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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 methods<sup>1</sup>. 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 positives<sup>2-5</sup>. Indeed,  
34 stress and contention can not only modify some animal behaviours but also entirely prevent  
35 others from being displayed<sup>6-8</sup>. 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 few meaningful opportunities for  
38 animals to exercise agency in their relationships, both between each other and with  
39 humans<sup>9</sup>. Gillespie wrote that 'there is a long tradition of studying nonhuman animals in  
40 spaces of animal use and exploitation, where researchers and teachers in effect become  
41 complicit through passive participation in violence against nonhuman animals...' <sup>10</sup>.  
42 According to Blattner et al. (2020)<sup>9</sup> who worked on animal agency in rehomed farm animals  
43 and from which this paper is inspired, 'longstanding ideological blinders and anthropocentric  
44 bias frame animals as limited beings whose lives unfold according to fixed genetic or species-  
45 specific scripts, rather than as complex subjects who act with intention and purpose, both  
46 individually and collectively'. We believe that constraint-based experiments are severely  
47 limited in terms of what we can learn from animals, in individual and group contexts.

48 Indeed, increasing numbers of publications show that many animals (mammals, birds and  
49 other creatures including octopuses) possess the neural substrates involved in emotions and  
50 consciousness<sup>11,12</sup>. Rats, primates and pigeons are capable of metacognition, i.e. knowing if  
51 they are wrong or right in a test<sup>13,14</sup>. Cetaceans and apes are conscious of their own  
52 existence, and that of others<sup>15</sup>. Self-awareness was also found in cleaner fishes<sup>16,17</sup>. Apes  
53 know what their conspecifics know<sup>18</sup> and believe<sup>19</sup>. Empathy has been observed in apes<sup>20</sup>

54 and in rats <sup>21</sup>. Finally, some apes have a sense of morality <sup>22–24</sup>. Researchers obtained these  
55 results by changing their way of thinking from an anthropocentric approach <sup>25</sup> to an  
56 acceptance of anthropomorphism <sup>26</sup>. For instance, self-awareness was not found in some  
57 species when the mirror test was used, but it was found when researchers used the senses  
58 of animals, such as the sense of smell for dogs <sup>27</sup> or vocalisations in gibbons <sup>28</sup>. Merleau-  
59 Ponty had already noted this problem in his *Causeries* back in 1948: researchers usually do  
60 not try to understand animals in their singularity, *as they are*, but rather in comparison with  
61 human beings, projecting essentially human characteristics on to animals <sup>29</sup>. However, this is  
62 a means to measure the distance between human beings and other animals rather than a  
63 tool allowing a real understanding of how animals live and express a subjective existence  
64 <sup>30,31</sup>. Studied in the light of properly human normative references, animals always lack  
65 something <sup>29</sup>. For as long as animals are studied from a human perspective and are tested in  
66 terms of human problems (capacity to count, to draw, to speak a human language) instead  
67 of their own questions and problems, they will always respond “as they can”<sup>32</sup>, without ever  
68 being able to fully express their agency. Animals interact with the world in their own ways  
69 and these ways, i.e. their agency, are precisely what we need to adopt to perform better  
70 research and develop a better understanding of how the brain and behaviour evolve.

## 71 **Animal agency**

72 Agency is the capacity of an actor to act in a given environment. In the broadest sense,  
73 agency is the ability to have an influence or an effect on something. In this sense, the agency  
74 is owned by all humans and animals, but also by viruses, stones or tornadoes as explained by  
75 Blattner et al. (2020) <sup>9</sup>. However, its focus might be narrower when agency is considered as  
76 the expression or manifestation of a subjective existence; agency implies affecting the world  
77 in ways that reflect a subject’s desires or will <sup>33</sup>. It refers to an individual pursuing its own  
78 good in its own way <sup>34</sup>. Blattner et al. <sup>9</sup> investigate animal agency in a sanctuary for formerly  
79 farmed animals, considering how a careful exploration of dimensions of agency in this  
80 setting might inform ideas of interspecies interactions (work, research, politics, etc.) and  
81 ethics. Their study focused on multispecific animals living in a sanctuary. For the owners of  
82 the sanctuary and for the study researchers, the sanctuary is an ‘integrated multispecies  
83 community or society whose members shape spaces and practices together, take on  
84 recognised social roles, and create and transmit social norms across species lines’. The

85 authors affirmed that we need to spend time in community with animals, to learn from  
86 them, and to be prepared to respond and adjust our learning process through relationships  
87 with them. This can be extended to scientific research, and means that animals should no  
88 longer be considered as the subjects of our experiments, but rather as participants. For  
89 example, when it comes to assessing animal intelligence, the researchers' focus should  
90 encompass goals that are meaningful, useful and of interest to animals instead of focusing  
91 on goals that are only relevant to the human scientist<sup>35</sup>. Animals should no longer be seen  
92 as objects of knowledge, or mere matter for the act of the human knower, but should rather  
93 be granted a status as an *agent* in the production of knowledge<sup>36</sup>. Interaction and  
94 communication have to go in both directions. We need to make ourselves understandable to  
95 animals. Of course, this communication would only be possible for some species, such as  
96 apes and some monkeys, cetaceans, certain birds including parrots or corvids, social  
97 carnivores and cephalopods. However, we need to extend this circle as some other species  
98 are surely able to understand our intentions as behavioural or even neuroscientific  
99 experiments. When researchers allow too little room for the animals' own forms of agency,  
100 the true abilities of these individuals are obscured<sup>37</sup>.

101 The study of agencies in animals can be divided into four schemes according to Blattner et al.  
102 (2020)<sup>9</sup> (Figure 1):

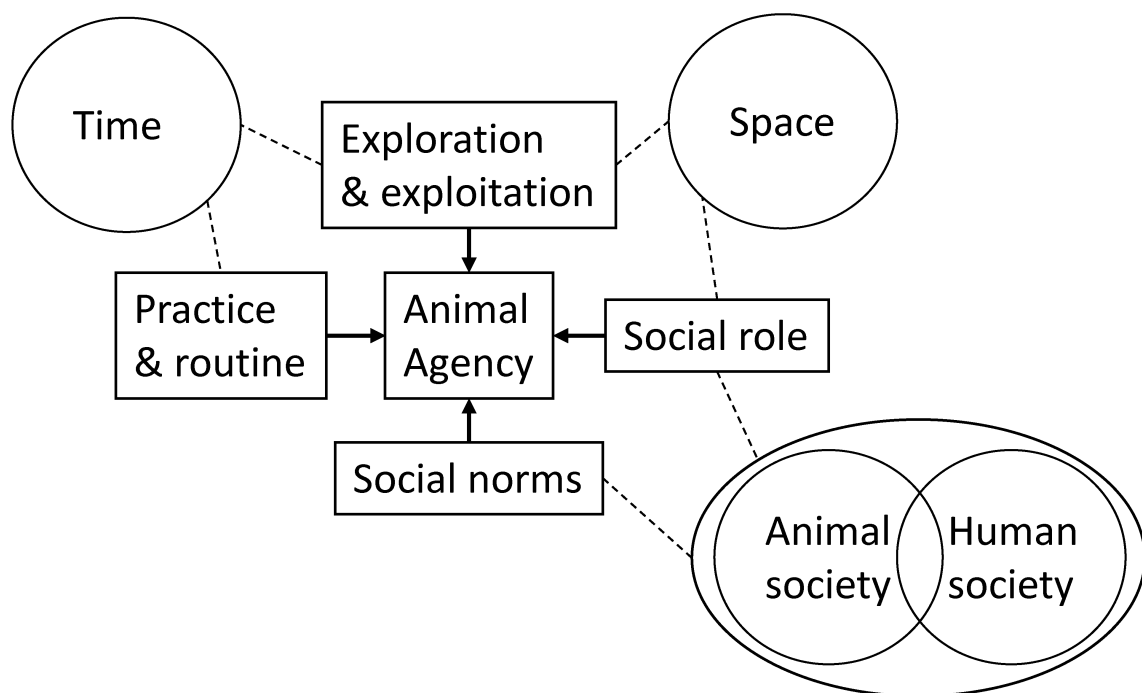
- 103 1. Agency through space and time: animals are mobile and explore/exploit their  
104 environments. This exploration and exploitation can be used to better understand  
105 the behaviours of animals but also their preferences in terms of habitats, sleeping  
106 areas and social relationships. Whilst this agency seems obvious for many  
107 researchers and is often applied for livestock and farmed animals<sup>38-40</sup>, it is rarely  
108 applied in comparative psychology or neuroscience. Specifically, modifications of the  
109 environment can be used to shape animal decisions and can remove some of the  
110 negative reinforcement that is still applied to animals. Animals could experience less  
111 stress in some parts of their environment than others, and carrying out experiments  
112 in these places could increase their motivation to participate and decrease the risk of  
113 false negatives<sup>41,42</sup>.
- 114 2. Agency through practice and routine: Animals have habits, even in the wild. Social  
115 animals collectively organise their day in order to meet their requirements and

116 maintain the advantages of living in groups<sup>43</sup>. Rather than forcing animals to  
117 participate in experiments, accepting that animals can accept or refuse to participate  
118 according to their routine would increase the robustness and viability of results. Any  
119 animals that want to be tested seek to use tablets or other interactive apparatus that  
120 are based on technologies such as RFID<sup>44,45</sup>; these tools respect their habits and  
121 routines. Medical aspects such as health checks or medical procedures that require  
122 constraints and restraints should also be based on these routines to decrease animal  
123 stress and injuries, as already shown in their use by zoos.

124 3. Agency through social roles: A social role is the behaviour expected of an individual  
125 who occupies a given social position or status. Individuals understand the place that  
126 conspecifics hold in their society. The adoption of roles that are recognised and  
127 acknowledged by others, and indeed mutually constructed with conspecifics, is an  
128 important dimension of relational agency and a means by which we can effectively  
129 affirm our subjective existence within a community. This role can be intraspecific or  
130 interspecific. Roles of individuals inside their group 'have been amply described in  
131 terms of dominance (policing behaviours, protecting groups), kinship and maternal  
132 relationships<sup>46</sup>. Individuals also develop strong relationships when they share similar  
133 attributes as sex or age. Group members influence each other, and particularly share  
134 knowledge<sup>47</sup>. Dominant or old individuals can transmit important information to  
135 others, and this social transmission can be used to make animals learn how to use  
136 experimental apparatus or spaces. These individuals can consequently become  
137 leaders. Multispecific and positive interactions or associations are also found  
138 naturally in the wild in situations such as multispecies group protection, interspecies  
139 grooming and predator alerts, even if negative interactions (cheating, predating,  
140 competition) are also observed. Blattner et al.<sup>9</sup> described multispecies interactions in  
141 the sanctuary for formerly farmed animals. Individuals of specific species adopt  
142 different roles with geese, cows or dogs acting as guardians and policers, cows  
143 teaching sheep and multispecies friendship and parenting. Multispecific leadership is  
144 also described in different reports with geese leading ducks and chickens, and goats  
145 leading sheep<sup>48-50</sup>.

146 4. Agency through social norms: Social norms are the customary rules that govern  
147 behaviour in groups and societies<sup>51</sup>. The previous example of learners and teachers

148 brings us to the subject of social norms. Behavioural rules and social systems are  
 149 partly genetic in animals but are also transmitted by cultures. In macaques, for  
 150 instance, species are divided into grades ranging from despotic and aggressive to  
 151 tolerant and democratic<sup>52</sup>. However, if an individual from one specific grade is  
 152 transferred into a group of another grade, it will adopt their behaviours. Many  
 153 traditions of tool use and social habits have been described in chimpanzees or  
 154 macaques<sup>53</sup>. Although collective decision processes are species-specific, variations  
 155 are observed between groups of the same species. The roles played by individuals  
 156 can lead to a strong leadership or the development of a more democratic process  
 157 such as votes<sup>54</sup>. Voting systems<sup>55</sup> are described in many species, with intentional  
 158 behaviours and perceptions of the mental states of conspecifics indicating some  
 159 theory of mind and reinforcing the idea of agency. A sense of community<sup>9</sup> seems to  
 160 exist in chimpanzees and in cetaceans, and indeed many other animals know exactly  
 161 who belongs or does not belong to their group by recognising the faces or voices of  
 162 group members.



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

166

167 These different instances show that animals have agency over their spatial, temporal and  
168 social environment. Animals can therefore be viewed as *agents*; their choice to act has direct  
169 consequences on their environment, or they can also resist conditions that do not please  
170 them, and act accordingly to change them <sup>56</sup>. Researchers could use this agency to increase  
171 animal welfare and obtain more viable and robust results, whilst extending the scope of  
172 behavioural and neuroscience research. Indeed, the great difficulty today is to measure the  
173 behaviours or the neuronal activities of aware animals whilst seeking to do so in natural  
174 conditions: the results of many experiments have been criticised, as the associated captivity,  
175 animal microbiota, genetic or behavioural variance of animals made it impossible to allow to  
176 reproduce or generalise any results that were unaffected by false negatives or false positives  
177 <sup>57-59</sup>. Often, in the research process, many of the limitations shown by the animals to date  
178 are actually the limitations of the scientific methods, rather than the animals themselves<sup>60</sup>.  
179 Similarly, Frans De Waal argues: 'All that most experiments have done thus far is testing the  
180 ape's theory of the human mind. We would do better to focus on the ape's theory of the ape  
181 mind' <sup>22</sup>. Following the concept of animal agency, we propose a future research framework  
182 to work with animals and progress in research.

### 183 **Future research framework**

184 We remember some years ago, talking with colleagues in neuroscience or medical research  
185 about applying the use of touchscreens in macaques, or suggesting to doctors that studying  
186 mouse personality could help to avoid false negatives or false positives. Our interlocutors  
187 laughed, saying that our suggestions were either unnecessary or impossible. Yet today, these  
188 projects have become reality. Touchscreens or joysticks are used to understand cognition  
189 and self-agency <sup>61</sup> in a wide range of species (pigs, macaques, baboons, goats, horses,  
190 etc.<sup>45,62-65</sup>). However, this use is still limited to behavioural studies and should now be  
191 extended to neuroscience<sup>1</sup>. There is a huge amount of literature describing how animal  
192 personality and microbiota can influence results. This success demonstrates the importance  
193 of not limiting our imagination about how we could work with animals to obtain new results  
194 in biological sciences.

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



198 possibilities. Experimental set-ups that restrain animals, such as restraint chairs or food  
199 privation, stress animals and prevent them both physically and mentally from fully  
200 expressing their agency. This challenge may certainly take time, but would be hugely  
201 beneficial. Patter and Blattner<sup>66</sup> suggest core principles to follow with animals: non-  
202 maleficence, beneficence and voluntary participation<sup>67</sup>. Economic or convenience  
203 euthanasia of animals should not be an option<sup>68,69</sup>. Euthanasia also has a strong impact on  
204 the emotions of caretakers<sup>70</sup>. Positive methods exist and have proved to be efficient<sup>6,71-75</sup>.  
205 The readiness of chimpanzees to voluntarily participate in interactions or allow humans to  
206 observe them can facilitate the measurement of embryo development and brain activities in  
207 unanesthetized and unrestrained individuals (Figure 2<sup>44</sup>). Unrestrained and voluntary  
208 animals can be trained to put their head in a mask<sup>76</sup> and be tested whilst receiving fruit  
209 juice. This allows the measurement of different metrics with eye tracking<sup>19,77,78</sup> and non-  
210 invasive neuroimaging<sup>79</sup> (Figure 3.A).

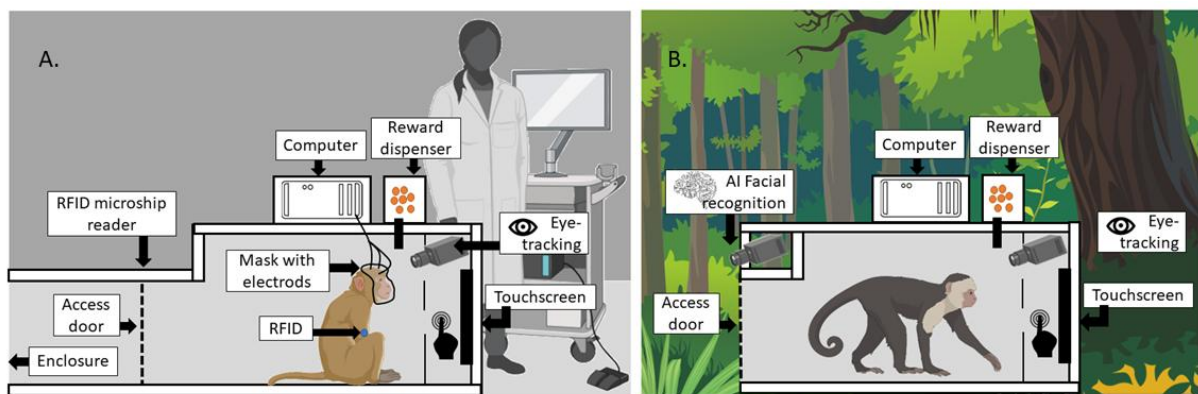
211



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

218

219 Traditional approaches involve bringing animals into a lab and restraining them while they  
220 perform tasks in order to ensure stable gaze-tracking and neural recordings (in the case of  
221 neuroscience). However, this unnatural setting does not permit the study of brain activity  
222 during natural, social and complex behaviours. Specific ethical guidelines exist now for  
223 research in the wild<sup>80,81</sup>. The likely benefits and possible negative effects of our presence  
224 and field methods on study subjects, their environment and the local human community  
225 should, of course, be considered<sup>82</sup>. New technologies allow us to bring science into the wild  
226 and test animals in a free condition in their natural environment, thus removing any  
227 experimental source of stress and measuring their entire behavioural repertoire. The  
228 animals studied can be identified using RFID techniques<sup>83</sup> but also via artificial intelligence  
229 with the recognition of individuals by videotracking<sup>84-86</sup>. The latter removes the need to  
230 catch animals. A location can then be defined where different touchscreens deliver food,  
231 with activation only for certain species and individuals. We can imagine going beyond the  
232 use of touchscreens with the implementation of eye-tracking and neuroimaging apparatus in  
233 the wild (Figure 3.B). This could open up new research avenues in species that are in danger  
234 of extinction or cannot be easily maintained in captivity.



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

239  
240 Some research, and especially the biomedical or physiological/cellular domains, cannot be  
241 performed outside the research structure. It is important for these experiments to respect  
242 the 3Rs but also to think about the Bateson cube<sup>87</sup>, meaning that scientists need to evaluate

243 the ethical acceptability of their research for society as a whole, including animals. The 3Rs  
244 can be extended by testing animals in viable conditions. Indeed, lab conditions were  
245 standardised for many years in terms of animal genetics, husbandry, food for study  
246 comparison and repeatability. However, this way of doing research is criticised today as  
247 animals are agents interacting with their world, and the lab conditions in which they live  
248 have a strong effect on them and thus on scientific results. Moreover, it is difficult to  
249 replicate similar conditions in the laboratory, as even animals that are genetically similar and  
250 live in similar environments develop different personalities<sup>88</sup>. Moreover, even if animals are  
251 living in similar conditions, similar food and litter sources affect their microbiota<sup>89-91</sup> and  
252 their behaviours differently<sup>92</sup>. Animal sociality was long forgotten in neuroscience or  
253 biomedical research, but it is an important part of animal agency<sup>9</sup>. Indeed, sociality has an  
254 important impact on the health of animals, and a great number of publications highlight the  
255 link between sociality and health ageing<sup>93-95</sup>. Making use of the sociality of animals, i.e. their  
256 agency, can even reverse cognitive decline and extend longevity<sup>96-98</sup>.

## 257 **Conclusion**

258 There is still much progress to be made to attain a more compassionate, less stressful and  
259 more robust animal research model. This requires training and teaching researchers to adopt  
260 new methods including animal agency and change their view of the role animals play in  
261 research. As Jacques Derrida wrote in *The Animal That Therefore I Am*, the traditional  
262 scientific and philosophical discourse on animals observes and speaks of non-human animals  
263 but never really engages with, experiments *with* or gains experience with the latter<sup>99</sup>: this  
264 type of discourse can therefore only position animals as mere passive objects of the  
265 theoretical knowledge these disciplines build. Such methods are completely blind to the  
266 animals' own processes of interacting with their world<sup>99</sup>, and are completely blind to their  
267 agency. This view of animals as objects is not limited to research but is also found in  
268 different aspects of everyday life (food, work, clothing, etc.). Researchers worldwide must  
269 have the conviction that ethical animal research must consider individuals as subjects of  
270 their own life and of their own world, and as co-creators of knowledge. Accepting this co-  
271 creation of knowledge can create new research questions from our anthropocentric view, as  
272 animal cognition dimensions are different from ours<sup>25</sup>. Animals are agents in our research.  
273 They are active in the research process and some researchers have even gone so far as to

274 add them in the acknowledgments or even list them as co-authors<sup>66,100</sup>. This recognition of  
275 animals as agents rather than objects is not approved of by some researchers, who consider  
276 that this is tantamount to removing animal agency, committing over-anthropomorphism and  
277 overstepping the will of animals to cooperate. Acknowledging animal agency could facilitate  
278 social acceptance of animal research<sup>67</sup> and be of benefit to the animals concerned (well-  
279 being through learning, creating and participating<sup>101</sup>). The consideration of animals as agents  
280 could be extended from research to other domains: a new ontology considering non-human  
281 animals as agents can have political, ethical and legal consequences. The concept of capital  
282 applied to animals needs to be extended to social capital, ecological capital and cultural  
283 capital<sup>102</sup>: we can learn from animals and they can be part of our societies<sup>103</sup>. This new way  
284 of viewing animal agency can therefore raise critical ethical questions in regard to the  
285 treatment of animals in research and to the place we grant them politically in our social  
286 world.

287

288

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