**ESCOLA UNIVERSITÁRIA VASCO DA GAMA**

Mestrado Integrado em Medicina Veterinária

Dissertação de Mestrado

# PERCEPTION OF CARETAKERS ON ANIMAL CONSCIOUSNESS IN WILDLIFE CONSERVATION

Valentine Blandine Michèle Yakhlef

**Coimbra, junho 2024**

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**Abreviations list**

AER package - Documentation, Applied Econometrics with R software (version 4.0.3)

BSc - Bachelor of Science

GLM - Generalised Linear Models

MASS package - Modern Applied Statistics with S

MSc - Master of Science

PCA - Principal Component Analysis

PhD - Doctor of Philosophy

P-values - Probability values

QQ-plots - Quantile–quantile plot

StepAIC - Akaike Information Criterion

UK - United Kindom

**Perception of caretakers on animal consciousness in wildlife conservation**

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*Abstract*

Human perception of animals' consciousness has evolved over time and influences the way they treat them. This study aimed to assess perceptions of animal consciousness in people working in conservation. Through an online survey, participants (n=87) were asked questions about animals' capabilities related with 10 dimensions of consciousness. The sum of the answers to the questions was validated as a “perception index” and it’s variation according to taxonomic, demographic, professional factors and the duration, type and frequency of interaction with animals was assessed with generalized linear models. Participants' perceptions varied with taxonomic class and the level of education, with mammals obtaining higher perception indexes than birds (-0.14; 34 95% CI -0.24,-0.03, p<0.01) or reptiles (-0.41; 95% CI -0.55,-0.27, p<0.01), and respondents holding a PhD exhibiting higher perception indexes than those with BSc’s (-0.19; 95% CI -0.32,-0.06, p<0.01) or secondary education (-0.18; 95% CI -0.32,-0.03, p=0.01). The attribution of consciousness followed a phylogenetic pattern, but several exceptions were noted on a finer scale supporting a multifactorial influence on the perception of animal consciousness that emerges upon a baseline phylogenetic pattern. Finally, the results suggest that conservationists overestimate animal consciousness compared to current scientific evidence, and highlight the need for further research on the convergence between perception, belief and evidence.

*Keywords:* animal mind; consciousness; conservation; human-animal relation; wildlife

Resumo

A percepção humana da consciência dos animais evoluiu ao longo do tempo e influencia a maneira como são tratados. Este estudo teve como objetivo avaliar as percepções da consciência animal em pessoas que trabalham em conservação. Através de uma pesquisa online, os participantes (n=87) foram questionados sobre as capacidades dos animais relacionadas com 10 dimensões da consciência. A soma das respostas às perguntas foi validada como um "índice de percepção" e sua variação de acordo com fatores taxonómicos, demográficos, profissionais e a duração, tipo e frequência de interação com os animais foi avaliada com modelos lineares generalizados. As percepções dos participantes variaram com a classe taxonómica e o nível de educação, com os mamíferos obtendo índices de percepção mais altos do que as aves (-0,14; IC 95% -0,24,-0,03, p<0,01) ou répteis (-0,41; IC 95% -0,55,-0,27, p<0,01), e os respondentes com doutorado exibindo índices de percepção mais altos do que aqueles com bacharelado (-0,19; IC 95% -0,32,-0,06, p<0,01) ou educação secundária (-0,18; IC 95% -0,32,-0,03, p=0,01). A atribuição de consciência seguiu um padrão filogenético, mas várias exceções foram observadas em uma escala mais fina, apoiando uma influência multifatorial na percepção da consciência animal que emerge a partir de um padrão filogenético básico. Finalmente, os resultados sugerem que os conservacionistas superestimam a consciência animal em comparação com as evidências científicas atuais, e destacam a necessidade de mais pesquisas sobre a convergência entre percepção, crença e evidência.

Palavras-chave: mente animal; consciência; conservação; relação humano-animal; vida selvagem animals

*Article*

# A global survey on the perception of conservationists regarding animal consciousness

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**Simple Summary:** Human attitudes toward wild animals have spawned debate and influence decision-making in wildlife research and conservation. It is known that the belief in the animal mind is one of the strongest and most consistent predictors of attitudes toward animal use. This study aimed to assess the perception of professionals involved in animal conservation regarding the dimensions of consciousness of the species with which they work. Responses from 87 participants followed what could be the expected pattern based on a phylogenetic scale (*scala naturae*), with consciousness increasing gradually from insects to mammals. However, departures from the phylogenetic scale wer detected on a finer scale, signalling the influence of other factors (*e.g.*, animal attributes and role in human life, cultural factors or the availability of scientific evidence) on how conservationits percieve the animal consciousness. Finally, the results also suggest that conservationists are likely to overestimate the consciousness abilities of the animals under their care, when compared to current scientific evidence.

**Abstract:** Human perception of animals' consciousness has evolved over time and influences the way they treat them. This study aimed to assess perceptions of animal consciousness in people working in conservation. Through an online survey, participants (n=87) were asked questions about animals' capabilities related with 10 dimensions of consciousness. The sum of the answers to the questions was validated as a "perception index" and it's variation according to taxonomic, demographic, professional factors and the duration, type and frequency of interaction with animals was assessed with generalized linear models. Participants' perceptions varied with taxonomic class and the level of education, with mammals obtaining higher perception indexes than birds (-0.14; 95% CI -0.24,-0.03, $p<0.01$) or reptiles (-0.41; 95% CI -0.55,-0.27, $p<0.01$), and respondents holding a PhD exhibiting higher perception indexes than those with BSc's (-0.19; 95% CI -0.32,-0.06, $p<0.01$) or secondary education (-0.18; 95% CI -0.32,-0.03, $p=0.01$). The attribution of consciousness followed a phylogenetic pattern, but several exceptions were noted on a finer scale supporting a multifactorial influence on the perception of animal consciousness that emerges upon a baseline phylogenetic pattern. Finally, the results suggest that conservationists overestimate animal consciousness compared to current scientific evidence, and highlight the need for further research on the convergence between perception, belief and evidence.

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**Keywords:** animal mind; consciousness; conservation; human-animal relation; wildlife

## 1. Introduction

How humans perceive animals' consciousness abilities has evolved over time. Aristotle was a vitalist and thought all living beings - plants, animals, humans - have souls and that "*for all animals, sensation is*" [1] (p. 141). René Descartes, like Aristotle, believed that mind and body are separate entities, but contrary to the former, did not think that animals had souls nor attributed the ability to experience feelings to animals [2]. Immanuel Kant attributed primacy to humans but acknowledged their indirect duties towards other sentient beings, and in the eighteenth century, the questioning of vivisection (for a detailed review see [3]) signalled an increasing recognition of animal consciousness. The concept of animal sentience—the capacity for animals to experience feelings—was highlighted by illuminist thinkers such as Voltaire, but it was Bentham who forged the foundation of a utilitarian approach based on animal sentience that has remained influential to date: "*The question is not, Can they reason? nor, Can they talk? but, Can they suffer?*"[4]. Therein lies the view that animals need not communicate or possess cognitive abilities like humans to be considered moral subjects. If they are conscious and can experience feelings (i.e. are sentient), their welfare needs to be considered. Since the end of the twentieth century, researchers recognized the implications of sentience for animal welfare decisions [5], and the social recognition of animal sentience and consciousness fueled by growing scientific evidence is reflected in the both the Cambridge and New York Declarations [6,7]. In these declarations, groups of scientists present simple and synthesised updates on animals consciousness to society. For example, The Cambridge Declaration focuses on the evidence indicating that the human neocortex is not the only structure associated with consciousness and that many other animals, namely "all mammals, birds, and octopuses," possess the necessary structures for consciousness. This neuroanatomical approach is based on the premise that if animals possess structures analogous to those that enable sentience, consciousness, and cognition in humans, then they are likely to possess analogous capabilities.

Several definitions are relevant to this discussion and have been used differently in the literature. For this study, cognition is distinguished from consciousness because the former encompasses several mental processes such as perception, memory, and learning, that have evolved to aid animals in coping and interacting with their external environment. Consciousness, on the other hand, represents the animals' capacity to be aware (of subjective, affective and perceptual experiences) [8,9] and allows the animal to perceive its environment and experience subjective feelings, such as pain or sadness. Finally, sentience will be considered to involve the capacity to feel and perceive. The acknowledgment that animals possess different levels of consciousness and cognition raises even more questions about their treatment and has influenced the way humans treat animals for centuries [10]. To date, consciousness remains one of the most relevant and challenging aspects to study among all biological phenomena [11]. The ultimate objective for researchers exploring animal consciousness involves identifying which animal species possess consciousness, to what degree, and understanding the nuances among them [8,12]. Recent studies by Birch and colleagues [8] have dealt with these different definitions by deconstructing the definitions into specific capabilities that animals may or may not possess, which they named as dimensions of consciousness. This approach has the advantage of overcoming the anthropocentric bias of the definitions themselves, by focusing on specific and objective capabilities of evolutionary and adaptive value, which can lead to different species having different types of sentience, consciousness, or cognition than humans. Subsequently, other authors have further applied this tool using practical examples [12]. It is noteworthy that some of the dimensions considered may fall under the definitions of sentience or cognition. However, as the focus of this study is on the individual dimensions and whether humans perceive animals as possessing them or not, the discussion of the hierarchical relations between the definitions is beyond our scope. This recent approach has provided some objective definitions of dimensions of consciousness that are easier to interpret and hence amenable to survey studies with people without scientific background in this field.

Over the centuries, human attitudes toward animals have been shaped by an increasing belief in animal minds and evidence of animal consciousness, and the consequent inclusion of an increasing number of organisms in the sphere of bioethical consideration, coined by Singer as the "expanding circle" [13]. However, this belief is shaped by the animals' species and tends to follow natural (*scala naturae*) [4] or sociozoological [14] scales, based on phylogeny or on the roles animals play in human lives. Human atitudes toward wild animals influence the likelihood of attribution of resources for their protection and conservation and these decisions have been shown to be influenced by species "charisma", with a bias toward large mammals and birds, even if other species are more numerous, more critical to ecosystem functioning or threatened [15,16].

Changes in the attitudes of humans toward wild animals have spawned debate and influenced decision-making in wildlife research and conservation, with approaches that involve invasive interventions or lethal sampling methods becoming increasingly unacceptable to society [17–19]. Studies on how conservation decisions are influenced by the perception of how animals experience life are lacking, but the few studies on domestic species indicate that the way people perceive animals' capabilities for cognition and consciousness directly influences the way they are treated [20–23]. Additionally, research indicates that the belief in the animal mind, which is inherently related to perceptions on animal consciousness, is one of the strongest and most consistent predictors of attitudes toward animal use [24–27]. However, most people have little contact with wild species, and their perception is subject to cultural differences, often influenced by myths, folklore [28] or primordial fears [29]. People working in conservation are uniquely positioned to empirically assess the capabilities for consciousness of wild species because they work closely with them on a daily basis, and are able to witness their behaviour and reactions. In this cross-sectional study, we aim to understand how people working in wildlife conservation centers perceive the consciousness of the animals under their care. Our first objective was to characterise the perception of caregivers on the capabilities for consciousness of the species under their care based on the dimensions proposed by Birch *et al.* [8] and Dung and Newen [12], and our second objective was to assess how those perceptions varied with species, demographic factors, and the duration and type of their interaction with the animals. Based on prior studies focusing on human attitudes toward animals, we predicted that the perception of animal consciousness would vary with respondent age and gender [30–32], and the level of familiarity with the animals [27], but we also expected these perceptions to vary with the geographical location, level of education and area of professional training of respondents in animal-related professions.

## 2. Materials and Methods

A cross-sectional study was performed using a survey built on the Google Forms platform. The survey was composed of four sections. The first consisted of demographic questions, while the second was composed of questions aimed at assessing participants' perception of the consciousness of a single species they most frequently worked with, assessed on a Likert scale ranging from 1 ("*completely disagree*") to 5 ("*completely agree*"). Questions on the perception of the capabilities for consciousness of the animals were based on the dimensions of animal consciousness proposed by Dung and Newen [12]. A detailed description of the development of the questions is available in the supplementary materials (S1). Due to the complexity of the questions, responses to the questions were not mandatory to proceed to the next part of the questionnaire, allowing participants the option to abstain from responding. The third part concerned the human-animal relation, with multiple-choice questions about the type and frequency of interaction respondents had with the animals. Finally, the last part consisted of a multiple-choice grid, aimed at assessing participants' perception of animal consciousness in different specific species, selected to include species from all classes, species considered pests or useful, predators and prey, and species with reputation of high cognitive capabilities. The species selected were the housefly (*Musca domestica*), cockroach (*Blattella germanica*), tree frog (*Agalychnis callidryas*), Atlantic salmon (*Salmo salar*), honey bee (*Apis mellifera*), ball python (*Python regius*), house sparrow (*Passer domesticus*), rat (*Rattus norvegicus*), leopard (*Panthera pardus*), common octopus (*Octopus vulgaris*), wolf (*Canis lupus*), raven (*Corvus corax*), bottlenose dolphin (*Tursiops truncatus*), African elephant (*Loxodonta africana*), and the chimpanzee (*Pan troglodytes*). The response scale ranged from 1 ("*has no consciousness*") to 7 ("*has consciousness comparable to humans*").

Before dissemination, the survey was piloted by two veterinarians (one animal welfare specialist and one experienced in wild/exotic animals), whose suggestions for improvement were considered. The Google Forms survey link was directly emailed to conservation centers and veterinarians working in conservation (n=156) across the world between the 20th of December 2023 and the 15th of March 2024 selected by non-probability sampling using internet searches followed by snowball sampling through shared contacts. The full questionnaire is provided in the supplementary materials (S2).

### *2.1 Data preparation*

Data cleaning was performed using Google Sheets. For statistical modelling, a priori defined categories of participants' professions were grouped into categories based on similarity: "*biologist, ecologist or conservationist*", "*ethologist*", "*keeper, caretaker or rehabilitator*", "*veterinarian*", "*veterinary technician or veterinary nurse*" and "*other*" (which included, for example, engineers, PhD students and attorneys). Regarding the education level of the participants, due to the low number of responses, the options "*primary education*" (n=1), "*lower secondary education*" (n=2), and "*upper secondary education*" (n=14) were grouped into the category "*secondary education or less*" (n=17). For each species chosen by the participants, different taxonomic levels (family, order and class) were established (see supplementary material, S3). The more commonly known Linnean taxonomic classification was used because the study focuses on people's perception of animals' consciousness. For example, while birds are placed in the Reptilia clade based on their ancestry [33], in this work they will be presented separately from reptiles, to meet the most widely used lay classification. The duration of the participants' work with the target animal species was converted into years and rounded up. A numerical value was assigned to each response to the question regarding the frequency [ranging from 0 ("*never interact*") to 4 ("*interact on a daily basis*")] and the type [ranging from 0 ("*no interaction*") to 6 ("*surrogate parenting for at least a period of the animal's life*")] of interactions between respondents and the animal of their choice. Responses where participants chose multiple species or did not provide specific species names (5 responses) were included in the sample demographics but excluded from descriptive and inferential analyses. In order to obtain a single dependent variable that encompassed the overall perception of each respondent on the consciousness capabilities of the species in question, a "*perception index*" was created by calculating the sum of the answers to all of the Likert scale questions from that respondent. Since the possible answers ranged from 1 to 5, the perception index resulted in a discrete variable of count data, ranging from 28 (answering 1 to all questions) to 140 (answering 5 to all questions).

### *2.2 Statistical analysis*

Descriptive statistical analysis was conducted using Google Sheets. Scores for each dimension of consciousness were calculated by averaging the scores of all the responses for each question, and then calculating the average score for all the questions pertaining to that dimension (see supplementary materials, S4). Radar diagrams adapted from the approach of Dung and Newen (2023) were created for the visualisation of respondents' perceptions on the abilities for consciousness of each taxonomic group, with dimensions ordered alphabetically (figures 1 and 2). Principal Component Analysis was employed to investigate the validity of the *perception index* as a single variable representing the participant's perception of animal consciousness. The average of perception index was calculated for each taxonomic class, order and family and illustrated in bar plots (supplementary materials, S5).

Analyses to determine which factors influence participants' perception of consciousness in the species they work with were performed using R version 4.0.3 [34]. For this purpose, the influence of relevant factors on the perception index was analysed using generalised linear models (GLM). First, a GLM was fitted with all candidate variables based on their biological relevance. Candidate variables included respondents' residence (grouped by continent), age, gender, level of education, profession, number of years working with the species, taxonomic class of the species, frequency of the respondents' interaction with the animals, and type of the respondents' interaction with the animals. Testing for multicollinearity was performed using variance inflation factor, with a cut-off value of 6, which led to the exclusion of two variables (location and the frequency of interaction with the animals). The models were checked for overdispersion with the function *dispersiontest* of the AER package [35]; the negative binomial distribution performed better that Poisson or quasi-Poisson distributions, and was hence selected for model fitting. Next, stepwise model selection was performed to obtain the most parsimonious model using the *stepAIC* function from the MASS package [36] and model assumptions were checked by visual inspection of QQ-plots and residuals vs. fitted plots, and by comparison of observed vs. simulated counts (posterior predictive check). Results of the final model are presented as estimates, p-values and 95% confidence intervals, and illustrated in forest plots.

## 3. Results

A total of 92 responses were obtained, with a response rate of 59.0%. Five responses were excluded from the analysis because respondents considered several species when answering the questionnaire, resulting in a final sample of 87 responses. A summary of the survey demographics can be found in the supplementary materials (S3). Responses were obtained from respondents of 30 nationalities, spanning the five continents (with a greater representation of European and American respondents). Participants defined themselves as biologists, ecologists or conservationists (35,6%), followed by veterinarians (27,6%) and keepers, caretakers or rehabilitators (25,3%), ensuring a balanced representation of the professions usually involved in conservation. Responses were obtained from respondents with varied levels of education and age classes, with a predominance of females (63.2%).

Respondents generally agreed that all species of animals represented in the survey possess consciousness capabilities in the dimensions of perceptual and evaluative richness, integration at and across time, and learning, with average scores between 3.71 and 4.30 (supplementary materials, S4). Average scores for the capabilities in the dimensions of experience of ownership, self-consciousness, reasoning, and experience of agency were close to 3 (*neither agree nor disagree*), and only capabilities in the dimension of abstraction obtained average scores in the range of disagreement (2.56). In terms of taxonomic class, the average agreement scores on the consciousness capabilities were generally higher in mammals, followed by birds, and then reptiles (figure 1). Insects, bony and cartilaginous fish, and cephalopods obtained only one answer each, with notably high scores (5.0) in the dimensions of integration at a time for insects and perceptual richness for cartilaginous fish.

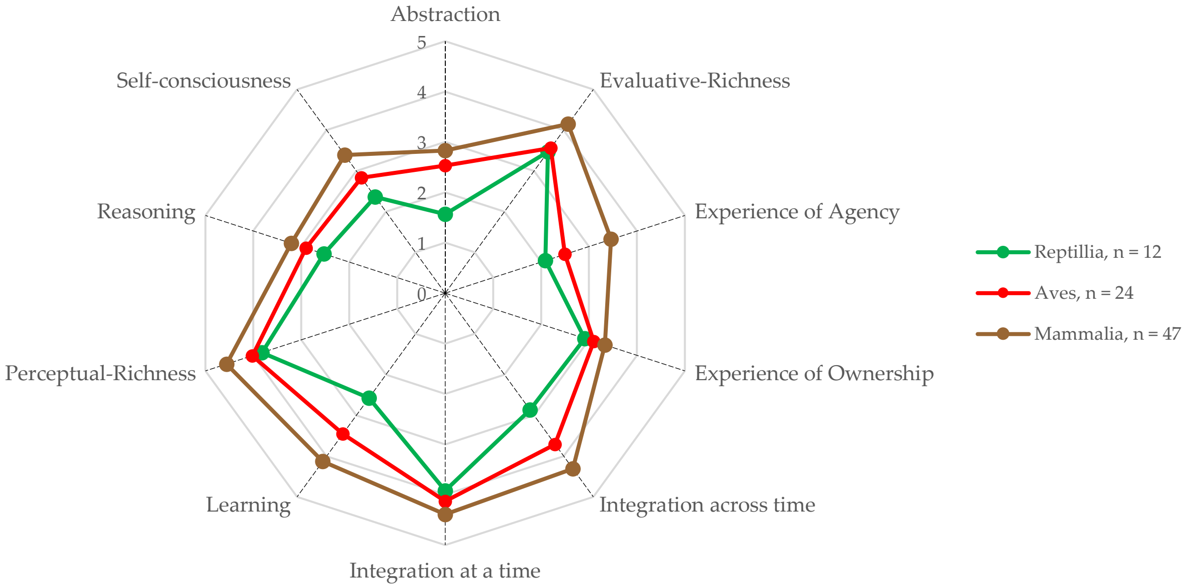


**Figure 1:** Average agreement scores regarding the capabilities for consciousness for each dimension calculated for each taxonomic class (classes with n>1).

Among mammals, elephants obtained the highest agreement scores regarding their capabilities for consciousness in the dimensions of perceptual and evaluative richness, experience of agency, and self-consciousness, but not for reasoning and abstraction, where primates scored highest, or integration at and across time, where odd-toed ungulates scored highest (figure 2.a). Within birds, differences in the agreement scores were noted between different avian groups, with psittacine birds obtaining higher scores in the dimensions of perceptual and evaluative richness and integration across time, and penguins achieving the highest agreement scores in the dimensions of self-consciousness and reasoning (figure 2.b). Finally, among reptiles, clear differences regarding agreement scores were found between groups, with higher scores being attributed to crocodilians, followed by chelonians, and finally snakes (figure 2.c).

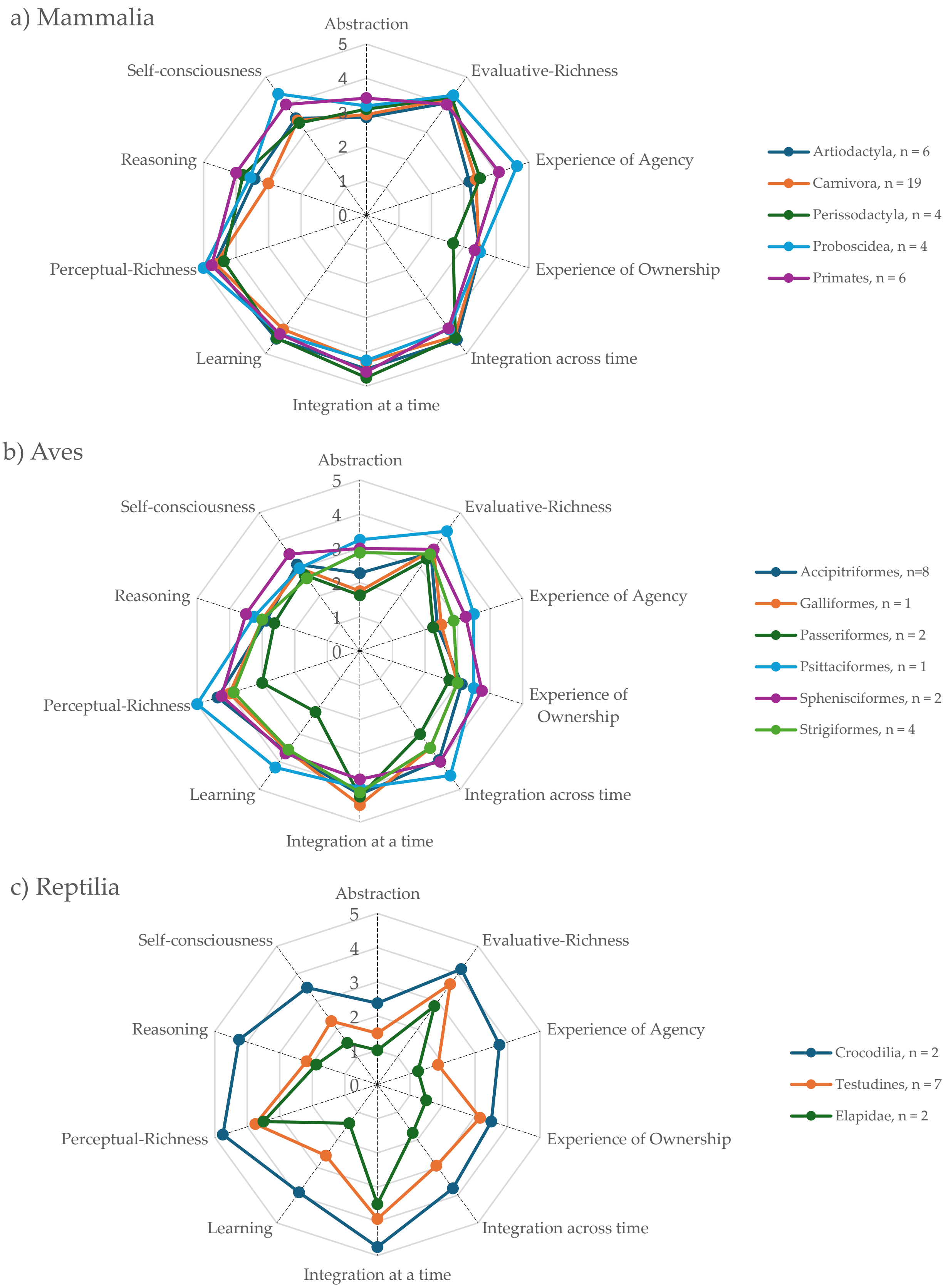


**Figure 2:** Average agreement scores regarding the capabilities for consciousness for each dimension calculated for each selected taxonomic groups within class mammals (a), birds (b) and reptiles (c).

### *3.1. Consciousness Perception Index*

After reduction of the dimensionality of the data and transformation of the original variables (28 questions) into a set of uncorrelated variables (principal components), 41.1% of the total variance was explained by the retained components, indicating that a substantial portion of the variability was captured. The first principal component closely mirrors the overall perception index, with an eigenvalue of 15.82, accounting for 38.5% of the total variance. The second eigenvalue obtained was 3.68, representing 8.9% of the total variance.

The average perception index differed between taxonomic classes (Figure 3). Among the classes with multiple observations in the sample, mammals scored highest on the perception index, followed by birds, and finally reptiles. The score of cephalopods (in this specific case, the common octopus) was the highest of all, cartilaginous fish had the third highest score, and insects scored higher than the average score for reptiles, but these classes had only a single observation. Average scores of perception index by order and family can be found in the supplementary materials (S5).

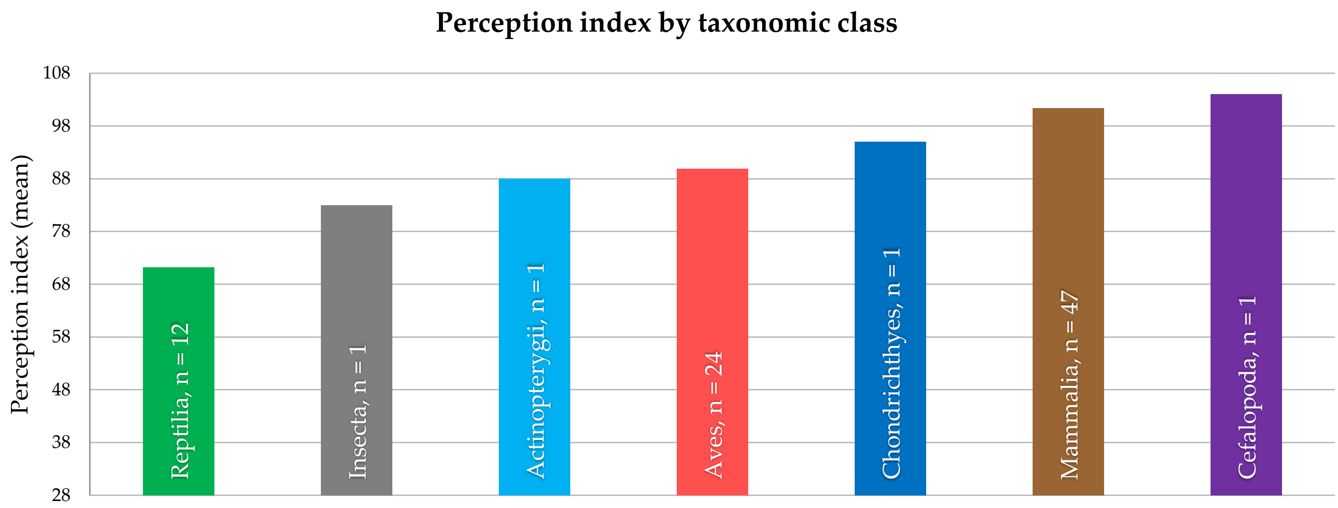


**Figure 3:** Distribution of the average animal consciousness perception index (range 28 to 140) according to the taxonomic class of the species considered by each respondent.

### *3.2 Factors that influence the perception index*

The variables retained in the most parsimonious model to explain the variation in the perception index included the animal class and the level of education of the respondent (figure 4). Respondents with a PhD did not differ significantly from those with a MSc but attributed significantly higher perception indexes when compared to those with a BSc and secondary education (high school) or less. In terms of animal class, respondents working with mammals attributed a significantly higher perception index to the animals they work with, when compared to respondents working with birds and reptiles. Finally, respondents working with birds also attributed higher perception indexes when compared to those working with reptiles.

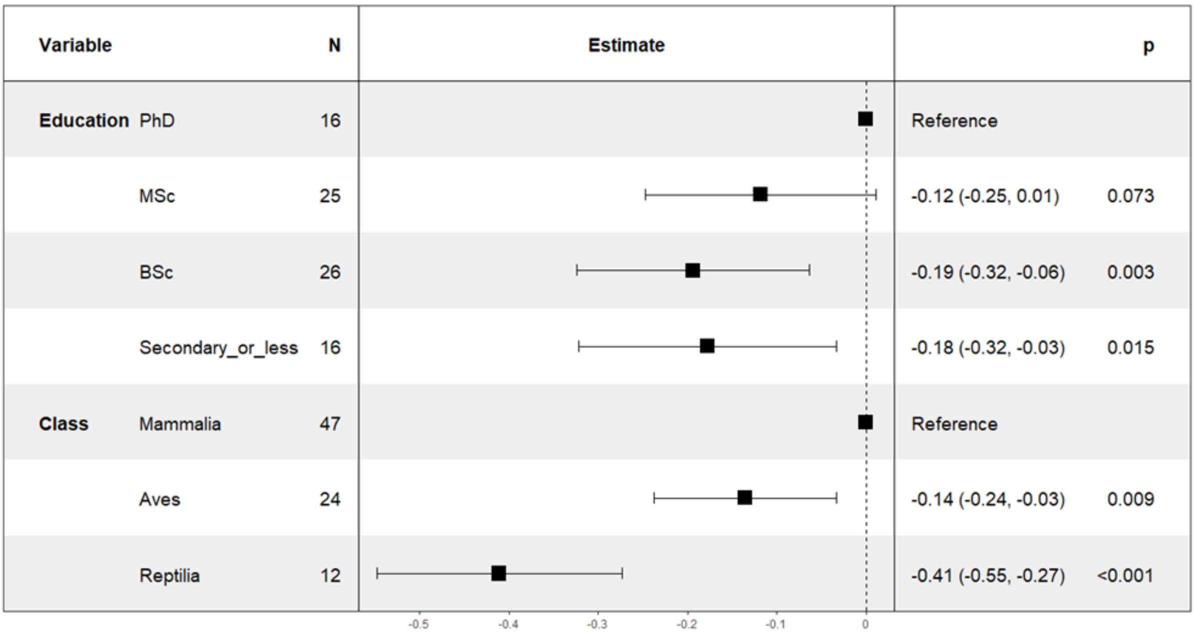


**Figure 4:** Results of the final (most parsimonious) generalized linear model explaining the variance in the animal consciousness perception index. Results are presented as estimates, 95% confidence intervals and p-values. For each factor, the variable level associated with higher perception indexes was chosen as the reference level.

### *3.3 Perceptions of respondents on selected well-known species*

The average scores obtained regarding the perception of capabilities for consciousness of selected well-known species showed clear differences between them. On a scale of one to seven, where a consciousness comparable to humans would correspond to a score of seven, the chimpanzee (6.6), elephant (6.2) and dolphin (6.2) obtained the highest scores. The highest score among non-mammalian animals was obtained by the raven (5.7), which was followed by the wolf (5.5) and then another non-mammalian species (a cephalopod), the common octopus (5.5). The leopard (5.2), rat (4.9) and house sparrow (4.1) followed with scores above the center point of the scale, after which the ball python (3.3), honeybee (3.3), salmon (3.2), tree frog (3.1), cockroach (2.3) and housefly (2.2) have scores below four.

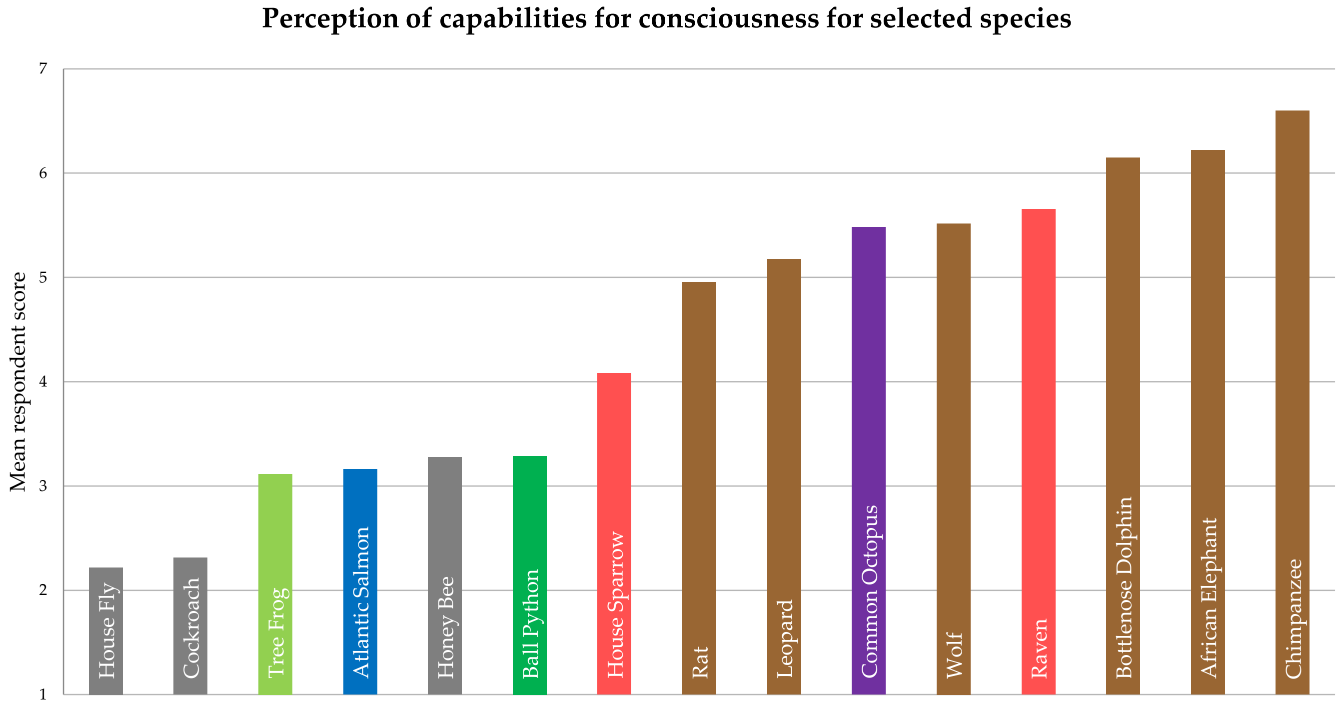


**Figure 5:** Average scores of respondents' perception of capabilities for consciousness for selected species (presented as means), on a scale from 1 ("*has no consciousness*") to 7 ("*has consciousness comparable to humans*"). Colors of the bars represent the taxonomic class: brown for mammals, purple for cephalopods, red for birds, grey for insects, blue for fish, dark green for reptiles, light green for amphibians.

## 4. Discussion

This study aimed to gauge the perception of professionals involved in conservation regarding the dimensions of consciousness of the animal species with which they work. As humans, our perception of animals' capabilities for consciousness influences the way we treat them. The results of our survey indicate that the perception of animals' capability for consciousness is influenced at a broad level by the animals' taxonomic class and the person's level of education. However, at the level of the species, variations at a finer scale exist that are likely due to factors other than demographic variables of the respondent or the taxonomic and phylogenetic characteristics of the species. Regarding the factors that influence the perception of animals' capabilities for consciousness among people working in conservation, it is noteworthy that respondent age and gender were not retained in the final models since these factors often influence perceptions and attitudes towards animals [30,31], including wildlife [32]. The number of years working with the species, the profession, and the frequency and type of the interaction with animal could be expected to influence human perceptions of animal consciousness due to differences in the respondents' familiarity with the species, capability to interpret the animals' behaviour, and different bonds with individual animals [27]. However, these factors were also excluded from the most parsimonious model and further research is required to help explain these results. While different professions were surveyed (*e.g.* veterinarians, biologists and keepers), a common professional culture among those involved in conservation could bias the statistical effect associated with the area of professional training. For example, a discourse analysis study concluded that some hunting organizations in Finland and the UK describe animals in a way that underestimates animal minds [37], which illustrates how industry culture might affect the perception of animal consciousness. Similarly, attitudes toward animals are likely to be influenced by the beliefs associated with working in conservation, as was observed in a study on the values and attitudes toward prairie dogs, where conservationists displayed the highest regard toward the animals among the sampled groups (ranchers, rural residents, urban residents) [38].

In general, the attribution of dimensions of consciousness followed what could be the expected pattern based on a phylogenetic scale (*scala naturae*), increasing gradually from insects to mammals [24,39]. However, when looking at our results at a finer taxonomic scale, several exceptions are noticeable. For example, psittacine birds (psittaciformes) and penguins (sphenisciformes), obtained higher perception ratings than other birds (figure 2.b), when assessed by the people working with them. The perception that a species is able to communicate  has been associated with more empathic attitudes toward animals [40], which might explain the scores for pisttacines, as well as a widespread reputation for being "intelligent" [41]. In the case of reptiles (figure 2.c), crocodilians obtained higher scores than chelonians and elapids (squamate reptiles), which, under the assumption that crocodilians and reptiles have earlier phylogenetic origins seems to contradict the general trend. However, more recent studies place crocodilians closer to birds in phylogenetic terms [42]. Additionally, crocodilians can be perceived as more closely related to humans compared to squamates, and particularly snakes, due to the presence of limbs, and other anatomical features such as a four chambered heart. Phylogenetic relatedness to humans has been associated with empathic attitudes toward animals [40]. In the case of snakes, limblessness and distinct patterns of behaviour and communication could lead to their perception as being more distant from humans than they phylogenetically are.

The question that required respondents to rate the consciousness of several well-known species (figure 5) offers further insight into these variations, because respondents' answers are not limited to the species they work with, and the selected species have particularities that differ from others of the same class. In this question, a departure from the *scala naturae* is observed in some cases, notably the raven and the octopus. The case of the raven is particularly interesting considering that it is included in the order passeriformes, just like the house sparrow. However, both science and media have contributed to a reputation of it being an intelligent species [43,44]. A similar case can be made for the octopus, a member of the coleoid cephalopods, considered the most cognitively advanced group of invertebrates [45]. The order of these species within the results indicates that scientific knowledge of complex cognitive abilities that have evolved in several lineages of animals influences the perception of the respondents, and/or that respondents are capable of perceiving that the animals possess these cognitive abilities. Another exception to the *scala naturae* is apparent in the placement of the honey bee above the tree frog and the salmon, and comparatively higher than the other insects (figure 5). While the octopus has been a target in cephalopod sentience, consciousness and cognition research, the bee has been one of the target species for insects [46]. However, an additional explanation that could influence these results is the "cultural inheritance" [47] of the sociozoological scale, with human attitudes towards animals being influenced by the attribution of the status of "good" or "bad" according to their relation with humans as pets, vermin, predators or tools [14]. This could justify the different scores attributed to bees, compared with cockroaches or house flies. Another justification could be found in the physical attractiveness of bees, compared to the other insects. Physical attractiveness, larger size and resemblance to humans were shown to increase support for a species' protection [48]. However, the comparatively high scores of the wolf suggest an alternative explanation, based on the beliefs of the specific group of respondents. Both bees and wolves are species with populations under threat and afforded conservation protection, while cockroaches and house flies are not, which might shape the way they are perceived and valued by people working in conservation.

When considering how we use or treat animals, it is worth discussing how our perception of their capabilities for consciousness aligns with their actual capabilities. An exploratory approach to this discussion can be attempted by comparing the results of our study with the results of Birch *et al.* [8] and Dung and Newen [12]. Birch *et al.* established dimension-based consciousness profiles for elephants, corvids, and cephalopods. The results obtained for elephants in our study are similar to the evidence-based profiles for consciousness obtained by Birch *et al.*, except for the dimension of perceptual-richness, which seem to be overestimated in our study, compared to the low scores related to the limited visual and tactile perceptual-richness of elephants [8]. Regarding cephalopods, the results of the two studies are also similar, except for an overestimation of the capabilities of integration at a time and self-consciousness in our study, compared to the limited evidence of those capabilities in cephalopods [8]. The overestimation of the consciousness capabilities of animals can result from an anthropomorphic perspective that is expected to be employed by humans to infer the consciousness of animals, since our own human consciousness is the only example that we can experience. It could therefore be expected that respondents would attribute to elephants the capability of a perceptual richness similar to humans, in the lack of further evidence. Altogether, the perception and attitudes toward animals are expected to be influenced by many factors, including the attributes of the animals, of humans, the utility of the animals to humans, cultural factors, and science [49]. The results of this study among conservation professionals seem to support the effect of this multifactorial influence upon a baseline perception based on a phylogenetic scale.

The greatest challenge of this study was to elaborate understandable questions to represent the operationalization of each dimension of animal consciousness. Despite the authors' best efforts, the complexity of the questions could hinder respondents to answer the survey, with the risk of biasing the results, for example, regarding the effect of the level of education. Since this research targets a very specific group of people, working in an area based on the belief that animals are worth conserving, the results should not be generalized to other populations.

## 5. Conclusions

Perceptions of animals' capabilities in each dimension of consciousness among people working in conservation varied on a broad scale with the taxonomy of the animal and the level of education of the respondent. However, on a finer taxonomic scale, variation within taxa was observed. Possible explanations include the influences that the existence of scientific evidence on animal cognition and consciousness, cultural factors, sociozoological factors, animal attributes, or characteristics of the respondents not captured in this study can have on their perceptions. When compared with actual evidence of consciousness, the results indicate that these respondents are likely to overestimate the consciousness abilities of the animals under their care. This study illustrates how the perception of animal consciousness, which influences behaviour toward animals, differs from the actual capabilities of animals, and highlight the need for further studies assessing the alignment between them.

**Supplementary Materials:** The following supporting information can be downloaded: **S1** – background information used to derive questions on the capabilities in each dimension of consciousness; **S2** – full questionaire; **S3** – demographic characterisation of the survey sample; **S4** – average Likert scale scores for each question and dimension of animal consciousness; **S5** – perception index according to taxonomic Class, Order and Family.

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investigation, V.Y.; resources, V.Y., M.M.S., A.L.P., A.A.; data curation, V.Y., A.A.; writing—original draft preparation, V.Y. and A.A.; writing—review and editing, V.Y., M.M.S., A.L.P., A.A.; visualization, V.Y. and A.A.; supervision, A.L.P., M.M.S., A.A. All authors have read and agreed to the published version of the manuscript.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. Survey participants were informed of the study's objectives, the confidentiality of their responses, and how their data would be used exclusively for research purposes, and responded voluntarily and anonymously.

**Data Availability Statement:** original data are available in the supplementary material. Any additional data are available upon request to authors.

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# Supplementary Material 1 (S1)

Both Birch and colleagues (2020) and Dung and Newen (2023) propose multidimensional scales because animal consciousness is extensive and varies across many dimensions. The approach proposed by Birch and colleagues (2020) Dung and Newen (2023) will be the starting point of our study on dimensions of animal consciousness. We will continue our research by exploring the bibliography used by these authors in order to define these dimensions.

**1- Perceptual-Richness**

Perceptual-Richness is linked to the way animals perceive their environment and more precisely the level of detail with which they consciously perceive it (Dung & Newen, 2023). This dimension of consciousness can be explored through “perceptual categorization”, “non-conceptual multisensory integration”, “cross-modal learning” and “discrimination learning” (Dung & Newen, 2023).

Perceptual categorization refers to the ability of living beings to classify the elements in its surroundings into distinct categories (Güntürkün *et al.*, 2018) by recognizing the physical appearance of these elements (Arterberry and Bornstein, 2002). In the first place animals learn to recognize a specific element and then transfer this knowledge in the presence of other elements (Güntürkün *et al.*, 2018). In the light of this information, we can formulate the following representative survey question: *“Do you think that the animals under your care can recognize elements in their surroundings and categorise them?”**. (Example: They see a keeper and to are able to classify him into the category "Human", or to see an insect, a fruit, a bottle of milk or a meat, and to classify it into the category "Food")*

No article was found including the definition of the term “Non-conceptual multisensory integration”

Cross-modal learning consists of combining information from different senses to improve learning in each of them (Zhang *et al.*, 2022). This allows animals to strengthen their memory, extract the logical structure of the world, facilitate perception and react quickly to events (Zhang *et al.*, 2014). Based on this knowledge, a representative survey question could be: *“Do you believe that the animals under your care are capable of enhancing their learning across multiple senses by associating information perceived through different senses?”* (Example: We present images of food to an animal along with a corresponding smell. The animal associates the image with the scent, so when it is searching for food and detects the learned odor, it knows that the associated food can be found).

Discrimination learning represents the ability for an animal to learn to react differently depending on whether it’s a rewarded stimulus or an unrewarded stimulus (Laska, 2015). The type of discrimination learning can be auditory (Kurt and Ehret, 2010), visual (Treviño *et al.*, 2013; Meagher *et al.*, 2020; Schumacher *et al.*, 2022), olfactory (Cohen, Putrino and Wilson, 2015; Laska, 2015) or texture mediated (Meagher *et al.*, 2020). With this information a representative survey question could be: *“Do you believe that the animals under your care are able to react differently depending on whether it’s a rewarded stimulus or an unrewarded one?”**. (Example: Animals might react differently to a husbandry cue depending on whether or not you are holding a food reward item)*

**2 - Evaluative-Richness**

It is the ability for an animal to evaluate changes in internal or external states. This dimension is related to the emotional states of animals (Birch, Schnell and Clayton, 2020). Evaluative-Richness can be investigated through “motivational trade-off (behaviour)”, “play”, “judgement biases” and “preference testing” (Dung and Newen, 2023). From this dimension we can formulate the following representative question: *“Do you believe that the animals under your care perceive and evaluate modification in their own internal or external states, and respond accordingly?”**. (Example: They perceive the change in temperature when they arrive in a cold or hot place and they perceive the change in their emotions when they move from well-being to sadness)*

Motivational trade-off (behaviour) tests the capacity for an animal to compromise between two choices (Gibbons *et al.*, 2022). In this test, an uncomfortable stimulus is applied to an animal (Gibbons *et al.*, 2022). We see if the animal prefers to endure the uncomfortable stimulus in order to get or to keep something he likes (Gibbons *et al.*, 2022) or if he rather gives up the thing he likes in order to end up with the uncomfortable stimulus (Adcock and Tucker, 2021). With this knowledge, a representative survey question could be: *“Do you think that the animals under your care are able to endure uncomfortable stimuli in order to get something they like?”**. (Example: They would be able to choose to endure electric shock or extreme temperature (very cold or very hot) in order to eat their favourite food)*

Providing a definition of play is a challenging task compared to other, more 'serious' behaviours, which are more easily definable (Palagi *et al.*, 2016). Play can be defined as spontaneous, enjoyable, and voluntary and it occurs when animals are free from environmental and social stress factors (Palagi *et al.*, 2016). Play requires a higher mental effort than most 'non-aggressive' behaviours because it demands advanced communication skills, improvisation, strategic timing, and creativity (Palagi *et al.*, 2016). In the light of this information we can formulate the following representative survey question: *“Do you consider that the animals under your care are capable of playing with other animals (of the same or other species)?”*

Judgement bias refers to the impact of emotions on the way ambiguous information is interpreted (Roelofs *et al.*, 2016). By having animals interpret ambiguous information, judgement bias is used to assess the mood of animals (Bateson and Nettle, 2015). To do so, animals undergo training to associate a positive stimulus with a reward and another stimulus with the absence of a reward (Bateson and Nettle, 2015). Then we present them with an ambiguous intermediate stimulus (Bateson and Nettle, 2015). Animals that respond to the ambiguous stimulus in the same way as the positive stimulus are considered to have a positive, optimistic mood, while those who respond in the same way as the negative stimulus are considered to have a negative, pessimistic mood (Bateson and Nettle, 2015). Based on this we can formulate the following survey question: *“Do you believe that the mood of animals under your care influences their judgement?”*. (Example: Animals' usual food bowl is placed empty in an unusual location. The animals might or not approach it depending on whether they interpret it as a feeding opportunity or not. Do you believe the animals under your care are more likely to approach it when they are in a good mood, compared to when they are in a bad mood, or experiencing negative emotions?)

Preference testing corresponds to the investigation of animals' preferences regarding various options (DePasquale, Sturgill and Braithwaite, 2020). Preference testing is used in the study of animal welfare and environmental enrichment (DePasquale, Sturgill and Braithwaite, 2020). In this test animals are offered several choices and their preferences are studied (DePasquale, Sturgill and Braithwaite, 2020). In the light of this knowledge, a representative survey question could be: *"Do you think that animals under your care can have preferences and attribute different values to different items or experiences?"**. (Example: Animals under your care are capable of attributing different values to different food items, rewards or enrichments, and will work harder to obtain those they prefer)*

**3- Integration at a time**

Integration at a time, also called "external synchronic unity", represents the ability for an animal to unify his perspective of an experiment at any given time (Dung and Newen, 2023) and to experience the world from a unique perspective (Birch, Schnell and Clayton, 2020). This dimension of consciousness can be investigated with "interocular transfer", "multi sensory integration" and "meta-control" (Dung and Newen, 2023). Based on this knowledge, a representative survey question could be: *"Do you believe that the animals under your care perceive the experiences they live in a unifying way?"**. (Example: An animal in search of food perceives the steps to get there—its movements, its discretion, its search for food or its hunt—as a continuous action and not as distinct events)*

Interocular transfer is a test that explores the capacity to transfer a learning from one eye to another (Ortega *et al.*, 2008). In this test animals learn a visual task within the visual field of one of their eyes, and the goal is to study if they are capable of performing the task in the visual field of the other eye (Ortega *et al.*, 2008). From this a representative survey question could be: *"Do you believe that the animals under your care have the capacity to perform a task in the visual field of one of their eyes when this task has been learned in the visual field of their opposite eye?"*. (Example: We cover the left eye of an animal and teach him to touch a mark with his head. Once he has learned the task, we cover its right eye instead and ask him to touch the mark again. The animal will be able to reproduce the experience with his left eye only)

Multi sensory integration represents the ability of an animal's brain to integrate information from various senses at the same time (Stein, Stanford and Rowland, 2014). Integration of several senses allows animals to have a better perception of a situation and thus make a decision in favour of their survival (Stein, Stanford and Rowland, 2014). With this information, a representative survey question could be: *"Do you believe that the animals under your care are able to assimilate information that comes from various senses at the same time?"**. (Example: They are able to see the movement of a bouncing ball and understand that the sound they hear at the same time is that of the ball. The same would apply for scents, tactile experiences in addition to acoustic and visual stimuli)*

Metacontrol corresponds to the dominance of one of the two cerebral hemispheres (Kavcic *et al.*, 2000), which inhibits the second and is more evident in species with cerebral asymmetry (Ünver, Xiao and Güntürkün, 2019). As each eye communicates with a respective hemisphere, Ünver, Xiao, and Güntürkün proposed an example of metacontrol in which animals are trained to perform monocular discrimination between a pair of stimuli. Once each hemisphere has learned to discriminate its stimuli, animals are then exposed binocularly to another pair of stimuli composed of the rewarded stimulus from each hemisphere, and the animals' reactions are studied (Ünver, Xiao and Güntürkün, 2019). A question to assess the respondents perception on this capability in animals could not be formulated.

**4 - Integration across time**

Integration across time, also called "external diachronic unity" (Dung and Newen, 2023) refers to animals' capacity to perceive the world and the events in an uninterrupted way (Birch, Schnell and Clayton, 2020). This dimension can be explored in animals through "apparent motion", "flicker-fusion threshold and considering the presence of a memory of objects and events, sufficient to recognize the identity of individuals or objects and understand the nature of occurring events (Dung and Newen, 2023). Based on this knowledge a representative survey question could be: *"Do you believe that animals under your care perceive the world and the events in an uninterrupted way?"*.* (Example: Do you think that the animals under your care perceive the world continuously, without interruption, while reacting to changes in their environment, and not as unrelated momentary events?)*

Apparent motion, also called illusory motion, is a visual illusion in which an animal perceives motion that is not identical to the actual motion present in the physical environment or when the object of their attention is completely static (Gori *et al.*, 2014). This phenomenon can be observed with a sequence of stationary lights that are flashed at precise intervals and is useful in order to analyse the mechanisms responsible for the perception of continuous motion in animals (Newsome, Mikami and Wurtz, 1986). With this knowledge a representative survey question could be: *"Do you believe that animals under your care can experience apparent motion?"* (Example: The same stationary object is presented in sequence to an animal, with different positions and at regular intervals. Despite the stationary nature of each individual frame, the rapid succession creates a visual illusion for the animals under your care, making them perceive the object in continuous motion).

Critical flicker-fusion represents the threshold at which intermittent illumination is perceived as continuous light (Landis and Hamwi, 1954). This allows the study of temporal resolution in animals (Lisney *et al.*, 2012), which corresponds to the time needed for an animal to acquire data to generate an image (Benjamin, Shaker and Rabbat, 2022). Critical flicker-fusion can be explored with electrophysiological or behavioural methods (Lisney *et al.*, 2012). Based on this information we can formulate the following survey question: *"Do you consider that the animals under your care can perceive, at a certain frequency, an intermittent illumination as continuous light?".* (Example: Intermittent light is presented to an animal. Gradually, the flicker frequency of this light is increased until reaching a threshold where the animal perceives a steady light instead of a flickering one)

**5- Self-consciousness**

Self-consciousness represents the ability for an animal to perceive itself as different from the world and be aware of it (Birch, Schnell and Clayton, 2020). Self-consciousness can be investigated with "bodily/body awareness", "mirror self recognition" and "mental time travel" (Dung and Newen, 2023). With this understanding, a representative survey question could be: *"Do you think that the animals under your care are aware of their own body position or movement?".*

Bodily/Body self-awareness represents the animal's knowledge of its own body in relation to its environment (Dale and Plotnik, 2017). It relies on the awareness of position and movement of the body and its parts and the awareness of the body's sensations (DeGrazia, 2009). This capacity can be evaluated with tests where the animal's own body prevents him from performing a task (Dale and Plotnik, 2017). In light of this information, we could use the following question as a representative survey question: *"Do you think that the animals under your care are able to understand that their own body prevents them from successfully resolving a problem?"**. (Example: they are able to understand that their size prevents them from passing through a narrow path)*

Mirror self recognition is a well-known method to investigate if an animal can recognize itself (Gallup, 1970). This test is based on the observation of animal's behaviour in reaction to themselves in the mirror with or without a mark (Gallup, 1970). Based on this information we can formulate a representative survey question: *"Do you believe that the animals under your care are able to recognize themselves in a mirror? (as distinct from another individual of the same or other species)"**.

Mental time travel represents an animal's capacity to remember events in its own past (episodic memory) and to project itself into the future (Suddendorf and Corballis, 2007). Investigations of mental time travel are based on the denial of the Bischof-Köhler hypothesis which states that animals are not able to prevent future needs that are different from their actual one's (Cheke and Clayton, 2012). With this knowledge, a representative survey question could be: *"Do you think that the animals under your care are able to remember events that happened to them in the past?"**. (Example: They are able to remember the loss of a loved one, or where they stored food)* (In the survey, this question was changed to the section on the "Integration across time" dimension because the specific example used was more relevant to that dimension) or even *"Do you believe that the animals under your care are able to plan their future, to act for their future needs?"**. (Example: They are able to anticipate and setting aside food for their future needs)* (In the survey, this question was changed to the section on the "Abstraction" dimension because the specific example used was more relevant to that dimension)

**6 - Experience of Agency**

The experience of agency refers to whether the animal feels that its actions are voluntarily controlled by itself, rather than just things that happen to it (Dung and Newen, 2023). The authors provide examples of tests used to determine if animals can experience agency such as "response-inhibition" and "delayed gratification tests". Based on this dimension, a representative survey question could be: *"Do you think that the animals under your care are able to understand that they are the one who controls their own actions?"*. (Example: An animal in search of food is aware that the outcome of his search will depend on his ability to control, his actions, his discretion, his speed, his agility, and his adaptation to the prey he pursues or the food he seeks to acquire).

Response inhibition is the ability for an animal to restrain his automatic reactions in order to respond to a stimulus more appropriately (Szabo, Noble and Whiting, 2019). This capacity has been tested with the detour reaching tasks (Vlamings, Hare and Call, 2010) and the object displacement tasks (Barth and Call, 2006). Based on this knowledge, a representative survey question could be: *"Do you think that the animals under your care are able to consciously control their automatic reactions in order to respond more adequately to a stimulus?"*. (Example: An animal suddenly hears a loud and frightening noise, but is able to consciously control his automatic reaction to flee or attack in order to respond more appropriately and ensure its safety)

Detour reaching tasks evaluate the capacity for an animal to develop indirect strategies to reach a reward when reaching directly the reward is not possible (Vlamings, Hare and Call, 2010). In this task animals have to make a detour around a transparent barrier in order to get the reward (Taylor *et al.*, 1990). The visual information of the reward right in front of the subject contradicts the tactile information suggesting the presence of a barrier (Taylor *et al.*, 1990). Variations of the initial test can be conducted, as seen in the article by Vlamings, Hare and Call (2010), where the animal has to reach around a barrier to access the reward. In the light of this information, we can formulate the following representative survey question: *"Do you think that the animals under your care are able to understand when they cannot directly achieve a reward and therefore implement indirect strategies to achieve it?"**. (Example: Animals are placed in front of a transparent box with food inside that they cannot reach directly. On the side of this box there is a small trap that they can open to reach the food. Animals are able to understand it and reach the food through this trap)*

The ability essential for an animal to track objects, to remember where food is located, is investigated with the object displacement task (Barth and Call, 2006). In this task, an animal must find an object hidden under a cup, which is then moved among other cups (Barth and Call, 2006). Animal's ability to understand that the object continues to exist even when it is not visible, and to remember the location of the object, is evaluated (Barth and Call, 2006). Based on this information, a representative survey question could be: *"Do you believe that the animals under your care are able to remember the localisation of objects?"*. (Exemple: According to you, do the animals under your care have the ability to remember that they found food in a specific location and return to it?)

Delayed gratification is the ability for an animal to forgo an immediate reward in order to access a better one in the long term (Beran, 2002). Binary choice tests are a way to test animals ability to delay gratification by presenting them with two choices, they can either take the reward now or wait (Anderson, Kuroshima and Fujita, 2010). Binary choice tests can be realised by presenting food (Stevens, Hallinan and Hauser, 2005) or comestible tools that can be used to get a more preferred food (Evans and Westergaard, 2006). Some of the binary choice tests allowed animals to modify their choice once made, in order to analyse commitment to the initial choices (Evans and Beran, 2007). But in most of these tests, once the animal makes a choice he can no longer change it (Evans and Beran, 2007). With this concept, a representative survey question could be: *"Do you think that the animals under your care are able to forgo an immediate reward in order to obtain a better one in the long term?"**. (Example: We present a piece of food to an animal but hold a favourite food item in our hand. It can either take the food or wait in order to receive the preferred food later. The animal is capable of understanding and waiting for the preferred food)*

Delay maintenance tasks enable the study of the degree of self-control. They analyse at which point the animal is no longer able to control himself (Evans and Beran, 2007). There are different types of delay maintenance tasks, either the addition of rewards one by one until the animal chooses to obtain the accumulated reward, or the reward is permanently available and the animal has to control himself continuously to get the better one (Evans and Beran, 2007). With this information, a representative survey question would be: *"Do you believe that the animals under your care can learn to control themselves and their impulses, even in front of a significant amount of food, in order to get a larger or a better reward ?"*. (Example: An animal has in front of him, at his disposal, a piece of food that he prefers. In front of him is placed a bowl filled with this same food. A keeper gives the animal food one by one until the animal takes the food but stops adding food once the animal eats. The animals under your care are able to control their desire to eat the available food because they understand that they can get all the food in the bowl).

**7 - Experience of Ownership**

The experience of ownership represents the capacity for an animal to perceive its body parts as belonging to him (Dung and Newen, 2023). "Body-world discrimination" and "rubber-hand or rubber-tail illusions" are ways to test this capacity (Dung and Newen, 2023). According to this we can formulate the following survey question: *"Do you believe that the animals under your care are able to perceive their body parts as their own?"**.

No article was found including the definition of the term Body-world discrimination.

Rubber-hand and rubber-tail illusions are experiments that test the ability for an animal to perceive body-parts as his own (Shokur *et al.*, 2013; Wada *et al.*, 2016). In these experiments, the hand or the tail of the animal is hidden and replaced by a fake one visible to the animal (Shokur *et al.*, 2013). Both are touched simultaneously, or separately and the animal response is measured (Shokur *et al.*, 2013). Based on these experiments, a representative survey question could be: *"Do you believe that the animals under your care are able to consider a rubber-hand or rubber-tail as their own hand or tail ?"**. (Example: The animals will recognize or react to a replica of one of their body parts (placed in proximity to the real part) as if it were their own)*

**8 - Reasoning**

Reasoning represents the ability to form thoughts and develop reasoning in different areas (Dung and Newen, 2023). It is possible to investigate this dimension through: "transitive inference", "mindreading", "metacognition" and "tool-use" (Dung and Newen, 2023). Based on this dimension of consciousness, a representative survey question could be: *"Do you think that the animals under your care can have developed thoughts and reason on a subject?"*.

Transitive inference is a form of reasoning where an animal, from initial information, manages to deduce a logical conclusion (Vasconcelos, 2008). It may be investigated with the "n-term" series task (Vasconcelos, 2008). From this knowledge, we can formulate a representative survey question: *"Do you think that the animals under your care are capable of inferring logical conclusions from initial information?"**. (Example: When an animal notices the surroundings getting darker (initial information), it will seek shelter to protect itself from a possible danger)*

The "n-term" series task is a method initially used for the study of children that has been adapted to the study of animals (Vasconcelos, 2008). In this task, a precise number of stimuli (n) is presented to an animal. Animals have reinforcement information only between adjacent stimuli (A and B or B and C) and their ability to infer results between non-adjacent stimuli (A and C) is evaluated (Vasconcelos, 2008). With this knowledge a representative survey question could be: *"Do you think that animals under your care can anticipate outcomes between two non-adjacent stimuli using results from comparisons between adjacent stimuli?"*. (Example: An animal is presented with images of fruits, some of which are associated with a reward. The animal learns that if it chooses the banana image (A) over the apple image (B), it will be rewarded. Similarly, if it chooses the apple image (B) over the orange image (C), it will be rewarded. If the banana image (A) and the orange image (C) are then presented, the animal will choose the banana image (A) through deduction)

Mindreading, also known as Theory of Mind (Hill *et al.*, 2018) is the capacity for an animal to infer other's thoughts, mental states, desires, beliefs and even goals (Krupenye and Call, 2019). It is used as a criterion to assess an evolved social cognition similar to that of humans and serves as a marker of cognitive sophistication in the realm of social interactions (Kano *et al.*, 2019). This capacity allows animals to communicate, to understand, interpret or predict other's actions (Krupenye and Call, 2019). This dimension can be explored through experiments such as the "desire-understanding sharing experiment", and the false belief experiments (Krupenye and Call, 2019). Based on this information, we can formulate the following representative survey question: *"Do you think that the animals under your care are capable of consciously deducing the thoughts, mental states, desires, beliefs and even the goals of others ?"**. (Example: Two animals face each other separated by a barrier. Only one of them receives food. The one who has received food is able to deduce that the other's desire to eat and hopes to receive food also)*

The desire-understanding sharing experiment is a method that studies the capacity for an animal to understand and respond to another's desire (Krupenye and Call, 2019). To do this, a specific food desire is induced in one animal, and the reaction of an adjacent animal that possesses this food is (Krupenye and Call, 2019). From this experiment, a representative survey question could be: *"Do you believe that the animals under your care are able to deduce another's desires and help satisfy them?"* (Example: Two animals face each other, separated by a barrier. Only one of them receives food. The one who has received food deduces the other's desire to receive the same food and shares it with him) (or even "Do you think that the animals under your care can understand and share the desired food with another?" *(Example: Two animals face each other, separated by a barrier. Only one of them receives food. The one who has received food deduces the other's desire to receive the same food and shares it with him. Even if he desires this food too)*, "Do you believe that the animals under your care are able to voluntarily share their food to meet the desire of another?" *(Example: Two animals face each other, separated by a barrier. Only one of them receives food. The one who has received food deduces the other's desire to receive the same food and shares it with him)*.

The false belief experiment is a standard test to assess "Theory of Mind", but while numerous studies have been conducted in humans, there have been few studies conducted in animals (O'Connell and Dunbar, 2003). Understanding false beliefs means recognizing that the actions of others are influenced not by the actual state of things but by their beliefs about reality. It involves an awareness that these beliefs might be different from one's own (Kano *et al.*, 2019). This experiment involves placing an animal in a situation where another animal has a false belief about the location or the nature of an object, to see if the animal reacts, taking into account that incorrect belief (Kano *et al.*, 2019). In the light of this information, a representative survey question could be: *"Do you believe that the animals under your care are able to recognize that the actions of others are influenced by their beliefs?"**. (Example: An animal is presented with an object that is then hidden under a cup in its presence. When the animal is absent, the object is moved under another cup. Another animal observes the scene. He knows the new location of the object and instinctively looks at the initial cup when the first animal returns. He anticipates its counterpart's false belief, knowing that the first animal thinks the object is still at its initial position)*

Metacognition involves the awareness and comprehension of an animal's own mental process and cognitive states (Foote and Crystal, 2007). In order to test whether an animal exhibits metacognition, it is subjected to a duration-discrimination test (Foote and Crystal, 2007). The animal has the option to either perform or refuse the test (Foote and Crystal, 2007). Refusing the test is associated with a small reward, succeeding in the test is associated with a large reward, while failure is associated with no reward (Foote and Crystal, 2007). If the animal possesses metacognition, it will more often refuse to take the test when the difficulty is high (Foote and Crystal, 2007). Regarding this information, a representative survey question could be: *"Do you believe that the animals under your care are aware of their own mental process and cognitive states?"* (Example: The animal is capable of recognizing that a test is too difficult for him and, therefore, chooses not to respond to it)

Tool-use involves the act of modifying the shape, position, or state of another object, organism, or the user themselves while holding or carrying the tool during or just before its use (Seed and Byrne, 2010). Long considered as unique to the human species, the ability to use tools has been demonstrated in certain animals such as elephants, dolphins, chimpanzees, as well as in some bird species (Striedter, 2013). The question of whether animals use tools for a specific purpose has been raised and explored in certain animal species where investigation was possible (Seed and Byrne, 2010). It has been found that in some species (especially chimpanzees, capuchin monkeys, and New Caledonian crows) tool use is guided for specific purposes (Seed and Byrne, 2010). In light of this information, a representative survey question could be: *"Do you believe that the animals under your care are able to use tools for a specific purpose?"**. (Example: Do you believe that the animals under your care are able to use a tool in order to get food?)*

**9 - Learning**

Animals' ability to learn things can be investigated with "trace conditioning", "reversal learning", "imitation learning" and "one trial learning" (Dung and Newen, 2023). From this dimension, a representative survey question could be: *"Do you think that the animals under your care are able to learn things or learn to do things?"**.

Trace conditioning is a way to study animals' capacity to learn to associate events separated in the time (Moye and Rudy, 1987). This associative learning can be evaluated through auditory, taste, visual and olfactory systems (Moye and Rudy, 1987). With this information a representative survey question could be: *"Do you think that the animals under your care are able to learn to associate two distant events in time?"**. (Example: They associate the sound of a bell with the delivery of food some time later)*

Reversal learning represents the ability for an animal to learn to make a discrimination between two stimuli and then to reverse his choice when both stimuli are redefined (Bublitz *et al.*, 2017). To do so, the animal has to learn to respond to a positive stimulus (Bublitz et al., 2017). Once the animal shows a high success rate of response, the stimulus is redefined: the positive stimulus becomes the negative one, and vice versa. If the animal reverses his choice, it indicates that he has 'learned to learn'. With this knowledge, a representative survey question could be: *"Do you think that the animals under your care are* *able to learn to discriminate between two choices and then reverse their choice when the two stimuli are redefined?"*. (Example: Two different images are presented to an animal. When the animal chooses the image with a tree, he receives a reward (positive stimulus), and when he chooses the image with a sun, he receives nothing. When the animal has a high success rate in choosing the image with a tree, the image associated with the reward becomes the one with a sun. The animal adapts, changes his choice, and selects the image with the sun)

Imitation learning represents animals' ability to learn to reproduce the action of someone else (Buttelmann *et al.*, 2007). In some cases animal imitation is adaptive (Bates and Byrne, 2010). By copying the current behaviour of other group members, individuals of social species can benefit from the knowledge of others and escape predators (Bates and Byrne, 2010). Behavioural synchrony, goal emulation, social mimicry, and contextual imitation are examples of imitation learning (Bates and Byrne, 2010). Based on this knowledge, we can formulate the following representative survey question: *"Do you believe that the animals under your care are able to reproduce the actions of another animal by imitation?"*.*

Behavioural synchrony, also known as contagion, refers to the phenomenon where animals copy the behaviour of other group members in a synchronised way (Bates and Byrne, 2010). Behavioural synchronisation requires that the animal recognize the action of others; Group grooming or coordinated movements during bird flights are examples of behavioural synchronisation (Bates and Byrne, 2010). In the light of this knowledge we can formulate the following survey question: *"Do you think that animals under your care are able to copy the behaviour of other group members synchronously?"*. (Example: The animals under your care are capable of joining others and imitating their behaviour at the same time for hunting or moving in a coordinated manner)

Goal emulation represents the fact that an animal is influenced after observing another animal achieve a goal and receive a reward (Bates and Byrne, 2010). Goal emulation involves an understanding of the motivations and objectives of others (Bates and Byrne, 2010). From this information a representative survey question could be: *"Do you believe that the animals under your care, after observing others achieve a goal and receive a reward, are influenced and attempt to achieve the same reward?"*.* (Example: An animal observes one of its conspecifics successfully obtaining food using a particular technique. The animal is then influenced and attempts to reproduce the same technique to achieve the same goal)*

Social mimicry consists of animals imitating the facial expressions, postures or manners of other animals in order to communicate a social message with them (Bates and Byrne, 2010). Contagious yawning and greeting are examples of this type of imitation (Bates and Byrne, 2010). Considering this information a representative survey question could be: *"Do you believe that the animals under your care are capable of imitating the facial expressions, postures or manners of other animals to communicate a social message?"*. (Example: When animals exhibit specifics sounds, gestures or body positions, the animals under your care will imitate the same patterns to convey a social message)

Contextual imitation refers to the imitation of actions or behaviours, already known to the animal that imitates the other, applied to a new context (Bates and Byrne, 2010). In the light of this information a representative survey question could be: *"Do you believe that the animals under your care can mimic actions* *they are already familiar with, but in a context different from their usual?"**. (Example: The animals under your care have developed specific food-seeking behaviours. If placed in a different environment, they will replicate these same behaviours)*

**10 - Abstraction**

Abstraction is the act of focusing on a specific characteristic of something, disregarding the rest, and applying this focus to everything that shares that same characteristic (Galizio and Bruce, 2018). This dimension can be investigated with "conceptual categorization" and "perspective-taking" (Dung and Newen, 2023). Based on this dimension we can formulate the following representative survey question: *"Do you think that the animals under your care are able to focus on something specific disregarding the rest and apply this to over elements that share this same characteristic?"*.* (Example: The animals under your care encounter shiny and matte objects in their environment. When they retrieve shiny objects, they receive a reward. Subsequently, they develop an abstraction by focusing solely on shiny objects)*

Conceptual categorisation refers to animals' capacity to recognise and categorise elements into categories (Martin-Malivel and Fagot, 2001). Unlike perceptual categorisation, conceptual categorisation is based on an understanding of the nature and functions of objects, as well as their roles in various events (Arterberry and Bornstein, 2002). In the light of this information, a representative survey question could be: *"Do you consider that the animals under your care are able to categorise elements into categories according to their nature, functions and roles?"**. (Example: Animals under your care recognise and categorise a wooden stick and a stone in the category: "tools used to get food")*

Perspective-taking represents the ability for an animal to see the world from another animal's point of view (Labash *et al.*, 2020). It relies on communication, memory, language, and perception and plays a fundamental role in understanding social dynamics across various situations (Labash *et al.*, 2020). It is a useful way for animals to infer what other animals know and anticipate what they will do next (Huber and Lonardo, 2023). From this information, a representative survey question could be: *"Do you conceive that the animals under your care are able to see the world from another animal's point of view?"**.
(* Questions and examples chosen for the survey)

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**Table S1.1** Summary of dimensions, investigation methods, corresponding questions, and examples used in the survey ([1] Questions and examples originally within the dimension "Self consciousness").

| Dimension | Investigation methods | Survey's affirmation about animals | Example |
|---|---|---|---|
| Perceptual Richness | ▪ Perceptual categorization<br>▪ Cross-modal learning<br>▪ Discrimination learning | They can recognize elements in their surroundings and categorize them | They see a keeper and are able to classify him into the category "Human", or they see an insect, a fruit, a bottle of milk or a meat, and classify it into the category "Food" |
| | | The animals of this species are able to react differently to a stimulus, depending on whether it's a rewarded stimulus or an unrewarded one | Animals might react differently to a husbandry cue depending on whether or not you are holding a food reward item |
| Evaluative Richness | ▪ Motivational trade-off (behaviour)<br>▪ Play<br>▪ Judgement bias<br>▪ Preference testing | They can perceive and evaluate their own internal or external environments, and respond accordingly | They perceive the change in temperature when they arrive in a cold or hot place and they perceive the change in their emotions when they move from well-being to sadness |
| | | They are able to endure uncomfortable stimuli in order to get something they like | They would be able to chose to endure electric shock or extreme temperature (very cold or very hot) in order to eat their favourite food |
| | | They can have preferences and attribute different values to different items or experiences | The animals under your care are capable of attributing different values to different food items, rewards or enrichments, and will work harder to obtain those they prefer |

| | | | |
|---|---|---|---|
| Integration at a time | ▪ Interocular transfer<br>▪ Multi sensory integration Meta-control | They perceive the experiences they live in a unifying way | An animal in search of food perceives the steps to get there—its movements, its discretion, its search for food or its hunt—as a continuous action and not as distinct events |
| | | They are able to assimilate information that comes from various senses at the same time | They are able to see the movement of a bouncing ball and understand that the sound they hear at the same time is that of the ball. The same would apply for scents, tactile experiences in addition to acoustic and visual stimuli |
| Integration across time | ▪ Apparent motion<br>▪ Flicker-fusion threshold<br>▪ Memory of objects and events | They are able to remember events that happened to them in the past [1] | They are able to remember the loss of a loved one, or where they stored food [1] |
| | | They perceive the world and the events in an uninterrupted way | Do you think that the animals under your care perceive the world continuously, without interruption, while reacting to changes in their environment, and not as unrelated momentary events? |
| Self consciousness | ▪ Bodily/Body awareness<br>▪ Mirror self recognition<br>▪ Mental time travel | They are able to understand that their own body prevents them from successfully resolving a problem | They are able to understand that their size prevents them from passing through a narrow path |
| | | They are able to recognize themselves in a mirror (as distinct from another individual of the same or other species) | |
| Experience of Agency | ▪ Response-inhibition | They are able to understand when they cannot directly achieve a reward and | Animals are placed in front of a transparent box with food inside that they cannot reach directly. On the side of this box there is a small trap that they can open to reach the food. Animals are able to understand it and reach the food through this trap |

| | | | |
|---|---|---|---|
| | ▪ Delayed gratification tests | therefore implement indirect strategies to achieve it | |
| | | They are able to forgo an immediate reward in order to obtain a better one in the long term | You present a piece of food to an animal but show a favourite food item in your hand. It can either take the food or wait in order to receive the preferred food later. The animal is capable of understanding and waiting for the preferred food |
| Experience of Ownership | ▪ Body-world discrimination<br>▪ Rubber-hand or rubber-tail illusions | They perceive their body parts as their own | |
| | | They consider a rubber-hand or rubber-tail as their own hand or tail | The animals will recognize or react to a replica of one of their body parts (placed in proximity to the real part) as if it were their own |
| Reasoning | ▪ Transitive inference<br>▪ Mindreading<br>▪ Metacognition<br>▪ Tool-use | They are capable of inferring logical conclusions from initial information | When an animal notices the surroundings getting darker (initial information), it will seek shelter to protect itself from a possible danger |
| | | They are capable of consciously deducing the thoughts, mental states, desires, beliefs and even the goals of others | Two animals face each other separated by a barrier. Only one of them receives food. The one who has received food is able to deduce that the other desires to eat and hopes to receive food also |
| | | They are able to recognize that the actions of others are influenced by their beliefs | An animal is presented with an object that is then hidden under a cup in its presence. When the animal is absent, the object is moved under another cup. Another animal observes the scene. He knows the new location of the object and instinctively looks at the initial cup when the first animal returns. He anticipates its counterpart's false belief, knowing that the first animal thinks the object is still at its initial position |
| | | They are able to use tools for a specific purpose | Do you believe that the animals under your care are able to use a tool in order to get food? |
| Learning | ▪ Trace conditioning<br>▪ Reversal learning<br>▪ Imitation learning<br>▪ One trial learning | They are able to learn things or learn to do things | |
| | | They can learn to associate two events distant in time | They associate the sound of a bell with the delivery of food some time later |

| | | | |
|---|---|---|---|
| | | They are able to reproduce the actions of another animal by imitation | |
| | | After observing others achieve a goal and receive a reward animals under your care can be influenced and attempt to achieve the same reward. | An animal observes one of its conspecifics successfully obtaining food using a particular technique. The animal is then influenced and attempts to reproduce the same technique to achieve the same goal |
| | | They can mimic actions they are already familiar with, but in a context different from their usual | The animals under your care have developed specific food-seeking behaviours. If placed in a different environment, they will replicate these same behaviours |
| Abstraction | ▪ Conceptual categorization<br>▪ Perspective-taking | They are able to plan their future, to act for their future needs [1] | They are able to anticipate and setting aside food for their future needs[1] |
| | | They are able to focus on something specific, disregarding the rest, and apply this to other elements that share this same characteristic | The animals under your care encounter shiny and matte objects in their environment. When they retrieve shiny objects, they receive a reward. Subsequently, they develop an abstraction by focusing solely on shiny objects |
| | | They are able to categorise elements into categories according to their nature, functions and roles | Animals under your care recognise and categorise a wooden stick and a stone in the category: "tools used to get food" |
| | | They are able to see the world from another animal's point of view | |

## Supplementary Material 2 (S2)

The full questionnaire can be accessed through the following link:
https://docs.google.com/forms/d/1EyuVdSYrujX1mi8cUpTBbJ9CQ4jSDeWvinyWWcBGCwg/edit;

# Supplementary Material 3 (S3)

**Table S3.1** Demographic characterisation of responses

| Variable | Level | n | % |
|---|---|---|---|
| Country of residence * | Africa | 8 | 8,70 |
| | America | 26 | 28,26 |
| | Asia | 3 | 3,26 |
| | Europe | 52 | 56,52 |
| | Oceania | 3 | 3,26 |
| | Total (N) | 92 | 100 |
| Nationality * | Africa | 7 | 7,61 |
| | America | 22 | 23,91 |
| | Asia | 6 | 6,52 |
| | Europe | 50 | 54,35 |
| | Oceania | 4 | 4,35 |
| | Multiple | 3 | 3,26 |
| | Total (N) | 92 | 100 |
| Age | 18-24 | 6 | 6.52 |
| | 25-34 | 35 | 38.04 |
| | 35-44 | 26 | 28.26 |
| | 45-54 | 16 | 17.39 |
| | 55-64 | 6 | 6.52 |
| | 65-74 | 3 | 3.26 |
| | Total (N) | 92 | 100 |
| Gender | Feminine | 56 | 60.87 |
| | Masculine | 36 | 39.13 |
| | Total (N) | 92 | 100 |
| Level of education | BSc | 27 | 29.35 |
| | MSc | 31 | 33.70 |
| | PhD | 19 | 20.65 |
| | Primary and secondary education | 15 | 16.30 |
| | Total (N) | 92 | 100 |
| Profession | Biologist, ecologist and conservationist | 32 | 34.78 |
| | Ethologist | 2 | 2.17 |
| | Keeper, caretaker and rehabilitator | 24 | 26.09 |
| | Other | 3 | 3.26 |
| | Veterinarian | 27 | 29.35 |
| | Veterinary technician and nurse | 4 | 4.35 |
| Work time duration | Minimum | Maximum | Average |
| | 0 | 52 | 9,96 ±9,23 |

**Table S3.2** Distribution of the country of residence of the participants

| Country of residence | n |
|---|---|
| Argentina | 2 |
| Australia | 2 |
| Austria | 4 |
| Belize | 1 |
| Botswana | 1 |
| Brazil | 6 |
| Bulgaria | 1 |
| Canada | 2 |
| Cayman Islands | 1 |
| Chile | 1 |
| Costa Rica | 1 |
| France | 24 |
| Germany | 1 |
| India | 3 |
| Ireland | 1 |
| Kenya | 1 |
| Kosovo | 2 |
| Namibia | 1 |
| New Zealand | 1 |
| Panama | 1 |
| Portugal | 10 |
| Prishtin | 1 |
| South Africa | 5 |
| Spain | 6 |
| UK | 2 |
| USA | 10 |
| Uruguay | 1 |
| Total (N) | 92 |

**Table S3.3** Distribution of the nationality of the participants

| Nationality | n |
|---|---|
| Albanian | 2 |
| American | 7 |
| Argentinian | 2 |
| Australian | 3 |
| Austrian | 3 |
| Belgian | 1 |
| Brazilian | 6 |
| British | 1 |
| Bulgarian | 1 |
| Canadian | 2 |
| Caucasian | 2 |
| Chilean | 1 |
| Costa Rican | 1 |
| French | 22 |
| German | 2 |
| Indian | 3 |
| Irish | 1 |
| Israeli | 1 |
| Italian | 1 |
| Jamaican | 1 |
| Kenyan | 1 |
| Motswana | 1 |
| New Zealander | 1 |
| Panamenian | 1 |
| Portuguese | 10 |
| Several | 3 |
| South African | 5 |
| Spanish | 4 |
| Swiss | 1 |
| Uruguayan | 1 |
| Kosovar | 1 |
| Total (N) | 92 |

**Table S3.4** Taxonomic class, order and family of animals participants chose to respond about (* These responses were excluded from further statistical analysis, as they did not adhere to the rule of focusing on a single specie)

| Class | Ordem | Family |
|---|---|---|
| Actinopterygii (n=1, 1,09%) | Anguilliformes (n=1, 1,09%) | Anguillidae (n=1, 1,09%) |
| Aves (n=24, 26,09%) | Accipitriformes (n=8, 8,70%) | Accipitridae (n=7, 7,61%) |
| | | Pandionidae (n=1, 1,09%) |
| | Apodiformes (n=1, 1,09%) | Apodidae (n=1, 1,09%) |
| | Charadriiformes (n=2, 2,17%) | Laridae (n=2, 2,17%) |
| | Falconiformes (n=1, 1,09%) | Falconidae (n=1, 1,09%) |
| | Galliformes (n=1, 1,09%) | Phasianidae (n=1, 1,09%) |
| | Passeriformes (n=2, 2,17%) | Ploceidae (n=1, 1,09%) |
| | | Dasyornithidae (n=1, 1,09%) |
| | Phoenicopteriformes (n=1, 1,09%) | Phoenicopteridae (n=1, 1,09%) |
| | Psittaciformes (n=1, 1,09%) | Strigopidae (n=1, 1,09%) |
| | Sphenisciformes (n=2, 2,17%) | Spheniscidae (n=2, 2,17%) |
| | Strigiformes (n=4, 4,35%) | Tytonidae (n=2, 2,17%) |
| | | Strigidae (n=2, 2,17%) |
| | Suliformes (n=1, 1,09%) | Sulidae (n=1, 1,09%) |
| Cephalopoda (n=1, 1,09%) | Octopoda (n=1, 1,09%) | Octopodidae (n=1, 1,09%) |
| Chondrichthyes (n=1, 1,09%) | Carcharhiniformes (n=1, 1,09%) | Sphyrnidae (n=1, 1,09%) |
| Insecta (n=1, 1,09%) | Odonata (n=1, 1,09%) | Lestidae (n=1, 1,09%) |
| Mammalia (n=47, 51,09%) | Artiodactyla (n=6, 6,52%) | Balaenopteridae (n=1, 1,09%) |
| | | Bovidae (n=2, 2,17%) |
| | | Cervidae (n=1, 1,09%) |
| | | Delphinidae (n=1, 1,09%) |
| | | Giraffidae (n=1, 1,09%) |
| | Carnivora (n=19, 20,65%) | Felidae (n=8, 8,70%) |
| | | Canidae (n=2, 2,17%) |
| | | Ursidae (n=9, 9,78%) |
| | Chiroptera (n=1, 1,09%) | Vespertilionidae (n=1, 1,09%) |
| | Eulipotyphla (n=5, 5,43%) | Erinaceidae (n=5, 5,43%) |
| | Perissodactyla (n=4, 4,35%) | Rhinocerotidae (n=1, 1,09%) |
| | | Equidae (n=3, 3,26%) |
| | Pilosa (n=1, 1,09%) | Choloepodidae (n=1, 1,09%) |
| | Primates (n=6, 6,52%) | Atelidae (n=3, 3,26%) |
| | | Hominidae (n=3, 3,26%) |
| | Proboscidea (n=4, 4,35%) | Elephantidae (n=4, 4,35%) |
| | Rodentia (n=1, 1,09%) | Caviidae (n=1, 1,09%) |
| Reptilia (n=12, 13,04%) | Crocodilia (n=2, 2,17%) | Gavialidae (n=1, 1,09%) |
| | | Crocodylidae (n=1, 1,09%) |
| | Squamata (n=3, 3,26%) | Elapidae (n=2, 2,17%) |
| | | Iguanidae (n=1, 1,09%) |
| | Testudines (n=7, 7,61%) | Cheloniidae (n=4, 4,35%) |
| | | Podocnemididae (n=1, 1,09%) |
| | | Emydidae (n=1, 1,09%) |
| | | Dermochelyidae (n=1, 1,09%) |
| | Several * (n=5, 5,43%) | |

# Supplementary Material 4 (S4)

**Table S4.1** Distribution of the averages and STDEV obtained for each question on animal consciousness

| Questions | Average | STDEV | n |
|---|---|---|---|
| Q28 | 1,89 | 1,08 | 82 |
| Q15 | 2,16 | 1,02 | 79 |
| Q18 | 2,27 | 1,28 | 81 |
| Q19 | 2,30 | 1,41 | 86 |
| Q11 | 2,52 | 1,27 | 82 |
| Q25 | 2,65 | 1,46 | 84 |
| Q13 | 2,68 | 1,34 | 84 |
| Q27 | 2,77 | 1,45 | 83 |
| Q26 | 2,94 | 1,36 | 82 |
| Q4 | 3,07 | 1,30 | 87 |
| Q17 | 3,08 | 1,40 | 84 |
| Q12 | 3,29 | 1,37 | 84 |
| Q23 | 3,34 | 1,39 | 86 |
| Q22 | 3,36 | 1,46 | 86 |
| Q10 | 3,62 | 1,27 | 85 |
| Q24 | 3,65 | 1,26 | 86 |
| Q9 | 3,76 | 1,08 | 83 |
| Q5 | 4,05 | 1,22 | 87 |
| Q8 | 4,07 | 1,15 | 86 |
| Q21 | 4,08 | 1,25 | 85 |
| Q2 | 4,09 | 1,20 | 86 |
| Q20 | 4,14 | 1,19 | 86 |
| Q14 | 4,15 | 1,05 | 86 |
| Q6 | 4,17 | 0,97 | 86 |
| Q7 | 4,34 | 0,89 | 87 |
| Q16 | 4,36 | 0,88 | 87 |
| Q3 | 4,43 | 0,88 | 87 |
| Q1 | 4,50 | 0,85 | 86 |

**Table S4.2** Distribution of the averages and STDEV obtained for each dimension of animal consciousness from which questions are derived.

| Dimensions of animal consciousness from which questions are derived | Average | STDEV |
|---|---|---|
| Abstraction (Q25, Q26, Q27, Q28) | 2,56 | 1,40 |
| Experience of Agency (Q12, Q13) | 2,98 | 1,38 |
| Reasoning (Q16, Q17, Q18, Q19) | 3,00 | 1,52 |
| Self-consciousness (Q10, Q11) | 3,07 | 1,38 |
| Experience of Ownership (Q14, Q15) | 3,16 | 1,43 |
| Learning (Q20, Q21, Q22, Q23, Q24) | 3,71 | 1,35 |
| Evaluative-Richness (Q3, Q4, Q5) | 3,85 | 1,28 |
| Integration across time (Q8, Q9) | 3,91 | 1,12 |
| Integration at a time (Q6, Q7) | 4,26 | 0,93 |
| Perceptual-Richness (Q1, Q2) | 4,30 | 1,06 |

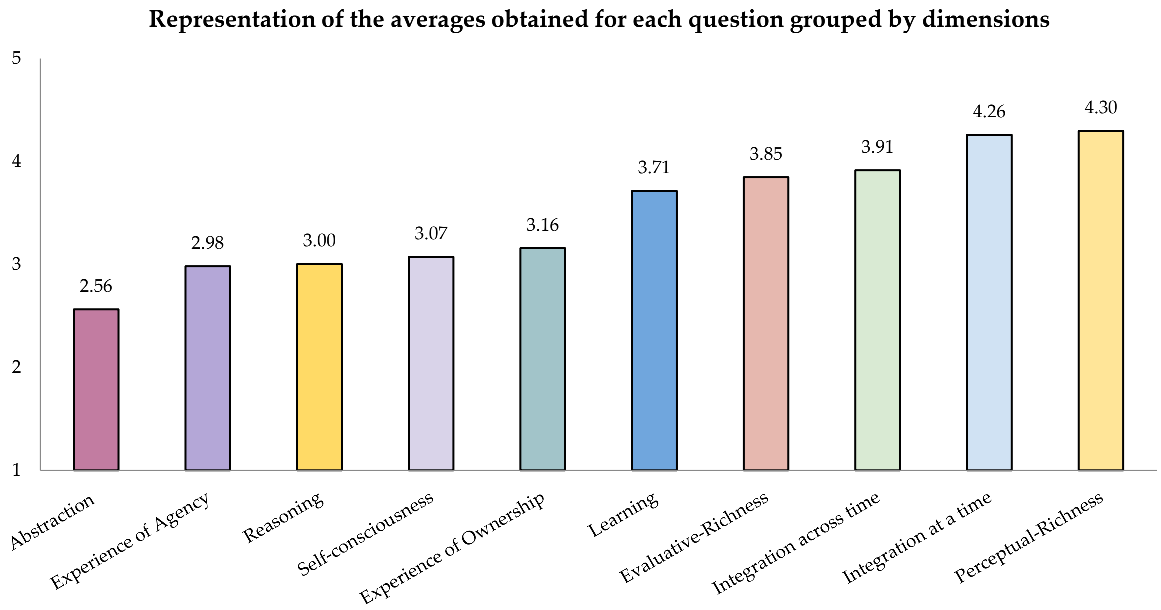


**Figure S4.1** Representation of the averages obtained for each dimension of animal consciousness from which questions are derived.

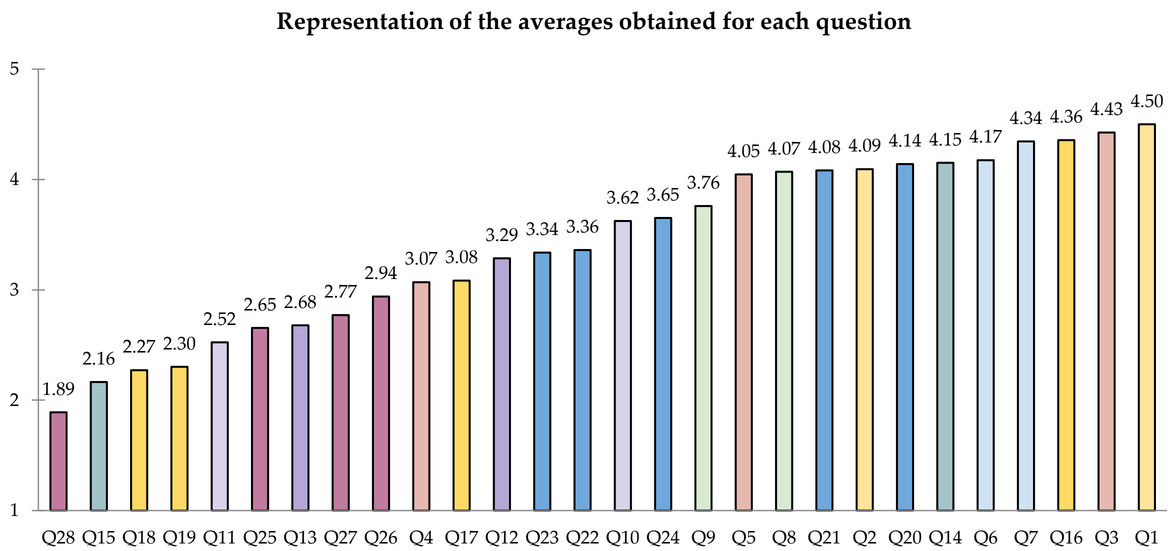


**Figure S4.2** Representation of the averages obtained for each question.

**Table S4.3** Distribution of the averages and STDEV obtained for each dimension of animal consciousness from which questions are derived, according to taxonomic classification.

| AVES (n=24) | | |
|---|---|---|
| **Dimensions of animal consciousness** | **Average** | **STDEV** |
| Experience of Agency | 2,50 | 1,03 |
| Abstraction | 2,53 | 1,26 |
| Self-consciousness | 2,83 | 1,17 |
| Reasoning | 2,90 | 1,34 |
| Experience of Ownership | 3,10 | 1,21 |
| Learning | 3,45 | 1,26 |
| Evaluative-Richness | 3,56 | 1,30 |
| Integration across time | 3,71 | 1,01 |
| Perceptual-Richness | 4,02 | 1,12 |
| Integration at a time | 4,13 | 0,91 |

| AVES (n=24) | | | |
|---|---|---|---|
| **Order** | **Dimensions of animal consciousness** | **Average** | **STDEV** |
| Accipitriformes (n=8) | Abstraction | 2,28 | 1,22 |
| | Experience of Agency | 2,38 | 1,09 |
| | Reasoning | 2,88 | 1,41 |
| | Self-consciousness | 3,13 | 1,20 |
| | Experience of Ownership | 3,13 | 1,09 |
| | Evaluative-Richness | 3,54 | 1,38 |
| | Learning | 3,65 | 1,27 |
| | Integration across time | 3,94 | 0,85 |
| | Integration at a time | 4,19 | 0,98 |
| | Perceptual-Richness | 4,37 | 1,17 |
| Galliformes (n=1) | Abstraction | 1,75 | 0,96 |
| | Experience of Agency | 2,50 | 0,71 |
| | Self-consciousness | 3,00 | 1,41 |
| | Experience of Ownership | 3,00 | 1,41 |
| | Reasoning | 3,00 | 1,63 |
| | Integration across time | 3,50 | 0,71 |
| | Learning | 3,60 | 0,55 |
| | Evaluative-Richness | 3,67 | 1,15 |
| | Perceptual-Richness | 4,00 | 1,41 |
| | Integration at a time | 4,50 | 0,71 |
| Passeriformes (n=2) | Abstraction | 1,63 | 0,92 |
| | Learning | 2,20 | 0,63 |
| | Experience of Agency | 2,25 | 0,50 |
| | Reasoning | 2,63 | 1,51 |
| | Self-consciousness | 2,75 | 0,96 |
| | Experience of Ownership | 2,75 | 1,26 |
| | Perceptual-Richness | 3,00 | 1,15 |

| | | | |
|---|---|---|---|
| | Integration across time | 3,00 | 0,82 |
| | Evaluative-Richness | 3,33 | 1,37 |
| | Integration at a time | 4,25 | 0,96 |
| Psittaciformes (n=1) | Self-consciousness | 3,00 | 1,41 |
| | Reasoning | 3,25 | 1,26 |
| | Abstraction | 3,25 | 0,96 |
| | Experience of Agency | 3,50 | 0,71 |
| | Experience of Ownership | 3,50 | 2,12 |
| | Integration at a time | 4,00 | 1,41 |
| | Learning | 4,20 | 0,84 |
| | Evaluative-Richness | 4,33 | 1,15 |
| | Integration across time | 4,50 | 0,71 |
| | Perceptual-Richness | 5,00 | |
| Sphenisciformes (n=2) | Abstraction | 3,00 | 0,76 |
| | Experience of Agency | 3,25 | 0,50 |
| | Self-consciousness | 3,50 | 0,58 |
| | Reasoning | 3,50 | 1,31 |
| | Evaluative-Richness | 3,67 | 0,82 |
| | Learning | 3,70 | 0,95 |
| | Integration at a time | 3,75 | 0,50 |
| | Experience of Ownership | 3,75 | 0,96 |
| | Integration across time | 4,00 | |
| | Perceptual-Richness | 4,25 | 0,96 |
| Strigiformes (n=4) | Self-consciousness | 2,63 | 1,60 |
| | Experience of Agency | 2,88 | 0,83 |
| | Abstraction | 2,88 | 1,41 |
| | Experience of Ownership | 3,00 | 1,31 |
| | Reasoning | 3,00 | 1,10 |
| | Evaluative-Richness | 3,50 | 1,17 |
| | Integration across time | 3,50 | 1,31 |
| | Learning | 3,56 | 0,92 |
| | Perceptual-Richness | 3,88 | 1,13 |
| | Integration at a time | 4,13 | 0,83 |

| MAMMALIA (n=47) | | |
|---|---|---|
| **Dimension of Animal Consciousness** | **Average** | **STDEV** |
| Abstraction | 2.83 | 1.44 |
| Reasoning | 3.21 | 1.53 |
| Experience of Ownership | 3.33 | 1.52 |
| Self-consciousness | 3.39 | 1.38 |
| Experience of Agency | 3.46 | 1.39 |
| Learning | 4.13 | 1.17 |
| Evaluative-Richness | 4.15 | 1.16 |
| Integration across time | 4.31 | 0.89 |
| Integration at a time | 4.39 | 0.91 |
| Perceptual-Richness | 4.56 | 0.95 |

| MAMMALIA (n=47) | | | |
|---|---|---|---|
| **Order** | **Dimensions of animal consciousness** | **Average** | **STDEV** |
| Artiodactyla (n=6) | Abstraction | 2.86 | 1.36 |
| | Experience of Agency | 3.17 | 1.53 |
| | Reasoning | 3.43 | 1.41 |
| | Self-consciousness | 3.50 | 1.43 |
| | Experience of Ownership | 3.50 | 1.27 |
| | Evaluative-Richness | 4.06 | 1.11 |
| | Learning | 4.47 | 0.86 |
| | Integration at a time | 4.50 | 0.67 |
| | Integration across time | 4.50 | 0.52 |
| | Perceptual-Richness | 4.67 | 0.78 |
| Carnivora (n=19) | Abstraction | 2.94 | 1.47 |
| | Reasoning | 3.01 | 1.61 |
| | Experience of Agency | 3.37 | 1.30 |
| | Self-consciousness | 3.42 | 1.24 |
| | Experience of Ownership | 3.47 | 1.52 |
| | Learning | 4.13 | 1.21 |
| | Evaluative-Richness | 4.21 | 1.18 |
| | Integration at a time | 4.29 | 1.04 |
| | Integration across time | 4.39 | 0.89 |
| | Perceptual-Richness | 4.63 | 0.97 |
| Perissodactyla (n=4) | Experience of Ownership | 2.67 | 1.97 |
| | Abstraction | 3.10 | 1.45 |
| | Self-consciousness | 3.33 | 1.37 |
| | Experience of Agency | 3.50 | 1.73 |
| | Reasoning | 3.79 | 1.37 |
| | Evaluative-Richness | 4.25 | 1.36 |
| | Perceptual-Richness | 4.38 | 0.92 |
| | Integration across time | 4.43 | 0.79 |
| | Learning | 4.45 | 1.00 |
| | Integration at a time | 4.75 | 0.46 |
| Proboscidea (n=4) | Abstraction | 3.19 | 1.38 |
| | Experience of Ownership | 3.50 | 1.51 |
| | Reasoning | 3.56 | 1.36 |
| | Integration across time | 4.13 | 1.13 |
| | Integration at a time | 4.25 | 1.04 |
| | Learning | 4.30 | 1.26 |
| | Evaluative-Richness | 4.33 | 0.65 |
| | Self-consciousness | 4.38 | 0.92 |
| | Experience of Agency | 4.63 | 0.74 |
| | Perceptual-Richness | 5.00 | |
| Primates (n=6) | Experience of Ownership | 3.33 | 1.44 |
| | Abstraction | 3.42 | 1.32 |

| | | | |
|---|---|---|---|
| | Evaluative-Richness | 4.00 | 1.28 |
| | Self-consciousness | 4.00 | 1.21 |
| | Reasoning | 4.00 | 1.10 |
| | Experience of Agency | 4.08 | 1.24 |
| | Integration across time | 4.09 | 1.04 |
| | Learning | 4.30 | 0.88 |
| | Integration at a time | 4.58 | 0.79 |
| | Perceptual-Richness | 4.75 | 0.45 |
| **Familly** | | | |
| Canidae (n=2) | Experience of Ownership | 3.50 | 1.29 |
| | Integration at a time | 3.75 | 0.50 |
| | Self-consciousness | 4.00 | 1.15 |
| | Experience of Agency | 4.00 | 1.15 |
| | Abstraction | 4.00 | 1.51 |
| | Reasoning | 4.13 | 0.99 |
| | Integration across time | 4.25 | 1.50 |
| | Evaluative-Richness | 4.33 | 1.03 |
| | Perceptual-Richness | 5.00 | |
| | Learning | 5.00 | |
| Felidae (n=8) | Abstraction | 2.55 | 1.45 |
| | Reasoning | 2.67 | 1.67 |
| | Experience of Agency | 2.94 | 1.65 |
| | Self-consciousness | 3.13 | 1.41 |
| | Experience of Ownership | 3.14 | 1.70 |
| | Learning | 3.85 | 1.42 |
| | Evaluative-Richness | 3.96 | 1.49 |
| | Integration at a time | 4.25 | 1.39 |
| | Perceptual-Richness | 4.33 | 1.37 |
| | Integration across time | 4.56 | 0.89 |
| Ursidae (n=9) | Abstraction | 3.03 | 1.38 |
| | Reasoning | 3.06 | 1.58 |
| | Self-consciousness | 3.56 | 1.10 |
| | Experience of Agency | 3.61 | 0.85 |
| | Experience of Ownership | 3.72 | 1.45 |
| | Learning | 4.18 | 1.05 |
| | Integration across time | 4.28 | 0.75 |
| | Evaluative-Richness | 4.41 | 0.84 |
| | Integration at a time | 4.44 | 0.70 |
| | Perceptual-Richness | 4.78 | 0.43 |

| REPTILIA (n=12) | | |
|---|---|---|
| **Dimension of Animal Consciousness** | **Average** | **STDEV** |
| Abstraction | 1.57 | 1.15 |
| Experience of Agency | 2.09 | 1.44 |
| Self-consciousness | 2.36 | 1.43 |
| Reasoning | 2.53 | 1.69 |
| Learning | 2.57 | 1.59 |
| Integration across time | 2.86 | 1.42 |
| Experience of Ownership | 2.91 | 1.51 |
| Evaluative-Richness | 3.47 | 1.50 |
| Perceptual-Richness | 3.82 | 1.22 |
| Integration at a time | 3.92 | 1.06 |

| REPTILIA (n=12) | | | |
|---|---|---|---|
| **Order** | **Dimensions of animal consciousness** | **Average** | **STDEV** |
| Crocodilia (n=2) | Abstraction | 2.38 | 1.77 |
| | Self-consciousness | 3.50 | 1.91 |
| | Experience of Ownership | 3.50 | 1.91 |
| | Integration across time | 3.75 | 1.50 |
| | Experience of Agency | 3.75 | 1.89 |
| | Learning | 3.90 | 1.52 |
| | Evaluative-Richness | 4.17 | 1.60 |
| | Reasoning | 4.25 | 1.49 |
| | Perceptual-Richness | 4.75 | 0.50 |
| | Integration at a time | 4.75 | 0.50 |
| Testudines (n=7) | Abstraction | 1.50 | 1.00 |
| | Experience of Agency | 1.86 | 1.17 |
| | Reasoning | 2.18 | 1.47 |
| | Self-consciousness | 2.29 | 1.27 |
| | Learning | 2.57 | 1.56 |
| | Integration across time | 2.93 | 1.38 |
| | Experience of Ownership | 3.15 | 1.46 |
| | Evaluative-Richness | 3.62 | 1.47 |
| | Perceptual-Richness | 3.75 | 1.36 |
| | Integration at a time | 3.93 | 1.07 |
| Squamata (n=3) | Abstraction | 1.00 | |
| | Experience of Agency | 1.25 | 0.50 |
| | Learning | 1.36 | 0.50 |
| | Self-consciousness | 1.50 | 1.00 |
| | Integration across time | 1.75 | 0.96 |
| | Experience of Ownership | 1.80 | 0.84 |
| | Reasoning | 2.11 | 1.69 |

| | | | |
|---|---|---|---|
| | Evaluative-Richness | 2.67 | 1.32 |
| | Perceptual-Richness | 3.33 | 1.32 |
| | Integration at a time | 3.33 | 1.03 |
| **Familly** | | | |
| Elapidae (n=2) | Abstraction | 1.00 | |
| | Experience of Agency | 1.25 | 0.50 |
| | Learning | 1.40 | 0.52 |
| | Self-consciousness | 1.50 | 1.00 |
| | Experience of Ownership | 1.50 | 0.58 |
| | Integration across time | 1.75 | 0.96 |
| | Reasoning | 1.88 | 1.64 |
| | Evaluative-Richness | 2.83 | 1.33 |
| | Perceptual-Richness | 3.50 | 1.29 |
| | Integration at a time | 3.50 | 1.29 |
| Iguanidae (n=1) | Learning | 1.00 | |
| | Evaluative-Richness | 2.33 | 1.53 |
| | Perceptual-Richness | 3.00 | |
| | Integration at a time | 3.00 | |
| | Experience of Ownership | 3.00 | |
| | Reasoning | 4.00 | |
| | Integration across time | NA | |
| | Self-consciousness | NA | |
| | Experience of Agency | NA | |
| | Abstraction | NA | |

# Supplementary Material 5 (S5)

**Table S5.1** Distribution of perception index according to the Class.

| Class | Average of PI | STDEV | n |
|---|---|---|---|
| Reptilia | 71,25 | 26,15 | 12 |
| Insecta | 83,00 | | 1 |
| Actinopterygii | 88,00 | | 1 |
| Aves | 89,92 | 18,12 | 24 |
| Chondrichthyes | 95,00 | | 1 |
| Mammalia | 101,38 | 17,41 | 47 |
| Cefalopoda | 104,00 | | 1 |

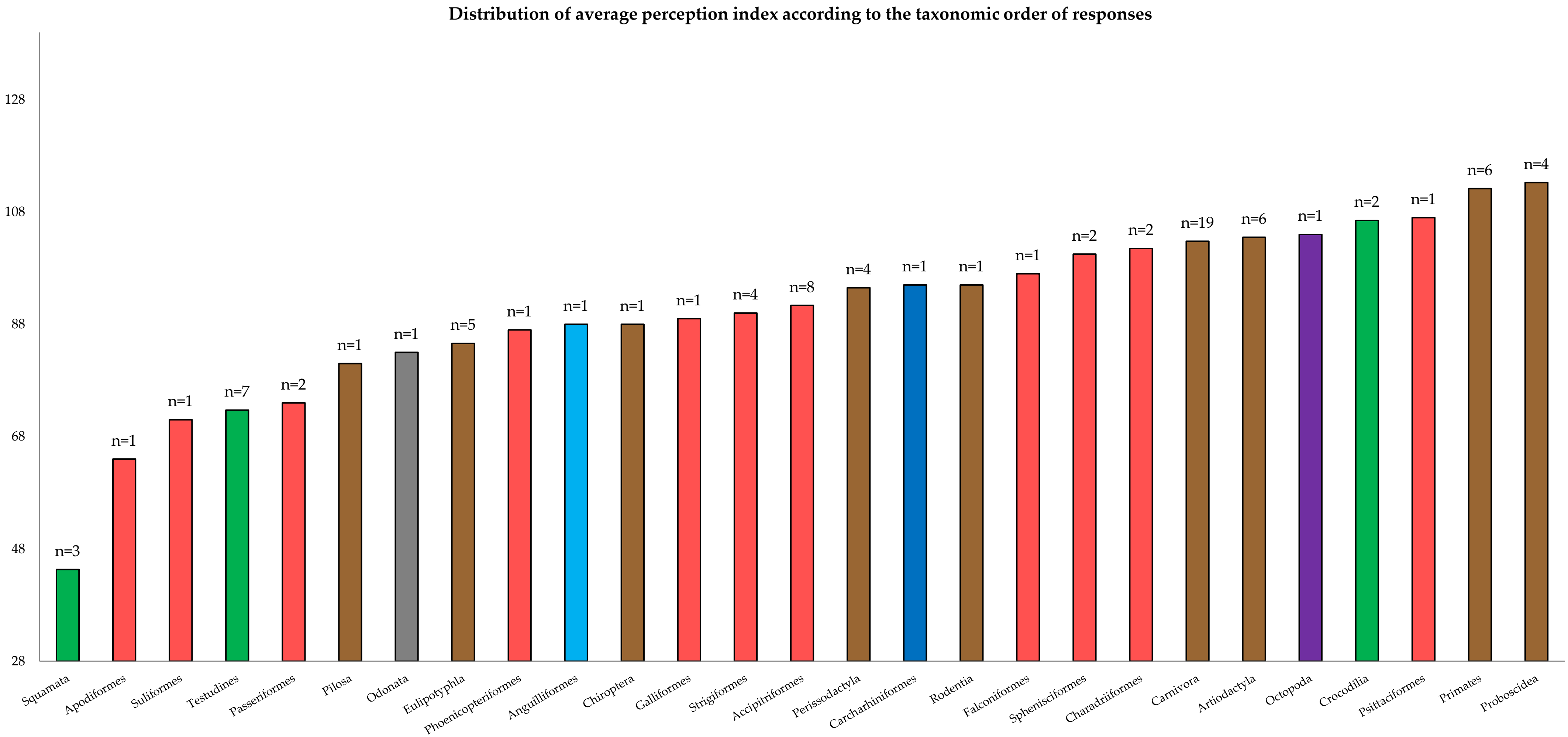


**Figure S5.1** Distribution of average perception index according to the taxonomic order of responses. Colors of the bars represent the taxonomic class: brown for mammals, purple for cephalopods, red for birds, grey for insects, blue for fish, dark green for reptiles.

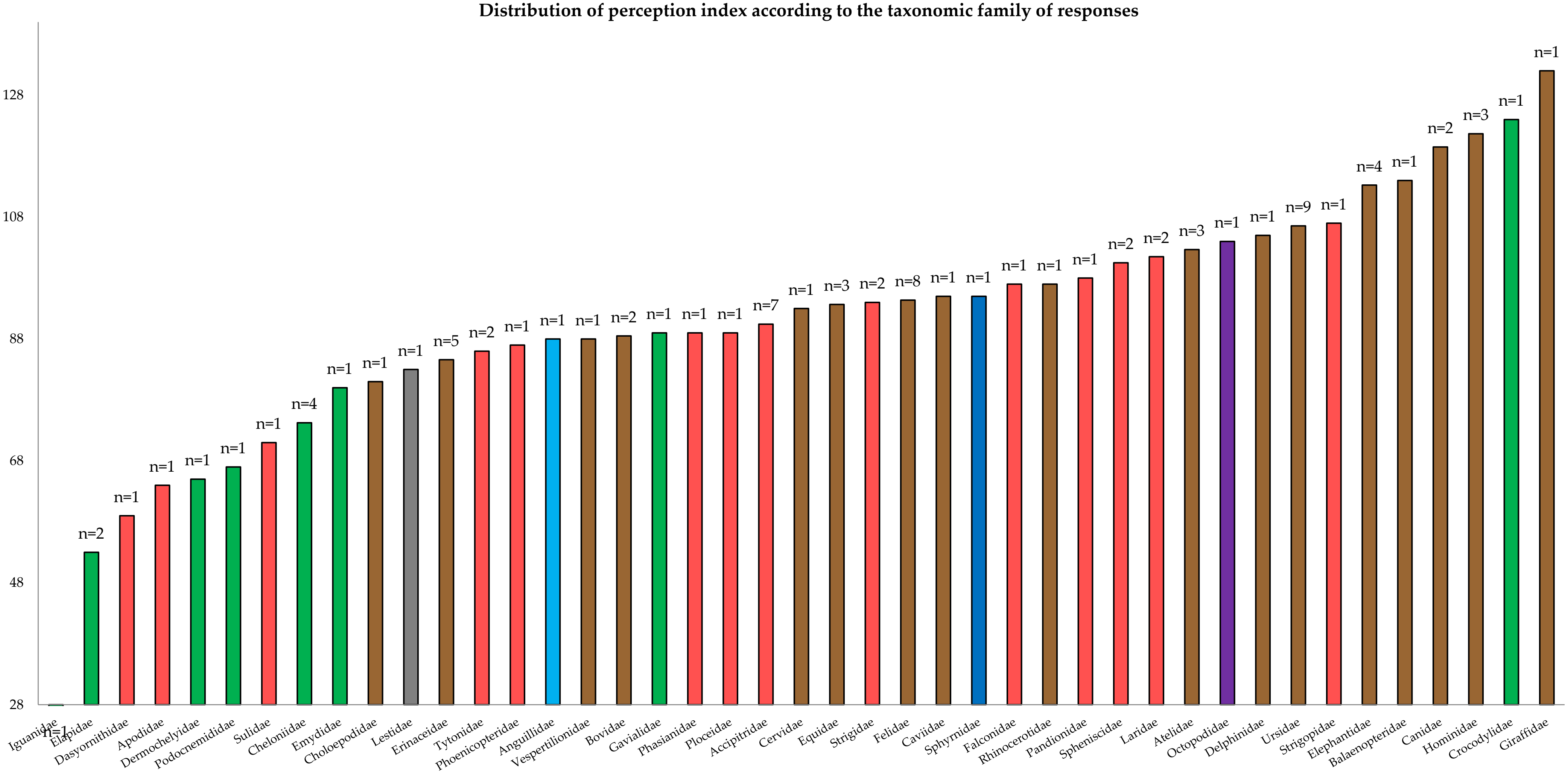


**Figure S5.2** Distribution of perception index according to the taxonomic family of responses. Colors of the bars represent the taxonomic class: brown for mammals, purple for cephalopods, red for birds, grey for insects, blue for fish, dark green for reptiles.