

Expose and protect: reflections on experimental scientific practices based on a case study

Marisol Marini^{1 2}

Stelio Marras³

¹ Universidade Estadual de Campinas, Instituto de Geociências,
Departamento de Política Científica e Tecnológica, Campinas, SP, Brasil

² McGill University, Department of Social Studies of Medicine,
Faculty of Medicine and Health Sciences, Montréal, Canada

³ Universidade de São Paulo (USP), Instituto de Estudos Brasileiros (IEB), São Paulo, SP, Brasil

Abstract

Based on ethnographic research, the article reflects on experimental surgical practices related to the development of ventricular assist devices (the so-called ‘artificial heart’). Focusing on the relationships between *animal models* and the numerous professionals involved in the experiment, the hypothesis of this article pinpoints the unavoidable game of exposing and protecting all the agents who establish relationships therein, as a condition for understanding and innovating on legitimate grounds. This game, ethnographically followed step by step, meets both scientific and ethical imperatives. The reflection leads us to consider, among other things, the sensitive, decisive character of otherness regarding experimental animals in the course of the experiments. According to the aforementioned hypothesis, this is when notions of *participation* and *disparticipation* in the game of otherness with these *animal models* seem to clarify the economy, simultaneously affective and intelligible, put into practice in the relationships performed therein.

Key words: Social studies of science; Laboratory ethnography; Ethics and knowledge in innovation; Animal models and experimentation; *Participatory* and *disparticipatory* otherness.

Expor e proteger: reflexões sobre práticas científicas experimentais a partir de um estudo de caso

Resumo

Baseado em etnografia, o artigo reflete sobre práticas cirúrgicas experimentais que envolvem a produção de Dispositivo de Assistência Ventricular (o chamado “coração artificial”). Com foco nas relações entre *modelos animais* e os diversos profissionais implicados no experimento, a hipótese do artigo aponta para o incontornável jogo entre expor e proteger todos os agentes ali relacionados, tal como condição para se conhecer e inovar em bases legítimas. Esse jogo, acompanhado no passo a passo etnográfico, atende assim a imperativos tão científicos quanto éticos. A reflexão leva a considerar, entre outras coisas, o caráter sensível e decisivo da alteridade com cobaias no curso dos experimentos. É quando noções de *participação* e *desparticipação* no jogo de alteridade com esses *modelos animais*, conforme a hipótese referida, parecem bem esclarecer a economia, a um só tempo afetiva e inteligível, posta em prática nas relações ali ensaiadas.

Palavras-chaves: Antropologia da ciência e da tecnociência; Etnografia de laboratório; Ética e conhecimento em inovação; Experimentação animal; Alteridade *participativa* e *desparticipativa*.

Expose and protect: reflections on experimental scientific practices based on a case study

Marisol Marini
Stelio Marras

Expose

The time had come for the long-awaited scene. It was another acute *in vivo test*¹ on an experimental animal to implant a ventricular assist device (VAD) – better known in the *lato sensu* as an artificial heart². The atmosphere combined tension and excitement in the operating room, where the highly experimental event was to be dramatised once again. It is 2016 and the event brings together a multidisciplinary team from an important cardiology centre in São Paulo³. Among the cast, renowned surgeons, a perfusionist, an instrumentalist, a veterinarian, laboratory technicians, bioengineers, medicines, reagents and a whole paraphernalia of technological devices. In such dramas, there is no actor, human or non-human, organic or mechanical, analogue or digital, that is not exposed and tested in the experiment.

The profile of each of those exposed is shaped depending on the event in question⁴. As with all exposure, vulnerability surrounds the beings present and subject to testing, though clearly each of them is exposed to different risks. For example, in this setting, no one was sure what the role of an anthropologist might be, ordinarily associated with the study of culture, social relations, and humans, not with experimental activities in medicine and natural and technical sciences. After overcoming the initial difficulties of being accepted in the environment, where such a presence was not expected, the anthropologist was exposed as an object of curiosity. For the surgical team, perhaps she played the role of an audience, but within the ethnographic task, she was also exposed. This was the case, for example, when they attributed kinship between her and the ‘patient’ (experimental animal, *animal model*) therein exposed to experimentation⁵.

1 Acute surgical procedures are characterised as short-term experimental tests for the validation of medical technologies under development. For them to be transformed into products intended for human patients, the devices need to undergo stabilisation procedures. Unlike long-term tests, in acute procedures, animals must remain in the surgical field for six hours with the device installed. Once the evaluation has been completed, the animals are euthanised.

2 Here we refer to data collected within the scope of Marini’s doctoral research (2018) regarding the production and use of cardiac technologies generally known as artificial hearts. The ethnography was conducted together with a network of researchers, institutions and several devices. Circulatory assist devices are technologies developed to assist or replace the heart function of patients suffering from heart failure. Their development is justified by the existence of high rates of cardiovascular diseases that result in heart failure. In the advanced stage, when patients become refractory to relevant medications, they must undergo heart transplants. Faced with the high demand for replacement and the scarcity of available human organs, so-called artificial hearts emerge as temporary and definitive alternatives. However, these are experimental, controversial and unstable strategies, much like transplants.

3 The names of the interlocutors mentioned in this article – bioengineers, doctors, veterinarians, surgical and vivarium technicians, etc. –, together with the names of the institutions, have been changed or withheld to maintain confidentiality. Here too, protection is required.

4 We understand that the agents of any composition of the real, like the experiment described here, gain their effective figuration and functionality only in the event itself, not before it. Even then, it is necessary that the relationships tested in the experiment remain constant or stable, as we are pursuing here, so that, in turn, we can expect from the agents the reiteration of the actions that they demonstrated in the experimental scene. In terms of Latour (1999a), this concerns the transition of the agents in question from ‘performance’ to ‘competence’.

5 In another situation, there was a joke that seemed to bring human and non-human animals closer together. The lead surgeon arrived at the laboratory while the surgical field was being prepared. After dressing, he passed by the anthropologist, who was waiting outside the room, at the window through which it was possible to observe the movement that took place in the operating room. This was not the only observation position occupied, but in that situation, this was the angle chosen. Upon entering the room, and noticing this unknown, unrecognised presence (who was not dressed as if she were part of the surgical team), the surgeon asked if the anthropologist was a relative of the patient. The jocular tone revealed that pigs do not have relatives who are able to watch and worry about their procedure (*disparticipation*), on the other hand, it explained the proximity considered by the surgeon, who ought to operate on that animal ‘as if’ it was a patient (*participation*).

With the scenario prepared, the appearance of this actor was now awaited, no less of a protagonist in the scene, within whose exposed chest the purpose of the experiment would be conducted. It was the pig, who had come from the vivarium to the operating room, accompanied by a technician, the veterinarian's assistant. The *in vivo* tests that succeed the bench tests are crucial for all those involved in the experiment – from the chief surgeon to the pivot bearing on the VAD –, all aligned and exposed according to the device being tested, all represented therein by their specific functional roles, also at risk in each moment.

Prior to the intervention that would transform the pig into a new temporary entity constituted by the fusion between its heart and the artificial device, another series of preparations had been made to ensure, as much as possible or desirable, that the pig was able to implant the device. As with previous procedures, the preparation – which principally includes the establishment of the 'surgical field'⁶ – consists of mimicking the surgical practice routinely performed on humans in the hospital's surgical centres, where this medical, bioengineering experimentation was now taking place. If all went well with the implantation of the device, the scene would extend for the six-hour follow-up period, at the end of which the pig would be sacrificed – technically speaking, it⁷ would be submitted to 'passive euthanasia' – according to the protocol procedure established by the ethics committee that operates in the institution itself.

While the surgical field was being set up for the intervention on the pig, the mood quickly cooled down: unexpectedly, the pig destined for experimentation 'died during the thoracotomy'⁸ – an interrupted procedure, with exclusion of the animal from the experiment, the test invalidated, no generation of expected data. All the preparation for the surgical intervention had been in vain: hair removal from the body regions that were to be operated on (to avoid infections), a procedure called trichotomy of the inguinal, cervical and thoracic regions; the insertion of introducers and catheters that enable communication between the inside and outside of the body through which the introduction of medications, measurements and collections takes place; intubation, which is the insertion of a tube into the trachea to assist in ventilating the animal throughout the procedure; and the application of mechanical ventilation, which is a form of artificial respiration designed to ensure the maintenance of gas exchange (since anaesthesia, muscle paralysis and subsequent replacement of cardiorespiratory functions make it impossible for the body to perform its normal ventilation). Finally, the team lost all the meticulous work of exposing the thorax as a means to access the animal's heart, whose half-open body has to remain alive for controlled communications between inside and outside – a division that is simultaneously reified and imploded by surgical interventions, when we consider that the metres of tubes spread across the room, enabling the blood to circulate through the space, distribute the body beyond the borders of the skin, reformulating the relevance and scale of what is inside and what is outside.

Surgical procedures are risky ventures. Cardiac surgeries, which are sub-specialties, are proven to be especially radical, dangerous, unstable, demanding a challenging specialisation, as highlighted by the surgeon who we witnessed in field research when performing paediatric surgeries, his area of expertise. He was emphatic in highlighting that the low demand for this surgical specialty in reference to the challenges: they are time-consuming surgeries in which errors are unacceptable, because they can be catastrophic. On the other hand, there are always new techniques emerging – which is why surgeons need to be constantly updating and improving. Like other procedures of medium or high complexity, cardiac surgeries carry the

6 For further explanation regarding the formation of the 'surgical field' and the debates on this, see Marini (2019). A brief description of this is also available below in the section 'Protect', together with the scope that we give to this prophylactic institution.

7 Authors' note on the translation: The English distinction between 'She or He' and 'It' contributes to our argument here. Thus, we have 'She or He' as *participation* and 'It' as *disparticipation*. The strategic alternation in the use of the pronoun can then be recognised, since far from being a mere detail or accident, it is affirmed as a device or resource, even when this is not conscious and intentional, to engender either continuities or discontinuities between beings that are present. Our argument is that this alternation proves to be crucial for the good of the procedures and of those involved in experiences like the one analysed in this article.

8 Thoracotomy is the incision to open the thoracic cavity, which in this case was for the VAD implantation experiment

risk of making the patient even more sick than they were before the intervention. Experimental surgeries, such as those performed on animals, which do not have the same infrastructure as surgical centres (despite the effort to reproduce the right conditions as closely as possible) are even more vulnerable to complications.

It is not uncommon for experimental animals to die during such experiments. Before this surgery, two other pigs had died ahead of schedule, with the DAV already implanted and working for a few hours, thus interrupting observations that were supposed to be more extensive. Less common, however, is what was now happening with this third pig submitted to surgery: he had ‘given up’ on living, as the vivarium technician informally put it in a formal environment. Or he had ‘surrendered himself’, as one of the bioengineers present said, even before interventions in the surgical field could be advanced. Upon rupture of its pericardium – the membrane that protects the heart – the pig surprisingly ‘went into sudden cardiac arrest’, as described in later reports⁹. The pericardium can be understood as the last physical boundary that separates the heart from its exterior. It is the membrane that remains after the skin, a layer of flesh and fat, and eventually the bones of the rib cage, are ruptured so that the heart is finally exposed and accessible to the eyes and hands of the surgeons, who can then manipulate the left ventricle, where the inlet cannula of the device is attached, as well as the aorta artery, where the outlet cannula goes, connected by anastomosis¹⁰ like in other procedures.

The team of surgeons and the veterinarian responsible reported that the animal had suffered a sudden sickness, for no apparent reason. This is how the case was stated in the reports and, with this justification, a request was made to the ethics committee to include one more animal, since in this aborted experiment it was not even possible to implant the device, let alone observe the interaction between the device and the organ, which are the two main objectives of the experiment. In a previous trial, another pig had died unexpectedly, explained as a result of fibrillation, a type of cardiac arrhythmia characterised by rapid, irregular beating of the atria, which may have been caused by the presence of microbubbles of air in the coronary arteries, resulting from difficulty in fixing the device cannula to the guide ring fixed to the heart. Although the cannula fitting to the guide ring seemed firm, difficulty in attaching the device parts to the heart – given the type of fitting developed by the bioengineers¹¹ – may have caused it to come loose, causing the entry of gases into the circulatory system, which must remain sealed¹². Technical objects, once exposed to composition with other agents with which they must work, are no less vulnerable. Evidently, this vulnerability begins to extend, as if through participation or contagion, to other agents or actors directly involved, such as the bioengineers who designed the socket.

Although it was not possible to follow the organ’s interaction with the device, the experiment was still considered valid, however, since on this occasion the artificial heart was implanted and the cause of death was attributed to complications in the procedure. Even though it was not possible to collect data regarding the pump in operation, since the animal died soon after implantation, when it was transferred from cardiopulmonary bypass and its circulatory functions were restarted, the trial ended early and abruptly, but it was not discarded. In the reports, the case was registered as ‘intercurrences when the animal came off ECC’ (extracorporeal circulation), at which point it was observed that the inlet cannula was loose in the guide ring.

9 When presenting the results in her doctoral thesis, one of the bioengineers responsible for the experiment cited another study with an electromechanical artificial ventricle implanted in 26 calves, in which five deaths from sudden cardiac arrest were recorded. This data was presented to justify the similar percentage of sudden cardiac arrest in the two studies. In these comparisons, the success rate is recognised since it follows the indices produced in the reference contexts.

10 Anastomosis is a surgical procedure designed to establish a relationship that allows flow between two tubular or hollow structures.

11 A careful analysis of the difficulties of meeting the requirements of fitting was developed by Marini (2021). Considering the difficulties that led engineers to reformulate the structure of the device, this imposed itself, requiring a new form. Since this creation took place based on the flaw identified, we affirm the understanding that imagination is an aspect of technoscientific production that goes through an embodiment due to the material and concrete engagement with things, and is not merely a projective, ‘mental’ idealisation. In an experimental regime, this engagement refers to odds and risks that concern everyone in the composition of technical apparatus.

12 This condition is described as an embolism, which is the obstruction of a blood or lymphatic vessel due to the presence of abnormal and insoluble elements, formed by a broad diversity of elements, including gas bubbles.

Despite an attempt to reposition the cannula after the fixing the device in place a second time, the animal's organ 'went into fibrillation'. But given that, up to that point, the setbacks had not outweighed the successes, the legitimacy of the experiment was justified.

Breakdowns like those described are events that usually have the power to expose the elements or agents that have been submitted to some composition: their working black boxes are opened¹³, other possible compositions are insinuated; other adjustments, substitutions or new alignment routes in the machinery in question. Breakdowns expose and render agents and relationships visible that were previously invisible or opaque because they are so stable and habituated. This was the case therein: the cannula fitting was exposed as imperfect in the experiment and its figuration enabled it to gain these contours *in the event*. Moreover, this was the case even in relation to the breakdown of, say, the organic machinery of the animals that did not withstand the procedure, since it had been possible to formulate reasonable explanations related to premature deaths, but not in the case of the pig that died for no apparent reason – or none directly related to the experiment – resulting in a death in vain. Now, an exposure in vain can dangerously disseminate the lack of protection of those concerned in the experimental scene (animals, surgeons, engineers, veterinarians, institutions, techniques, prestige, etc.).

If the opinion of the bioengineer was discarded, according to whom the pig had 'surrendered himself', even more so was the opinion of the vivarium technician, according to whom the pig had 'given up' on the experiment by relinquishing its own life. However, for the technician, this opinion was based on an embodied experience with the pig, in their backstage interactions prior to the experiment itself, that of the cherished scene in the operating room. For him, the animal had already given up on the experiment, it was no longer performing satisfactorily in the preparatory stages in the vivarium. Now it was the technician who exposed himself to certain, veiled derision from the other professionals who saw themselves duly authorised to diagnose the official 'good reasons'¹⁴ for that sudden intercurrent. Not being a surgeon or a veterinarian, the technician was responsible for nothing more than ensuring the material conditions, together with the animal under his guard and care, that contribute to the smooth running of the procedure. He did not possess specialised, legitimate knowledge to issue similar reports. However, his dismissed point of view, exposed in therein as mere opinion, was based on care devoted to the animal in the vivarium and the pig's lack of resistance when carried from the vivarium to the operating room. Along this path, the animals are already pre-anesthetised, a measure taken to reduce the level of stress, as determined by ethical parameters, and indeed useful to the experiment, since a less stressed animal responds better to the extremes imposed by these experimental surgical procedures.

From the vivarium to the operating room, the animals are carried on open carts, the same ones intended for transporting boxes and heavy objects, precisely because the experimental animals are already pre-anesthetised and, therefore, are unable to make this journey through their own effort. Once in the operating room, the animals are placed on a stretcher, which because it is higher than that of the cart, requires that they be lifted, and thus requires a certain strength from the auxiliary technicians who accompany them, sometimes with the assistance of the bioengineers and veterinarian, particularly when the models used weigh around 70 kg, like pigs. This was the case of the pig that 'gave up' or 'gave up on itself', since the one in the previous experiment, weighing 45 kg, arrived at the operating table under complaints from the surgeon, whose objection was based on the indication that the 'the aortic arch of the animal showed significantly reduced dimensions' (compared to the ideal average human). In response to this objection, the mass of the second animal selected was approximately 60 kg, a trend that was applied in the following procedures, with animals above 70 kg, like the pig that 'gave up' on the experiment.

¹³ On the productivity of breakdowns, see Latour (2014); on opening black boxes, Latour (1987).

¹⁴ On naturalistic 'good' and 'bad reasons', see Pignarre (1997) and Marras (2002). Here, we argue that the validity of distinguishing the good reasons from the bad when understanding the placebo effect, the object of Pignarre's work, also applies to the case in question.

According to the technician, unlike the resistance that the animals usually present along this path, even when pre-anesthetised, involving bodily movements and agitation, the pig in question did not show the expected resistance, which in turn made it difficult for the technician to carry it, because by ‘giving up’ and transferring its weight fully to those who carried it, the animal’s body felt heavier than others with similar mass, like those they had handled in previous procedures. Its behaviour of ‘surrendering himself to’ to anaesthesia – of throwing all its weight, of not resisting the possible threats that awaited it¹⁵ – was interpreted by the technician as a sign of its weakness, its unwillingness to engage in the procedure, which was reinforced by its unforeseen death, as if it had given up on the experiment and on life itself.

Protect

It can be argued, as some of the bioengineers present did, that the technician’s interpretation of the animal giving up was unfounded from the viewpoint of science and naturalistic ‘good reasons’ (Pignarre, 1997), it was merely laic speculation (rebuked as fanciful or imaginative) expressed by an assistant who was less qualified in his academic career. However, the role of vivarium technicians and veterinary assistants, similar to that of nursing professionals, implies a *sui generis* experience that the function of the anthropologist exposed therein did not think should be neglected in her descriptions and analyses.

As a rule, the assistant and the veterinarian are the only professionals who encounter the animals before anaesthesia. In this case, the assistant technician was probably the only person who had been face to face with the pig that had given up on following through with the scene. It was this vivarium technician who held the animal’s limbs so that it would not react to the sting of the injection, who felt the weight of its body when carrying it to the stretcher, who tied its legs, as well as those of the other pigs that had participated in previous procedures. It is the technician’s role to be responsible for the care and protection of the animals placed in their keeping. Among other reciprocal attentions with the animals in their keeping, therefore, their knowledge includes the experience of touch, and that of one living being face to face with another, looking each other in the eye. Therein, an entire semiotics of the carnal takes place that evades those who do not live it each time, in each situation, facing the idiosyncrasies or differences of every human-animal relationship that is initiated. It was this experience that enabled the technician to recognise and announce a distinct disposition already evident in the body weight of that pig compared with other animals of the same or lower mass, but which seemed lighter. Here is what he read as indicative of the ‘giving up’ of that particular pig, his body surrendered¹⁶. Such a reading requires considering touch as both an interpretive and a physical resource.

Thus, where touch and the exchange of glances are developed (cf. Haraway, 2003 and 2008), where responsive attention to signs by awakened beings is cultivated, it is there that we note how a notion considered outdated, forgotten, or even estranged in anthropology, and in philosophy, begins to make sense: the notion of *participation*, which marked the thinking of French philosopher and sociologist Lucien Lévy-Bruhl in his work at the onset of the twentieth century¹⁷. The ethnographic extract that we avail ourselves of here invites us to review the pertinence of relationships of continuity or *participation* between beings – as in the present

15 We emphasise that all ethical criteria were met for animal welfare, such as pre-anaesthesia, the function of which is to reduce stress. The fact that there is resistance and struggle on the part of the animals is in no way indicative of mistreatment. The same veterinarian, who also worked with companion or domestic animals, such as dogs and cats, reported that stress is also present in procedures performed in his private clinic, completely disconnected from his work with experimental research. A certain tension and resistance while the animals are awake is not unique to experimental practice. There is resistance even in surgeries that aim to cure diseases in domestic animals.

16 It is possible that the technician risked voicing his assessment only because he was among a committed collective that had failed to develop plausible, measurable scientific explanations. No measurements, biological or biomedical knowledge were found that might explain the event in that setting.

17 Regarding attempts to positively restore the notion of *participation*, particularly when considering continuities between beings and environments in the geohistorical epoch of the Anthropocene, see Marras (2019).

case, the relationship between the vivarium technician and the pig that ‘surrendered himself’¹⁸. We signalise the general definition of *participation* that Goldman (1994: 199), in his scrutiny of the work of Lévy-Bruhl, summarises as follows:

A network of connections, interpenetrations and dependencies of all beings and things in the universe with each other. Everything and everyone are immersed in a kind of universal consubstantiality, which causes each element to be mysteriously connected to all the others (...); synthesis is there *a priori* and the world, a kind of organism intersected with reciprocal connections.

This concerns the character of continuity, consubstantiality, contagion, intimate bond or participation of affections between heterogeneous beings or entities, thus considered as open to each other, presupposing and possessing each other reciprocally¹⁹. Thus, for the case under examination, we were witness to the pig in the human and the human in the pig. Since they are inscribed in the naturalistic tradition of the modern world, when asked, doctors, like those followed in this ethnography, will readily recognise the continuity between humans and animals through the theory on the evolution of species, through their more or less distant transformations into each other and from their origins. Otherwise, research on experimental animals (in this case, mammals) would be meaningless. Hence, these animals act as substitute *models* for humans – and, in our name, in the name of science and knowledge, they are sacrificed. As such, these successive sacrifices (more so those that occur in vain) are disturbing²⁰. Thus, as much as this continuity is established on a purely biological plane, and that ‘human exceptionalism’ (Haraway 2008) operates among us, guaranteed by the official modernist division between nature and culture (Latour 1991), even the staunchest naturalist does not doubt the sentient nature of non-human animals – in general, the larger the mammal used as an experimental animal, the greater the perception of this fact. Even if the animal is emptied of any subjectivity or intentionality, there is no doubt regarding the pains and pleasures that it feels.

We observed, moreover, that agency in the most sentient, autonomous and rational of beings is both limited and suspended by anaesthesia²¹. However, a good surgical procedure depends on this, above all, more complex and acute procedures. At the very least, the establishment of the ‘surgical field’ is intended to purify and ensure unwanted participations (such as voluntarism, subjectivation, will) are controllable by means of a technical, chemical apparatus. Thus, what can be said concerning a body that gives up on itself? What can be said regarding the aforementioned giving up, prior to complete sedation? The point is that if intersubjectivity emerges between the beings present (and could be productive for the medical and scientific purposes in question), to the same extent, it is necessary to consider that intentionality becomes problematic

18 Without doubt, we could also unfold the relationships of *participation* between, for example, bioengineers and technical objects, all subject to testing in the experiment. To ensure the brevity of this article, we focused, albeit exemplarily, on the relationships between the human and non-human animal in the scene described.

19 Here we use the notion of ‘reciprocal possession’ by Gabriel Tarde (1999 [1895]).

20 ‘We don’t kill, we sacrifice’, says the young researcher, leaning on the bench, who says he is already feeling ‘depressed’ by the routine of ‘using’ animal ‘models’ in his research on Marfan syndrome (cf. Marras, 2014, p. 248). ‘Sacrifice’, ‘use’ and ‘model’ are terms among many others that, in our view, form part of the task of trying to protect research and researchers who expose animals in experiments, as a requirement of producing scientific knowledge. In accordance with the argument of this article, these are terms that seek *disparticipation*, that is, to produce discontinuity between animals and humans in scientific experiments, particularly those that can inflict pain and death on ‘experimental animals’ (another term with a similar function). It should be noted that, within this scope of practices, language and mobilisation of the world’s resources always go together, they are interdependent.

21 There is a debate concerning the manner in which the cyborg relationships established with anaesthesia – which limits the capacity for human agency, while simultaneously redistributing it, in that the body and technologies are intimately intertwined – allow us to reconsider the traditional notion of agency, including the possibility of unintentional agency (Goodwin, 2008). To what extent is it possible to attribute agency to patients in a coma or undergoing an operation? In his proposal to redefine the concept of agency, Goodwin suggests that devices that allow us to measure vital signs/body signals become part of the agency of the entity composed of the organism and the technical apparatus. The patient’s physiological signals, therefore, are recognised through the mediation of signals and sounds emitted by the machine. It is worth asking, however, whether this is not a very mechanistic concept of human agency, as Slatman has (Marini, 2018b: 118).

and could become a factor in the pollution of the good practices in question, including the surgical practices mentioned above. Perhaps it can be said that the ever-pressing challenge therein is to convert intersubjectivity into interobjectivity.

To be affected by the pain that the animal might suffer, to sympathise with its injuries, like those caused in experimental animals during medical experiments, illustratively alludes to Rousseauian *pitié* (Marras, 2014). It takes great effort, an entire ritualistic technique of protection on the part of the medical team, which begins with their training, for these professionals learn to deal with the suffering of humans, including the need to protect their own sanity, but, naturally, also in relation to experimentation on non-human animals. We readily recognise that the reason for existence of animal ethics committees is almost solely based on compassion and participation, on this device that requires ‘humanisation’ of the death of experimental animals submitted to scientific experiments. The effort to humanise the treatment and death of these experimental animals attests to the fact of participatory continuity (also referred to as the Christian inspiration of compassion, sympathy, commiseration, condolence) perceived in this setting between humans and animals. It is therefore necessary for the person to protect themselves against what may appear to be ruthless, barbaric, and difficult to bear when handling animals in these extreme tests. In other words, the action of animal ethics committees has the effect of protecting both laboratory animals and humans, given this participatory continuity between them. The opposite of this care and attention appears as scientific, civilisational excrescence that must be avoided at all costs – like the constant recollection of Nazi experiments, which they intended to protect by identifying them as scientific, while in the same act failing to protect the sciences.

For the sake of argumentative precision, it is worth observing certain important differences in the relationship with animals, albeit briefly, especially to properly situate the problem of empathy. It is true that animals in vivariums are safeguarded by ethical regulation standardised by a committee invested with the proper authority, but their fate is unavoidable: sacrifice. While they are protected from ill-treatment, they are not protected from their certain, fatal outcome. The nature of this dynamic is of a very different type from that instituted, for example, in hunting, where the game of relationships is tested and risked with each undertaking. In this case, the disentanglement is not guaranteed. If, behind the scenes and on the stage of scientific experimentation, empathy manifests itself as a recognition of subjectivity (that can denounce an animistic inclination), it is necessary to consider that compassion does not operate as a projection of a moral ideal, but is expressed in terms of a technical, ritualistic pragmatics that requires concrete, material effort. By claiming a dark aspect of empathy in relationships with other animal species, Nils Bubandt and Rane Willerslev (2015) intend to suspend the notion of empathy as a moral virtue. Illuminating the relationship between empathy and deception is the idea behind the term they have suggested – ‘tactical empathy’ – which is related to a deceptive, predatory purpose. This concerns assuming the other’s point of view in order to deceive them. As the authors discuss, otherness, in the mimicry of the other, is reinforced and stressed in favour of the success of the activity of hunting. There is, therefore, a nexus between empathy, sociality and deception that reveals a certain management of otherness for venatorial purposes by the hunters. Empathic identification in these cases acts precisely to reinforce otherness, but for deceitful purposes²², and is ultimately destined towards capture and predation. Hence the claim to disassociate the empathic faculty from the moral economy implicit in the concept of empathy²³.

22 Here we remember the Deleuzian definition of animal in his *L'Abécédaire* (1988-89), which is also in line with the tactics of deception in the work of Bubandt and Willerslev: the animal, proposes the philosopher, is ‘un être fondamentalement aux aguets’ [a being fundamentally on the lookout].

23 Historically, the idea of empathy as a human virtue – which emerges in the midst of liberal theories – is constructed as anathema against violence, trickery and deceit. It is a virtuous antidote that promotes understanding, trust and compassion, the antithesis of deceit, aggression and conflict. As indicated, Bubandt and Willerslev (2015) argue against the prevalence of this tonic.

In the hunting situations examined by Bubandt and Willerslev, all beings are subject to the position of prey and predator. Predation in these contexts is a condition of existence, the game of capture involves seduction, and is not without risks and dangers. Empathic mimesis, such as human hunters imitating an elk, is precisely what contributes to making hunting effective, and it is crucial that the make-believe mechanisms are not exposed. In contrast, regarding the case that we examine here, it seems that we are facing engagements and problems of a very different nature. If empathy can denote a moral virtue, if compassion is a projection that can reveal an animistic participation, circumstantially, what matters in the scene where we do ethnography is the effectiveness of these devices and dispositions in the control of risks when faced with recognising the subjectivity of the animals in this setting. We have thus established a kind of contract that envisions, as far as possible, legal, moral and psychic protections. Here, deceit, simulation, the game of make-believe, do not prevail. This is why we suggest that, in our case, it is not a matter of questioning whether the recognition of subjectivity is something that necessarily leads to positive or elusive feelings of empathy, but rather of recognising the establishment of a pact. The compassion assumed by ethical regulation, however, does not rule out the remaining efforts for technical and ritualistic protection. However, if the empathic device provided by the ethics committee guarantees the outcome of relationships, it cannot guarantee the consent of all parties if we recognise the pig's unwillingness to adhere to the procedure.

It appears as if we are facing a phenomenon that Descola (1998) characterises as merely ascribing rights and legal principles to a given class of beings, that is, a mechanism for protecting animals by granting them rights – or imposing duties on humans towards them –, without fundamentally calling into question the modern separation between nature and society. We are not satisfied, however, with reducing this to its legal scope, since what we observe are intersubjective participations and the recognition not only of rights, but of intentionality, which leaks in relationships and into the routine management of practices. This, after all, is what ethics committees do: they protect animals from abuse, protect humans from legal and moral judgments, and reveal that, despite scientific efforts to desubjectify the interiorities of agents in relationships, guarding against routinely emerging animistic, empathetic leanings is imperative.

However, if the participatory feeling of compassion supports an ethical edifice that to some extent protects the beings present in similar laboratory dramas, this feeling may also paralyse action, compromising scientific practices and knowledge. The line that separates the signals to advance and the signals to retreat is tenuous. General norms can be challenged with each new experimentation, with each new scene, with each new constraint, with each new alignment of agents that threatens the expected course. In any case, we reiterate that it is possible to recognise a series of devices, of varying degrees of subtlety, that medicine makes use of to protect itself from the often paralysing effects of compassion, of participatory continuity between beings. Here, we feel it is worth mentioning a significant one, mostly because it is so banal, the expression '*vir a obito*' [end in death], indeed, it was used by professionals exposed to the laboratory scene and accompanied by the ethnography of this article. It is an official, technical expression, used constantly in medical-scientific reports, to avoid fully assimilating the effects of death, even in relation to human patients. This validates the hypothesis that technical reason integrates the effort not to confuse subjects who are present, like the medical teams and patients, so that thus distanced, a situational, operative difference is restored between subject and object, doctor and patient, humans and animals. With the brakes of compassion under control – wherein, it must be stressed, language plays a decisive role – action can follow its course on legitimate and tolerable grounds²⁴.

24 Apropos, to protect resonates with Maria Puig de la Bellacasa's (2017) proposition concerning care; of how this politically ambivalent notion, considered far from innocent, remits an impure involvement. This involvement does not concern fusion, but rather maintaining an adequate distance. At this point, it seems pertinent to refer to Haraway's (2003) notion of 'significant otherness'. This concerns knowing how to 'honor difference' in each 'ontological choreography', in each dance of immanence of 'emergent naturecultures' that Haraway collates with 'categorical abstractions', rigid identities that pre-exist relationships.

Examples like this abound and can be widely mapped. Two others we consider worth mentioning, which appeared in the ethnography analysed here and that provide indications of the dangers of the contaminating participation (affective and material) of agents among themselves. The first refers to the establishment of the ‘surgical field’, which consists of covering the patient’s body apart from an exposed opening in the region that is submitted to surgical intervention. The justification immediately raised for this device is to protect the patient from the risks of contamination, due to the contiguity of the exposed surfaces. However, if protection is required, it is because the ever-present risk of contamination comes from the participation of undesirable microbiological agents (for example, hospital bacteria) where the sterilised region must remain as such. Moments of high bodily exposure are moments that also require strong protection because the inescapable data with which they work in this setting concerns what we call participation – in this case, the participation of agents that take on the figuration of infectious germs, the infection being a clear indication that organic agents, highly heterogeneous among themselves and of no less disparate origins, can be dangerously infected and continue within each other²⁵.

It is the ontological consubstantiality of organic beings with each other (like pigs and humans) that operates there, informed by the organic and evolutionary kinship between species, both as an indispensable strategy for the invention/discovery of new surgical procedures (and new drugs and therapeutic treatments) and in measuring the risks of contagion and opportunistic infections that must be ritually avoided through absolute technical rigor.

However, as we advance here, we shall present another solid justification for establishing the surgical field: that of also protecting professionals on the surgical team, since, restricted to seeing and touching only the region exposed by opening the field, the surgeon can then concentrate without the risk, and without minimising the risk, of having to stand before the entirety of an organism, whose similarity with their own leads them, through the participatory continuity to which they are exposed, to the unproductive and undesirable situation of having to deal not with the ‘analytical animal’ (which the surgeon must engage), but with the ‘naturalistic animal’ (from which they must distance themselves)²⁶. The ‘analytical’ refers precisely to parts, such as those exposed by the opening of the surgical field. The subjects that the surgical action is composed of (arteries, vessels, prostheses, organs, etc.) should reside there, and only there. It could be said that the latter risk is of the symbolic order, while the former is of the material order. However, here we will not be discussing the problematic character, perhaps barely pertinent or even worthless, of this opposition (material versus symbolic), particularly when it is so ontologically determined. Rather opening ontologies (including the surgical incisions in the bodies themselves) is all that is at stake in the scene, more so at the level of acute experimentation, much like the scientific-medical experimentation we have been following ethnographically. We are therefore faced with the relational character of ontologies open to one another – character that is as auspicious (on which the advancement of medical sciences depends) as it is dangerous (such as the septic, sanitary and hygienic risk of visible or invisible, macro or microscopic, beings in contact)²⁷.

25 To us, the principle that informs the notion of ‘immune system’ does not seem to indicate anything else.

26 On the decisive difference between ‘analytical animal’ and ‘naturalistic animal’, see Lynch (1988).

27 From human patients to *animal models*, with symmetrical and asymmetrical treatments, using different types and degrees of empathy, we have here the emulation of the commitment and responsibility of the surgical team towards a person, thus training surgeons who need to avoid the threat of putting human life at risk. Indeed, one of the surgeons interviewed in the ethnography revealed that medical and surgical residents are gradually trained in simulation models, using plastic parts for learning the structures, and *animal models*, which can be organs detached from their dead or living bodies submitted to procedures. From his point of view, in each of these cases the commitment is different, and the responsibility of operating on a human being imposes greater anxieties. In the best seller *Do no harm*, neurosurgeon Henry Marsh reveals: ‘I dislike talking to patients on the morning of their operation. I prefer not to be reminded of their humanity and their fear, and I do not want them to suspect that I, too, am anxious’ (Marsh 2016: 49). Perhaps within this, something close to the type of ‘tactical empathy’ proposed by Bubandt and Willerslev (2015) can be encountered, and within the game of dissimulation perceived in hunting, in which, according to the authors, the viewpoints of others are assumed in order to deceive them. This is not what happens between pigs and laboratory humans, as we argue here; however, it could be considered to be similar to the ‘dehumanisation’ intended in surgeries performed on patients to ensure greater efficacy during the same – or a controlled dehumanisation, so to speak, that in any case is subservient to humanisation, to the promotion of the patient’s health – a humanising promotion that spreads and is distributed among all the entities involved.

The second example stems from the refusal of the team in the operating room to seriously consider the attribution of intentionality, as suggested by the vivarium technician and veterinarian assistant, to the pig that 'gave up' on the experiment. It is a refusal not so much of the anthropomorphic character assigned to the animal, but rather of the excess anthropomorphism attributed by the technician, as if a boundary, never definitively established, was undesirably crossed therein. Or as if the participatory experience of the vivarium technician with the animal under their care was not allowed to spill over into the surgical-laboratory room, where an alternate control of subjectivities must come into play. However, the participatory relationship between the animal and the technician in the daily life of the vivarium has to occur so that the animal model is maintained under the right conditions, as required by the extremes of surgical interventions. In order to understand the core of so many scientific practices, like the case study in question, it seems imperative to dismantle the assumed paradox that it is necessary to deal with either the 'analytical animal' or the 'naturalistic animal' (Lynch, 1988). Our research shows that the technical and objective quality of the 'analytical animal', as required by the experiments, depends on the convivial and environmental quality of the 'naturalistic animal' in the vivarium. There is no interobjectivity without intersubjectivity.

We learn from Latour (1991) that, at the very least and above all in scientific concepts and practices, all purification presupposes mixtures and vice versa. Separating and mixing, mixing and separating – this is how the sciences proceed, testing this measure each time, comprised of advances and retreats, of the production of vulnerabilities and protections. Hence, ultimately, it does not seem credible to affirm, and even less so peremptorily, that the manner of originating and providing existences in modern sciences is either one or the other – purifying or mixing²⁸. It is worth repeating that purification of the 'analytical animal' is impossible without care in the cultivation of the 'naturalistic animal'. An animal that arrives in a state of stress in the operating room threatens the chances of success for the ongoing experiment. Thus, we understand why the surgeons and bioengineers made fun of the opinion of the vivarium technician, who assigned anthropomorphic intentions to the animal that had 'given up' on living and, as a result, on continuing to participate in that experiment. Where there is intention, there must be spirit, subjectivity, or subject to the image of humans – this incites compassion and restores participation that, inside the operating room, must be purified, controlled, at the risk of constraining and polluting the progress of the experimental scene should the act continue, since the scene is protected by various forms of decorum and prohibition.

Since anthropologists tend to pay attention and take the jests, jeers and mockery they witness in the field seriously, we similarly dealt with the witticism about barbecuing the pigs and, as the witty remark proceeded, that it was necessary to report its death to its relatives. This refers to something we witnessed a few times, particularly at the end of the experiments, when prior to euthanasia induced by substances that silently executed the animals, a few of the bioengineering researchers who still remained in the operating room, together with laboratory technicians, fantasised about a different fate for the animals that, once they have left the vivarium, cannot return there, and must invariably be sacrificed. Instead of sacrificial incineration, they said, in a jocular tone, it would be better to dedicate the animals to 'a good barbecue', were it not for the amount of medication recently applied to the animals, thus making their consumption as safe human food

28 As we understand from Bruno Latour's (1991) anthropology of the moderns, in the practices of the sciences, the mixtures of the most heterogeneous entities or beings are previously ensured by the ontologisation of everything that exists between what is natural and what is social. This bicameral purification of the real ensures the unimpeded course of mixtures, which since then were freed from fears and taboo, decorum and impediments, concerning what might originate from unforeseen monstrosities by the real previously known in its forms and forces – whether social or natural. This 'constitution' of the modernist edifice entered into crisis due to the ontological proliferation it generated, to the point where the 'hybrids' became monsters that were no longer recognisable as natural or social, no longer easily distributable in one or other chamber, one or other 'ontological home'. It is worth noting, however, that the destitution of the transcendental character of the natural/social opposition does not eliminate the service, the intelligibility, the making of the world of this opposition in immanence, and not only that of scientific production, of life and the activities of moderns (Marras, 2021).

unfeasible. This or similar jokes would not be made with a human patient. We suggest that doing so with a non-human animal in this setting fulfils the important role of affirming the discontinuity between pigs and humans, as fundamental as the continuity that brings them together.

Merely verbalising it, the act of imagining consuming that meat produces an empathic gap between human and non-human animals. The joke emerges, however, at the moment of possibly the greatest difference between them. In surgical centres, death is rarely decreed during or shortly after surgery, which will require the stabilisation (or not) of the patient in an intensive care unit. Therein, after only a few hours, depending on the severity of the procedure, it will be possible to evaluate the success of stabilisation. In other words, there are mechanisms to assess whether the correction in question was well executed. However, even when the signs are positive, it is still possible that the radical situation of vulnerability to which bodies submitted to invasive surgeries are exposed to, like in heart surgery, hinders their recovery and results in death. In contrast, regarding experimental surgeries on non-human animals, the outcome is given at the outset: it is non-negotiable and redefines the role of animals in this chain of knowledge production and device development. Even when dead, the bodies of patients may still be veiled and honoured by their relatives, while the bodies of pigs will end up in a freezer, waiting to be collected by the sector of city hall responsible for their incineration: nothing vain or innocent in that which the joke referred to. It fulfils the reinforcement of operational differences – and this enables operations to be performed (see note 5).

Summary and final considerations

Thus far, we have gathered sufficient data to support the argument that, at least in comparable scientific activities involving similar organic forms, it is never a question of deciding, conclusively or for all situations, between images of reality (ontology) and technical procedures (methodology) based either on participatory continuity or on discontinuity between the beings present. In anthropological vocabulary, these two modes of identification – naturalism and animism (and for our purposes, only these) – are not mutually exclusive, but alternate in the course of the actions and knowledge at each experimental stage. In other respects, we agree with Latour (1991) that official modern naturalism makes use of the ruse of staunching the effects of participation, however unofficial and proliferate, applying step-by-step purifying mechanisms intended to ensure strategic separations between ontological orders: here the thing, there the person; here the non-human, there the human; here the object, there the subject; here the intention, there the mechanism; here the natural facts, there the social facts; and so on.

The point, however, in the ethnographic case we are examining, is that we encounter the renewed pertinence of animism and participation among us moderns, and this at the centre of an activity, of scientific activity, with which, predominantly and even today, it is customary to associate the disenchantment or objectification of the world. However, our examination ran into proprieties and interdictions that are not to be confused with mystification that concerns the pure domain of sentimentality, the pollution of knowledge. Thus, no longer the opposite of rationality and cognitive maturity. No longer error or difficulty operating distinctions. No longer the mysticism with which modernity has wrongly accused the so-called *others*. Hence, the *participationist* image of so-called traditional peoples, in contrast to moderns, is no longer sustainable. It seems to us that it is much more realistic to comprehend how this or that regime of *participation* and *disparticipation*, making use of continuities and discontinuities between living beings (involving the most varied consequences of life and death), each sets in motion in every experience of the composition of reality (Marras, 2021).

Indeed, in our opinion, knowing how to make constant use of the continuous and the discontinuous among the living beings exposed therein, and sensitive to each other, is what primarily integrates scientific intelligence and intelligibility, perhaps even specifically medical intelligence and intelligibility in regimes

of high-level experimentation, much like the ethnographic extract taken here as a source and a reference. In these regimes, the generation of knowledge certainly requires cautious equilibriums between exposing and protecting *animal models*, but no less so for others concerned in this setting: from the anthropologist to the surgeon, from the vivarium technician to the bioengineer, from the perfusionist to the veterinarian. In this sense, everyone in the scene resembles experimental animals, albeit with very different consequences for each part. An experiment worthy of the name, calls into question prestige, funding, institutions, titles, careers: or the very lives of non-human animals directly or indirectly involved in the simulations. It is difficult for anyone to leave there exactly as they entered. Moreover, the testers are tested in the tests.

The point to highlight and reiterate is that, just as exposure, without which there is no failure or success in experiments, affects all those involved in the experimental scene (with different meanings and weights for each actor), so too protection, which results from exposure and makes everyone vulnerable, is required of humans and animals involved in these test situations. Where there is exposure and openness to being vulnerable, there must be some protection. From this game between exposure and protection, new knowledge can emerge, as is always desired and expected, together with technical innovations, such as those pursued in the experiments narrated here regarding the ventricular assist device. In fact, the ethnographic case that guided our reflections here precisely reveals this game of alternations made at moments of opening and moments of closing, at moments of transpositions and at moments of limits.

Knowing requires the risks of exposure, which in turn require protective counterparts. Stabilising new understandings and new techniques puts the methodological imperative of destabilising the entities under testing (including, we assert, those who test, and not least the instruments, the technical objects, also subject to testing). This forced stress moves passions and convictions, anxieties and speculations – all there, far from the calm and ordering of a previously stabilised scientific fact, whose image, as current as it is inexact, tends to strongly generalise scientific activity as that of the discovery of a reality that is already there, ready and waiting for its unveiling by a simple spell. From the field research, according to the argument developed here, we were also able to gather clear evidence that confirms the practical effort of dealing both with *participation* with the animal and with what we call *disparticipation*, this selective discontinuity between organic human and non-human beings, all otherwise exposed to the experimentation in question.

We said that participation, even in a naturalistic regime, appears as a given: mammals, more so those of similar body size like humans and pigs, are strongly considered as continuous with each other by derivations of a general evolutionary basis. For this reason, making use of so-called *animal models* is not only mandatory for numerous experiments, including surgeries and testing new drug molecules, but also for participation that assumes an animist inclination, that of commiseration and empathy, which therefore gives rise to setbacks, interdictions, slowdowns, taboos and protections that meet ethical and moral duties. And finally, presupposed participation in relation to sanitary protective measures and septic control, given the constant threat of everything falling apart with undesirable, uncontrolled contamination, especially when bodies and things are mutually exposed to unprecedented associations on the stage of surgical and laboratorial experimentations.

Clearly, in the experimental scene, everything and everyone becomes unproductively unprotected when people do not pay attention to such material and symbolic sensitivities and acts of vigilance. Hence, inflicting vain, careless suffering on experimental animals in these experiments is to be exposed, without protection, to that which prosaic understanding calls *dehumanisation*. Those who dehumanise others considered deserving of compassion and the right to life are dehumanised in a continuous act – that which, in the previously evoked language of Rousseau, is recognised as *pitié*. When this occurs, knowledge itself is polluted. That is why ethics committees, like those focused on the welfare of animals cultivated in vivariums, end up protecting the candour and suitability of knowledge in production. Without subjective care, the desired objectivity is lost.

There is no naturalism or objectification that somehow does not have to do with this ineradicable background of continuity between humans and animals.

The conclusion remains that humanised treatment in relation to *animal models* is, rather, a matter of measurement and strategy. In other words, the animistic productivity of continuity between humans and animals, aimed at preserving legitimate and tolerable bases each time the scientific production of knowledge is entered into, should not prevent the interventions that naturalism opens and enables for experimental scientific activities. Hence the ritual effort (in which jocular tirades fulfil their role) of discontinuing with the animal, of affirming that pigs are pigs and humans are humans. Otherwise, if the trans-species continuity between humans and pigs were not staunched at strategic and decisive moments, it would impede or seriously complicate the course of experimentation. So how can we not recognise that naturalism and animism are composed of, alternate between, and inter-adjust to one another in the production of this knowledge? By methodologically engaging in both modes of identifying with animals subject to testing, that is how we obtain, on the one hand, the authorisation for the experiments, and, on the other, the legitimate figuration of the expendable in the myriad animals that 'end up dead' in the name of science.

Finally, we can now state that the dynamics of exposing and protecting human and non-human living beings involved in highly invasive and experimental interventions (like those the ethnographic extract examined here) primarily integrate acceptable technical and scientific knowledge and practices. This must be the case, as long as the otherness of the beings present therein, open to each other, proves to be ethically regulated – formally and informally. Such scientific activities are vitally dependant on this kind of reciprocal, albeit asymmetrical, opening of beings that expose themselves, but not without the corresponding protections, while taking advantage of these regulated openings, in order to provide chances to grant contours to new and emerging knowledge.

We defend that in similar experimental scenes the ontology of beings is submitted to the pragmatic course of the tests. Therein, they are what they do or fail to do in methodologically oriented inter-respondent regimes. Their essences are shown in their actions, according to each concurrence of circumstances, foreseen and unforeseen, the expected and the imponderable. They are ontologies obtained each time (Marras, 2021). We are in the midst of fact-making and talk-making – a regime of society or association between humans and animals (the focus of this article), without excluding technical objects and all manner of the most heterogeneous actors. Everything and everyone are at risk, without which nothing safe can emerge in scientific knowledge. No new certainties without the methodical provocation of uncertainties. Here we find the most auspicious character of adventure of the sciences, of this choreography composed of dances and counter-dances of human and non-human agents linked in experimental scenes. Even where life and death lurk – sensitively and dramatically.

Received: April 07, 2021

Approved: August 06, 2022

Translated by Phil Badiz

*This research received financing from the São Paulo Research Foundation (FAPESP - process no. 2013/02389-2). Due to a post-doctoral scholarship, also from FAPESP (process no. 2018/22183-3), we were able to produce and translate the present article.

References

- BUBANDT, N.; WILLERSLEV, R. 2015. "The Dark Side of Empathy: Mimesis, Deception, and the Magic of Alterity". *Comparative Studies in Society and History*, 57(1): 5-34. doi:10.1017/S0010417514000589
- DELEUZE, G. 1996. *L'Abécédaire de Gilles Deleuze*. Claire Parnet. A French television programme produced by Pierre-André Boutang in 1988–1989. Available at: <https://www.youtube.com/watch?v=SlNYVnCUvVg> at 16:04. Accessed on Jan 20, 2022.
- DESCOLA, Philippe. 1998. "Estrutura ou sentimento: a relação com o animal na Amazônia". *Mana* [online], 4(1): 23-45. Available at: <https://doi.org/10.1590/S0104-93131998000100002>
- GOLDMAN, Marcio. 1994. *Razão e diferença: afetividade, racionalidade e relativismo no pensamento de Lévy-Bruhl*. Rio de Janeiro: Grypho/Editora da UFRJ.
- GOODWIN, Dawn. 2008. "Refashioning Bodies, Reshaping Agency". *Science, Technology and Human Values*, 33(3): 345-363. ISSN 1552-8251
- HARAWAY, D. 2003. *The Companion Species Manifesto: Dogs, People, and Significant Otherness*. Chicago: Prickly Paradigm Press.
- _____. 2008. *When Species Meet*. Minneapolis: University of Minnesota Press.
- LATOUR, Bruno. 1987. *Science in Action: How to follow scientists and engineers through society*. Cambridge: Harvard University Press.
- _____. 1991. *Nous n'avons jamais été modernes : essai d'anthropologie symétrique*. Paris: La Découverte.
- _____. 1999a. *Politiques de la nature : comment faire entrer les sciences en démocratie*. Paris: La Découverte.
- _____. 2014. *Cogitamus: six lettres sur les humanités scientifiques*. Paris: La Découverte.
- LYNCH, Michael E. 1988. "Sacrifice and the Transformation of the Animal Body into a Scientific Object: Laboratory Culture and Ritual Practice in the Neurosciences". *Social Studies of Science*, 18(2): 265-289.
- MARINI, Marisol. 2018. *Corpos Biônicos e Órgãos Intercambiáveis - As práticas científicas e a produção de saberes sobre corações não-humanos* (PhD thesis), São Paulo, FFLCH/USP.
- _____. 2018b. "Por uma filosofia/antropologia do corpo: materialismo fenomenológico ou fenomenologia materialista". Entrevista com Jenny Slatman. *Revista de Antropologia*, 61(1): 103-124. <https://doi.org/10.11606/2179-0892.ra.2018.145517>
- _____. 2019. "Unproductive Participation and Protection Against Germs: Technical-Ritualistic Practices in Heart Surgery". *Vibrant*, 16, e16604. ISSN 1809-4341. Available at: <http://dx.doi.org/10.1590/1809-43412019v16d604>. [Accessed 31 August 2022]
- _____. 2021. "A atuação da imaginação no desenvolvimento de Corações Artificiais: por uma compreensão da corporificação e partilha da imaginação". *Mana* [online], 27(2). Available at: <https://doi.org/10.1590/1678-49442021v27n2a207>. [Accessed 31 August 2022]
- MARRAS, Stelio. 2002. "Ratos e homens – e o efeito placebo: um reencontro da Cultura no caminho da Natureza". *Revista Campos*, 2: 117-133.
- _____. 2014. "Virada animal, virada humana: outro pacto". *Scientiæ Studia*, v. 12, n. 2 [Accessed August 31, 2022], pp. 215-260. Disponível em: <https://doi.org/10.1590/S1678-31662014000200002>.
- _____. 2019. "Troca e participação na era do fim: revisão de conceitos à força dos constrangimentos ecológicos-ambientais". In: S. Dias et al. (ed.), *Conexões Deleuze e cosmopolíticas e ecologias radicais e nova terra...* Campinas: ALB; FE/UNICAMP. pp. 151-180.
- _____. 2021. "A herança do dualismo modernista natureza/sociedade". *Revista de Filosofia Moderna e Contemporânea*, 9(3): 293-315.
- MARSH, Henri. 2016. *Do No Harm: Stories of Life, Death, and Brain Surgery*. London: Picador.

- PIGNARRE, P. 1997. *Qu'est-ce qu'un médicament? Un objet étrange entre science, marché et société*. Paris: La Découverte.
- PUIG DE LA BELLACASA, Maria. 2017. *Matters of care: speculative ethics in more than human worlds*. Minneapolis: University of Minnesota Press.
- TARDE, Gabriel. 1999 [1895]. *Monadologie et sociologie*. Paris: Institut Synthélabo.

Marisol Marini

State University of Campinas, Institute of Geosciences, Department of Science and Technology Policy, Campinas, SP, Brazil
McGill University. Department of Social Studies of Medicine. Faculty of Medicine and Health Sciences. Montréal, Canada.
<https://orcid.org/0000-0002-4424-0888>
Email: marisolmmarini@gmail.com

Stelio Marras

University of São Paulo, Institute of Brazilian Studies, São Paulo, SP, Brazil
<https://orcid.org/0000-0002-4283-1107>
Email: smarras@usp.br