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Animal agency can accelerate behavioural and neuroscience research

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Abstract

Despite increasing numbers of publications showing that many animals possess the neural substrates involved in emotions and consciousness, animals are still restrained and forced to take part in applied or fundamental research. However, these restraints stress animals and may result in false negatives or false positives. A change is needed in researchers' work paradigm with animals to progress in behavioural and neuroscience research and thus gain access to hitherto inaccessible yet important scientific results. Animals interact in their own ways with the world and researchers need to adopt these ways, i.e. their agency, to perform better research and develop a better understanding of how the brain and behaviour evolve. This paper discusses how animal agency can not only be the key to more wide-ranging and improved research in existing domains, but can also lead to new research questions resulting from anthropocentric view.

Keywords: 3Rs, animal research, ethology, ethics, sentience

Introduction

By definition, animal research requires the involvement of animals. Although researchers have made great progress and improved experimental conditions for animals through application of the 3R rules (replace, reduce, refine), some behavioural experiments showed that animals are still restrained through different processes such as throw nets, restraint chairs, cages or food deprivation[1–6]. According to McMillan and colleagues[2], too many researchers still continue to use methods that entail negative reinforcement, whilst procedures using restraint chairs could comprise positive reinforcement methods [2]. Beyond the ethical issues of such restraints for animals, these examples of experimental set-ups lead us to consider which possibilities and results have yet to be investigated and more importantly, whether such invasive protocols could lead to false negatives or false positives [7–10]. False negatives or False positives mean that studies show respectively negative (not expected, H0) or positive results (expected, H1) but these results are not due to the tested condition (e.g. a drug, a gene, an environmental condition) but to uncontrolled factors (e.g., stress, personality). Indeed, stress and contention can not only modify some animal behaviours but also entirely prevent others from being displayed [11–13]. Some authors as Patter, Blattner, Matsuzawa, King B.J. or McMillan [14–17] consider that the current 3R framework is not sufficient to ensure that animals are meaningful participants, which is crucial to guarantee that scientific results are not altered by stress or personality of animals. These studies with restraints offer few meaningful opportunities for animals to exercise agency in their relationships, both between each other and with humans[18]. Gillespie wrote that 'there is a long tradition of studying nonhuman animals in spaces of animal use and exploitation, where researchers and teachers in effect become complicit through passive participation in violence against nonhuman animals…' [19]. According to Blattner et al. (2020) [18] who worked on animal agency in rehomed farm animals and from which this paper is inspired, 'longstanding ideological blinders and anthropocentric bias frame animals as limited beings whose lives unfold according to fixed genetic or species-specific scripts, rather than as complex subjects who act with intention and purpose, both individually and collectively'. Restraint-based experiments are severely limited in terms of what researchers can learn from animals, in individual and group contexts.

Indeed, increasing numbers of publications show that many animals (mammals, birds and other creatures including octopuses) possess the neural substrates involved in emotions and consciousness [20,21]. Rats, primates and pigeons are capable of metacognition, i.e. knowing if they are wrong or right in a test [22,23]. Cetaceans and apes are conscious of their own existence, and that of others [24]. Self-awareness was also found in cleaner fishes [25,26]. Apes know what their conspecifics know [27] and believe [28]. Empathy has been observed in apes [29] and in rats [4]. Finally, some apes have a sense of morality [30–32]. Researchers obtained these results by changing their way of thinking from an anthropocentric approach [33] to an acceptance of anthropomorphism [34]. For instance, self-awareness was not found in some species when the mirror test[24] was used, but it was found when researchers used the senses of animals, such as the sense of smell for dogs [35] or vocalisations in gibbons [36]. Merleau-Ponty had already noted this problem in his *Causeries* back in 1948: researchers usually do not try to understand animals in their singularity, *as they are*, but rather in comparison with human beings, projecting essentially human characteristics on to animals [37]. However, this is a means to measure the distance between human beings and other animals rather than a tool allowing a real understanding of how animals live and express a subjective existence [38,39]. Studied in the light of properly human normative references, animals always lack something [37]. For as long as animals are studied from a human perspective and are tested in terms of human problems (capacity to count, to draw, to speak a human language) instead of their own questions and problems, they will always respond "as they can"[40], without ever being able to fully express their agency. Animals interact with the world in their own ways and these ways, i.e. their agency, are precisely the view what researchers need to adopt to perform better research and develop a better understanding of how the brain and behaviour evolve.

Animal agency

Agency is the capacity of an actor to act in a given environment. In the broadest sense, agency is the ability to have an influence or an effect on something. In this sense, the agency is owned by all humans and animals, but also by viruses, stones or tornadoes as explained by Blattner et al. (2020) [18]. However, its focus might be narrower when agency is considered as the expression or manifestation of a subjective existence; agency implies affecting the world in ways that reflect a subject's desires or will [41]. It refers to an individual pursuing its own

good in its own way [42]. Blattner et al. [18] investigate animal agency in a sanctuary for formerly farmed animals, considering how a careful exploration of dimensions of agency in this setting might inform ideas of interspecies interactions (work, research, politics, etc.) and ethics. Their study focused on multispecific animals living in a sanctuary. For the owners of the sanctuary and for the study researchers, the sanctuary is an 'integrated multispecies community or society whose members shape spaces and practices together, take on recognised social roles, and create and transmit social norms across species lines'. Blattner et al. [18] as Frans de Waal [43], Le Leindre et al.[22,23], Meijer[44] affirm that researchers need to spend time in community with animals, to learn from them, and to be prepared to respond and adjust scientific learning process through relationships with them. This means that animals should no longer be considered as the subjects of scientific experiments, but rather as participants. For example, when it comes to assessing animal intelligence, the researchers' focus should encompass goals that are meaningful, useful and of interest to animals instead of focusing on goals that are only relevant to the human scientist [45]. Animals should no longer be seen as objects of knowledge, or mere matter for the act of the human knower, but should rather be granted a status as an *agent* in the production of knowledge [46]. Interaction and communication have to go in both directions. Researchers need to make themselves understandable to animals as many species are able to understand our facial expressions and emotions[47–52]. Of course, this communication would only be possible for some species, such as apes and some monkeys, cetaceans, certain birds including parrots or corvids, social carnivores and cephalopods. However, researchers need to extend this circle as some other species are surely able to understand their intentions as behavioural or even neuroscientific experiments, particularly in rats and mice being the most used animals in laboratories but having sense of empathy[4,53,54] and feeling human intention (i.e. Pygmalion effect[48]). When researchers allow too little room for the animals' own forms of agency, the true abilities of these individuals are obscured[55].

The study of agencies in animals can be divided into four schemes according to Blattner et al. (2020) [18] (Figure 1):

1. Agency through space and time: animals are mobile and explore/exploit their environments. This exploration and exploitation can be used to better understand the behaviours of animals but also their preferences in terms of habitats, sleeping

areas and social relationships and conduct to new disciplines as animal geographies[56] or animal mobilities[57]. Whilst this agency seems obvious for many researchers and is often applied for livestock and farmed animals [58–60], it is rarely applied in comparative psychology or neuroscience. Specifically, modifications of the environment can be used to shape animal decisions and can remove some of the negative reinforcement that is still applied to animals. Animals could experience less stress in some parts of their environment than others, and carrying out experiments in these places could increase their motivation to participate and decrease the risk of false negatives [61,62].

2. Agency through practice and routine: Animals have habits, even in the wild. Social animals collectively organise their day in order to meet their requirements and maintain the advantages of living in groups [63]. Rather than forcing animals to participate in experiments, accepting that animals can accept or refuse to participate according to their routine would increase the robustness and viability of results. Any animals that want to be tested seek to use tablets or other interactive apparatus such as artificial fruits[64] or opening boxes[65] with food inside that are based on technologies such as RFID[66,67]; these tools respect their habits and routines. Medical aspects such as health checks or medical procedures that require restraints should also be based on these routines to decrease animal stress and injuries, as already shown in their use by zoos.
3. Agency through social roles: A social role is the behaviour expected of an individual who occupies a given social position or status. Individuals understand the place that conspecifics hold in their society. The adoption of roles that are recognised and acknowledged by others, and indeed mutually constructed with conspecifics, is an important dimension of relational agency and a means by which researchers can effectively affirm their subjective existence within a community. This role can be intraspecific or interspecific. Roles of individuals inside their group 'have been amply described in terms of dominance (policing behaviours, protecting groups), kinship and maternal relationships [68]. Individuals also develop strong relationships when they share similar attributes as sex or age[69–73]. Group members influence each other, and particularly share knowledge [74]. Dominant or old individuals can transmit important information to others, and this social transmission can be used to make animals learn

how to use experimental apparatus or spaces. These individuals can consequently become leaders. Multispecific and positive interactions or associations are also found naturally in the wild in situations such as multispecies group protection, interspecies grooming and predator alerts, even if negative interactions (cheating, predating, competition) are also observed. Blattner et al.[18] described multispecies interactions in the sanctuary for formerly farmed animals. Individuals of specific species adopt different roles with geese, cows or dogs acting as guardians and policers, cows teaching sheep and multispecies friendship and parenting. Multispecific leadership is also described in different reports with geese leading ducks and chickens, and goats leading sheep [75–77].

4. Agency through social norms: Social norms are the customary rules that govern behaviour in groups and societies [78]. The previous example of learners and teachers brings us to the subject of social norms. Behavioural rules and social systems are partly genetic in animals but are also transmitted by cultures [68,79–82]. Many traditions of tool use and social habits have been described in chimpanzees or macaques [83]. Although collective decision processes are species-specific, variations are observed between groups of the same species. The roles played by individuals can lead to a strong leadership or the development of a more democratic process such as votes [84]. Voting systems [85] are described in many species, with intentional behaviours and perceptions of the mental states of conspecifics indicating some theory of mind and reinforcing the idea of agency. A sense of community [18] seems to exist in chimpanzees and in cetaceans, and indeed many other animals know exactly who belongs or does not belong to their group by recognising the faces or voices of group members.

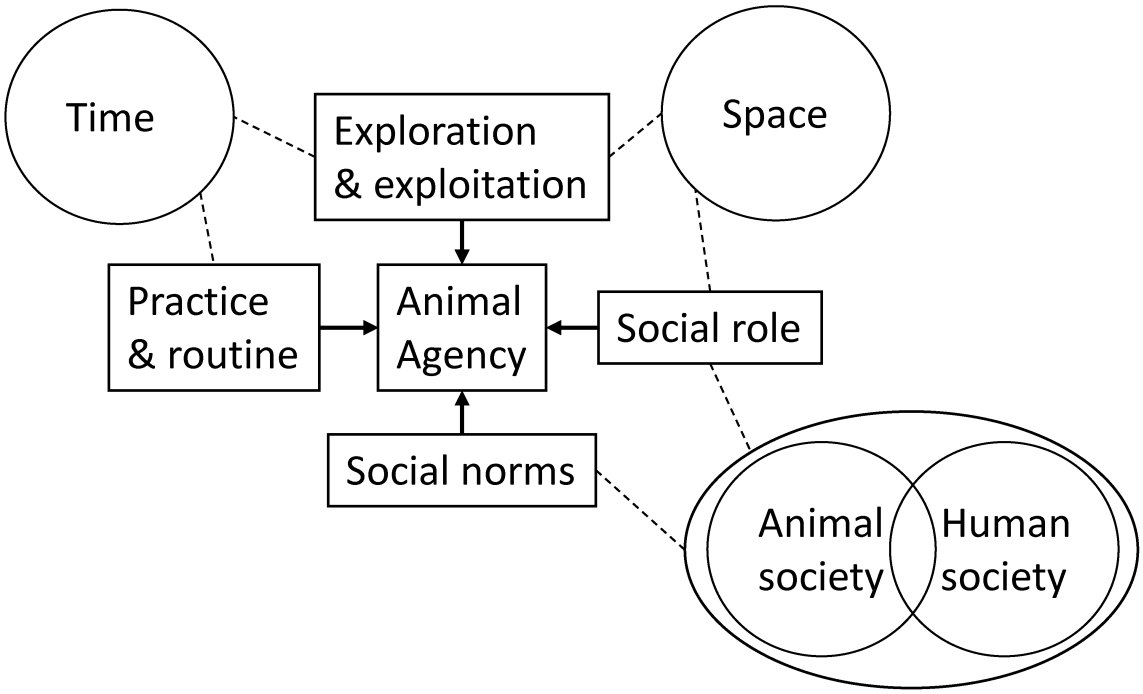

Figure 1: The four schemes of animal agency (squares) and the environmental factors affecting them (circles)

These different instances show that animals have agency over their spatial, temporal and social environment. Animals can therefore be viewed as *agents*; their choice to act has direct consequences on their environment, or they can also resist conditions that do not please them, and act accordingly to change them [86]. The behaviours animal show, facial expressions they display, the places they occupy are cues to indicate their willingness. Researchers could use this agency to increase animal welfare and obtain more viable and robust results, whilst extending the scope of behavioural and neuroscience research. Indeed, the great difficulty today is to measure the behaviours or the neuronal activities of aware animals whilst seeking to do so in natural conditions: the results of many experiments have been criticised, as the associated captivity, animal microbiota, genetic or behavioural variance of animals made it impossible to allow to reproduce or generalise any results that were unaffected by false negatives or false positives [87–89]. Often, in the research process, many of the limitations shown by the animals to date are actually the limitations of the scientific methods, rather than the animals themselves[90]. Similarly, Frans De Waal argues: 'All that most experiments have done thus far is testing the ape's theory of the human mind. We would do better to

190 focus on the ape's theory of the ape mind' [30]. Following the concept of animal agency, this
191 paper proposes a future research framework to work with animals and progress in research.

192 **Future research framework**

193 Some years ago, applying the use of touchscreens in macaques, or studying mouse
194 personality was almost unimaginable in neuroscience. Yet today, these projects have
195 become reality. Touchscreens or joysticks are used to understand cognition and self-agency
196 [91] in a wide range of species (pigs, macaques, baboons, goats, horses, rats, mice, etc.[67,92–97]).
197 However, this use is still limited given its potential even if more and more neuroscience
198 studies use it in mice or rats [98–101]. There is a huge amount of literature describing how
199 animal personality and microbiota can influence results. This success demonstrates the
200 importance of not limiting scientific imagination about how researchers could work with
201 animals to obtain new results in biological sciences.

202 First researchers need to change their way of thinking to a perspective of working *with*
203 animals rather than *on* animals. Animals are agents endowed with intentions which
204 transcend traditional subject-object relations. Researchers need to trust their
205 capabilities[102,103] in order to increase research possibilities. Experimental set-ups such as
206 restraint chairs or food privation, stress animals and prevent them both physically and
207 mentally from fully expressing their agency. This challenge may certainly take time, but
208 would be hugely beneficial. Patter and Blattner [14] suggest core principles to follow with
209 animals: non-maleficence, beneficence and voluntary participation [104]. Positive methods
210 exist and have proved to be efficient [6,11,105–108]. The readiness of chimpanzees (not used
211 anymore for invasive experiments but present in primate research centers[109]) to voluntarily
212 participate in interactions or allow humans to observe them can facilitate the measurement
213 of embryo development and brain activities in unanesthetized and unrestrained individuals
214 (Figure 2[66]). Unrestrained and voluntary animals can be trained to put their head in a mask [5]
215 and be tested whilst receiving fruit juice. This allows the measurement of different metrics
216 with eye tracking [28,110,111] and non-invasive neuroimaging [112] (Figure 3.A).

217

Figure 2: (A) Developmental neuroscience. Fetal brain development in chimpanzees was measured by a non-invasive ultrasound technique. (B) EEG recordings in a chimpanzee. The chimpanzee quietly sat on the chair and allowed the experimenter to put electrode patches on the skin of her forehead and the top of her head. Photos provided with the courtesy of Satoshi Hirata.

Some traditional approaches involve bringing animals into a lab and restraining them while they perform tasks in order to ensure stable gaze-tracking and neural recordings. However, this unnatural setting does not permit the study of brain activity during natural, social and complex behaviours. Specific ethical guidelines exist now for research in the wild [113,114]. The likely benefits and possible negative effects of researchers' presence and field methods on study subjects, their environment and the local human community should, of course, be considered [115]. New technologies allow us to bring science into the wild and test animals in a free condition in their natural environment, thus removing any experimental source of stress (as they would come by themselves to be tested) and measuring their entire behavioural repertoire. This allows to study behavioural responses and the brain activity during natural, social and complex behaviours. This field works are possible in many species including rodents[116–118]. The animals studied can be identified using RFID techniques [119] but also via artificial intelligence with the recognition of individuals by videotracking [120–122]. The latter removes the need to catch animals. A location can then be defined where different touchscreens deliver food, with activation only for certain species and individuals.

Researchers can imagine going beyond the use of touchscreens with the implementation of eye-tracking and neuroimaging apparatus in the wild (Figure 3.B). This could open up new research avenues in species that are in danger of extinction or cannot be easily maintained in captivity. As Schaefer and Claridge-Chang wrote, 'the new automation is not just faster: it is also allowing new kinds of experiments, many of which erase the boundaries of the traditional neuroscience disciplines (psychology, ethology and physiology) while producing insight into problems that were otherwise opaque'[123].

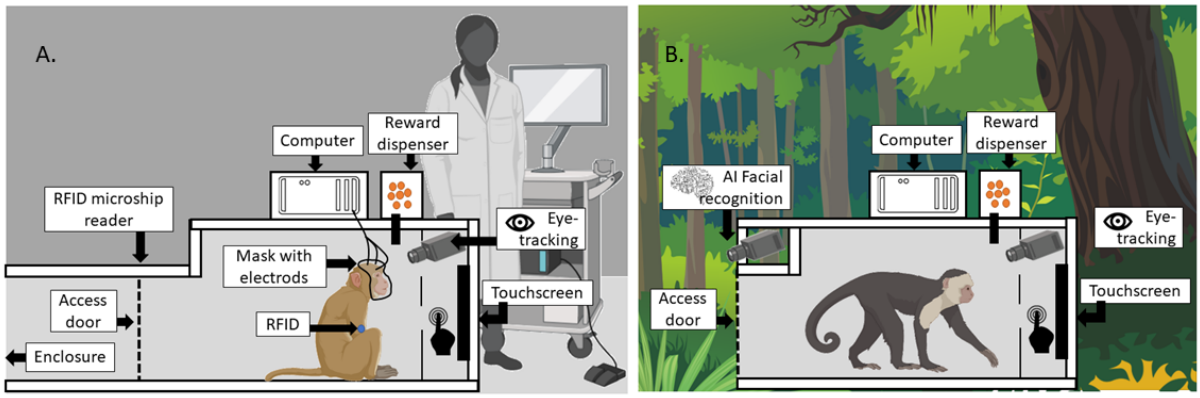

Figure 3: (A) Non-invasive neuroimaging and eye-tracking system with voluntary experience in the lab. (B) Non-invasive touchscreen system with voluntary engagement and individual identification in the wild. This figure was realized using FAVPNG.com and Biorender.

Some studies, and especially the biomedical or physiological/cellular domains, cannot be performed outside the laboratory. It is important for these experiments to respect the 3Rs but also to think about the Bateson cube [124], meaning that scientists need to evaluate the ethical acceptability of their research for society as a whole, including animals. The 3Rs can be extended by testing animals in viable conditions. These too standardized lab conditions for instance decrease the replicability of studies by decreasing the behavioural variability (issue called standardization fallacy[125,126]). Indeed, lab conditions were standardised for many years in terms of animal genetics, husbandry, food for study comparison and repeatability. However, this way of doing research is criticised today as animals are agents interacting with their world, and the lab conditions in which they live have a strong effect on them and thus on scientific results. Moreover, it is difficult to replicate similar conditions in the laboratory, as even animals that are genetically similar and live in similar environments

develop different personalities [127]. Moreover, even if animals are living in similar conditions, similar food and litter sources affect their microbiota [128–130] and their behaviours differently [131]. Animal sociality was long forgotten in neuroscience or biomedical research, but it is an important part of animal agency [18]. Indeed, sociality has an important impact on the health of animals, and a great number of publications highlight the link between sociality and health ageing [132–134]. Making use of the sociality of animals, i.e. their agency, can even reverse cognitive decline and extend longevity [135–137].

Conclusion

Great efforts are made towards animal but there is still much progress to be made to attain a more compassionate, less stressful and more robust animal research model. This requires training and teaching researchers, through MOOC [138,139], books[17,43,102,140] or workshops, to adopt new methods including animal agency and change their view of the role animals play in research. As Jacques Derrida wrote in *The Animal That Therefore I Am,* the traditional scientific and philosophical discourse on animals observes and speaks of non-human animals but never really engages with, experiments *with* or gains experience with the latter [141]: this type of discourse can therefore only position animals as mere passive objects of the theoretical knowledge these disciplines build. Such methods are completely blind to the animals' own processes of interacting with their world [141], and are completely blind to their agency. This view of animals as objects is not limited to research but is also found in different aspects of everyday life (food, work, clothing, etc.). Researchers worldwide must have the conviction that ethical animal research must consider individuals as subjects of their own life and of their own world, and as co-creators of knowledge. Accepting this co-creation of knowledge can create new research questions from anthropocentric view, as animal cognition dimensions are different from ours[33]. Animals are agents in scientific research. They are active in the research process and some researchers have even gone so far as to add them in the acknowledgments or even list them as co-authors [14,142]. This recognition of animals as agents rather than objects is not approved of by some researchers, who consider that this is tantamount to removing animal agency, committing over-anthropomorphism and overstepping the will of animals to cooperate. Acknowledging animal agency could facilitate social acceptance of animal research [104] and be of benefit to the animals concerned (well-being through learning, creating and participating[143]). The

consideration of animals as agents could be extended from research to other domains: a new ontology considering non-human animals as agents can have political, ethical and legal consequences. The concept of capital applied to animals needs to be extended to social capital, ecological capital and cultural capital [144]: citizens but not only researchers can learn from animals and they can be part of human societies [145]. This new way of viewing animal agency can therefore raise critical ethical questions in regard to the treatment of animals in research and to the place humans grant them politically in human social world.

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