Article

Do they really try to save their buddy? Anthropomorphism about animal epimeletic behaviours

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Simple Summary: Anthropomorphism should have appeared to better understand other animal species (or the world in general). However, anthropomorphism may have different consequences: beneficial or not, especially for animals, and we need to pay attention about how we deal with it. Still, few studies are focusing on the factors affecting anthropomorphism and we need more quantitative studies to know which factors influence how strong humans attribute mental states and cognitive abilities to other animals. In this study, we asked participants to answer an online questionnaire about videos: an individual (a sparrow, an elephant and a macaque) displayed behaviours towards an inanimate conspecific who suddenly got back to conscious at the end of the footage. A fourth video showed a dog-robot kicked by an engineer to demonstrate its stability. Men and older participants attribute less mental states to animals. Similarly, people working with animals or having at least one pet at home demonstrated less anthropomorphism. Conversely, we found that animal protection association members demonstrated strong automatic anthropomorphism and were farer from biological reality than non-members. Understanding how one can play with these factors can conduct to better relationships with animals as encourage human-robot interactions.

Abstract: In this study, we asked participants to answer an online questionnaire about videos showing animal epimeletic behaviours: an individual (a sparrow, an elephant and a macaque) displayed behaviours towards an inanimate conspecific who suddenly got back to conscious at the end of the footage. A fourth video showed a dog-robot kicked by an engineer to demonstrate its stability. After each video, questions were asked to score the degree of anthropomorphism of participants, from mentophobia (no attribution whatever the species) to full anthropomorphism and to measure how close participants are to biological reality (actual scientific knowledge). A first important result is that there is a negative correlation (about 61%) between the anthropomorphism score (AS) and the biological reality one (BRS) showing a wrong statement. The heterogeneity of responses proved that all levels of anthropomorphism are covered from mentaphobia to full anthropomorphism. However, the scores participants attributed to animals differ according to the species shown in the video and to human characteristics. Understanding how one can play with these factors can conduct to better relationships with animals as encourage human-robot interactions. Finally, such reflective anthropomorphism can lead to an increase of human empathy and sociality, finally increasing our humanity.

Keywords: Empathy, comparative thanatology, cognitive biases, animal ethics, mentaphobia, primates, elephants, birds, robot doi:10.20944/preprints202008.0711.v1

1. Introduction

Despite harmful anthropic consequences on biodiversity, humans seem to show biophilia [1,2], an innate affinity for other living organisms and more importantly be interested in non-human animals [3]. This can be observed from the youngest age, when human babies are more attracted by animals than inanimate or animate objects [4] and when the first words they pronounced count many animals calls [5]. Biophilia is possible in any individual but is expressed in some people and cultures more than others [6]. During their evolutionary history, humans have also tended to attribute their own traits, emotions, or intentions to non-human entities. This trend is well known - Darwin (1872) already noted that people tend to qualify non-humans as human-like beings - and designed as anthropomorphism. The term *anthropomorphism* is first used in 1753, originally in reference to the heresy of applying a human form to the Christian God (Oxford English Dictionary, 1989). Whether we appreciate it or not, are aware of it or not, as humans we do anthropomorphise animals but also objects or other natural phenomena [9]. Anthropomorphism may have different consequences [10,11]: beneficial or not, especially for animals, and we need to pay attention about how we deal with it.

As far as human and animal relationships exist, the Animal (here, englobes non-human animals) has been conceptualized following three different and major ways: the humanized animal, the "Beast-Machine" and the animal as a sensitive being [12]. The humanized animal has been the most widespread conception in the history of civilizations consisting in considering the animal as a 'little man' or a modified one [13]. Following such conception, animals have even been deified as in Ancient Egypt or dragged in front of a tribunal court as in Europe of Middle Age (e.g. domestic cats, Serpell, 2000). Much later, during the 17th century, it was good form to consider non-human animals as insensitive objects or machines following Descartes and Malebranche's postulate (Descartes, 1637). The use of 'it' for an animal is a good example of objectification [16–18]. But such mechanistic conception of the animal was questioned at the following century with, for example, Adam Smith who stated in his Theory of Moral Sentiments (1759) that "animals are not only the causes of pleasure and pain, but are also capable of feeling those sensations, they are still far from being complete and perfect objects, either of gratitude or resentment […]". Thanks to ethnographic records, however, it should be borne in mind that culture and religious background influence attitudes and interactions of humans toward other species [19]. For instance, monotheistic religions such as Judaism, Christianity and Islam which forward anthropocentric views tend to argue that animals are 'secondary creations' designed to serve human interests while vegetarian cultures such as Hinduism revere cows [20]. Today, it is clear thanks to the researches in animal behaviour and cognition that animals are sentient (i.e., capacity to feel, perceive or experience subjectively) and capable of high cognitive capacities at least, in birds and mammals [21–23] since these capacities are still questioned in reptiles and fishes [24–27]. Now we do know that comparing human behavioural traits to animals ones, particularly non-human primates, conducts to a better understanding of the evolution and the development of these traits in humans (Cheney and Seyfarth, 2008; de Waal, 2016; Matsuzawa, 2001; Tomasello and Call, 1997). But it is important to recall that one century ago, append the terms 'emotion', 'intelligence' or 'strategy' to animals was considered as a scientific sin and an expression of weakness. In this line, Donald Griffin created the term *mentaphobia* to define the high reluctance to refer to animal consciousness [32] when describing animal behaviour, as we could not compare the incomparable [33]. This reluctance is also defined as *anthropodenial* (de Waal, 1999).

The 20th century saw several ways of thinking before arriving to an explicit anthropomorphism, in comparison to the automatic one [35,36]. Indeed, three levels of anthropomorphism may be defined based on Donald Norman's theory of emotional design: visceral one, behavioural one, and reflective one [37]. The visceral level is based on the first impression humans have on the physical attributes of animals. The behavioural level defines perception relating to animal behaviour and lastly the reflective level is based on how humans relate to the animal. Hans the Clever horse is a good illustration of changing hypotheses, from visceral/behavioural ones to reflective one, about the cognitive processes underlying the behaviours of this animal who was known to be capable to resolve mathematical problems [38]: in reality this horse was not good mathematician but simply reacted to

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the emotions and facial expressions of the persons surrounding and watching him. According to Morgan's cannon (1894), "in no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale" (reviewed in Ghiselin, 1983; Sober, 1998). Edward Thorndike (1898) said that anecdotes [43] should be verified by behavioural experimentations and these experiments should show simple cognitive mechanisms in non-human animals. These philosophical and scientific theories of Beast-Machine, or *mechanomorphism* [44,45] were however jeopardized with many studies showing that animals have complex emotions and cognitive capacities and may develop advanced and flexible social strategies [31,32,46,47]. However, complex collective behaviours may also come from simple rules even if for a long time, scientists thought that a strong leadership and intelligence should underlie such a complexity in ants nest building or birds flocks [48–50].

In the light of the recent discoveries about cognitive complexity in animals (at least in primates but see in dolphins [51–53] or in parrots [47,54,55]), anthropomorphism gave a better scientific hypothesis than the Morgan's cannon as this anthropomorphism was according to de Waal (2016) and Griffin (2013) more parsimonious than thinking animals as unanimated objects or machines. However, anthropomorphism might also be an obstacle to the good understanding of animal behaviour and may conduct to wrong hypotheses and false results in science, as well in a fundamental way (Are animals thinking?) as in an applied way (Are animals feeling?). Indeed, as *Homo sapiens*, we cannot think in another way than humans and we are devoted to make judgment errors about animal sentience (de Waal, 2016). More generally we may have suboptimal decisions due to well-known cognitive biases [56–59]. In an evolutionary point of view, anthropomorphism or 'morphism' if we care about other species (e.g. *crotalomorphism* for snakes, *mamalomorphism* for mammals, *macacomorphism* for macaques, etc. ; Keeley, 2004; Rivas and Burghardt, 2002) should have appeared to better understand other animal species (prey, predator, competitor, informer, etc.), and in this way increase individual survival. This is still relevant for some ethnic groups, which are primarily hunter-gatherers and animistic peoples (e.g. pygmy peoples or uncontacted tribes residing in the Amazon rainforest). Furthermore, many trackers and behavioural ecologists tend to break down distances between them and their model species to improve their capture success for instance. That is without getting into all the rewilding processes observed in present-day societies [62]. Based on this hypothesis, anthropomorphism should not be arbitrary since the attribution of mental states to others is rooted in common and ancient brain substrates [63]. According to the specialists of cave art, "animals […] were integral to the evolution of the human brain to the extent that the encoding of animal forms seems to have become a dedicated domain of the visual cortex" [64] which appears as a logical evolution since seeing and recognizing animals (as species but also as individuals) was an essential condition to survive.

However, one might recognize that some individuals are more triggered to make anthropomorphism towards animals as some express more biophilia [6]. This variance, from mentaphobia to constant anthropomorphism, is affected by different factors. Culture is a first factor affecting the way humans anthropomorphize. Following Descola (2015, 2013)'s postulates, the way we see or consider Nature (and animals as a part of it) is a social product which can follow four different modes of lectures or ontologies such as animism (in Amazonia for example), totemism (in Aboriginal Australia for example), analogism (in India for example) and naturalism (in western cultures only). The way people empathize is linked to the way they anthropomorphize [67,68]. A good example is diets: compared to omnivores, vegetarians show a higher brain response of empathy-related areas when observing scenes of animals suffering [69]. Scientific knowledge is another factor affecting the probability to decrease errors when anthropomorphizing. A good example of this is tourists visiting Atlas Mountains in Morocco or Algeria and facing Barbary macaques (*Macaca sylvanus*). As non-experts, they read and understand the "bared-teeth" facial mimic of these monkeys as smiles whilst they are real threats and may provoke real conflicts with animals. However, such judgment error may easily decrease with experience but also with educational panels providing correct information [70]. Considering pets, dogs behaviours are also well and correctly interpreted when persons have experience to be with them [71,72]. However, dog owners may bring false mental attributions to their pets more than professionals [73,74]. Regarding cats, their complex social behaviours are frequently misunderstood by owners, jeopardizing their species-specific needs while impacting their welfare [75]. Still, few studies are focusing on the factors affecting anthropomorphism and we need more quantitative studies to know which factors influence how strong humans attribute mental states and cognitive abilities to other animals.

In this study, we asked participants to answer an online questionnaire about videos showing animal behaviours. The first three videos showed an individual (a sparrow, an elephant and a macaque) displaying behaviours towards an inanimate conspecific who suddenly got back conscious at the end of the footage (see images in figure 1). These behaviours are interpreted as *epimeletic*, meaning relating to altruistic behaviour towards an injured animal, mostly described in dolphins [76–82]. A fourth video showed a dog-robot kicked by an engineer to demonstrate its stability. After each video, questions were asked to score the degree of anthropomorphism of participants, from mentophobia (no attribution whatever the species) to full anthropomorphism and to measure how close participants are to biological reality (actual scientific knowledge). We analysed the distributions of these two scores (anthropomorphism score and biological reality score) globally and per species and we then compared them to several socio-demographic variables participants gave us through the questionnaire.

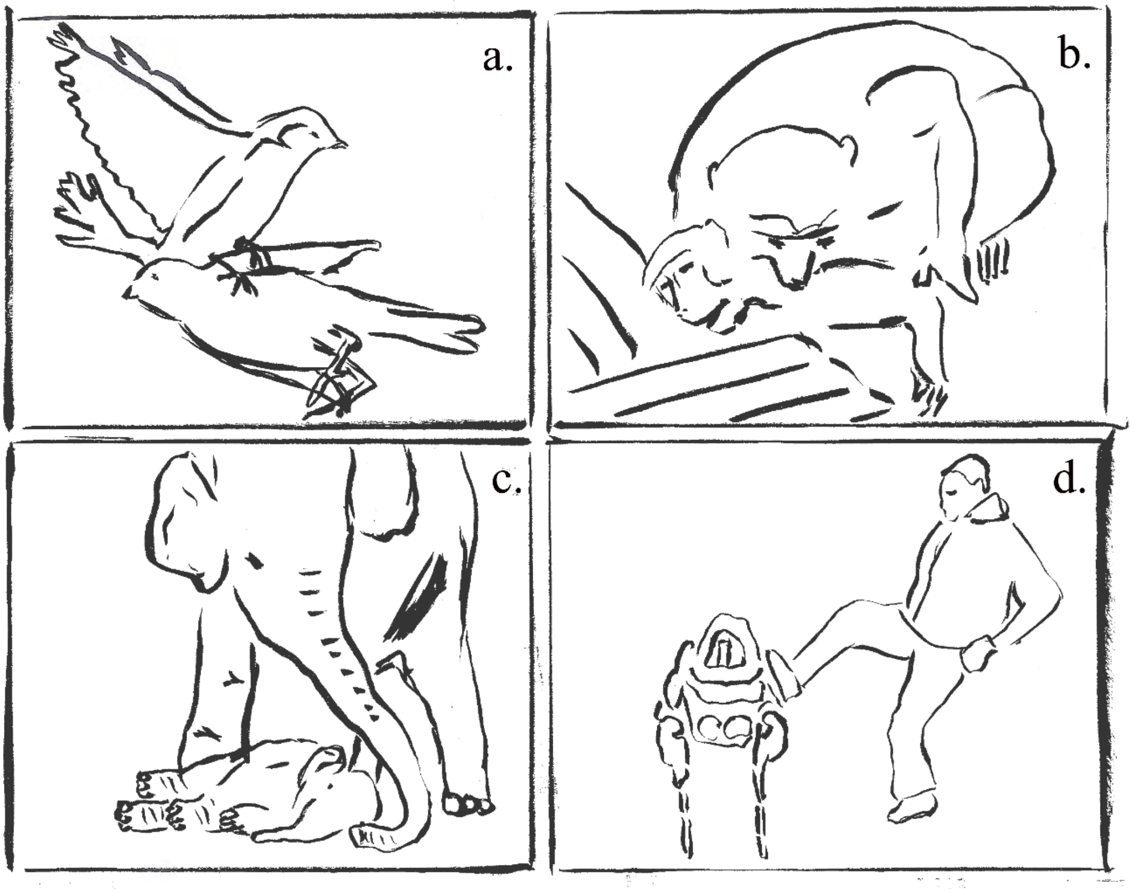

Figure 1. Drawings of the different epimeletic behaviours of (a.) a sparrow, (b.) a rhesus macaque, (c.) an elephant towards an unconscious congener. (d.) An engineer kicking a dog-robot. Credit to Cédric Sueur.

2. Materials and Methods

2.1. Participants

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2,160 participants answered all questions of our questionnaire. Age distribution is given in the figure 2 as well as academic levels distribution. 72.5% of participants were women and 26.8% were men (0.7% did not defined their gender). 42.5% of participants had a job in link with animals. 76.8% had at least one pet at home and 26.5% were members of an association of animal protection. Unbalance in ratio (gender and diploma) is offset with sample size and was considered in statistical analyses.

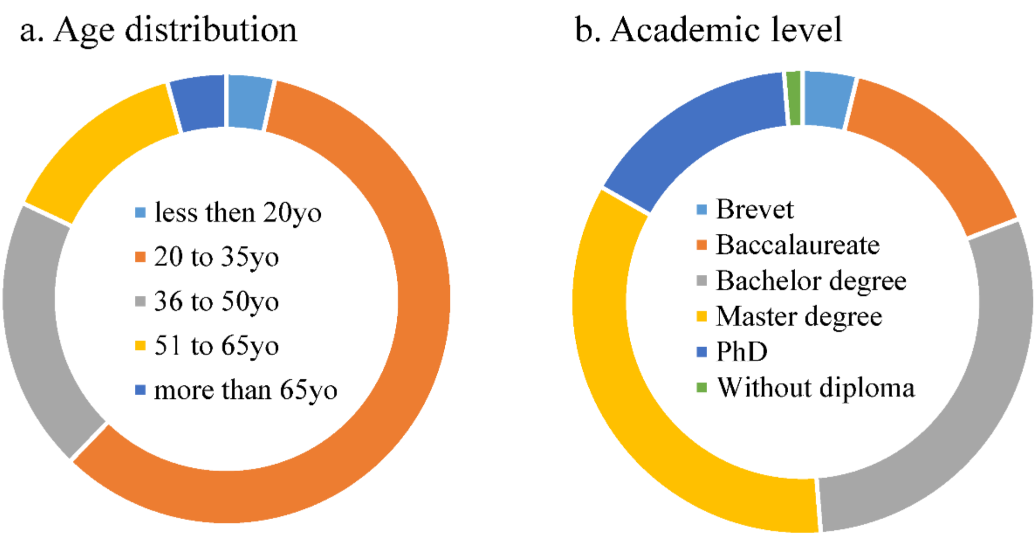

Figure 2. Age and academic levels distribution of the 2,160 participants to the study. JSC is junior school certificate (GSCE or Brevet).

2.2. Research ethics

All data were anonymous, and participants were given sequential numerical identities according to the moment they answered the questionnaire. Participants had the possibility to be informed about the study and its results by contacting us with email address given in the questionnaire. We followed the ethical guidelines of our institution (CNRS-IPHC, Strasbourg, France).

2.3. Design of the questionnaire

We build an easy-to-fill questionnaire on Google Forms that we then sent out on two social Medias (Facebook, Twitter) and on mailing lists, asking people to widely disseminate our survey through their networks.

The questionnaire was in French and sent to French citizens. It was composed of questions about socio-demographic variables of participants, the intentionality and awareness of animals displaying specific behaviours on the videos, their feelings when watching the dog-robot kicked by the engineer.

We proposed four videos (3 concerning animals and one concerning a dog-robot) followed by questions.

The first three videos concerned (a) a sparrow (*Passer domesticus*; video available here https://youtu.be/wphd1HjT6mg), (b) a rhesus macaque (*Macaca mulatta*; video available here https://youtu.be/_hivJjO2btA) and (c) an elephant (*Elephas maximus*; video available here

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https://youtu.be/_mKfJuEJk8E) (Figure 1). The order of videos was randomised in order that the answer given for a species did not influence the answers given for the two others. One video (elephant) contained speaker's voice but a preliminary study showed that participants feelings were not answered by it.

The same three questions were asked for each animal species. These questions are:

(Q1) Do you think that this individual had the intention to save its inanimate conspecific by acting like this? Possible answers: "Yes", "No", "Maybe".

(Q2) Do you think that this individual was aware about the risk of imminent death of its conspecific? Possible answers: "Yes", "No", "Maybe".

(Q3) Do you think that individuals of this species are aware of what death is? Possible answers: "Yes", "No", "Maybe".

After these three videos, a fourth video was proposed to participants. This video does not show epimeletic behaviour but is prone to anthropomorphism. This video (available here: https://youtu.be/4NzcB6TMzjw) showed a four-legs robot, looking like a dog. At two moments on the video, an engineer kicks the dog-robot to demonstrate its stability (at 24" and 30") but see also other videos of Boston Dynamics **[83,84]**. After watching the video, the participants had to answer two questions:

> (Q4) What do you feel when the man kicks the robot and that the latter is destabilized? Possible answers (non-exclusive): "Surprise", "Amusement", "Anger", "Sadness", "Nothing".
>
> (Q5) Do you think your feeling is justified? Possible answers: "Yes", "No", "Maybe".

The socio-demographic questions asked to participants concerned:

(1) Their age: possible answers "less than 20yo", "20 to 35yo", "36 to 50yo", "51 to 65yo", "older than 65yo",

(2) Their gender: "woman", "man", "non-defined",

(3) Their academic levels: possible answers "without diploma", "brevet (GCSEs)", "baccalaureate (A levels)", "Bachelor degree", "Master degree", "PhD",

(4) Whether their profession was linked to animals; possible answers "Yes", "No",

(5) Whether they possessed at least one pet at home; possible answers "Yes", "No",

(6) Whether they belonged to an Animal Protection Association: possible "Yes", "No".

2.5. Data analysing

In a first step of our analyses, we tried to identify which factors may underlie the level of anthropomorphism of participants. We calculated an Anthropomorphism Score (AS). In this way, we attributed scores to the different questions (from Q1 to Q4). For Q1 to Q3 (given for each species), we gave the following scores: 0 if the participant answered "No"; 0.5 if the participant answered "Maybe", 1 if s/he answered "Yes". For Q4, we gave the score 0 when the participant answered "Nothing", 0.5 for "Surprise" and "Amusement" (secondary emotions), 1 for "Anger" and "Sadness" which are part of the primary emotions. Answers for Q4 were not exclusive but we took the highest score only (we did not make the sum). We then have 3 questions for each of the

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three species and one question for the robot, giving a total of 10 points. Consequently, we got an AS score going from 0 for participants demonstrating mentaphobia to 10 for persons demonstrating full anthropomorphism (i.e., giving the same mental states to animals compared to humans).

In a second step, we tried to identify which factors underlie how close humans are to biological reality when looking at animal behaviours in the three videos. We calculated a Biological Reality Score (BRS). We defined here biological reality as what we know currently from literature and scientific observations of animal mental states (consciousness, intentionality). To define a benchmark, we asked international experts (N=14, named in the acknowledgments) in primatology and animal behaviour to answer the same questions we asked to participants (from Q1 to Q3) and we compared the answers of the two communities. Even if we cannot be sure at 100% that what experts answered is the biological reality, meaning the true and right mental states of animals, they were quite on the same line, given a high probability to be correct **[85,86]**. They answered "No" for all questions in birds, answering "No" in majority for the monkey (50% of "No" for Q1, 86% of "No" for Q2, and 76% "No" for Q3) and being much prone to give intentions for the elephant (0% of "No" for Q1, 0% of "No" for Q2, and 50% "No" for Q3). In this way, we considered as the correct answer:

- "No" for the three questions with the bird,

- "Maybe" for Q1, "No" for Q2 and Q3 with the monkey,

- "Yes" for Q1 and Q2 but "Maybe" for Q3 with the elephant.

We gave the score 1 when a participant gave the same answer than the experts, 0.5 when it was unsure, 0 when the participant gave a different answer than the experts. The BSR score ranges from 0 (far from the expert opinions) to 10 (similar as experts) with 10 defined as participants demonstrating biological reality.

We used Chi-square test to compare different absolute frequencies and Kolmogorov-Smirnov test as well as a Spearman rank correlation test to compare the distributions of the two scores (AS and BRS). We used GLM to test the influence of the six socio-demographic variables (age, gender, academic level, profession, pet ownership and animal right membership) and the order of questions on both scores with quasi-Poisson law. The significance level was set at 0.05. Statistical analyses were performed with the statistical software R 3.5.0.

3. Results

Distribution and comparisons of scores

The distribution of Anthropomorphism Score (AS) and of Biological Reality Score (BRS) are given in the figure 3. The two distributions are different (W=1311700, $p<0.0001$) but correlated ($p<0.0001$, $r=-0.61$). The mean AS is 6.6±2.3 (min=0; max=10; median = 7) whilst the mean BRS is 5.1±1.4 (min=2; max=9; median = 5). The AS average score is 6.6/10, above a random mean (5/10, Wilcoxon paired rank test, V= 1730700, $P<0.0001$) with almost no one making mentaphobia (16 upon 2161, i.e. 0.7%) whilst the strongest frequencies are among the highest scores (10 and close to 10). However, the distribution of the BRS score is not different from a random one (Wilcoxon paired rank test, V= 923280, $P=0.08$).

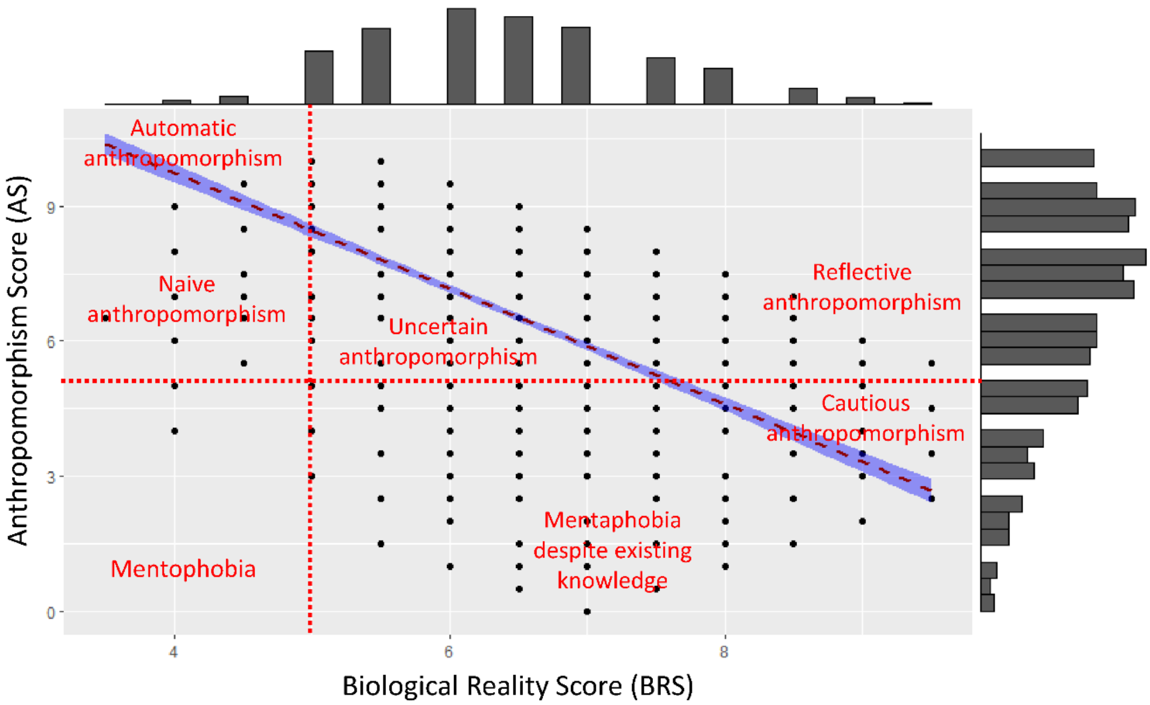

Figure 3. Frequency distribution (histograms) for the anthropomorphism score (AS_TOTAL, y) and the biological reality score (BRS_TOTAL, x). The red dot line indicates the regression line between the two distributions with the confidence interval in blue. According to this regression line and the middle score (i.e., 5) for AS and BRS, we divided the figure in different parts indicating anthropomorphism: from mentaphobia to automatic anthropomorphism to reflective anthropomorphism.

Concerning the animals' videos, the distribution of AS and of BRS for each species are given in the figures 4a. and 4b. The scores are not distributed in the same way according to the species, as well for AS (chi^2=756, df=2, p<0.0001; p-value for all post-hoc tests < 0.05) as for BRS (chi^2=1582, df=2, p<0.0001; p-value for all post-hoc tests < 0.05). Concerning the anthropomorphism score, the lowest mean but the highest variance is attributed to the sparrow (1.62±0.93), followed by the monkey (2.05±0.75) and the elephant (2.39±1.57). The lowest biological reality score but still with the highest variance is attributed to the sparrow (1.17±1.00), followed by the macaque (1.30±0.51) and then the elephant (2.18±0.37).

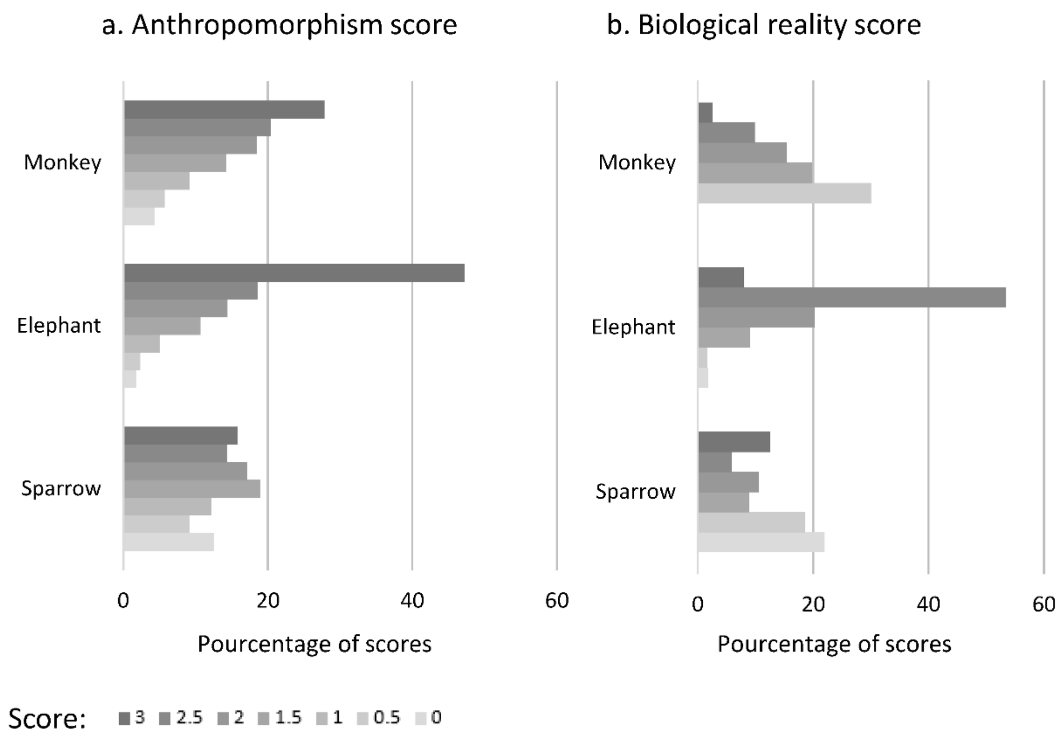

Figure 4. Distribution for each animal species of (a.) anthropomorphizing scores and (b.) Biological reality score as percentage of answers.

Concerning the dog-robot, on the 2,160 participants, 645 (29.8%) answered that they feel nothing when it was kicked, 1,233 (57.1%) answered that they have only one feeling, 256 (11.8%) answered that they have two feelings, 26 (1.3%) answered that they have the three proposed feelings. Among the different feelings' participants indicated, the most important one is sadness (36.1%), followed by surprise (34.8%), and anger (22.7%). Participants answered amusement in only 6.3%. 1,242 (57.5%) participants answered that their feeling is justified, 397 (18.4%) answered "Maybe" and 521 (24.1%) answered that their feeling is not justified. However, this distribution is different between participants who answered that they felt nothing compared to the ones who answered that they felt something (whatever the emotion was, fig. 5; $chi^2=321$, df=5, $p<0.0001$).

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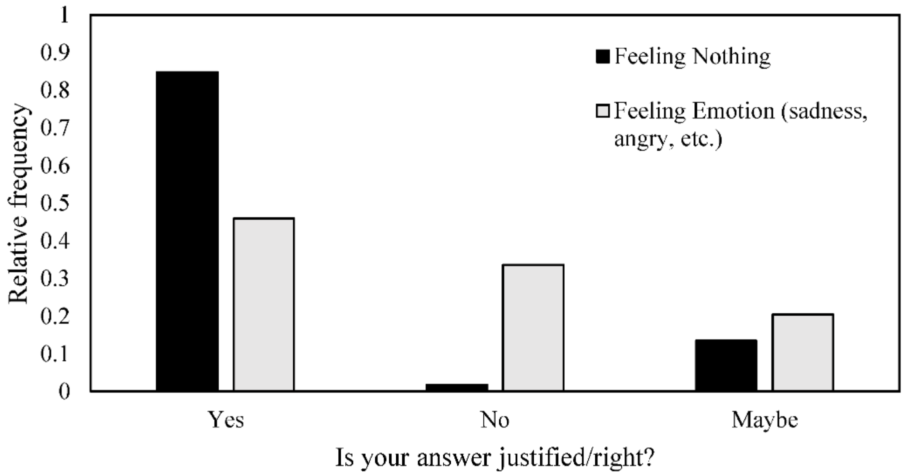

Figure 5. Relative frequency of answers Yes/No/Maybe to the question "Do you think that this feeling is justified?" for participants who answered feeling nothing or an emotion (sadness, surprise, angry) when the robot was kicked by an engineer

Socio-demographic factors affecting scores

The factors used in the model and their statistical effect are indicated in the table 1 for the anthropomorphism score and in the table 2 for the biological reality score. Effect size is indicated by the t value. Usually, an absolute t value higher than 1.9 indicates a significant effect (p<0.05). The highest the absolute t value, the strongest the effect. Age influences negatively anthropomorphism score. Older participants are, lower their anthropomorphism score are. However, the effect is not found on the biological reality score. Gender influenced both scores, with men who anthropomorphised less and who were closer to biological reality than women. Concerning the academic levels of the participants, only the participants holding a PhD appear different to participants with no diploma. PhDs demonstrate less anthropomorphism and get higher biological reality scores.

Table 1. Statistical values for the GLzM with the anthropomorphizing score as response variable. For Age, indicated factors are compared with Age [less than 20yo]. For Gender, man is compared to woman. For academic level, factors are compared to [Without diploma]. For the remaining questions [Yes] is compared to [No]. For the Estimate and the t value, a positive value indicates a positive influence of the factor; a negative value indicates a negative influence. Significance: * < 0.05, **< 0.01, ***<0.001.

Factors	Estimate	Std. Error	t value	Pr(>|t|)	Sign
(Intercept)	2.136	0.076	28.143	<0.0001	***
Age [20 to 35yo]	-0.046	0.040	-1.147	0.252	
Age [36 to 50yo]	-0.091	0.042	-2.19	0.029	*

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Age [51 to 65yo]	-0.095	0.043	-2.213	0.027	*
Age [older than 65yo]	-0.118	0.052	-2.255	0.024	*
Gender [Man]	-0.064	0.017	-3.708	0.0002	***
Academic Level [Brevet]	0.072	0.072	1.006	0.315	
Academic Level [Baccalaureate]	-0.025	0.065	-0.377	0.706	
Academic Level [Bachelor degree]	-0.015	0.064	-0.236	0.814	
Academic Level [Master degree]	-0.048	0.064	-0.755	0.450	
Academic Level [PhD]	-0.168	0.066	-2.551	0.011	*
Profession in link with animals [Yes]	-0.162	0.016	-10.113	<0.0001	***
Having at least one pet at home [Yes]	-0.037	0.018	-2.05	0.041	*
Animal Protection Association membership [Yes]	0.075	0.017	4.507	<0.0001	***
Order of questions (monkey first, sparrow last)	-0.089	0.015	-5.973	<0.0001	***

Table 2. Statistical values for the GLM with the biological reality score as response variable. For Age, indicated factors are compared with Age [less than 20yo]. For Gender, man is compared to woman. For academic level, factors are compared to [Without diploma]. For the remaining questions [Yes] is compared to [No]. For the Estimate and the t value, a positive value indicates a positive influence of the factor; a negative value indicates a negative influence. Significance: * < 0.05, **< 0.01, ***<0.001.

Factors	**Estimate**	**Std. Error**	**t value**	**Pr(>|t|)**	**S**
(Intercept)	1.431	0.064	22.29	<0.0001	*
Age [20 to 35yo]	0.001	0.033	0.04	0.968	
Age [36 to 50yo]	0.034	0.035	0.981	0.327	

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Age [51 to 65yo]	0.042	0.036	1.184	0.236	
Age [older than 65yo]	0.073	0.043	1.707	0.088	.
Gender [Man]	0.036	0.013	2.694	0.007	*
Academic Level [Brevet]	0.001	0.061	0.014	0.989	
Academic Level [Baccalaureate]	0.077	0.055	1.397	0.163	
Academic Level [Bachelor degree]	0.057	0.054	1.052	0.293	
Academic Level [Master degree]	0.082	0.054	1.507	0.132	
Academic Level [PhD]	0.116	0.055	2.112	0.035	*
Profession in link with animals [Yes]	0.135	0.012	10.972	<0.0001	*
Having at least one pet at home [Yes]	0.029	0.014	1.981	0.048	*
Animal Protection Association membership [Yes]	-0.049	0.013	-3.677	0.0002	*
Order of questions (monkey first, sparrow last)	0.047	0.012	4.012	<0.0001	*

Participants having a profession in link with animals got a lower anthropomorphism score and a higher biological reality one. We obtained the same double effect with the possession of a pet at home. However, an opposite effect is observed with members of an animal protection association: they anthropomorphism more and got a lower score of biological reality.

Finally, the order of questions also has an impact on both scores: when questions about the monkey were shown first and the ones about the birds last, participants got a lower score of anthropomorphism and a higher score of biological reality than the contrary. When looking at each species, the anthropomorphism score is higher, whatever the species, when video of the sparrow is shown first, but the higher difference between the two conditions is observed for the monkey (sparrow video shown first: sparrow = 1.69±0.89, elephant = 2.46±0.71, macaque = 2.26±0.81; monkey video shown first: macaque = 1.88±0.87, elephant = 2.33±0.77, sparrow = 1.59±1.01).

4. Discussion

This study aimed at understanding the process of anthropomorphism through videos of animals in difficulty and a kicked robot. A first important result is that, according to the events we showed (epimeletic behaviours in animals and kick of a robot), there is a negative correlation (about 61%) between the anthropomorphism score (AS) and the biological reality one (BRS). Moreover, the heterogeneity of AS for a same BRS is large (see Figure 3). A positive correlation between AS and BRS would show a right statement from participants (they answer correctly using more a reflective anthropomorphism) but a negative correlation shows in fact a wrong statement: they answer incorrectly using mostly automatic anthropomorphism, but see the figure 3 for the different mechanisms proposed. Indeed, the heterogeneity (i.e., the rest of the variance meaning 39%) and the distribution of the AS scores proved that all levels of anthropomorphisms are covered from mentaphobia (not giving attributes to animals even if they have) to full anthropomorphism through

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automatic one (giving systematically attributes to animals despite a lack of personal knowledge). Our results allowed us to identify other types of anthropomorphism: naïve anthropomorphism (i.e., for making anthropomorphism despite a lack of personal knowledge but not giving it systematically), uncertain anthropomorphism (i.e., for making anthropomorphism despite some personal knowledge but not giving it systematically) and cautious anthropomorphism (i.e., for making anthropomorphism but less than could be done according to the scientific knowledge). This heterogeneity in the way humans attribute mental states to animals depends on several factors such as the animal species considered, the behaviours displayed by the animals but also the factors depending more on human experience (personal but also scientific knowledge) and personality (i.e., mainly here the degree of empathy of people (Connor et al., 2018; Furnham et al., 2003; Taylor and Signal, 2005).

Different cognitive processes (i.e., agency detection, social cognition, motor matching mechanisms, empathy for pain, mental representations, inductive and causal reasoning) are implied in anthropomorphism (see Urquiza-Haas and Kotrschal, 2015 for a review). These mechanisms mostly help to better face the world, including animate entities as animals (e.g. finding resources by observing other animal species, interpreting interspecific and intraspecific threatening, avoiding predation). The posterior superior temporal sulcus **[88]** and the mirror neurons **[89]** are used to treat social information within the same species (*Homo sapiens* in our case) but also to react to other ones **[90]** as well as robots movements or facial expressions **[91,92]**. So humans inevitably and unconsciously anthropomorphise, as our score confirms it. The negative correlation with the BRS shows that the anthropomorphism showed by participants is quite systematic. However, the scores they attributed to animals were different according to the species shown in the video. The lowest AS is attributed to the sparrow but with the highest variance (meaning that we observed the most of different answers). On the other side, participants attributed more mental states and cognitive processes to the macaque and the elephant, with less difference in the responses. Urquiza-Haas and Kotrschal (2015) argued that when the phylogenetic distance with the species humans observed increases, we make less anthropomorphism or this one is more reflective than automatic (i.e., visceral). This reflective attribution of intentions is mirrored in the heterogeneity (variance) of the answers (as for the sparrow). Similarity in decisions and responses show accuracy **[93]**. According to this, a low variance, meaning a high level of agreement, should indicate a causal reasoning whilst an automatic or implicit anthropomorphism should be used when heterogeneity in the attribution of mental states is observed. In addition with phylogenetic distance, sharing morphological and behavioural traits may also conduct in stronger anthropomorphic thinking. This is why for instance, the highest difference between AS and BRS is observed with the macaques since the monkey seems to do some massage to its partner in order to reanimate him. However, any of the 13 experts we questioned were convinced by the intention of the monkey to reanimate his conspecific and the mental representation behind this behaviour. From now, no systematic study proved that sparrows or rhesus macaques are aware of death, whilst some elements conducted researchers to think that it is probably the case in elephants **[94–96]**. So, to summarise, there is more an automatic anthropomorphism with the sparrow, conducting to a higher variance, whilst the anthropomorphism is more reflective with the macaques and the elephant. Concerning the robot, as it shared common morphological and behavioural traits with dogs (four legs and same way to move), participants reacted more in an automatic way. This is confirmed with the high number of sadness and surprise answers we obtained. However, what is more striking is that people were not sure about the rightness of their feeling: 45.9% only when people feel an emotion versus 84.8% of certainty for participants saying that they feel nothing. So participants reacted, felt emotions but then, doubted about its accuracy (Is it right to feel this emotion?). Gazzola et al. (2007) already showed this automatic process of humans with robots. The way humans reacted here does not depend only on the animal species but also on their movements and actions as explained above **[98,99]**.

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So when the anthropomorphism becomes more automatic, more heterogeneity is observed about the attribution of mental states. But where does this variance come from? As quickly suggested in the introduction, many factors that we focused on in this study may intervene in the way we perceive animals' minds. First, in link with cognitive biases and automatic reactions discussed above, the order of questions, meaning the animals and the actions participants watched first, have an influence on their AS: when the video of the bird is shown first, the global score and the score for each species are higher. The highest difference between the two order conditions is observed with the rhesus macaques: the AS got almost +0.5 point when participants watched this video last. They are influenced by the two first videos and increased the score. This bias is well known is psychology, comparable to Anchoring bias, and is found in humans **[59]** as in other species **[57]**. This bias may lead to suboptimal decisions **[100]** because individuals are influenced by previous actions in their actual decision.

Age is another factor affecting AS (but not BRS) with older participants attributing less mental states to animals. This is not due however to their experience and knowledge (as the BRS does not increase with age). This result might be explained by a difference of the perception of animals (and robots) through media as televisions or books according to the different generations. Animals or inanimate objects (robots but also trains or cars) are more and more anthropomorphised in cartoons or comics and the language or the images used to describe animals or objects has an effect on children's tendency to attribute human-like traits to the latter **[101,102]**. Nevertheless, studies showed different results about the impact - negative or positive according to studies - of this everyday anthropomorphism on animals conservation and welfare **[10,103]**. For instance, anthropomorphic selection (i.e., the selection by humans of morphological traits – eyes, nose, ears, etc. - making the animals more humans) is one of the more severe welfare problems currently found in pets, particularly dogs **[104]**. Alternatively, using a *humanizing* language to emphasize the human qualities of dogs increase beneficent action for them, so could be used to improve animal welfare (Butterfield *et al.* 2012).

Gender also affects attribution of mental states with women demonstrating more anthropomorphism. This difference between men and women is well known for cognitive processes as decision-making **[105]**, risk-taking **[106]**, sociality **[107]** and empathy **[108,109]**(Vitulli 2006). Oxytocin, an hormone produced in link with offspring recognition, sociality and empathy, has directly been linked to attitudes towards animals **[87]**. Indeed, gender is one of the strongest predictor of caring about animals with women being more protective towards animals in different situations **[67,110–113]**. This general effect of gender might be due to the evolutionary history of animal females to protect their offspring **[114,115]** and the link between social cognition and morphism **[9]**.

Interestingly, the academic level has not such a great impact on the attribution of mental states: only the PhD participants got lower AS and higher BRS than persons with no diploma. This may confirms the impact of social media we described in a previous paragraph: animals are now highly present in medias, with specific magazines as in National Geographic or in BBC World **[116–118]**, and people may have a global knowledge about animals. Only people holding a PhD and being experts on animal behaviour or other similar domains are more careful about their interpretations. Similarly, people working with animals or having at least one pet at home demonstrate less anthropomorphism and appeared closer to reality in their mental states attributions than people who do not. This might mean that being almost every day with animals leads persons to be more careful in their interpretations when observing them (Apostol et al. 2013). With highest experience and jobs for which they are emotionally implied, humans may show less empathy towards animals. Indeed, people working on animal physiology as vets take emotional distances with animals **[112,120]** as surgeons could do with humans.

It is interesting to find in our study that people having at least one pet at home demonstrate less anthropomorphism as this one is usually consider as a member of the family **[121]**. More interestingly, Albert and Bulcroft (1987) showed that a person changing her status to single, divorced or remarried people makes more anthropomorphism then after, projecting some human qualities to their pet such as this one will never abandon them (Blouin, 2012; Seps, 2010). This trait-based behaviour can be related to sociality motivation (i.e., the need to feel socially connected with others, (Paul et al. 2014). Moreover, some pet owners even celebrate the birthday of their animals **[125]**. So, the result we found presently is quite in contradiction with the literature. We may explain this contradiction by the fact that animals showed in the current videos are not pets but wild animals. Participants does not attribute the same mental states or demonstrate the same empathy to these two categories of animals, pets and wildlife. The more striking example is owners possessing a cat and its impact on biodiversity (McDonald et al. 2015; Tschanz et al. 2011;Coleman et al., 1997; Nemes, 2018). Whilst they care about the welfare of their cat and of cats in general, they are less implied in the care of animals suffering under the claws of their cat (Loyd et al. 2017) and the loss of biodiversity **[128,129]**. This is a moral schizophrenia **[130,131]** for which the care of biodiversity and other animals could never overpass the owners' compassion for the cats **[132]**. The relationships owners linked with their pets increases oxytocin level, which has a direct link on empathy and anthropomorphism but this latter is selective and more attributed to their own pets **[87,133,134]**.

Conversely, we found that animal protection association members demonstrated strong anthropomorphism and were farer from biological reality than non-members. Members of such associations should show, as vegetarians, higher anthropomorphism and higher empathy. Anthropomorphism and empathy are different but highly linked as empathy is one of the cognitive processes explaining anthropomorphism **[9]**. The empathy-related areas of vegetarians brain are more activated than the ones of omnivores **[69,135]**. As these persons are usually more empathic (towards humans, but see for instance Monaghan, 2013; Nagtzaam, 2017) and having a higher perspective taking (i.e., adopting the perspective of someone else), they are systematically more empathic towards animals and then more prone to become a member of an animal protection association or vegetarians **[119]**.

This study determined several factors influencing how much humans anthropomorphise: those depending on the animal species or behaviour and those depending more on human characteristics. Understanding how one can play with these factors can conduct to better relationships with animals as encourage human-robot interaction **[138,139]**. Last but not least, such anthropomorphism can lead to an increase of human empathy and sociality, finally increasing our humanity (universal virtue as defined in Peterson and Seligman, 2004). Playing with these variables may also solve biodiversity conservation problems as proposed for charismatic animals or not ones, vertebrates or invertebrates **[10,11,141–144]**.

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