



# How Do Technologies Affect How We See and Treat Animals? Extending Technological Mediation Theory to Human-animal Relations

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## Abstract

Human practices in which animals are involved often include the application of technology: some farmed animals are for example milked robotically or monitored by smart technologies, laboratory animals are adapted to specific purposes through the application of biotechnologies, and pets have their own social media accounts. Animal ethicists have raised concerns about some of these practices, but tend to assume that technologies are just neutral intermediaries in human-animal relations. This paper questions that assumption and addresses how technologies might shape human-animal relations in non-neutral ways. Building on the technological mediation approach, it proposes that technologies can influence human-animal relations by *amplifying* and *reducing* certain aspects of animals in human perception or by *inviting* and *inhibiting* certain actions towards animals. The paper next considers, in two concretizing steps, how this theoretical starting point can enrich ethical discussions on technology and human-animal relations. First, it shows how the technological mediation approach can help to conceptualize a main concern that has been raised regarding the impact of technologies on human-animal relations, namely the concern that animals might be ‘instrumentalized’ or ‘objectified’ in certain technological practices. Second, it considers how this approach can guide investigations of how particular technologies might affect human-animal relations, taking genetic selection technologies as used in livestock breeding as a case. The paper closes by briefly reviewing the prospects and challenges for the application of the technological mediation approach to human-animal relations, thus sketching directions for future research.

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# 1 Introduction: Technological Practices and Human-animal Relations

Animals are involved in a wide range of human activities, and these activities often involve technology<sup>1</sup> as well. Pet owners regularly create social media accounts on behalf of their animals, some of which become internet celebrities. In animal agriculture, animals may be managed by technologies such as milking robots, monitored by ‘smart’ sensor technologies, or bred with the help of biotechnologies like genomic selection. The use of technologies on animals (and their cells and tissues) is also part of many biomedical experiments, and includes for example the application of genome editing to create animal ‘models’ for human medical conditions.

The fact that animals are involved raises distinct ethical questions with respect to such technological practices. A main issue is how these practices affect animal welfare, but ethical discussion also includes concerns ‘beyond welfare’ (e.g. Bovenkerk 2020, Thompson 2008, Sandøe et al. 2014). A largely neglected issue, however, is how technologies can affect human-animal relations. Even publications claiming that animals are ‘instrumentalized’ or ‘objected’ in certain technological practices seem to presuppose that technologies are merely tools which enable humans to treat animals as instruments in particular ways: technologies are understood as *neutral* intermediaries that do not affect the nature of human-animal relations.<sup>2</sup> Scholarly literature that draws on actor-network theory does recognize that technologies can shape how humans relate towards animals in non-neutral ways. Technologies are in this literature recognized as ‘nonhuman actors’: they make a difference in a state of affairs, if only because they influence how human agents act (Latour 2005). This implies that technologies can also affect how humans act towards animals, notwithstanding the fact that the latter are themselves actors too. However, actor-network theory proceeds from the methodological assumption that all types of actors relate to other actors in symmetrical ways (Latour 2005), which restricts how actor-network theory can explain the impact of technologies on human actions. Importantly, it does not address how technologies might affect human perceptions of or attitudes towards animals.

Drawing on technological mediation theory as developed by Verbeek<sup>3</sup> (e.g. 2006, 2011, 2016), this paper proposes that technologies can influence how humans *perceive* animals by ‘amplifying’ or ‘reducing’ certain aspects of animals in human perception and how humans *treat* animals by ‘inviting’ or ‘inhibiting’ certain actions towards animals. Recognizing these ways in which technologies can mediate how humans relate to animals arguably leads to more insightful ethical analyses of technological practices involving animals, and may be helpful in ethical technology design.

The next section of this paper introduces technological mediation theory and considers how it can be extended, on a conceptual level, to technological practices involving animals. The paper then considers, in two concretizing steps, how this theoretical starting

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<sup>1</sup> We are thinking primarily of material objects rather than processes or procedures when using the word ‘technology’, but we also address practices in which such material objects are applied (‘technological practices’). We agree with Grunwald (2021), however, that trying to define ‘technology’ in general terms runs into problems and that the meaning of this word typically becomes clear in context.

<sup>2</sup> This point is discussed more elaborately in Section 3.

<sup>3</sup> Although other theoretical approaches could be called ‘mediation theories’, Verbeek’s arguably offers the richest framework for analyzing how particular technologies co-shape human-world relations. For example, Feenberg’s critical theory of technology is more restricted because of its focus on how technologies shape *power* relations, while Marcuse’s work addresses technology as a general phenomenon rather than particular technologies (cf. Ihde 2009).

point can enrich ethical discussions on technology and human-animal relations. First, Section 3 shows how the technological mediation approach helps to conceptualize and address a main ethical concern that has been raised with regard to the impact of technologies on human-animal relations: the concern that animals might be ‘instrumentalized’ or ‘objectified’ in certain technological practices. Second, Section 4 considers how this approach can guide investigations of how particular technologies affect human-animal relations, taking genetic selection in livestock breeding as a case. Section 5 closes by briefly reviewing the prospects and challenges for the application of the technological mediation approach to human-animal relations, thus sketching directions for future research.

## 2 Technological Mediation Theory and its Relevance to Human-animal Relations

Technological mediation theory (Verbeek 2006, 2011, 2016) addresses how technologies co-shape our relations to the world, including other people and ourselves, in non-neutral ways. On a straightforward extension of this theory, it also offers helpful theoretical resources for research on how technologies affect human-animal relations. The current section presents key concepts and ideas from technological mediation theory and considers how these apply to technologies that mediate human-animal relations. This merely serves to establish conceptual connections between technological mediation theory and human-animal relations. The current section therefore remains fairly abstract, and the examples that it does provide should not be interpreted as empirical claims: at most, they illustrate how technological mediation theory can be used as a framework to generate hypotheses for research in this area. More fleshed-out examples of how technological mediation theory can be applied to human-animal relations follow in later sections.

A negative starting point for technological mediation theory is the rejection of technological instrumentalism, or the view that technologies are merely value-neutral ‘means to ends’ (Verbeek 2006, 2011). A main point of reference here is Heidegger (2002 [1962], 2008 [1927]), who holds that understanding technology as a means to an end does not capture the essence of technology. This essence is that technology use involves a particular way of relating to being: human involvement with reality takes place *through* technological artifacts, and this affects how humans are ‘present in’ the world and how the world is ‘present to’ humans in non-neutral ways (cf. Verbeek 2011). What is distinctive about modern technologies such as hydroelectric plants, for instance, is that they approach and reveal nature as a standing reserve of resources that can be unlocked, transformed, stored up, distributed, and switched about for future utilization (Heidegger 2002 [1962]).

Technological mediation theory elaborates on the ways in which technologies can influence human-world relations non-neutrally and aims to offer theoretical resources for the ethical evaluation and design of technologies. It is important to emphasize, though, that technological mediation theory as developed by Verbeek (2006, 2011, 2016) aims to support analyses of how *particular* technologies mediate human-world relations.<sup>4</sup> While it recognizes that there are intricate two-way connections between particular technologies and

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<sup>4</sup> It deserves to be noted, however, that technological mediation theory does not assume that a specific technology can be strictly demarcated. It recognizes that technologies often get tailored to specific uses (Verbeek 2011, Rosenberger 2014) and attain various functions depending, among others, on how they are combined with other technologies in practice (Ihde 1990)

how we understand and act in the world on a general level (as explained later in this section), it follows the ‘empirical turn’ in the philosophy and ethics of technology that calls for analyzing specific technologies rather than critiquing technology as a general phenomenon (Verbeek 2011, cf. Ihde 2009). In our view, this means that general claims about how technologies affect human-world or human-animal relations should either be avoided or be substantiated by analyses of particular technologies.

Technological mediation theory (Verbeek 2006, 2011, 2016) proposes that technologies mediate two general types of relations between humans and the world. Drawing on post-phenomenology (Ihde 1990, 2009), it firstly states that technologies mediate hermeneutic human-world relations, i.e. one’s perception and interpretation of the world. The general idea here is that technologies can co-shape one’s intentional relations towards the world, by virtue of which the world is revealed in a particular way; human intentionality and technology can *combine* in unique ways of being directed at the world. In an ‘embodiment relation’, a technology changes one’s bodily relation towards the world in an experientially relevant way (e.g. when looking through glasses, handling a hammer, or driving a car). In a ‘hermeneutic<sup>5</sup> relation’, the technology represents an aspect of the world in a way that makes it accessible to interpretation (e.g. when an ultrasound screen represents a fetus). An ‘alterity relation’ pertains when the technology is itself the object, not as a means to engage with something else in the world, but as the end-point of the user’s intentional directedness (e.g. when someone interacts with a robot or an ATM). Finally, a ‘background relation’ pertains when a technology shapes the world someone experiences but is itself at the background of experience (e.g. when a heating system that warms one’s home). In each of these cases, humans engaging with the world through technology are directed towards the world differently, and accordingly reveal different aspects of the world, than they would without the technology. In changing our intentional directedness towards the world, technologies magnify or *amplify* certain aspects of the world we experience, and at the same time de-emphasize or *reduce* other aspects (Ihde 1990). For example, looking at the moon through a telescope literally amplifies the moon in our experience, but makes the moon’s distance to other celestial bodies fall outside of our perception.

The four categories of human-technology-world relations distinguished by Ihde (1990, 2009), combined with the concepts of amplification and reduction, also help to analyze how particular technologies mediate human perceptions of animals. As an example of an embodiment relation, webcams installed in a wilderness area or on a farm allow people to see certain animals without being physically present.<sup>6</sup> However, where and how the webcams are placed might affect which animals and animal behaviors will be seen (an instance of amplification) and which will escape from view (an instance of reduction). ‘Smart’ farming technologies that present aggregated data on animals for the farmer to interpret exemplify the hermeneutic relation. In this case, which data are collected, processed and finally presented to the farmer (amplification) and which characteristics of the herd are not represented (reduction) might influence how she believes her animals are doing (cf.

<sup>5</sup> Somewhat confusingly, the term ‘hermeneutic relation’ is used in two different ways by Verbeek (2006, 2011). First, this term is used in contrast to ‘practical relation’; in this use it refers to all relations that involve knowing or interpreting the world. Second, this term denotes a specific type of hermeneutic relation in the first sense: the type of relation that pertains when humans interpret the world through some technology-derived representation of the world.

<sup>6</sup> We follow Ihde (2009) in understanding cameras as instantiating the embodiment relation. What is crucial in an embodiment relation, for Ihde, is that the object as it appears in mediated perception is isomorphic to how it appears in non-mediated perception, and this applies to cameras.

Bos et al 2018). The alterity relation pertains when a private person engages with media devices rather than her pet, for instance, or when a farmer interacts with technologies such as milking robots rather than the animals on her farm. The technology becomes the terminal object of the user's attention (amplification) in these cases, while the animals move to the background of awareness (reduction). Finally, the background relation pertains when a technology shapes the context in which humans perceive animals. An automated climate control system might for example allow a farmer not to concern herself with housing conditions such as temperature and humidity (reduction), which might save her time to simply watch the animals (amplification).

Again following Ihde (1990), technological mediation theory makes an important distinction between *microperception* (immediate and focused bodily perception in actual seeing, hearing, etc.) and *macroperception* (a more general cultural or hermeneutic perception that informs and orients microperception). Recognizing that the micro and macrolevels of perception are linked in 'flexible and ambiguous' ways (Ihde 1990), several approaches for studying these links have been proposed in the literature, including approaches drawing on interviews, focus group discussions, and conversation analysis (Keymolen 2020, Verbeek 2016).

In the current context, the question is how microperceptions and macroperceptions of animals are interrelated and mediated by technology. The perception of an animal in a particular technologically mediated encounter may well be affected by general, culturally embedded views on animals. For example, someone who believes that animals blindly follow their instincts may well watch and interpret a particular cow's behavior quite differently than someone who believes that animals have agency and act on individual preferences. On the other hand, such general perceptions may not be independent from how animals are perceived in specific contexts, which may be co-shaped by technologies. The latter influence seems particularly difficult to investigate, but some suggestions on how to address the interrelations between microperceptions and macroperceptions of animals are offered in later sections.

Drawing in particular on Latour's work on artifactual agency (e.g. Latour 1992), technological mediation theory secondly stipulates that technologies mediate our *practical* relations to the world, i.e. our actions towards others, ourselves, and our physical environment (Verbeek 2006, 2011). Technologies co-determine how we interact physically with the world. According to Latour (1992), technologies encode 'programs of action' or 'scripts' in which users are prescribed (with varying levels of force) to act in certain ways. For example, an annoying alarm can be installed in a car to enforce the program of action 'if someone drives a car, she wears a seatbelt', and a speed bump materially enforces the program of action 'if someone drives here, she does not speed'. Technologies enforce these programs of action by *invitation* and *inhibition*: they enable or even encourage certain actions while disabling or discouraging other actions (Verbeek 2006, 2011). On our interpretation, this encouragement and discouragement is a consequence of the technology's material or technical features, but also of psychological or motivational factors: the aforementioned alarm encourages wearing a seatbelt primarily because it is experienced as annoying, while a speed bump may not discourage speeding for someone who does not mind damaging the car she is driving.

The concepts of 'invitation' and 'inhibition' can be extended straightforwardly to human-animal relations. The idea is that technologies can make certain human actions probable or attractive while making other actions improbable or unattractive, and there is no conceptual reason why this could not apply to human actions involving animals. It has been claimed, for example, that social media stimulate users to obtain pets with characteristics that are popular

on social media. This has supposedly increased demand for breeds like pugs and decreased demand for black dogs, as the former are considered ‘instagrammable’ while the latter are notoriously difficult to photograph favorably (Maddox 2021).

Finally, another important concept is ‘multistability’. This refers to the idea that one can relate to a technology in a range of ways, but is constrained by the technology’s physical or technical characteristics (Ihde 1990, 2009). Public benches can for example be used either for sitting or lying down on them, unless vertical dividers prevent the latter (cf. Rosenberger 2014). Similarly, a hammer could be used as a carpentry tool, a paperweight, etcetera, but its material constitution excludes using it as a flotation device. Multistability can be analyzed by identifying the typical or dominant way of using the technology in a given cultural context and contrasting this to its alternative ‘stabilities’ (Rosenberger 2014, Keymolen 2020). Such an analysis can be based on empirical research or imagination and should according to Rosenberger (2014) address how one could take a different bodily and perceptual comportment towards the technology, enact an alternative program of action through it, and tailor its design to alternative uses. This is meant to reveal concretely how different relations to a technology – and accordingly to the world – are possible.

The notion of multistability counters the deterministic idea that a technology which influences human-animal relations in a particular way must necessarily have this effect. It suggests that alternative ways of relating to the technology – and hence different ways of relating towards animals through these technologies – may be possible. At the same time, the range of possible stabilities is constrained by its technical features, and an even narrower range of stabilities may make sense to potential users in a given context. For example, the dominant use of a milking machine is for milking, and while milking machines are also being used to collect various kinds of data, there may be little interest in adapting them so that cows can watch movies as they are being milked. An analysis of how a particular technology affects human-animal relations should thus recognize that this technology can be used in various ways, possibly with different consequences for human-animal relations, but can focus on its dominant stability and other plausible ways in which the technology may be used (cf. Rosenberger 2014). Which possible applications require consideration is up to the analyst’s judgment (*ibid.*), but will depend among others on the general purposes for which they will presumably be appropriated or the practices in which they will come to be embedded. For example, whether and how farmers will use technologies such as ‘smart’ cameras and GPS-tracking collars probably depends, among others, on whether they keep their animals indoor or on pasture. How humans relate to animals in current practices thus provides one clue as to whether and how certain technologies will be used, although it should be acknowledged that such practices may themselves adapt to new technologies.

This section extended concepts from technological mediation theory to human-animal relations, and offered examples of how these concepts may help to address how certain technologies influence human-animal relations. The aim was to establish technological mediation theory as an interesting starting point for more thorough investigations of how particular technologies mediate human-animal relations. The next section shows how this theoretical starting point opens new perspectives for ethical discussions on the supposed ‘instrumentalization’ or ‘objectification’ of animals in certain technological practices.

### 3 Applying the Technological Mediation Approach to Human-animal Relations: Technologies and the Instrumentalization of Animals

Technological mediation theory suggests that technologies can co-shape perceptions of and actions towards animals. The current section shows how this idea can enrich ethical thinking on the instrumentalization of animals in technological practices.<sup>7</sup>

The concern that animals would be ‘instrumentalized’ or ‘objectified’ has been raised with regard to various technological practices. For example, Hauskeller (2007) and Ung-Lanki (2014) call attention to the far-reaching instrumentalization of test animals as a result of the application of advanced biotechnologies in biomedical animal experimentation, and Bos et al. (2018) are concerned that precision livestock farming (i.e. applying process engineering technology to the management of livestock production) will objectify animals unless care is implemented appropriately. The potential use of genome editing in farm animal breeding has been associated with an aggravated instrumentalization of animals as well (Bovenkerk 2020). On the other hand, Palmer (2011) has called into question whether applying genetic technologies could be considered instrumentalizing, as the ‘non-identity problem’ applies: these technologies do not harm already existing animals or violate their rights, but instead make different animals to come into being.

Animal ethicists have also discussed what it means to instrumentalize or objectify an animal and when and why this would be ethically problematic. Drawing on Kant’s ethics, instrumentalization has been defined as treating an end-in-itself as a mere means to an end, and objectification as assigning an end-in-itself the status of an object (Bos et al. 2018). An important question has been how this Kantian account can be applied to animals, which requires establishing, contra Kant, that animals are ends-in-themselves (cf. Hauskeller 2007, Camenzind 2020). A second main point of reference has been Nussbaum (1995), who defines objectification as “treating as an *object* what is not an object, what is, in fact, a human being” and list seven possible features of objectifying treatments. Bos et al. (2018) extend Nussbaum’s definition to animals and apply her list of objectifying treatments to consider how precision livestock farming might objectify animals, and Camenzind (2020) draws on Nussbaum (1995) to develop criteria for when using an animal as a means to human ends is ethically problematic. Finally, some animal ethicists (e.g. Bovenkerk 2020) have drawn on Brom (1997) to distinguish between three types of instrumentalizing relations: *seeing* an animal as an instrument, *treating* an animal as an instrument, and *turning* an animal *into* an instrument.

Although animal ethicists have explicated what it means to instrumentalize or objectify an animal and have objected to technological practices which would involve the instrumentalization or objectification of animals, they have not distinguished different ways in which technologies can be involved in the instrumentalization and objectification of animals. Instead, they generally seem to have presupposed that technologies are merely means which enable humans to treat animals in certain instrumentalizing or objectifying ways. This presupposition fits the instrumentalist understanding of technology: viewing technologies merely as neutral means to ends precludes the possibility that technologies could be involved in the instrumentalization and objectification of animals in other, non-neutral

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<sup>7</sup> Animal ethicists have also invoked concepts which are related to instrumentalization and objectification but draw on different philosophical traditions, including alienation, commodification, and de-animalization. Analyzing the interrelations between these notions and instrumentalization and objectification is beyond the scope of this paper, however.

ways. Technological mediation theory challenges this instrumentalist understanding of technology and suggests that technologies might also be involved in the instrumentalization and objectification of animals by affecting how animals are perceived and how they are treated. The general idea is not that certain technologies are instrumentalizing by themselves, but rather that instrumentalizing perceptions and treatments of animals might result from certain *combinations* of human intentionality and technology. This opens up significant new perspectives for ethical discussions on the instrumentalization and objectification of animals in technological practices, and therefore deserves to be explored and developed further. The remainder of this section lays the conceptual groundwork that is required for applying technological mediation theory to technological practices in which animals are supposedly instrumentalized or objectified.<sup>8</sup>

As a first step, instrumentalization must be conceptualized in terms of human-animal relations that can (but need not) be mediated by technology. Following Brom (1997), three types of instrumentalizing relations that can obtain between a human (X) and an animal (Y) can be distinguished. First, the relation 'X sees Y as an instrument' can be understood as a hermeneutic human-animal relation. Applying technological mediation theory suggests that this relation can (but need not be) mediated by technology: certain technologies might 'amplify' instrument-like features of animals in human perception or 'reduce' features by virtue of which animals would be perceived as more than instruments. A technology such as precision livestock farming could for example represent animals in a way that focuses on features that are instrumental to human interests (see Bos et al 2018). Second, 'X treats Y as an instrument' can on technological mediation theory be understood as a practical relation that may hold between humans and animals. A technology could contribute to this type of instrumentalization by 'inviting' actions in which animals are treated as instruments or by 'inhibiting' actions in which animals would be treated as no mere instruments. For example, gene editing has made the use of animals as bioreactors and as organ donors more feasible and attractive, and both applications involve using animals as instruments in unique ways. Finally, 'X turns Y into an instrument' can on technological mediation theory arguably be approached as a special instance of the relation 'X treats Y as an instrument': turning an animal into an instrument involves treating the animal in a way that changes it so that the animal (or its offspring) can be treated as a means to certain ends more effectively.<sup>9</sup> For example, turning a mouse into an 'animal model' for biomedical research means taking actions (e.g. injecting tumor cells) to change the mouse in certain ways, and aims to enable drawing more valid conclusions when treating it as an experimental subject. As a special instance of treating animals as instruments, the potential mediating role of technology is again the invitation or inhibition of actions towards animals, in this case actions that involve changing them.

A second step in developing a technological mediation perspective on the instrumentalization of animals must be to specify what it means to see or treat animals as instruments or objects. Although one could again draw on Kant and Nussbaum here, we believe that a Heideggerian conceptualization of instrumentalization and objectification can be developed that fits a technological mediation perspective more naturally and has some additional strengths. Technological mediation theory already shares important theoretical

<sup>8</sup> For the sake of presentational simplicity, some of the following paragraphs will address only the concept of instrumentalization. Unless instrumentalization and objectification are distinguished explicitly, these paragraphs are meant to apply to the concept of objectification as well.

<sup>9</sup> Note that this interpretation also avoids the non-identity problem raised by Palmer (2011).



commitments with Heidegger's works, on which it builds in significant ways. Heidegger's phenomenological ontology (which is explained in the next paragraph) fits technological mediation theory's emphasis on human-world relations and how these take shape through one's (technological) involvement in the world. More particularly, for our purposes, Heidegger supplies a phenomenological account of what it means to perceive anything as an instrument or object that can be developed into a thoroughly relational conceptualization of what it means to instrumentalize animals. Heidegger's works also suggest some interesting new perspectives on the ethical (or perhaps more properly existential) problems involved for both humans and animals.

Instrumentalization and objectification can be defined in Heideggerian terminology with reference to *Sein und Zeit* (2008 [1927]). Here, Heidegger lays down a phenomenological ontology, in which ontological categories are systematically correlated to how we humans relate to Being. Our usual stance towards Being is one of practical involvement, which reveals beings as instruments (beings 'ready-to-hand') and structures the world as a totality of instrumental relations (*ibid.*: H69, H83-H88, H111). Suspending our practical concerns instead reveals beings as objects that are just there (beings 'present-at-hand') and structures the world as a totality of objects that we dwell alongside (*ibid.*: H61, H71-H73). We are revealed to ourselves not as objects among objects but as a relation towards Being ('being-in-the-world'), and we recognize other humans as beings with this same directedness at Being (*ibid.*: H53-60, H117-H126). However, we can disregard or ignore another human's being-in-the-world, which makes him appear as merely present-at-hand or ready-to-hand (*ibid.*: H55). In such a case we do not adopt the proper mode of solicitude towards the other, in which we would support his care for an authentic involvement with the world, but concern ourselves with the other only insofar as he is relevant to our own practical involvements with the world, or regard him as an object that is just there among other objects (*ibid.*: H57, H121). These possible relations to the other, which can arguably be instantiated by our actions as well as our perceptions,<sup>10</sup> can reasonably be named 'instrumentalization' and 'objectification', respectively.

Although *Sein und Zeit* does mention 'life' as an ontological category of its own and passingly mentions the use of animals as beings ready-to-hand (*ibid.* H50, H70), Heidegger has discussed the ontological status of animals primarily in lectures of later date (see Foltz 1993, Elden 2006). Basically, his view is that animals are 'poor-in-world': like humans they are directed at a 'world' that is shaped by their practical concerns, but this world is comparatively simple because animals (lacking language and ontological understanding) have fewer potential ways to engage with Being. 'Poor' in world as they may be, animals do appear as more than beings ready-at-hand or present-at-hand because of their directedness at and engagement in a world of concern. Their engagement in a world of concern can be disregarded, however, and this applies when someone sees or treats animals as beings that are merely ready-at-hand or present-at-hand (cf. Foltz 1993). Such perceptions or treatments can again be called 'instrumentalizing' or 'objectifying'.

A Heideggerian perspective thus calls attention to a particular way in which humans and animals can be instrumentalized (or objectified): by disregarding their engagement in a world structured by *their* concerns. In animal agriculture, for example, animals can be instrumentalized even if physical suffering is avoided and their basic physiological

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<sup>10</sup> It may be noted that praxis is primary for Heidegger and shapes perception in crucial ways. Although the relation between praxis and perception is relevant for the analysis of how technologies mediate human-animal relations, we cannot adequately cover this issue in this paper.

needs are met. Even though they are poor-in-world, their being-in-the-world means that animals should be able to engage with their world of concern authentically. This requires that we do not concern ourselves with animals only insofar as they are relevant to our own practical involvements with the world, but adopt a mode of solicitude that supports (or at least does not threaten) their authentic engagement with their world of concern.

A Heideggerian perspective also calls attention to existential problems faced by those who instrumentalize others. Heidegger's main concern in *Die Frage nach der Technik* (2002 [1962]) is that modern technology, by revealing nature increasingly as a standing reserve of resources (cf. section 2 of this paper), changes our relation to Being. If we do not understand that modern technology shows Being in non-neutral ways, we are at risk of losing other, more primordial ways of relating to Being. Because man is defined ontologically by his directedness at Being – namely as being-in-the-world – this is an existential problem that must be of the utmost importance for man himself. Humans instrumentalizing non-human animals arguably face a variant of this problem. Non-human animals form an ontologically unique class of beings, so if someone's relation to animals is determined strongly by their own practical concerns, then this person has a restricted relation to a significant realm of Being. The intuitive problem here is that someone who sees or treats animals mainly as food producers or disease models fails to co-exist animals in more existentially meaningful ways.

With this conceptual groundwork in place, technological mediation theory can be used as a theoretical framework for more advanced analyses of how certain technological practices may or may not instrumentalize animals. Such an analysis should address a particular technology; more general claims about how technology is involved in the instrumentalization of animals should either be avoided or be substantiated with reference to particular technologies. Moreover, the analysis should differentiate between a technology's different (dominant and alternative) stabilities, recognizing that whether and how animals are instrumentalized may differ across those stabilities. One can then consider, for one or more of these stabilities, whether and how the technology amplifies or reduces relevant characteristics of animals in human perception. It seems difficult to draw firm conclusions about how instrumentalizing perceptions in particular encounters with animals (microperception) might affect general, culturally embedded views on animals (macroperception), but addressing the reverse influence might be feasible. Finally, one can consider whether and how the technology invites instrumentalizing treatments of animals or inhibits treating them in non-instrumentalizing ways, given psychological and motivational factors that apply in the contexts in which the technology is embedded.

The technological mediation approach to the instrumentalization of animals we have just sketched rather theoretically obviously requires further development. Most importantly, it still lacks an empirical approach for investigating whether and how particular technologies lead to instrumentalizing perceptions of and actions towards animals. Empirical methods for investigating the mediating effects of technologies have been proposed earlier (Rosenberger 2014, Verbeek 2016, Keymolen 2020), but we have not addressed whether these are indeed suitable methods for investigating the technological mediation of human-animal relations. Another issue that requires further attention is how instrumentalizing microperceptions and macroperceptions relate to each other. One perspective that deserves consideration is that instrumentalizing macroperceptions of animals are *institutionalized* in technological practices which involve animals and that these practices support

instrumentalizing perceptions of animals in particular situations. The works of Feenberg and Marcuse may be particularly helpful for addressing this issue.<sup>11</sup>

Such limitations being noted, the current section has hopefully shown that a technological mediation perspective offers important directions for ethical work on the potential instrumentalization of animals in technological practices. At the same time, addressing only the potential instrumentalization or objectification of animals, while ethically significant, means taking a quite limited perspective on how technologies might mediate human-animal relations. Although some technological practices may involve the instrumentalization of animals, other technologies or other practices involving the same technology may shape human-animal relations in different (and perhaps more positive) ways. The next section therefore exemplifies how technological mediation approach can be applied to address the mediating effects of a particular technology on human-animal relations more broadly.

#### **4 Technological Mediation and Human-animal Relations: a Case Analysis of Genetic Selection Technologies in Livestock Breeding**

This section illustrates how a technological mediation perspective can be applied to analyze how a particular technology (or actually a narrow set of similar technologies) affects human-animal relations, taking genetic selection technologies as a case. The point is not to give a complete analysis, if only because the case raises certain empirical questions that cannot be answered satisfactorily here. Rather, the aim is to show how a technological mediation perspective can structure analyses of a technology's influence on human-animal relations, raising important empirical questions along the way.

Genetic selection draws on genetic parameters to predict how well an animal's progeny will perform in certain respects, for example milk yield, fertility, and mastitis resistance. This requires drawing a DNA sample (for example by collecting a hair or some embryonic tissue), mapping the animal's genetic features with a genetic array or assay, and using specialized software to statistically compare these to the genetic features of a large group of animals whose performance on traits of interest has been recorded. Such a comparison can centre on 'snips' of DNA that are known to be associated with traits of interest, but in the case of genomic selection takes place on the level of the full genome.

It is important to note, first, that genetic selection technologies are multistable: they can be embedded in breeding practices in several different ways. Lonkila and Kaljonen (2018) show that some Finnish dairy farmers select their breeding animals exclusively on the basis of genetic parameters, while others use genetic selection in combination with other evaluation practices (e.g. physical inspection or performance prediction based on ancestry records), and yet others do not use genetic selection. Holloway and colleagues (2011) discuss the role of genetic assessment in how sheep and beef cattle breeders in the UK make selection decisions. These authors also observe that some breeders use genetic assessment as a replacement of other selection methods, while others use it in conjunction with more traditional ways of evaluating breeding animals, and yet others choose not to use it. Whether these technologies are used instead of or in addition to other selection methods affects how they mediate human-animal relations, as discussed below.

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<sup>11</sup> We thank two anonymous reviewers for this suggestion.

Genetic selection technologies, if they are used, mediate a breeder's hermeneutic relations towards his or her animals. Breeding assessments were traditionally made by a breeder in close physical interaction with the animal; seeing and feeling the actual animal were important parts of this. For those who rely exclusively on genetic assessment, breeding decisions take place largely behind computer screens, on the basis of representations of animals' genotypic and phenotypic characteristics (for example of 'estimated breeding values'). The human-technology-animal relation that obtains here is a hermeneutic relation (in Ihde's 1990, 2009 sense): breeders are intentionally directed at animals *through* technologically generated representations of those animals which they must interpret. Those who combine genetic assessments with sensory evaluations, on the other hand, are sometimes directed towards animals in this mediated way and sometimes in ways that are unmediated by (this) technology (cf. Holloway et al. 2011, Lonkila and Kaljonen 2018).

At this point, a technological mediation perspective raises the question whether (or how) perceptions of animals are influenced by genetic selection technologies. Although empirical research is required to answer this question convincingly, it seems reasonable to expect that genetic selection technologies do indeed amplify and reduce certain aspects of animals in breeders' (micro)perceptions. Whether the DNA mapping technology used concentrates on particular DNA segments or covers the whole genome, a representation of an animal's characteristics will presumably focus on characteristics that can be bred for and are considered valuable for farming. On the other hand, phenotypes which are not considered significant for breeding, which are not measured and recorded frequently, or which are not (known to be) correlated to genotypic variants will usually be out of scope. According to some (Holloway et al. 2011; Twine 2010), genetic selection in practice focuses heavily on traits that are economically relevant for breeders and farmers. If so, genetic selection amplifies characteristics in virtue of which animals do or do not suit these stakeholders' economic aims and reduces characteristics that have little economic relevance. This would mean that animals are perceived, through a representation of their economically relevant genetic qualities as assessed by genetic selection technologies, primarily as potential means to breeders' and farmers' (economic) ends. Such a perception could, incidentally, be considered instrumentalizing according to the account proposed in the previous section: one would primarily perceive animals as beings ready-to-hand that are relevant to one's own practical involvements with the world, not as beings-in-the-world towards which it is proper to adopt a mode of solicitude.

Holloway et al. (2011) make a further claim on how genetic selection technologies affect how breeders perceive animals, which apparently specifies what it means for breeders to see animals as means to their ends. Quoting breeders who kill large groups of animals (e.g. "the bottom 50%") based purely on assessments of their genetic merit, these authors conclude that animals who are considered unfit for breeding become more 'killable' due to genetic selection technologies. Part of the explanation, according to Holloway and colleagues, is that because breeders are directed at animals through abstract representations of their genetic qualities rather than physical interaction, the moral status of individual animals would be de-emphasized for breeders. That some animals would appear as 'killable' because of their low genetic value, if there is such a perception, could arguably be considered instrumentalizing from a Heideggerian perspective: the animals would appear as unfit for breeding and as expendable because breeders would mainly be concerned with these animals in terms of their own practical involvements with the world. Such claims clearly call for further substantiation, however.

It is also important to note that genetic selection technologies do not have to be used (solely or mainly) for the optimization of economically relevant traits. They also enable

breeding for societally relevant traits; one can for example try to reduce the environmental impact of animal agriculture by breeding for low methane excretion. Representations of animals based on genetic selection technologies could even include traits that serve no clear human interest, for example some welfare traits that have no economic relevance, which would arguably mean that the animals would be represented as more than means to human ends. Whether such alternative applications of the technology are not only possible but plausible, given motivational factors that apply in farm animal breeding, should be settled by further (empirical) research. The point to note here is that such alternative technological stabilities might instantiate different human-animal relations.

Our discussion of how genetic selection technologies might affect hermeneutic human-animal relations has thus far focused on microperception, or at least on perceptions of particular groups of humans (breeders and farmers) in particular contexts (farm animal breeding practices which include the use of genetic selection technologies). It is quite difficult to tell how such microperceptions might affect macroperceptions of animals. First, it is unclear to what extent and how breeders' and farmers' more general views on animals are affected. The varied and complex perceptions that breeders and farmers have of animals are well-noted. Is there any indication that genetic selection technologies have been changing those more general perceptions? Second, is there any reason to think that perceptions outside of breeding and farming have been or will be affected? It could be suggested that because genetic selection technologies aim to understand animals in terms of (epi)genetic characteristics that affect certain phenotypic traits, these technologies support reductionist views on animals (cf. Twine 2010). This claim seems more plausible for genetic 'technoscience' in general than for genetic selection in particular, however; moreover, it is yet unclear how such reductionist views would be settled with the growing recognition of the complexity of animals' cognitive, emotional and social lives (cf. Twine 2010).

The clearest link between microperceptions that are mediated by genetic selection technologies and macroperceptions of animals may be in the other direction. Twine (2010) and Holloway and colleagues (2011) argue that genetic selection fits within the broader development which they call 'geneticization': the increasing tendency in biology to understand life in genetic terms. This geneticization can arguably be unpacked as the macroperception that animals can, at least for practical purposes such as breeding, be adequately known by understanding their genetic features. This macroperception apparently explains why some breeders rely exclusively on genetic evaluation, while the fact that other breeders do not use genetic selection or use it in conjunction with other selection methods suggests that this macroperception is not shared universally. Another relevant macroperception may be the culturally embedded view that animals can (and may) be used as means to human ends various ways. If animals are seen potential instruments across many contexts, seeing animals from an instrumental perspective in the context of genetic selection merely reflects a more general orientation towards animals. Following Ihde (1990), such macroperceptions would explain how breeders engage with and see animals in particular technologically mediated encounters. These suggestions on which macroperceptions influence breeders' microperceptions arguably call for further empirical substantiation, however.

Genetic selection technologies may also mediate human-animal relations on a practical level by inviting or inhibiting certain actions; they arguably make certain actions possible or attractive while making others impossible or unattractive. A first noteworthy point is that these technologies allow breeding for new phenotypic traits. Large databases in which phenotypic data are paired to fine-grained (epi)genetic data enable finding new phenotype-genotype correlations, and breeding programs can draw on these correlations to breed for new phenotypes. Research projects using such an approach aim, for instance, at breeding

animals that efficiently convert feed (e.g. roughage) into milk or meat or that excrete lower amounts of methane. Genetic selection technologies 'invite' breeding for such phenotypic traits in the sense that they make breeding for them possible. Whether these technologies will also make breeding for these traits attractive will depend partly on the context. When financial incentives are offered to breed for traits that are considered societally relevant, for example, the technology may invite breeding for traits that have no (direct) market value. Thus, the question that needs to be asked is how the possibilities offered by genetic selection technologies and the motivational factors that apply in the breeding sector combine into different breeding decisions, possibly with different implications for animals.

Second, Twine (2010) has argued that genetic selection technologies encourage addressing societal objections to intensive animal agriculture without actual deintensification. Twine fears that genetic selection will thereby discourage transitioning to husbandry systems that he considers more environmentally sustainable and animal-friendly. Although this seems rather speculative, there would be clear and important implications for human-animal relations.

Third, genetic selection technologies affect which animals, and possibly also how many of them, are removed from breeding programmes. Holloway and colleagues (2011) cite breeders praising the 'toughness' of their breeding programmes, in which only animals with the best genetic profiles and physical characteristics are used, while animals with genetic or physical 'flaws' are removed and killed. It thus seems that genetic assessment has motivated some breeders to add selection criteria, resulting in 'tougher' selection. Other breeders have come to base their selection decisions solely on genetic criteria, however (Holloway et al. 2011; Lonkila and Kaljonen 2018), in which case it is unclear *a priori* whether selection has become more strict. Selection on physical characteristics can itself be quite stringent and may involve rejecting animals that would be suitable for breeding according to genetic assessments; switching to genetic selection might hence even result in fewer animals being deselected and discarded. The multistability of genetic selection technologies is again relevant here: how breeders embed these technologies in their practices affects their selection criteria and thus, presumably, also which and how many animals pass their selection. Again, further empirical research may enable drawing more solid conclusions.

Finally, genetic selection technologies may invite the use of advanced reproductive technologies. A main appeal of genetic assessment over previous assessment strategies is that the qualities of a candidate breeding animal can be predicted before it has had any offspring. Indeed, an animal's genetic features can be mapped and statistically associated to phenotypic features even at an embryonic stage. Genetic selection technologies also enable improving selection at the female side. Because female animals (especially cows) typically have fewer offspring than male breeding animals, less reliable results about their breeding qualities can be obtained by evaluating the performance of their offspring conventionally. Genetic selection technologies allow correlating the genetic and phenotypic qualities of large groups of female animals, even if these do not share a common lineage, which enables predicting the phenotypic qualities of their offspring more reliably. These considerations may make the use of egg collection, *in vitro* fertilization, embryo selection, and embryo transfer – some of which involve quite invasive procedures – more attractive for breeding. When genetic selection technologies have identified a female animal with high qualities for breeding, her oocytes can be collected, artificially matured, and fertilized with semen from a compatible male breeding animal. The embryos that result can, possibly after embryo selection informed by genetic selection technologies, be brought to term by surrogate mothers. The point of this procedure would be to create genetically superior

offspring from this top female breeding animal, and to create more of them than would otherwise be possible. Genetic selection technologies do not necessitate the use of these reproductive technologies, and these latter techniques can be applied in traditional breeding as well. However, combining genetic selection technologies with advanced reproductive technologies seems particularly attractive to breeders because this combination maximizes the extent to which animals 'improve' genetically between generations (Lund et al. 2021), and genetic improvement is generally considered the aim of breeding (e.g. Turner 2010). Applying reproductive technologies to increase the value that top breeding animals have for breeding can arguably be considered instrumentalizing: it seems to involve treating these animals primarily as beings ready-to-hand that are relevant to breeders' practical involvements with the world. It must be noted however that genetic selection technologies can also motivate the use of reproductive technologies in other, possibly more benign ways. For example, genetic arrays can be used to identify eggs which contain male embryos. Killing day-old male chicks can then be prevented by keeping their eggs from hatching, which is often considered to be preferable from an animal welfare perspective.<sup>12</sup>

This section applied a technological mediation perspective on human-relations to genetic selection technologies. It did not intend to offer a robust analysis of how genetic selection technologies mediate human-animal relations, but rather aimed to illustrate how technological mediation theory can be used as a theoretical starting point for such an analysis and how it raises empirical questions along the way. These questions concern, among others, how genetic selection technologies are likely to be embedded in breeding practices, how microperceptions and macroperceptions of animals interact and are mediated by genetic selection technologies, how motivational factors that apply in the breeding sector affect which possibilities of genetic selection technologies will be pursued, and how this will shape human-animal relations.

## 5 Conclusions

This paper proposed taking technological mediation theory (Verbeek 2006, 2011, 2016) as a theoretical starting point for research into how technologies affect human-animal relations, and showed how concepts from this theory can guide discussions on the supposed instrumentalization of animals in certain technological practices as well as analyses of how particular technologies mediate human-animal relations. There are certainly challenges to be overcome when applying technological mediation theory to human-animal relations, however. Most significantly, the conceptual framework that has been developed here has to be supplemented by proper empirical methods. The proof will in the end be in the pudding: it has to be shown that a technological mediation approach to human-animal relations leads to insightful analyses of technological practices in which animals are involved.

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**Data Availability** Not applicable.

<sup>12</sup> We thank an anonymous reviewer for suggesting this example.

**Code Availability** Not applicable.

## Declarations

**Conflicts of Interest** KK reports having no conflicting interests. FLBM reports having no conflicting interests.

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