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1 **Animal agency can accelerate behavioural and neuroscience research**

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9

10 **Abstract**

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

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

23 Introduction

24 By definition, animal research requires the involvement of animals. Although researchers
25 have made great progress and improved experimental conditions for animals through
26 application of the 3R rules (replace, reduce, refine), some behavioural experiments showed
27 that animals are still forced to enter experimental apparatus through different processes
28 such as throw nets, restraint chairs, cages or food privation. Thirty percent of researchers
29 still continue to use methods that entail negative reinforcement, whilst 70% of procedures
30 using restraint chairs could comprise positive reinforcement methods¹. Beyond the ethical
31 issues of such constraints for animals, these examples of experimental set-ups lead us to
32 consider which possibilities and results have yet to be investigated and more importantly,
33 whether such invasive protocols could lead to false negatives or false positives²⁻⁵. Indeed,
34 stress and contention can not only modify some animal behaviours but also entirely prevent
35 others from being displayed⁶⁻⁸. Some authors consider that the current 3R framework is not
36 sufficient to ensure that animals are meaningful participants, which is crucial to guarantee
37 that scientific results are not altered. These contexts offer little meaningful scope for animals
38 to exercise agency in their relations, both between each other and with humans. Gillepsie
39 wrote that 'there is a long tradition of studying nonhuman animals in spaces of animal use
40 and exploitation, where researchers and teachers in effect become complicit through
41 passive participation in violence against nonhuman animals...' ⁹. Longstanding ideological
42 blinders and anthropocentric bias frame animals as limited beings whose lives unfold
43 according to fixed genetic or species-specific scripts, rather than as complex subjects who
44 act with intention and purpose, both individually and collectively. We believe that
45 constraint-based experiments are severely limited in terms of what we can learn from
46 animals, in individual and group contexts.

47 Indeed, increasing numbers of publications show that many animals (mammals, birds and
48 other creatures including octopuses) possess the neural substrates involved in emotions and
49 consciousness^{10,11}. Rats, primates and pigeons are capable of metacognition, i.e. knowing if
50 they are wrong or right in a test^{12,13}. Cetaceans and apes are conscious of their own
51 existence, and that of others¹⁴. Self-awareness was also found in cleaner fishes^{15,16}. Apes
52 know what their conspecifics know¹⁷ and believe¹⁸. Empathy has been observed in apes¹⁹
53 and in rats²⁰. Finally, some apes have a sense of morality²¹⁻²³. Researchers obtained these

54 results by changing their way of thinking from an anthropocentric approach ²⁴ to an
55 acceptance of anthropomorphism ²⁵. For instance, self-awareness was not found in some
56 species when the mirror test was used, but it was found when researchers used the senses
57 of animals, such as the sense of smell for dogs ²⁶ or vocalisations in gibbons ²⁷. Merleau-
58 Ponty had already noted this problem in his *Causeries* back in 1948: researchers usually do
59 not try to understand animals in their singularity, *as they are*, but rather in comparison with
60 human beings, projecting essentially human characteristics on to animals ²⁸. However, this is
61 a means to measure the distance between human beings and other animals rather than a
62 tool allowing a real understanding of how animals live and express a subjective existence
63 ^{29,30}. Studied in the light of properly human normative references, animals always lack
64 something ²⁸. For as long as animals are studied from a human perspective and are tested in
65 terms of human problems (capacity to count, to draw, to speak a human language) instead
66 of their own questions and problems, they will always respond “as they can”³¹, without ever
67 being able to fully express their agency. Animals interact with the world in their own ways
68 and these ways, i.e. their agency, are precisely what we need to adopt to perform better
69 research and develop a better understanding of how the brain and behaviour evolve.

70 **Animal agency**

71 Agency is the capacity of an actor to act in a given environment. At its broadest, agency is
72 the ability to have influence over, or an effect on, something. In this sense, agency is
73 possessed by all humans and animals, but also by viruses, stones or tornadoes. However, its
74 focus might be narrower when agency is considered as the expression or manifestation of a
75 subjective existence; agency implies affecting the world in ways that reflect a subject’s
76 desires or will ³². It refers to an individual pursuing its own good in its own way ³³. Blattner et
77 al. ³⁴ investigate animal agency in a sanctuary for formerly farmed animals, considering how
78 a careful exploration of dimensions of agency in this setting might inform ideas of
79 interspecies interactions (work, research, politics, etc.) and ethics. Their study focused on
80 multispecific animals living in a sanctuary. For the owners of the sanctuary and for the study
81 researchers, the sanctuary is an ‘integrated multispecies community or society whose
82 members shape spaces and practices together, take on recognised social roles, and create
83 and transmit social norms across species lines’. The authors affirmed that we need to spend
84 time in community with animals, to learn from them, and to be prepared to respond and

85 adjust our learning process through relationships with them. This can be extended to
86 scientific research, and means that animals should no longer be considered as the subjects
87 of our experiments, but rather as participants. For example, when it comes to assessing
88 animal intelligence, the researchers' focus should encompass goals that are meaningful,
89 useful and of interest to animals instead of focusing on goals that are only relevant to the
90 human scientist³⁵. Animals should no longer be seen as objects of knowledge, or mere
91 matter for the act of the human knower, but should rather be granted a status as an *agent* in
92 the production of knowledge³⁶. Interaction and communication have to go in both
93 directions. We need to make ourselves understandable to animals. Of course, this
94 communication would only be possible for some species, such as apes and some monkeys,
95 cetaceans, certain birds including parrots or corvids, social carnivores and cephalopods.
96 However, we need to extend this circle as some other species are surely able to understand
97 our intentions as behavioural or even neuroscientific experiments. When researchers allow
98 too little room for the animals' own forms of agency, the true abilities of these individuals
99 are obscured³⁷.

100 The study of agencies in animals can be divided into four schemes³⁴ (Figure 1):

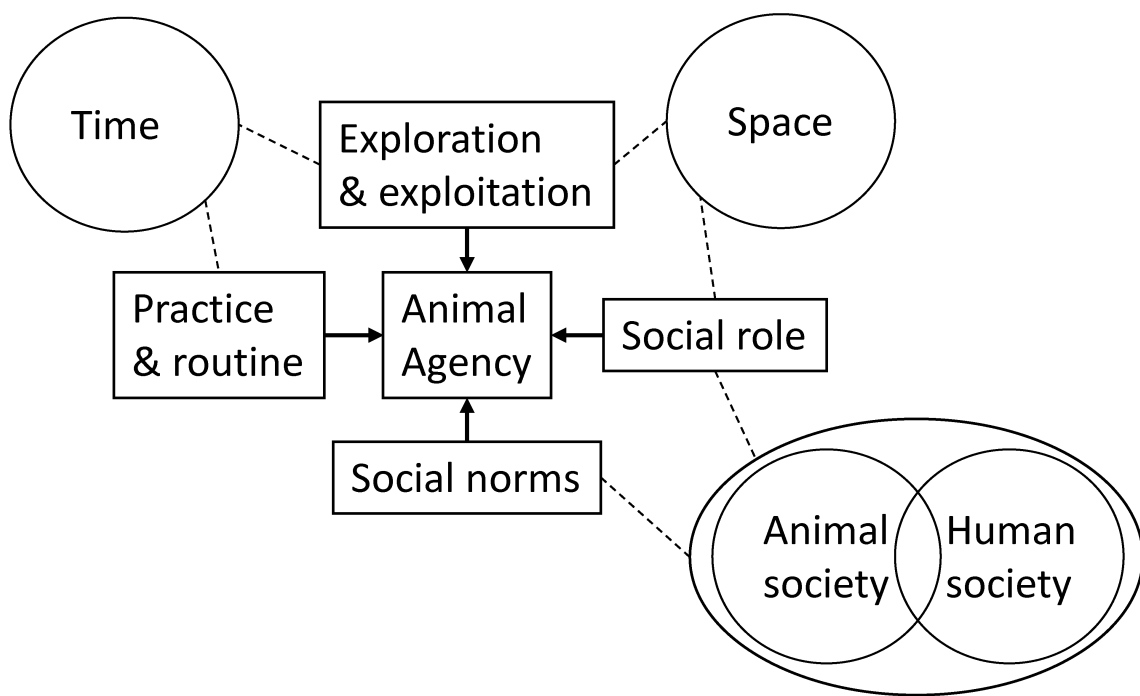
- 101 1. Agency through space and time: animals are mobile and explore/exploit their
102 environments. This exploration and exploitation can be used to better understand
103 the behaviours of animals but also their preferences in terms of habitats, sleeping
104 areas and social relationships. Whilst this agency seems obvious for many
105 researchers and is often applied for livestock and farmed animals³⁸⁻⁴⁰, it is rarely
106 applied in comparative psychology or neuroscience. Specifically, modifications of the
107 environment can be used to shape animal decisions and can remove some of the
108 negative reinforcement that is still applied to animals. Animals could experience less
109 stress in some parts of their environment than others, and carrying out experiments
110 in these places could increase their motivation to participate and decrease the risk of
111 false negatives^{41,42}.
- 112 2. Agency through practice and routine: Animals have habits, even in the wild. Social
113 animals collectively organise their day in order to meet their requirements and
114 maintain the advantages of living in groups⁴³. Rather than forcing animals to
115 participate in experiments, accepting that animals can accept or refuse to participate

116 according to their routine would increase the robustness and viability of results. Any
117 animals that want to be tested seek to use tablets or other interactive apparatus that
118 are based on technologies such as RFID^{44,45}; these tools respect their habits and
119 routines. Medical aspects such as health checks or medical procedures that require
120 constraints and restraints should also be based on these routines to decrease animal
121 stress and injuries, as already shown in their use by zoos.

122 3. Agency through social roles: A social role is the behaviour expected of an individual
123 who occupies a given social position or status. Individuals understand the place that
124 conspecifics hold in their society. The adoption of roles that are recognised and
125 acknowledged by others, and indeed mutually constructed with conspecifics, is an
126 important dimension of relational agency and a means by which we can effectively
127 affirm our subjective existence within a community. This role can be intraspecific or
128 interspecific. Roles of individuals inside their group 'have been amply described in
129 terms of dominance (policing behaviours, protecting groups), kinship and maternal
130 relationships⁴⁶. Individuals also develop strong relationships when they share similar
131 attributes as sex or age. Group members influence each other, and particularly share
132 knowledge⁴⁷. Dominant or old individuals can transmit important information to
133 others, and this social transmission can be used to make animals learn how to use
134 experimental apparatus or spaces. These individuals can consequently become
135 leaders. Multispecific and positive interactions or associations are also found
136 naturally in the wild in situations such as multispecies group protection, interspecies
137 grooming and predator alerts, even if negative interactions (cheating, predateding,
138 competition) are also observed. Blattner et al.³⁴ described multispecies interactions
139 in the sanctuary for formerly farmed animals. Individuals of specific species adopt
140 different roles with geese, cows or dogs acting as guardians and policers, cows
141 teaching sheep and multispecies friendship and parenting. Multispecific leadership is
142 also described in different reports with geese leading ducks and chickens, and goats
143 leading sheep⁴⁸⁻⁵⁰.

144 4. Agency through social norms: Social norms are the customary rules that govern
145 behaviour in groups and societies⁵¹. The previous example of learners and teachers
146 brings us to the subject of social norms. Behavioural rules and social systems are
147 partly genetic in animals but are also transmitted by cultures. In macaques, for

148 instance, species are divided into grades ranging from despotic and aggressive to
 149 tolerant and democratic ⁵². However, if an individual from one specific grade is
 150 transferred into a group of another grade, it will adopt their behaviours. Many
 151 traditions of tool use and social habits have been described in chimpanzees or
 152 macaques ⁵³. Although collective decision processes are species-specific, variations
 153 are observed between groups of the same species. The roles played by individuals
 154 can lead to a strong leadership or the development of a more democratic process
 155 such as votes ⁵⁴. Voting systems ⁵⁵ are described in many species, with intentional
 156 behaviours and perceptions of the mental states of conspecifics indicating some
 157 theory of mind and reinforcing the idea of agency. A sense of community ³⁴ seems to
 158 exist in chimpanzees and in cetaceans, and indeed many other animals know exactly
 159 who belongs or does not belong to their group by recognising the faces or voices of
 160 group members.



161
 162 Figure 1: The four schemes of animal agency (squares) and the environmental factors
 163 affecting them (circles)

164

165 These different instances show that animals have agency over their spatial, temporal and
166 social environment. Animals can therefore be viewed as *agents*; their choice to act has direct
167 consequences on their environment, or they can also resist conditions that do not please
168 them, and act accordingly to change them ⁵⁶. Researchers could use this agency to increase
169 animal welfare and obtain more viable and robust results, whilst extending the scope of
170 behavioural and neuroscience research. Indeed, the great difficulty today is to measure the
171 behaviours or the neuronal activities of aware animals whilst seeking to do so in natural
172 conditions: the results of many experiments have been criticised, as the associated captivity,
173 animal microbiota, genetic or behavioural variance of animals made it impossible to allow to
174 reproduce or generalise any results that were unaffected by false negatives or false positives
175 ⁵⁷⁻⁵⁹. Often, in the research process, many of the limitations shown by the animals to date
176 are actually the limitations of the scientific methods, rather than the animals themselves⁶⁰.
177 Similarly, Frans De Waal argues: 'All that most experiments have done thus far is testing the
178 ape's theory of the human mind. We would do better to focus on the ape's theory of the ape
179 mind' ²¹. Following the concept of animal agency, we propose a future research framework
180 to work with animals and progress in research.

181 **Future research framework**

182 We remember some years ago, talking with colleagues in neuroscience or medical research
183 about applying the use of touchscreens in macaques, or suggesting to doctors that studying
184 mouse personality could help to avoid false negatives or false positives. Our interlocutors
185 laughed, saying that our suggestions were either unnecessary or impossible. Yet today, these
186 projects have become reality. Touchscreens or joysticks are used to understand cognition
187 and self-agency ⁶¹ in a wide range of species (pigs, macaques, baboons, goats, horses,
188 etc.^{45,62-65}). However, this use is still limited to behavioural studies and should now be
189 extended to neuroscience¹. There is a huge amount of literature describing how animal
190 personality and microbiota can influence results. This success demonstrates the importance
191 of not limiting our imagination about how we could work with animals to obtain new results
192 in biological sciences.

193 First we need to change our way of thinking to a perspective of working *with* animals rather
194 than *on* animals. Animals are agents endowed with intentions which transcend traditional
195 subject-object relations. We need to trust their capabilities in order to increase our research

196 possibilities. Experimental set-ups that restrain animals, such as restraint chairs or food
197 privation, stress animals and prevent them both physically and mentally from fully
198 expressing their agency. This challenge may certainly take time, but would be hugely
199 beneficial. Patter and Blattner ⁶⁶ suggest core principles to follow with animals: non-
200 maleficence, beneficence and voluntary participation ⁶⁷. Economic or convenience
201 euthanasia of animals should not be an option ^{68,69}. Euthanasia also has a strong impact on
202 the emotions of caretakers ⁷⁰. Positive methods exist and have proved to be efficient ^{6,71–75}.
203 The readiness of chimpanzees to voluntarily participate in interactions or allow humans to
204 observe them can facilitate the measurement of embryo development and brain activities in
205 unanesthetized and unrestrained individuals (Figure 2⁴⁴). Unrestrained and voluntary
206 animals can be trained to put their head in a mask ⁷⁶ and be tested whilst receiving fruit
207 juice. This allows the measurement of different metrics with eye tracking ^{18,77,78} and non-
208 invasive neuroimaging ⁷⁹ (Figure 3.A).

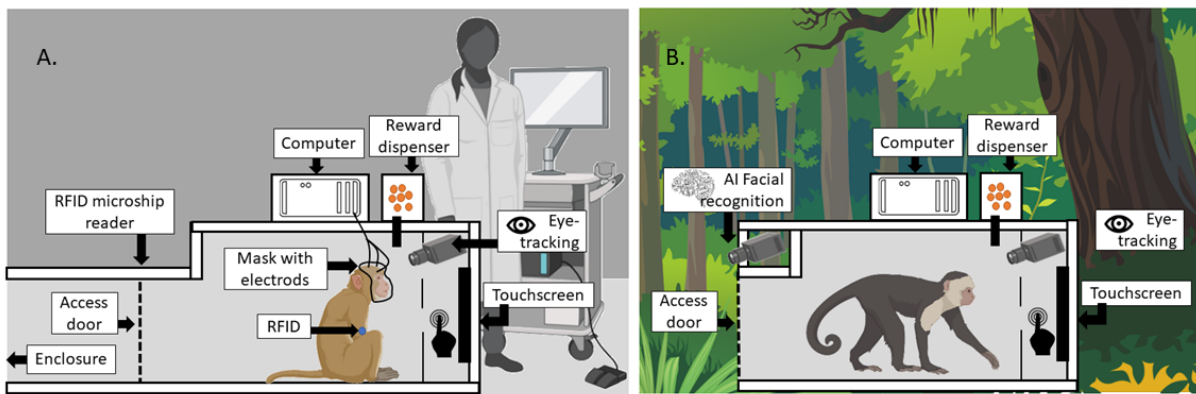
209



210
211 e 2: (A) Developmental neuroscience. Fetal brain development in chimpanzees was
212 measured by a non-invasive ultrasound technique. (B) EEG recordings in a chimpanzee. The
213 chimpanzee quietly sat on the chair and allowed the experimenter to put electrode patches
214 on the skin of her forehead and the top of her head. Photos provided with the courtesy of
215 Satoshi Hirata.

216

217 Traditional approaches involve bringing animals into a lab and restraining them while they
218 perform tasks in order to ensure stable gaze-tracking and neural recordings (in the case of
219 neuroscience). However, this unnatural setting does not permit the study of brain activity
220 during natural, social and complex behaviours. Specific ethical guidelines exist now for
221 research in the wild^{80,81}. The likely benefits and possible negative effects of our presence
222 and field methods on study subjects, their environment and the local human community
223 should, of course, be considered⁸². New technologies allow us to bring science into the wild
224 and test animals in a free condition in their natural environment, thus removing any
225 experimental source of stress and measuring their entire behavioural repertoire. The
226 animals studied can be identified using RFID techniques⁸³ but also via artificial intelligence
227 with the recognition of individuals by videotracking^{84–86}. The latter removes the need to
228 catch animals. A location can then be defined where different touchscreens deliver food,
229 with activation only for certain species and individuals. We can imagine going beyond the
230 use of touchscreens with the implementation of eye-tracking and neuroimaging apparatus in
231 the wild (Figure 3.B). This could open up new research avenues in species that are in danger
232 of extinction or cannot be easily maintained in captivity.



233
234 Figure 3: (A) Non-invasive neuroimaging and eye-tracking system with voluntary experience
235 in the lab. (B) Non-invasive touchscreen system with voluntary engagement and individual
236 identification in the wild. This figure was realized using FAVPNG.com and Biorender.

237
238 Some research, and especially the biomedical or physiological/cellular domains, cannot be
239 performed outside the research structure. It is important for these experiments to respect
240 the 3Rs but also to think about the Bateson cube⁸⁷, meaning that scientists need to evaluate

241 the ethical acceptability of their research for society as a whole, including animals. The 3Rs
242 can be extended by testing animals in viable conditions. Indeed, lab conditions were
243 standardised for many years in terms of animal genetics, husbandry, food for study
244 comparison and repeatability. However, this way of doing research is criticised today as
245 animals are agents interacting with their world, and the lab conditions in which they live
246 have a strong effect on them and thus on scientific results. Moreover, it is difficult to
247 replicate similar conditions in the laboratory, as even animals that are genetically similar and
248 live in similar environments develop different personalities⁸⁸. Moreover, even if animals are
249 living in similar conditions, similar food and litter sources affect their microbiota⁸⁹⁻⁹¹ and
250 their behaviours differently⁹². Animal sociality was long forgotten in neuroscience or
251 biomedical research, but it is an important part of animal agency³⁴. Indeed, sociality has an
252 important impact on the health of animals, and a great number of publications highlight the
253 link between sociality and health ageing⁹³⁻⁹⁵. Making use of the sociality of animals, i.e. their
254 agency, can even reverse cognitive decline and extend longevity⁹⁶⁻⁹⁸.

255 **Conclusion**

256 There is still much progress to be made to attain a more compassionate, less stressful and
257 more robust animal research model. This requires training and teaching researchers to adopt
258 new methods including animal agency and change their view of the role animals play in
259 research. As Jacques Derrida wrote in *The Animal That Therefore I Am*, the traditional
260 scientific and philosophical discourse on animals observes and speaks of non-human animals
261 but never really engages with, experiments *with* or gains experience with the latter⁹⁹: this
262 type of discourse can therefore only position animals as mere passive objects of the
263 theoretical knowledge these disciplines build. Such methods are completely blind to the
264 animals' own processes of interacting with their world⁹⁹, and are completely blind to their
265 agency. This view of animals as objects is not limited to research but is also found in
266 different aspects of everyday life (food, work, clothing, etc.). Researchers worldwide must
267 have the conviction that ethical animal research must consider individuals as subjects of
268 their own life and of their own world, and as co-creators of knowledge. Accepting this co-
269 creation of knowledge can create new research questions from our anthropocentric view, as
270 animal cognition dimensions are different from ours²⁴. Animals are agents in our research.
271 They are active in the research process and some researchers have even gone so far as to

272 add them in the acknowledgments or even list them as co-authors^{66,100}. This recognition of
273 animals as agents rather than objects is not approved of by some researchers, who consider
274 that this is tantamount to removing animal agency, committing over-anthropomorphism and
275 overstepping the will of animals to cooperate. Acknowledging animal agency could facilitate
276 social acceptance of animal research⁶⁷ and be of benefit to the animals concerned (well-
277 being through learning, creating and participating¹⁰¹). The consideration of animals as agents
278 could be extended from research to other domains: a new ontology considering non-human
279 animals as agents can have political, ethical and legal consequences. The concept of capital
280 applied to animals needs to be extended to social capital, ecological capital and cultural
281 capital¹⁰²: we can learn from animals and they can be part of our societies¹⁰³. This new way
282 of viewing animal agency can therefore raise critical ethical questions in regard to the
283 treatment of animals in research and to the place we grant them politically in our social
284 world.

285

286

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