells another story. In addition, these problematisations that they generate are not simply uttered by humans. Rather, science assembles human and nonhuman actants to tell its stories, and to reinforce and expand the network over vast distances. For example, official science is not limited to national boundaries, as these document actants act as immutable mobiles that connect a variety of actants in disparate contexts. Networks thereby create links across space. Significantly, the complexities of their problematisations are integral to the scientific process. That is, by drawing upon selective knowledges and by mobilising convoluted arguments, these stories can only be articulated by science actants. For example, the PERV network (in ‘Risk and Trust: Science, Infection and Health’), circulates particular PERV scientific research in specific ways and at the expense of other
kinds of knowledges, which also sustains its privileged position as an OPP. This is done to favourably communicate arguments of ‘no PERV risk’, and thus uphold continued XTP research. Furthermore, this also serves to focus attention on one xenozoonotic risk amongst a collection of potentially unknown risks.

This approach marginalises contrasting and conflicting stories, including those that may emanate from within the sciences. Opposing scientific problematisations are subject to much scrutiny and criticism, and are externalised from the PERV network. For instance, Patience et al.’s (1997a) work posed significant hurdles for continued XTP development. Subsequent problematisations, however, have been mobilised that adhere to the PERV network’s narratives and are consequently advanced as the ‘truth’. These represent or ‘speak’ for the PERV network, and prove PERV safety in XTP. The focus of the PERV network, however, is selective, choosing to narrow down xenozoonotic risk to PERV at the expense of other plausible xenozoonotic events; events which are less known and less predictable. The result of this problematisation is the rendering of other stories as unimportant, inconsequential, erroneous, invisible and nonexistent (see ‘Risk and Trust: Science, Infection and Health’ and ‘Risk and Uncertainty: Science and Zoonosis’).
These understandings also reveal that networks can exist within networks. The PERV network functions within a scientific network, which also functions in the broader XTP network. In addition, when entering such networks and listening to the actant stories, it is revealed that ‘ready made science’ is an illusion. As ambiguity and uncertainty continue to reign, there remains ‘science in the making’. This means that stories can (and do) exist within the PERV network that narrate a lack of scientific knowledge, technical rationality, and a need for more certainty (in ‘Risk and Uncertainty: Science and Zoonosis’). These stories, by mobilising different problematisations, could create conflict within the network, compromise its construction, and lead to its breakdown. This is not the case. Rather, these stories still reinforce the knowledges within the PERV network, while asserting the need for more scientific knowledge. Therefore, uncertainties that circulate in the network are contained in the network itself; controlled by the constant work of appearances; perpetuating ‘ready made science’. This also involves systematic reinforcement of the expertise and objective rationality of science/scientists, and their position as an OPP to XTP and xenozoonotic safety.

An important element of these processes by the scientific and PERV network is how they function to sustain the boundary between the sciences and society. That is, science advances its own expertise and knowledge at the expense of the social. Therefore, only science
can access, mobilise and use technical rationalities to designate an appropriate source animal for and the risks of XTP. At the same time, technical rationalities cannot finalise and make certain the desired ‘scientific’ problematisations, particularly in the face of multiple resistances. As a result, science draws upon cultural rationalities in their problematisations. For example, in selecting a source animal for XTP, science asserts that nonhuman primates are unacceptable to the public due to their shared characteristics with humans (in ‘The Biological Gaze: Selecting a Source Animal’). Furthermore to combat ambiguity, science draws on everyday social negotiations and interactions with risk to demonstrate the contrasting safety of XTP (in ‘Risk and Trust: Science, Infection and Health’). These problematisations function to provide the appearance of measurability and certainty in amongst immeasurability and uncertainty. Therefore cultural rationalities, as understood and designated by technical rationalities, can be mobilised to continue desirable narratives that sustain and expand the PERV and scientific networks.

It is important to note that these processes do not involve science directly engaging with the publics. To be more precise, science straddles the illusionary divide between science/society, crossing backwards and forwards at will and convenience. Consequently, social knowledges and experiences are utilised by scientific networks in an attempt to further black box and disguise XTP’s status of
'science in the making'. In addition, science mobilises the social in general to justify XTP, as human need becomes an intermediary that 'propels' and 'drives' scientific research and development. As a result, science and XTP function for the good of humanity (see 'Xeno-what? A Literature Review' and 'Risk and Trust: Science, Infection and Health'). Any other competing stories on scientific motivations behind XTP, such as prestige, financial gain, and investments of time and desire, are silenced (or marginalised).

Thus, science is not self-sustaining. The social nourishes scientific networks and assists in propelling its narratives. Science is therefore not autonomous, as it heavily relies on the social to uphold, continue and expand its stories. Science also requires the social to accept its problematisations in order to continue its privileged social position and to expand its network/s. A dynamic thereby exists between science and the social; the two cannot be separated. Therefore, science stories also feature throughout the stories of the research participants, though their problematisations may differ.

It would be a mistake to think this thesis is solely about science’s mobilisation of the social to advance its own problematisations and networks. Rather, this thesis focuses on the dynamic between the two and how they construct - and conflict with - each other. The publics are represented in science stories, and science is represented in the publics’ accounts. Science’s accounts of the
social, however, are not necessarily correct, and can clash. That is, conflicts between science and social problematisations are about different knowledges and rationalities which, in turn, lead to different beliefs and experiences. This is a very important point to remember in public consultation and regulatory decision-making processes.

At the same time, science’s attempts to enrol the public into predetermined problematisations and networks are highly successful. In general, the research participants display much faith in the stories and problematisations circulated by science, trusting in their expertise and cognitive capabilities to make informed decisions on selecting a source animal for XTP (see ‘The Biological Gaze: Selecting an Animal’). This includes an expectation that science has comprehensive and complete knowledge on XTP prior to, during and following clinical trials. As a result, science’s espousal of its own technical rationalities and expertise can lead to heavy social obligations and expectations that they may not be able to fulfil.

Such trust by the research participants is not only exhibited by continuing science’s stories, but by also supplementing these stories. For example, by connecting xenozoontic risks to known experiences of risk from pre-existing medical conditions and to current zoonotic social concerns, the research participants render XTP risk as everyday, mundane and banal – not to be celebrated nor feared, simply managed and dealt with through scientific expertise
and technical rationality (see ‘Risk and Trust: Science, Infection and Health’). Consequently, the research participants accept science’s expertise, problematisations, and role as an OPP to XTP. This does not happen, however, without question, meaning science cannot simply speak for the publics. Tension arises between science and the social, based on conflicting and differing rationalities, both of which are highly valuable and important.

As a result, even when science’s problematisations are not contested by the research participants, this does not simply translate to the research participants accepting the entire story. Elements can be rejected, without compromising the overall narrative of the network. Therefore, while the research participants demonstrate trust in the scientific network, they do not agree on limiting animal selection to a comparative animal/human analysis that is restricted to two scientifically predetermined animal species. They are open to a diversity of animal use, and do not eliminate nonhuman primates on ethical grounds, as was socially problematised by official science (see ‘The Biological Gaze: Selecting an Animal’). In addition, while official science and the research participants mobilise existing social exploitations to justify the use of pigs in XTP, the research participants also differentiate between the processes of the MLI and

[In this vein, the words of Latour (1999: 17) ring strongly: “If scientists want to bridge the two-culture (science/society) for good, they will have to get used to a lot of noise and, yes, more than a little bit of nonsense”. Bridging the gap between science/society should therefore involve science talking about sciences and the social, and the social talking about the social and the sciences.]
XTP. This movement does not compromise science’s story, but it does demonstrate that existing social exploitations of animals do not simply translate, equate to and justify animal exploitations in XTP (see ‘The Sociozoologic Gaze: Using Animals’). As a result, the sciences cannot use existing forms of animal exploitation to justify XTP. Furthermore, the research participants narrate a need to create a sociozoologic scale within an animal species, which serves to problematise the individual bodies of animals within a species. That is, what an animal is, how it should be used, and how its ontology is defined, is dependent on human designation. This is based on the individual animal’s content (how they have been bred for a particular purpose), and context (where they are kept and raised). Official science’s choice of an animal species on the whole is too general as for the research participants, as for them it is the individual animal itself which matters. In other words, official science focuses on a species while the research participants focus on individuals. This is further complicated by the intimate relations the research participants experience with ‘pets’, which creates complications and contradictions in their animal problematisations and XTP (see ‘The Sociozoologic Gaze: Using Animals’). These differences between science/social problematisations and rationalities therefore creates tensions. At the same time, it is difficult for science to confront these cultural rationalities, as they also draw upon personal and subjective experiences and knowledges. Therefore, science can talk about the

\[249\] This point might also connect to other kinds of animal industries.
social, but it cannot claim to represent it. This is particularly highlighted by those problematisations and stories that resist and reject those circulated by the XTP and PERV networks. This can be seen by the animal actants, whose refusal to enrol creates and sustains significant barriers and hurdles for the network. Attempts are therefore continuously circulated to try and successfully translate these actants (for example, GE and cloning). Animals, however, continue to resist (unsurprisingly).

While these stories from the publics are circulating, so are other problematisations. These oppose and discard the narratives created by the sciences (technical rationalities) in preference to others (cultural rationalities). The research participants can therefore reject official science’s stories on a whole or, on the other hand, can adapt, change or introduce ambiguity. Furthermore, if part of the scientific narrative is rejected, this can lead to the unsustainability of the story in total and the creation of counter rhetorics. For instance, Peter Collignon utilises scientific research on PERV, and xenozoonosis in general, to highlight the uncertainties of science. When problematised with the dangerous history of zoonosis and the limitations of human technical rationalities, XTP becomes unviable and dangerous. It is the scientific uncertainty, fear of the unknown, and the immeasurability of risk, which further stimulate the unease of the research participants who negatively tell of the potential xenozoonotic impact on current and future generations (see ‘Risk
and Uncertainty: Science and Zoonosis’). Significantly, technical uncertainty provides the opportunity for opposing and differing problematisations to surface. It is these types of stories on xenozoonosis that threaten the translations of the PERV network, and places the XTP network as it exists in doubt.

Significantly all of these diverse, complementary and disagreeing stories operate within the same network; the XTP network. At the risk of repetition, the XTP network in Australia is not ‘ready made science’. It remains to be ‘science in the making’. This is stimulated in many ways, including the rejection by the NHMRC (2005; 2004b) of the XWP’s recommendations, the current five year moratorium on clinical XTP trials in Australia, and the scientific reservations that reign in the scientific network (and the resultant uncertainties in the publics). This remains a network in development; a network open to disintegration and fragmentation. The PERV network can therefore be seen as an attempt to gain solidarity, and to stabilise these uncertainties and to provide stability to the XTP network. Currently, however, it is unsuccessful in straddling the science/society divide. When the current mortarium on human clinical XTP trials expires in 2009, such ambiguities within the sciences and the publics must be taken into serious account, without privileging one over the other. After all, XTP is a technoscience aimed at the publics.
The significance of this thesis is bound to the Australian XTP network as ‘in the making’. The public consultative processes of 2002 and 2004 are inadequate, as they adhere and listen to selective and particular versions of problematisations and truths. That is to say, preference has been given to particular technical rationalities at the expense of competing technical rationalities and cultural rationalities. For example, the XWP (2003b; 2002) had decided prior to public consultation that Australia should precede with XTP. This view continued, and stood in contrast to the vast majority of public narratives. Therefore, the public’s stories were ultimately irrelevant to the process and outcome. In addition, almost no submissions were received from people targeted by the technology, yet it was presumed by the XWP (2003b) that they could represent or ‘speak’ for them. As revealed through this thesis, however, this is not necessarily the case.

This thesis stands in opposition to these processes. While it has shown commonalities between the problematisations of the sciences and the social, it has also demonstrated how tensions remain in the sciences, and the pressure and conflict between differing rationalities. This thesis actively sought and gathered the stories and problematisations from a wide variety of actants, who were specifically implicated in or targeted by XTP and its networks. It was not presumed prior to entering the network what the actants would say, though official science indicated what the scientific networks
might generally narrate. Furthermore, all stories are valued equally, whether they emanate from documents, scientists, the general public, regulatory bodies, and on. Again, this stands in opposition to the public consultative processes of the XWP, which privileged its own rationalities and, in particular, technical rationalities. This selective use of favourable rationalities is ‘storyism’, ‘factism’, ‘truthism’ and ‘realityism’.

Finally, it cannot be presumed that science can speak for and represent the publics. Each should be respected for their own rationalities. It should be remembered that problematisations and stories will justify and advance their own position at the expense of others. Once again, this should be corrected when the current Australian moratorium on human clinical XTP trials is reviewed.
## Appendix 1.0 – The History of Xenotransplantation

<table>
<thead>
<tr>
<th>DATE</th>
<th>ANIMAL-TO-HUMAN XT</th>
<th>PATIENT CONDITION/S</th>
<th>TRANSPLANT (N.)</th>
<th>PATIENT SURVIVAL/IMPROVEMENT</th>
<th>RESEARCHER AND/OR COUNTRY OF RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1501</td>
<td>Canine bone</td>
<td>?</td>
<td>1</td>
<td>?</td>
<td>Baha’ al-Dawla, Iran</td>
</tr>
<tr>
<td>ca. 1501</td>
<td>Canine bone</td>
<td>?</td>
<td>1</td>
<td>?</td>
<td>Ala-ul-Din, Herat (Afghanistan)</td>
</tr>
<tr>
<td>16th to 18th centuries</td>
<td>Sheep blood transfusions</td>
<td>Various, including human blood extracted from leach applications</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>16th to 19th centuries</td>
<td>Skin grafts from dogs, cats, rabbits, chickens, cockerels, pigeons, lizards and frogs</td>
<td>Burns</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>17th century</td>
<td>Numerous animal blood transfusions</td>
<td>Differing/numerous conditions</td>
<td>?</td>
<td>Paris Society of Physicians and Royal Society (England) banned procedure in 1678</td>
<td>England and France</td>
</tr>
<tr>
<td>1628</td>
<td>Sheep blood transfusions</td>
<td>Resuscitation attempt</td>
<td>?</td>
<td>Did not revive</td>
<td>Italy</td>
</tr>
<tr>
<td>1667</td>
<td>Sheep blood transfusions</td>
<td>Mental afflictions</td>
<td>?</td>
<td>Did not alter</td>
<td>Samuel Pepys, London</td>
</tr>
<tr>
<td>1667</td>
<td>Lamb blood transfusions</td>
<td>Fever amongst other conditions</td>
<td>Numerous</td>
<td>Reported success; patient with fever recovered; 1 patient died</td>
<td>Jean-Baptiste Denis, France</td>
</tr>
<tr>
<td>1667</td>
<td>Calf blood transfusion <em>(three in total)</em></td>
<td>Madness</td>
<td>1</td>
<td>Head and shock symptoms; madness returned; died after third transfusion</td>
<td>Jean-Baptiste Denis, France</td>
</tr>
<tr>
<td>1668</td>
<td>Lamb blood transfusion</td>
<td>Paralysis</td>
<td>1</td>
<td>?</td>
<td>Jean-Baptiste Denis, France</td>
</tr>
<tr>
<td>1668</td>
<td>Canine bone</td>
<td>?</td>
<td>1</td>
<td>?</td>
<td>Job van Meeneren, the Netherlands (?)</td>
</tr>
<tr>
<td>1668</td>
<td>Canine bone</td>
<td>Repair of skull</td>
<td>1</td>
<td>Later removed due to religious persecution</td>
<td>Russia</td>
</tr>
<tr>
<td>Late 17th century</td>
<td>Animal blood transfusions</td>
<td>Violent outbursts and tempers</td>
<td>?</td>
<td>2</td>
<td>England (Rome)</td>
</tr>
<tr>
<td>1849</td>
<td>Bullock blood transfusions</td>
<td>Soldiers with cholera</td>
<td>?</td>
<td>All died</td>
<td>William A. Hammond, Annapolis (USA)</td>
</tr>
<tr>
<td>1872</td>
<td>Sheep blood transfusions</td>
<td>Twice given to a woman</td>
<td>1</td>
<td>?</td>
<td>Albini, Italy</td>
</tr>
<tr>
<td>1874</td>
<td>Lamb blood transfusions *</td>
<td>?</td>
<td>31</td>
<td>?</td>
<td>Hasse, Nordhausen (Germany)</td>
</tr>
<tr>
<td>1874</td>
<td>Lamb blood transfusions</td>
<td>?</td>
<td>2</td>
<td>?</td>
<td>Gradle, Chicago (USA)</td>
</tr>
<tr>
<td>1875</td>
<td>Rabbit cheeks</td>
<td>?</td>
<td>45</td>
<td>?</td>
<td>Houzé de l’Aulnoit, France</td>
</tr>
<tr>
<td>1873-1880</td>
<td>Milk transfusions from cows and goats</td>
<td>As a blood substitute</td>
<td>?</td>
<td>?</td>
<td>USA</td>
</tr>
<tr>
<td>1880</td>
<td>Pedicled skin grafts from living lamb to child</td>
<td>?</td>
<td>1</td>
<td>Died</td>
<td>E.W. Lee, Chicago (USA)</td>
</tr>
<tr>
<td>1882</td>
<td>Sheep blood transfusions</td>
<td>von Willebrand disease</td>
<td>1</td>
<td>Full recovery reported</td>
<td>F.Dedolph, Minnesota (USA)</td>
</tr>
<tr>
<td>1887</td>
<td>Rabbit eye</td>
<td>?</td>
<td>1</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Late 1880s</td>
<td>Unpedicled skin grafts from live frogs</td>
<td>To cover raw skin (i.e. – burns)</td>
<td>300-400</td>
<td>Possible temporary protection for natural healing</td>
<td>Ranking</td>
</tr>
<tr>
<td>1890</td>
<td>Lamb blood transfusions</td>
<td>Typhoid fever</td>
<td>?</td>
<td>?</td>
<td>Jenkins, USA</td>
</tr>
<tr>
<td>1893</td>
<td>Fragments of sheep pancreas</td>
<td>Diabetes</td>
<td>1</td>
<td>?</td>
<td>Williams, England (Bristol)</td>
</tr>
<tr>
<td>1896</td>
<td>Sheep urethral</td>
<td>Repair human urethral</td>
<td>1</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>1902</td>
<td>Slices of rabbit kidney into child</td>
<td>Renal failure</td>
<td>1</td>
<td>16 days</td>
<td>Princeteau 1905, Bordeaux (France)</td>
</tr>
<tr>
<td>1905</td>
<td>Pig kidney</td>
<td>?</td>
<td>1</td>
<td>Did not function</td>
<td>Ullman, Vienna</td>
</tr>
<tr>
<td>1906</td>
<td>Pig kidney</td>
<td>?</td>
<td>1</td>
<td>3 days</td>
<td>Jaboulay, France</td>
</tr>
<tr>
<td>DATE</td>
<td>ANIMAL-TO-HUMAN XT</td>
<td>PATIENT CONDITION/S</td>
<td>TRANSPLANT (N.)</td>
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<td>RESEARCHER AND/ OR COUNTRY OF RESEARCH</td>
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<tr>
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<td>------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>1906</td>
<td>Goat kidney</td>
<td>?</td>
<td>1</td>
<td>3 days</td>
<td>Jaboulay, France</td>
</tr>
<tr>
<td>1910</td>
<td>Macaque kidney</td>
<td>?</td>
<td>1</td>
<td>32 hours</td>
<td>Unger, Berlin (Germany)</td>
</tr>
<tr>
<td>1913</td>
<td>Monkey kidney</td>
<td>?</td>
<td>1</td>
<td>60 hours</td>
<td>Schonstadt</td>
</tr>
<tr>
<td>1914</td>
<td>Chimpanzee bone graft</td>
<td>Wounded World War I soldier</td>
<td>1</td>
<td>3 days</td>
<td>Voronoff</td>
</tr>
<tr>
<td>1914-1918</td>
<td>Sheep blood transfusions</td>
<td>Wounded soldiers</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>1963-1964</td>
<td>Baboon kidney</td>
<td>End-stage renal failure</td>
<td>6</td>
<td>19 days to 2 months</td>
<td>Starzl et al. 1964, Denver (USA)</td>
</tr>
<tr>
<td>1964</td>
<td>Chimpanzee heart</td>
<td>Heart disease</td>
<td>1</td>
<td>45 minutes (pacemaker also fitted)</td>
<td>Hardy et al. 1964, Jackson (USA)</td>
</tr>
<tr>
<td>1964</td>
<td>Chimpanzee kidney</td>
<td>?</td>
<td>1</td>
<td>?</td>
<td>Hardy, USA</td>
</tr>
<tr>
<td>1964</td>
<td>Chimpanzee kidney</td>
<td>?</td>
<td>1</td>
<td>3 days</td>
<td>Hume 1964, Richmond (USA)</td>
</tr>
<tr>
<td>1964</td>
<td>Chimpanzee kidney</td>
<td>?</td>
<td>31</td>
<td>Max. 49 days</td>
<td>Traeger 1964, Lyon (France)</td>
</tr>
<tr>
<td>1965</td>
<td>Chimpanzee kidney</td>
<td>?</td>
<td>2</td>
<td>Max. 4 months</td>
<td>Goldsmith 1964</td>
</tr>
<tr>
<td>1966</td>
<td>Chimpanzee kidney</td>
<td>?</td>
<td>1</td>
<td>31 days</td>
<td>Coetesini 1966, Rome (Italy)</td>
</tr>
<tr>
<td>1966</td>
<td>Dog skin</td>
<td>Burns</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>1966</td>
<td>Pig kidney</td>
<td>End-stage renal failure</td>
<td>1</td>
<td>48 hours</td>
<td>Rene Kuss, 1966</td>
</tr>
<tr>
<td>1966-1973</td>
<td>Chimpanzee livers to children</td>
<td>?</td>
<td>3</td>
<td>Max. 14 days</td>
<td>Starzl 1989, Denver (USA)</td>
</tr>
<tr>
<td>1968</td>
<td>Sheep heart</td>
<td>Heart AG failure</td>
<td>1</td>
<td>Rejected in 10 minutes (before surgery finished)</td>
<td>Cooley, Austin (USA)</td>
</tr>
<tr>
<td>1968</td>
<td>Pig heart</td>
<td>Bridge to heart AG</td>
<td>1</td>
<td>Rejected immediately</td>
<td>Ross, London</td>
</tr>
<tr>
<td>1969</td>
<td>Chimpanzee heart</td>
<td>?</td>
<td>2</td>
<td>4 hours</td>
<td>Marion, Lyon (France)</td>
</tr>
<tr>
<td>1969</td>
<td>Baboon liver</td>
<td>?</td>
<td>1</td>
<td>9 days</td>
<td>Starzl, Denver (USA)</td>
</tr>
<tr>
<td>1970</td>
<td>Baboon liver</td>
<td>?</td>
<td>1</td>
<td>72 hours</td>
<td>Leger, Paris (France)</td>
</tr>
<tr>
<td>1970</td>
<td>Chimpanzee liver</td>
<td>?</td>
<td>1</td>
<td>26 hours</td>
<td>Giles and Starzl, Denver (USA)</td>
</tr>
<tr>
<td>1971</td>
<td>Baboon liver</td>
<td>?</td>
<td>2</td>
<td>Less than 2 days</td>
<td>Pouyet and Berard, Lyon (France)</td>
</tr>
<tr>
<td>1974</td>
<td>Chimpanzee liver</td>
<td>?</td>
<td>1</td>
<td>14 days</td>
<td>Starzl, Denver (USA)</td>
</tr>
<tr>
<td>1977</td>
<td>Baboon heart</td>
<td>Open-heart surgery failure</td>
<td>1</td>
<td>6 days</td>
<td>Barnard 1977, Cape Town (South Africa)</td>
</tr>
<tr>
<td>1977</td>
<td>Chimpanzee heart</td>
<td>Open-heart surgery failure</td>
<td>1</td>
<td>4 days</td>
<td>Barnard 1977, Cape Town (South Africa)</td>
</tr>
<tr>
<td>1983</td>
<td>Pig skin</td>
<td>Burns</td>
<td>3</td>
<td>?</td>
<td>Ersek, Austin (USA)</td>
</tr>
<tr>
<td>1984</td>
<td>Baboon heart to newborn</td>
<td>Hypoplastic left heart syndrome</td>
<td>1</td>
<td>20 days</td>
<td>Bailey et al. 1985, Loma Linda (USA)</td>
</tr>
<tr>
<td>1987</td>
<td>Rabbit liver cells</td>
<td>?</td>
<td>1</td>
<td>Recovered for hospital discharge</td>
<td>Berkley (USA)</td>
</tr>
<tr>
<td>1989</td>
<td>Pig liver cells</td>
<td>Liver failure</td>
<td>59</td>
<td>63% survival of patients</td>
<td>Latvia</td>
</tr>
<tr>
<td>1990</td>
<td>Xenoperfusion through pig kidneys</td>
<td>Diabetics on chronic dialysis</td>
<td>?</td>
<td>?</td>
<td>England</td>
</tr>
</tbody>
</table>

**Appendix 1.1 – The History of Xenotransplantation**
<table>
<thead>
<tr>
<th>DATE</th>
<th>ANIMAL-TO-HUMAN XT</th>
<th>PATIENT CONDITION/S</th>
<th>TRANSPLANT (N.)</th>
<th>PATIENT SURVIVAL/ IMPROVEMENT</th>
<th>RESEARCHER AND/ OR COUNTRY OF RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>Xenoperfusion through pig spleen</td>
<td>Chronic posttraumatic and hematogenic osteomyelitis</td>
<td>51</td>
<td>Reduction in severity of symptoms and immune stabilisation; reduced hospitalisation by average of 7 days</td>
<td>Uragil'deev et al. 1991</td>
</tr>
<tr>
<td>1991-1992</td>
<td>Transgenic pig heart and xenoperfusion through pig heart (AG bridge)</td>
<td>Marfan syndrome</td>
<td>1</td>
<td>23 hours</td>
<td>Czaplicki et al. 1992</td>
</tr>
<tr>
<td>1992</td>
<td>Pig liver</td>
<td>?</td>
<td>1</td>
<td>2 days</td>
<td>Los Angeles (USA)</td>
</tr>
<tr>
<td>1992</td>
<td>Pig heart</td>
<td>?</td>
<td>1</td>
<td>24 hours</td>
<td>Religa and Czaplicki, Sosnowiec (Poland)</td>
</tr>
<tr>
<td>1992</td>
<td>Baboon liver</td>
<td>Liver failure from chronic hepatitis B and HIV</td>
<td>1</td>
<td>70 days</td>
<td>Starzl et al. 1993, Pittsburgh (USA)</td>
</tr>
<tr>
<td>1993</td>
<td>Pig liver and xenoperfusion through pig kidney (AG bridge)</td>
<td>Fulminant hepatic failure with hepatitis C</td>
<td>1</td>
<td>26 hours</td>
<td>Makowka et al. 1995, Los Angeles (USA)</td>
</tr>
<tr>
<td>1993</td>
<td>Baboon liver</td>
<td>Liver failure from hepatitis B</td>
<td>1</td>
<td>In a coma for 26 days</td>
<td>Starzl et al. 1993, Pittsburgh (USA)</td>
</tr>
<tr>
<td>1996</td>
<td>Pig foetal islet cells</td>
<td>Type-1 diabetics</td>
<td>2</td>
<td>Partial response</td>
<td>Robert Elliot, New Zealand</td>
</tr>
<tr>
<td>1996-1997*</td>
<td>Bioartificial liver device with pig liver cells (AG bridge or to recovery)</td>
<td>(a) 15x fulminant hepatic failure (waiting AG)</td>
<td>28</td>
<td>(a) 1 recovered without AG; 16 successfully bridged to AG (b) all 3 recovered after successful re-AT (c) Slight clinical improvement; 2 recovered after becoming candidates for and receiving AG; 8 died at periods of 1-20 days</td>
<td>Chen et al. 1997</td>
</tr>
<tr>
<td>1997*</td>
<td>Bioartificial liver device with pig liver cells (AG bridge or to recovery)</td>
<td>(a) 18x fulminant hepatic failure (waiting AG)</td>
<td>31</td>
<td>(a) 1 recovered without AG; 16 successfully bridged to AG; 1 died (b) all 3 recovered after successful re-AT (c) Slight clinical improvement; 2 recovered after becoming candidates for and receiving AG; 8 died at periods of 1-21 days</td>
<td>Watanabe et al. 1997</td>
</tr>
<tr>
<td>1997</td>
<td>Pig foetal neural cells</td>
<td>Parkinson’s disease</td>
<td>10</td>
<td>Possible improvement</td>
<td>Deacon et al. 1997, Belmont (USA)</td>
</tr>
<tr>
<td>1997</td>
<td>Pig heart, lungs and kidney (‘cluster’ XT)</td>
<td>?</td>
<td>1</td>
<td>1 week</td>
<td>Dhaniram Saruah, Assam (India)</td>
</tr>
<tr>
<td>1998*</td>
<td>Bioartificial liver device with pig liver cells (AG bridge or to recovery)</td>
<td>(a) 23x fulminant hepatic failure (waiting AG)</td>
<td>43</td>
<td>(a) 3 recovered without AG; 17 successfully bridged to AG; 1 improved but other problems lead to death at 21 days (b) all 10 recovered after successful re-AT (c) Slight improvement; 2 recovered after becoming candidates for and receiving AG; 8 died at periods of 1-21 days</td>
<td>Kamohara et al. 1998</td>
</tr>
<tr>
<td>1999</td>
<td>Pig skin</td>
<td>Burns</td>
<td>15</td>
<td>?</td>
<td>Vogt, Bochum (Germany)</td>
</tr>
<tr>
<td>2000</td>
<td>Newborn pig islet cells</td>
<td>Type-1 diabetes</td>
<td>6</td>
<td>2 patients with some evidence of graft function</td>
<td>Elliot et al. 2000</td>
</tr>
<tr>
<td>2000-present*</td>
<td>Pig pancreatic islets</td>
<td>Type-1 diabetes</td>
<td>12-22</td>
<td>10x reduced insulin by up to 80% 4x insulin free</td>
<td>Raphael Valdes, Mexico City (Mexico)</td>
</tr>
</tbody>
</table>

* These could possibly be the same trial.  ^ While Valdes reports significant success, these results have not been officially published or peer-reviewed for validity. Therefore, the results cannot be ascertained. For example, ethics problems with the research have forestalled publications and one conference presentation (Penson III 2004: 392), and data to evidence of survival and function of pig islets is yet to be produced (Auchincloss in Birmingham 2002: 1047).
<table>
<thead>
<tr>
<th>DATE</th>
<th>ANIMAL-TO-HUMAN XT</th>
<th>PATIENT CONDITION/S</th>
<th>TRANSPLANT (N.)</th>
<th>PATIENT SURVIVAL/ IMPROVEMENT</th>
<th>RESEARCHER AND/ OR COUNTRY OF RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Pig foetal neural cells</td>
<td>Huntington’s disease</td>
<td>12</td>
<td>No clinical improvement</td>
<td>Fink et al. 2000, Diacrin/Genzyme, Massachusetts (USA)</td>
</tr>
<tr>
<td>2000</td>
<td>Pig foetal neural cells</td>
<td>Parkinson’s disease</td>
<td>12</td>
<td>Phase I trial. 10 with clinical improvement of 12%; some with up to 30% improvement. Long term results?</td>
<td>Fink et al. 2000, Massachusetts (USA)</td>
</tr>
<tr>
<td>2000</td>
<td>Pig foetal neural cells</td>
<td>Stroke</td>
<td>5</td>
<td>4 improved, 2 had strokes. Suspended April 2000</td>
<td>Diacrin, USA</td>
</tr>
<tr>
<td>2002</td>
<td>Bioartificial liver device with pig liver cells (AG bridge or to recovery)</td>
<td>Liver failure</td>
<td>10</td>
<td>Improved symptoms; 6 bridged to AG; 2 died following AG</td>
<td>Samuel et al. 2002</td>
</tr>
<tr>
<td>2002</td>
<td>Bioartificial liver device with pig liver cells (AG bridge or to recovery)</td>
<td>Liver failure</td>
<td>7</td>
<td>Improved symptoms; 6 bridged to AG</td>
<td>Morsiani et al. 2002</td>
</tr>
<tr>
<td>2002</td>
<td>Bioartificial liver device with pig liver cells (AG bridge or to recovery)</td>
<td>Liver failure</td>
<td>7</td>
<td>1 recovered; 6 bridged to AG</td>
<td>van de Kerkhove et al. 2002</td>
</tr>
<tr>
<td>2002?</td>
<td>Pig foetal neural cells</td>
<td>Parkinson’s disease</td>
<td>9 subjects/ 9 placebos</td>
<td>Phase II trial. Subjects and placebos improved</td>
<td>Diacrin/Genzyme, USA</td>
</tr>
<tr>
<td>2005</td>
<td>Pig foetal islet cells with Sertoli (testicular) cells</td>
<td>Type-1 diabetes</td>
<td>2</td>
<td>?</td>
<td>Raphael Valdes, México City (México)</td>
</tr>
<tr>
<td>2007</td>
<td>Pig islet cells</td>
<td>Type-1 diabetes</td>
<td>2</td>
<td>Phase I/IIa trial</td>
<td>Skilfasovsky Institute in Moscow (Russia); Living Cell Technologies</td>
</tr>
<tr>
<td>2007-2008</td>
<td>Pig islet cells</td>
<td>Type-1 diabetes</td>
<td>9</td>
<td>Plan to commence in late 2007</td>
<td>Living Cell Technologies, New Zealand</td>
</tr>
<tr>
<td>?</td>
<td>Pig foetal neural cells</td>
<td>Severe epilepsy</td>
<td>1</td>
<td>?</td>
<td>Boston (USA)</td>
</tr>
<tr>
<td>?</td>
<td>Cow chromaffin (adrenal) cells</td>
<td>Chronic pain in terminal cancer patients</td>
<td>10 (further trials of &gt;100)</td>
<td>7 with less pain and reduced narcotic intake to death (up to 5 months)</td>
<td>Poland, Switzerland, Czech Republic, USA</td>
</tr>
<tr>
<td>?</td>
<td>Sheep cells; mostly from foetuses</td>
<td>?</td>
<td>?</td>
<td>1 improved</td>
<td>Switzerland</td>
</tr>
<tr>
<td>?</td>
<td>Transgenic hamster cells</td>
<td>Lou Gehrig’s disease</td>
<td>?</td>
<td>?</td>
<td>Aebischer (Switzerland)</td>
</tr>
<tr>
<td>?</td>
<td>Pig foetal neural cells</td>
<td>Focal epilepsy</td>
<td>3</td>
<td>1 improved</td>
<td>USA</td>
</tr>
<tr>
<td>?</td>
<td>Xenoperfusion with pig liver cells</td>
<td>Liver disease</td>
<td>?</td>
<td>?</td>
<td>Belgium, Germany, Italy, Spain, Holland, USA</td>
</tr>
<tr>
<td>?</td>
<td>Xenoperfusion through pig liver</td>
<td>Liver disease</td>
<td>?</td>
<td>?</td>
<td>USA</td>
</tr>
<tr>
<td>Present</td>
<td>Frog skin</td>
<td>Burns</td>
<td>?</td>
<td>?</td>
<td>Brazil and Vietnam</td>
</tr>
<tr>
<td>Present</td>
<td>Lizard and rabbit skin</td>
<td>Burns</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>1990s to present</td>
<td>Pig skin</td>
<td>Burns</td>
<td>?</td>
<td>Throughout the world</td>
<td></td>
</tr>
<tr>
<td>Future?</td>
<td>Pig foetal neural cells</td>
<td>Parkinson’s disease</td>
<td>16 subjects/ 16 placebos</td>
<td>Phase III trial</td>
<td>Diacrin/Genzyme, USA</td>
</tr>
</tbody>
</table>


Appendix 1.3 – The History of Xenotransplantation
**Subjects and Year of Study**

<table>
<thead>
<tr>
<th>Subjects and Year of Study*</th>
<th>Method</th>
<th>N.</th>
<th>Accept Animal Breeding for XTP or XTP Research</th>
<th>Accept XT Regardless of Situation</th>
<th>Accept XT When Alternatives Have Failed, Not Available or As an Emergency</th>
<th>Accept XT With Increased Uncertainty and Risk</th>
<th>Accept Pig XT or As a XT Source</th>
<th>Accept Nonhuman Primate XT or As a XT Source</th>
<th>Researcher and/or Country of Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>General public (1993)</td>
<td>Telephone survey</td>
<td>6127</td>
<td>-</td>
<td>-</td>
<td>AG unavailable: 51%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Gallup Organization Inc. (1999); United States of America</td>
</tr>
<tr>
<td>AT recipients (&gt;1 year) from Alfred Hospital (H) and Australian Transplant Games, Bathurst (G)</td>
<td>Structured interview questionnaire</td>
<td>H: 63  G: 56</td>
<td>H: 78%  G: 61%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Okada-Takagi and Williams (1993); Australia</td>
</tr>
<tr>
<td>People with renal failure and on the AT waiting list for at least 1 year</td>
<td>Questionnaire</td>
<td>136</td>
<td>68%</td>
<td>50%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Arundell et al. (1994) in Mohaci et al. (1999: 40); Australia</td>
</tr>
<tr>
<td>Potential AG recipients (1994?)</td>
<td>-</td>
<td>?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Survey presented at 1994 symposium in Mohaci et al. (1999: 40); United Kingdom</td>
</tr>
<tr>
<td>Acute Care Nurses</td>
<td>Questionnaire</td>
<td>1663</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18.9%</td>
<td>19%</td>
<td>-</td>
<td>Mohaci et al. (1995); Australia</td>
</tr>
<tr>
<td>Young People (11-18 years)</td>
<td>Questionnaire with information</td>
<td>238</td>
<td>55%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>People waiting for an AGs (kidney, heart or heart/lung)</td>
<td>Survey with XTP information</td>
<td>188</td>
<td>69%  GE: 64%</td>
<td>48%  Unsure: 42%  For family member: 45%</td>
<td>AG unavailable: 55%  AG failure: 13%  Medical failure: 9%</td>
<td>- 27%</td>
<td>13%</td>
<td>-</td>
<td>Arundell and McKenzie (1997); Victoria, Australia</td>
</tr>
<tr>
<td>General public</td>
<td>Mail-out questionnaire</td>
<td>236</td>
<td>-</td>
<td>Self: 74%  For family member: 72%</td>
<td>-  With reduced success rate of 40%:  Self: 47%  For family member: 49%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Hanlon (1997); Sydney Australia</td>
</tr>
<tr>
<td>People with renal failure (potential AG recipients and AG recipients)</td>
<td>Questionnaire</td>
<td>?</td>
<td>47.8%</td>
<td>41.6%</td>
<td>-</td>
<td>-</td>
<td>41.6%</td>
<td>41.6%</td>
<td>Mohaci et al. (1997); Australia</td>
</tr>
<tr>
<td>Dialysis patients</td>
<td>Questionnaire with GE explanation</td>
<td>858</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Transgenic kidney: 78%  Unwilling: 17%</td>
<td>-</td>
<td>-</td>
<td>Ward (1997) in Long et al. (2002: 281) and Mohaci et al. (1999: 40); United Kingdom</td>
</tr>
<tr>
<td>AG recipients (1993)</td>
<td>Survey with multiple choice and open-response questions</td>
<td>100</td>
<td>-</td>
<td>80%  Refuse: 20%</td>
<td>-</td>
<td>42%</td>
<td>44%</td>
<td>-</td>
<td>Coffman et al. (1998); United States of America</td>
</tr>
<tr>
<td>General public (1997)</td>
<td>Survey</td>
<td>?</td>
<td>42.4%</td>
<td>-</td>
<td>Oppose: 49%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Moatti (1998); France</td>
</tr>
<tr>
<td>General public</td>
<td>Questionnaire</td>
<td>1060</td>
<td>-</td>
<td>40%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Sanner (1998); Sweden</td>
</tr>
</tbody>
</table>

* Year is included if the year when the research was conducted is different from the year of publication.

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**Appendix 2.0 – Quantitative Social Research on Xenotransplantation**
| SUBJECTS AND YEAR OF STUDY* | METHOD | N. | ACCEPT ANIMAL BREEDING FOR XTP OR XTP RESEARCH | ACCEPT XT REGARDLESS OF SITUATION | ACCEPT XT WHEN ALTERNATIVES HAVE FAILED, NOT AVAILABLE OR AS AN EMERGENCY | ACCEPT XT WITH INCREASED UNCERTAINTY AND RISK | ACCEPT PIG XT OR AS A XT SOURCE | ACCEPT NONHUMAN PRIMATE XT OR AS A XT SOURCE | RESEARCHER AND/OR COUNTRY OF RESEARCH |
|-----------------------------|--------|----|-----------------------------------------------|---------------------------------|-----------------------------------------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|---------------------------------|--------------------------------|
| AT recipients (R) and non-recipients (N) | Survey | R: 1424 N: 500 | Accept as worthy – R: 94%; N: 99%; Research to continue – R: 88.7%; N: 90.4% | R: 74%; N: 73% | Need another transplant and AG unavailable – R: 15.7%; N: 13.6% | - | - | Preferred option | National Kidney Foundation in King (1998); United States of America |
| General public | Survey | 2526 | Refuse: 39% | AG unavailable (self or family member): 54% | - | - | - | Health Canada (1999); Canada |
| Physicians (P), nurses (N), technicians (T), students (S) | Survey with XTP information on potential infectious risks and animal source details | P: 91 N: 128 T: 85 S: 321 | With XTP definition – P: 94.3%; N: 87.2%; T: 92.6%; S: 90.6% | With XTP definition – P: 54.9%; N: 33.9%; T: 41.3%; S: 48.3% | With XTP definition – P: 69.2%; N: 60.8%; T: 68.4%; S: 72.1% | With theoretical infectious risk information – P: 74.1%; N: 71.4%; T: 73.9%; S: 87.7% | P: 88.1%; N: 74.8%; T: 85.1%; S: 82.3% | - | Julvez et al. (1999); France |
| People who have received an AG (AG) or are waiting for an AG (W) (1997-1998) | Questionnaire | AG: 722 W: 327 | GE: 84% | 77% with the following – • As a bridge to AG only: 33% • Prefer XT: 10% • In emergency – AG: 56%; W: 26% • Refuse: 7% | From more intense medication: 58% | - | - | Schlitt et al. (1999); Germany |
| General public (P), teachers (T), farmers (F) | Telephone survey | P: 1203 T: 304 F: 201 | Useful application: 70% Morally acceptable: 55% Worthy to be encouraged: 60% GE: 52% | - | - | - | - | Yann Campbell Hoare Wheeler (1999); Australia |
| Undergraduate students: medicine (M), nursing (N), education (E), social science (S), biomedical science (BS), biomedical analysis (BA), pharmacy (P), science and technology (ST), veterinary medicine (V), agriculture (A) | Survey | 1875 | 95% | A: 84.6%; BA: 73.6%; BS: 73.7%; E: 51.3%; M: 79%; N: 51.5%; P: 84.5%; S: 59.7%; T: 81.1%; V: 76.8%; <3 years study: 56.3% >3 years study: 77.8% | - | - | - | Hagelin et al. (2000); Sweden |
| General public in New England (NE) and the remainder of the United States of America (USA) | Telephone survey with open-ended questions | NE: 101 USA: 400 | NE: 67.5% USA: 47% Oppose (NE): 39% | NE: 69.3% USA: 53.8% Refuse (USA): 23% | Life or death (USA): 54% | - | - | - | Cassileth et al. (2001); United States of America |

Appendix 2.1 – Quantitative Social Research on Xenotransplantation

* Year is included if the year when the research was conducted is different from the year of publication.
<table>
<thead>
<tr>
<th>SUBJECTS AND YEAR OF STUDY*</th>
<th>METHOD</th>
<th>N.</th>
<th>ACCEPT ANIMAL BREEDING FOR XTP OR XTP RESEARCH</th>
<th>ACCEPT XT REGARDLESS OF SITUATION</th>
<th>ACCEPT XT WHEN ALTERNATIVES HAVE FAILED, NOT AVAILABLE OR AS AN EMERGENCY</th>
<th>ACCEPT XT WITH INCREASED UNCERTAINTY AND RISK</th>
<th>ACCEPT PIG XT OR AS A XT SOURCE</th>
<th>ACCEPT NONHUMAN PRIMATE XT OR AS A XT SOURCE</th>
<th>RESEARCHER AND/OR COUNTRY OF RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>General public (P), law students (L), medical students (M), patients with diseases not treatable with AT (D), people with an AG and waiting an AG (AG)</td>
<td>Closed-question questionnaire</td>
<td>P: 68 L: 32 M: 27 D: 32 AG: 29</td>
<td>-</td>
<td>P: 34%; L: 39%; M: 59%; D: 69%; AG: 100%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Franti et al. (2001); Rome, Italy</td>
</tr>
<tr>
<td>Undergraduate students: religious (R), nonreligious (N), Protestants (P), Catholics (C), Muslims (M)</td>
<td>Closed-question questionnaire</td>
<td>2903</td>
<td>-</td>
<td>R: 48.9%; N: 70.7%; P: 51.8%; C: 42.7%; M: 37.5%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Hagelin et al. (2001); Kenya, Sweden and Texas (United States of America)</td>
</tr>
<tr>
<td>People waiting for an AG (AG) and their caregivers (CG)</td>
<td>Questionnaire</td>
<td>AG: 59 CG: 54</td>
<td>-</td>
<td>AG: 14%; CG (partner should accept): 10%; CG (partner should not accept): 2%; CG (did not respond): 76%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Long et al. (2002); United Kingdom</td>
</tr>
<tr>
<td>General public (2001)</td>
<td>Structured interview with some explanatory statements</td>
<td>1000</td>
<td>66%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Lundin and Idvall (2005); Sweden</td>
</tr>
<tr>
<td>Undergraduate students: medicine (M), agriculture (A), veterinary medicine (V), psychology (P), educational science (E)</td>
<td>Questionnaire</td>
<td>585</td>
<td>77.9% GE: 68.2%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>De Bona et al. (2004); Italy</td>
<td></td>
</tr>
<tr>
<td>General public (16 years of age and older)</td>
<td>National telephone poll</td>
<td>1487</td>
<td>-</td>
<td>Life or death: 70%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Pfizer Australia and Transplant Australia (2004); Australia</td>
</tr>
</tbody>
</table>

Year is included if the year when the research was conducted is different from the year of publication.

Appendix 2.2 – Quantitative Social Research on Xenotransplantation
### Chart 1 - What is Xenotransplantation?

**Animal cell therapies**

**Example:** Using insulin-producing cells from a pig pancreas to treat a person with type 1 diabetes

- Pig
  - Insulin-producing cells from the pancreas
  - Transplant to suitable site in body of recipient
  - Human
  - Pig cells produce insulin and may avoid need for further insulin injections

**Animal external therapies**

**Example:** Using pig liver cells in an external device for the treatment of organ failure

- Pig
  - Liver
  - Cells transferred into chambers of external device
  - Blood from patient purified by passing through device
  - Patient may be stabilised while waiting for human liver donor

**Animal organ transplants**

**Example:** Using a pig kidney to replace a kidney in a person with kidney failure

- Pig
  - Kidney
  - Replace failed kidney
  - Human
  - Patient may have restored kidney function


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Appendix 3.0 - Charts used in Focus Groups and Interviews
“[…] nonhuman primates (such as baboons and other monkeys) are not a suitable source for any of the proposed animal therapies (external therapies, cell therapies or organ transplants) because of the risk of infections to the recipient and the wider community.

At present, pigs are considered to be the most likely and appropriate nonhuman source of organs and tissues. The anatomy and functioning of pigs is very similar to those of humans. Pigs are domesticated animals that are easy to breed, and, importantly, pigs are suitable for genetic modification […]."

Acknowledgement: Xenotransplantation Working Party (2003a: 11, original emphasis)

Chart 2 - Animals (XT Source)

Appendix 3.1 - Charts used in Focus Groups and Interviews
“Researchers predict that immune rejection of animal-to-human transplants may be avoided by genetically modifying the source animals, as well as by treating the human recipient with drugs to suppress their immune response (immunosuppressant drugs). Genetic modification of source animals involves inserting some human genes into the animals to make their cells, tissues and organs behave more like human-to-human transplants.

This raises some difficult ethical issues about the rights and welfare of the animals, such as whether the insertion of human genes may make the animal in some way ‘human’, or whether inserted genes cause unexpected side effects in the animals. [...] The aim is to make sure that the animals retain the essential characteristics of their species”.


Chart 3 - Animals (Genetic engineering)
“The main risk for a person receiving animal transplant therapy is that the transplant might not function properly. However, there is also a risk that one of the wide range of viral, bacterial and other infections known to occur in the source animals, will infect the transplant recipient causing disease. […] Unfortunately, for both human-to-human and animal-to-human transplantation, the potential for an infection to occur is increased by the drug treatment that transplant patients receive to suppress the immune system and help prevent rejection of the transplant.

While known animal infections may not pose a serious problem, animal-to-human transplantation does carry another potential risk that has more serious implications for both the individual patient and the wider community. This is the risk that a previously unknown disease, or a new form of a known disease, might emerge and infect recipients of animal transplants and subsequently spread to close contacts and the general public, causing a serious new epidemic”.

Acknowledgement: Xenotransplantation Working Party (2003a: 8, original emphasis)

Chart 4 - Infectious Risk

Appendix 3.3 - Charts used in Focus Groups and Interviews
“Because of the infection risks, it would [...] be necessary to discuss the trial with the family and other close contacts and carers of the trial participant and to inform them of any potential infection risks they face as a result of the trial. [...] even if the transplant itself were unsuccessful, it may be necessary for participants and their close contacts to continue to be checked for infectious diseases. This means that, [...] they would not be able to withdraw from the monitoring and follow-up associated with infectious diseases. They would also not be able to donate their organs, tissues or cells at any time during their life or after death [...].

Tissue samples from all procedures would need to be stored in a central tissue bank for future reference. Details of all trial participants and close contacts would also need to be entered in a central register to ensure that they could be traced and followed-up in future. This information would also need to be available to other countries so that trial participants and contacts could be traced, even if they were to move or travel abroad”.

Acknowledgement: Xenotransplantation Working Party (2003a: 14, original emphasis)

Chart 5 - Recipient Monitoring and Surveillance

Appendix 3.4 - Chart used in Focus Groups and Interviews

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