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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 restrained and forced to  
13 take part in applied or fundamental research. However, these restraints stress animals and  
14 may result in false negatives or false positives. A change is needed in researchers' work  
15 paradigm with animals to progress in behavioural and neuroscience research and thus gain  
16 access to hitherto inaccessible yet important scientific results. Animals interact in their own  
17 ways with the world and researchers need to adopt these ways, i.e. their agency, to perform  
18 better research and develop a better understanding of how the brain and behaviour evolve.  
19 This paper discusses how animal agency can not only be the key to more wide-ranging and  
20 improved research in existing domains, but can also lead to new research questions resulting  
21 from 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 restrained through different processes such as throw nets, restraint  
28 chairs, cages or food deprivation<sup>1-6</sup>. According to McMillan and colleagues<sup>2</sup>, too many  
29 researchers still continue to use methods that entail negative reinforcement, whilst  
30 procedures using restraint chairs could comprise positive reinforcement methods<sup>2</sup>. Beyond  
31 the ethical issues of such restraints for animals, these examples of experimental set-ups lead  
32 us to consider which possibilities and results have yet to be investigated and more  
33 importantly, whether such invasive protocols could lead to false negatives or false positives  
34 <sup>7-10</sup>. False negatives or False positives mean that studies show respectively negative (not  
35 expected, H0) or positive results (expected, H1) but these results are not due to the tested  
36 condition (e.g. a drug, a gene, an environmental condition) but to uncontrolled factors (e.g.,  
37 stress, personality). Indeed, stress and contention can not only modify some animal  
38 behaviours but also entirely prevent others from being displayed<sup>11-13</sup>. Some authors as  
39 Patter, Blattner, Matsuzawa, King B.J. or McMillan<sup>14-17</sup> consider that the current 3R  
40 framework is not sufficient to ensure that animals are meaningful participants, which is  
41 crucial to guarantee that scientific results are not altered by stress or personality of animals.  
42 These studies with restraints offer few meaningful opportunities for animals to exercise  
43 agency in their relationships, both between each other and with humans<sup>18</sup>. Gillespie wrote  
44 that 'there is a long tradition of studying nonhuman animals in spaces of animal use and  
45 exploitation, where researchers and teachers in effect become complicit through passive  
46 participation in violence against nonhuman animals...' <sup>19</sup>. According to Blattner et al. (2020)  
47 <sup>18</sup> who worked on animal agency in rehomed farm animals and from which this paper is  
48 inspired, 'longstanding ideological blinders and anthropocentric bias frame animals as  
49 limited beings whose lives unfold according to fixed genetic or species-specific scripts, rather  
50 than as complex subjects who act with intention and purpose, both individually and  
51 collectively'. Restraint-based experiments are severely limited in terms of what researchers  
52 can learn from animals, in individual and group contexts.

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

## 77 **Animal agency**

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

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

110 The study of agencies in animals can be divided into four schemes according to Blattner et al.  
111 (2020)<sup>18</sup> (Figure 1):

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

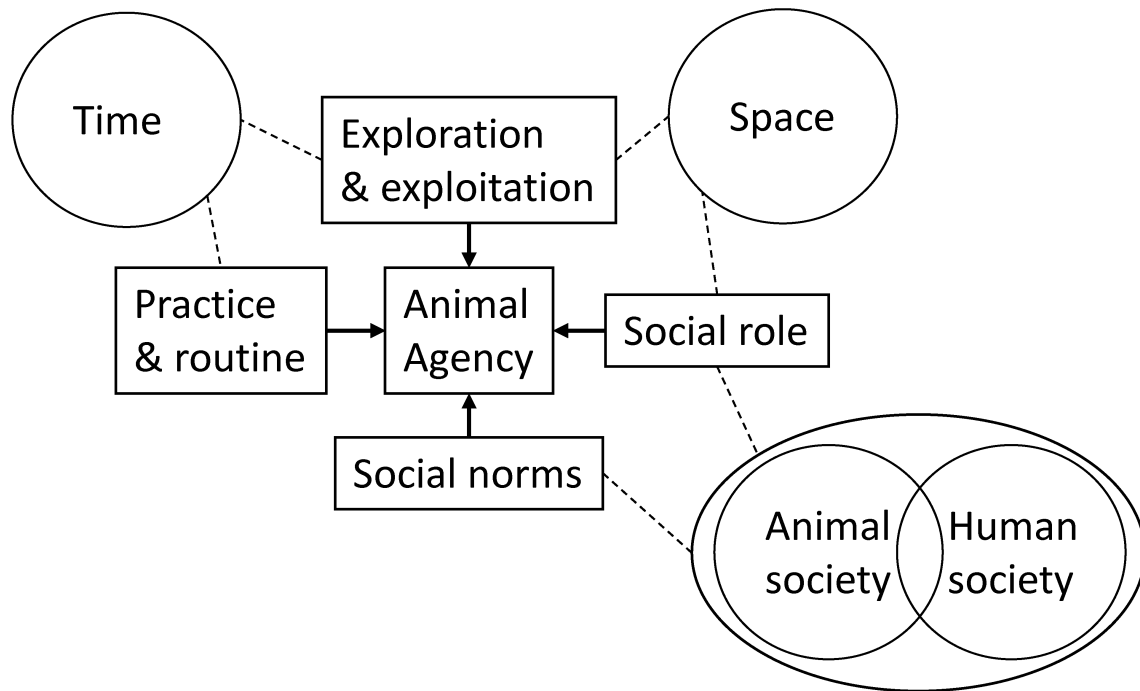
115 areas and social relationships and conduct to new disciplines as animal geographies<sup>56</sup>  
116 or animal mobilities<sup>57</sup>. Whilst this agency seems obvious for many researchers and is  
117 often applied for livestock and farmed animals<sup>58-60</sup>, it is rarely applied in  
118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

124 2. Agency through practice and routine: Animals have habits, even in the wild. Social  
125 animals collectively organise their day in order to meet their requirements and  
126 maintain the advantages of living in groups<sup>63</sup>. Rather than forcing animals to  
127 participate in experiments, accepting that animals can accept or refuse to participate  
128 according to their routine would increase the robustness and viability of results. Any  
129 animals that want to be tested seek to use tablets or other interactive apparatus  
130 such as artificial fruits<sup>64</sup> or opening boxes<sup>65</sup> with food inside that are based on  
131 technologies such as RFID<sup>66,67</sup>; these tools respect their habits and routines. Medical  
132 aspects such as health checks or medical procedures that require restraints should  
133 also be based on these routines to decrease animal stress and injuries, as already  
134 shown in their use by zoos.

135 3. Agency through social roles: A social role is the behaviour expected of an individual  
136 who occupies a given social position or status. Individuals understand the place that  
137 conspecifics hold in their society. The adoption of roles that are recognised and  
138 acknowledged by others, and indeed mutually constructed with conspecifics, is an  
139 important dimension of relational agency and a means by which researchers can  
140 effectively affirm their subjective existence within a community. This role can be  
141 intraspecific or interspecific. Roles of individuals inside their group 'have been amply  
142 described in terms of dominance (policing behaviours, protecting groups), kinship  
143 and maternal relationships<sup>68</sup>. Individuals also develop strong relationships when they  
144 share similar attributes as sex or age<sup>69-73</sup>. Group members influence each other, and  
145 particularly share knowledge<sup>74</sup>. Dominant or old individuals can transmit important  
146 information to others, and this social transmission can be used to make animals learn

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

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



171

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

174

175 These different instances show that animals have agency over their spatial, temporal and  
 176 social environment. Animals can therefore be viewed as *agents*; their choice to act has direct  
 177 consequences on their environment, or they can also resist conditions that do not please  
 178 them, and act accordingly to change them<sup>86</sup>. The behaviours animal show, facial expressions  
 179 they display, the places they occupy are cues to indicate their willingness. Researchers could  
 180 use this agency to increase animal welfare and obtain more viable and robust results, whilst  
 181 extending the scope of behavioural and neuroscience research. Indeed, the great difficulty  
 182 today is to measure the behaviours or the neuronal activities of aware animals whilst  
 183 seeking to do so in natural conditions: the results of many experiments have been criticised,  
 184 as the associated captivity, animal microbiota, genetic or behavioural variance of animals  
 185 made it impossible to allow to reproduce or generalise any results that were unaffected by  
 186 false negatives or false positives<sup>87-89</sup>. Often, in the research process, many of the limitations  
 187 shown by the animals to date are actually the limitations of the scientific methods, rather  
 188 than the animals themselves<sup>90</sup>. Similarly, Frans De Waal argues: 'All that most experiments  
 189 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' <sup>30</sup>. 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 <sup>91</sup> in a wide range of species (pigs, macaques, baboons, goats, horses, rats, mice, etc.<sup>67,92-97</sup>).  
197 However, this use is still limited given its potential even if more and more neuroscience  
198 studies use it in mice or rats <sup>98-101</sup>. 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<sup>102,103</sup> 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 <sup>14</sup> suggest core principles to follow with  
209 animals: non-maleficence, beneficence and voluntary participation <sup>104</sup>. Positive methods  
210 exist and have proved to be efficient <sup>6,11,105-108</sup>. The readiness of chimpanzees (not used  
211 anymore for invasive experiments but present in primate research centers<sup>109</sup>) 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<sup>66</sup>). Unrestrained and voluntary animals can be trained to put their head in a mask <sup>5</sup>  
215 and be tested whilst receiving fruit juice. This allows the measurement of different metrics  
216 with eye tracking <sup>28,110,111</sup> and non-invasive neuroimaging <sup>112</sup> (Figure 3.A).

217

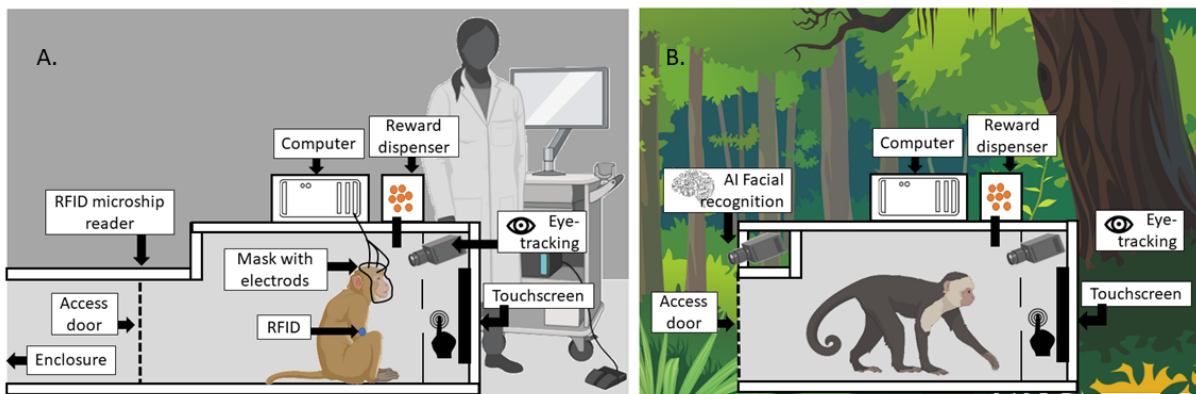


218  
219 Figure 2: (A) Developmental neuroscience. Fetal brain development in chimpanzees was  
220 measured by a non-invasive ultrasound technique. (B) EEG recordings in a chimpanzee. The  
221 chimpanzee quietly sat on the chair and allowed the experimenter to put electrode patches  
222 on the skin of her forehead and the top of her head. Photos provided with the courtesy of  
223 Satoshi Hirata.

224

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

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



247  
248 Figure 3: (A) Non-invasive neuroimaging and eye-tracking system with voluntary experience  
249 in the lab. (B) Non-invasive touchscreen system with voluntary engagement and individual  
250 identification in the wild. This figure was realized using FAVPNG.com and Biorender.

251  
252 Some studies, and especially the biomedical or physiological/cellular domains, cannot be  
253 performed outside the laboratory. It is important for these experiments to respect the 3Rs  
254 but also to think about the Bateson cube <sup>124</sup>, meaning that scientists need to evaluate the  
255 ethical acceptability of their research for society as a whole, including animals. The 3Rs can  
256 be extended by testing animals in viable conditions. These too standardized lab conditions  
257 for instance decrease the replicability of studies by decreasing the behavioural variability  
258 (issue called standardization fallacy<sup>125,126</sup>). Indeed, lab conditions were standardised for  
259 many years in terms of animal genetics, husbandry, food for study comparison and  
260 repeatability. However, this way of doing research is criticised today as animals are agents  
261 interacting with their world, and the lab conditions in which they live have a strong effect on  
262 them and thus on scientific results. Moreover, it is difficult to replicate similar conditions in  
263 the laboratory, as even animals that are genetically similar and live in similar environments

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

## 271 **Conclusion**

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

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

302

303

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