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Consciousness and Emotions in Non-Human Animals: Are Laypeople More or Less Skeptical than Experts?

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Abstract

Consciousness and the capacity to experience affective states, such as pain, pleasure, fear, and hunger (i.e., sentience) are seen as key determinants of an individual's moral status, a view that is shared by scientists, philosophers, and laypeople. Whether (and which) non-human animals are believed to possess these capacities can therefore have important consequences for how they are treated. In this registered report (Lifecycle Journal registration number 152, *https://doi.org/10.71240/lcyc.238674*), we measured people's attributions of consciousness and emotions to a diverse set of animals, testing whether laypeople overattribute (as suggested by research on anthropomorphizing) or underattribute these mental capacities to animals (as suggested by research on motivated mind denial). Animal consciousness and emotions are famously challenging to study. In the absence of an unambiguous benchmark against which

people's beliefs could be compared, we tested whether laypeople, a nationally representative sample of 600 U.S. participants, are more or less skeptical about animal consciousness and emotions than scientific experts, a sample of 100 behavioral ecologists, evolutionary biologists, and other animal researchers. We find that, compared to scientific experts, laypeople were less likely to attribute consciousness (-8 percentage points), and substantially less likely to attribute emotions (-21 percentage points) to non-human animals. Laypeople were on average more confident in their beliefs than scientific experts.

A Research Plan for this Outcomes Report was published in Lifecycle Journal here: *https://lifecycle-flax.fly.dev/journal/articles//152/index.html*

Registration

The research plan for this study can be accessed here: https://lifecycle-flax.fly.dev/journal/articles//152/index.html.

Materials

The study materials are available here: https://osf.io/9v3rh/.

Data

The data for the expert and laypeople samples are available here: https://osf.io/9v3rh/.

Code

The analysis code is available here: https://osf.io/9v3rh/.

Paper

Consciousness and Emotions in Non-Human Animals: Are Laypeople More or Less Skeptical than Experts?

Bastian Jaeger[1], Stefan Leach[2], & Matthew Zipple[3]

Do non-human animals experience emotions and other conscious experiences? This question has occupied scholars for centuries (Aristotle, 1994; Darwin, 1872; Descartes, 2019; Nagel, 1974), and it remains a key question in biology, philosophy, neuroscience, and other disciplines (e.g., Browning & Birch, 2022; Calvo & Segundo-Ortin, 2022).[1] Beliefs about the mental capacities of animals have important real-word consequences. According to many moral views, individuals qualify for moral treatment (i.e., they should be considered moral patients) if they are sentient, that is, if they have the capacity to experience valenced states, such as pain, pleasure (Birch 2024; Jaworska & Tannenbaum, 2021; Singer, 1981). These views are not only held by moral philosophers. Many studies underline the importance of mind attribution for laypeople's treatment of animals (Gray et al., 2012; Mameli, 2006). One seminal study found that the moral standing of an animal was most strongly predicted by their perceived sentience (Gray et al., 2007), and this association was recently replicated across six diverse countries (Jaeger & Bosten, 2025). In short, it is important to understand people's subjective beliefs about animal minds because these beliefs inform people's treatment of animals.

While many challenges for the study of animal minds remain, recent years have seen important developments (Andrews, 2024; Birch et al., 2020; Crump et al., 2022; Gibbons et al., 2022) and experts seem to show considerable agreement on many important questions (Andrews et al., 2024; Zipple et al., 2024). However, it remains unclear whether laypeople's beliefs reflect this emerging understanding. In the present study, we therefore test whether laypeople, a representative sample of the U.S. population, are more or less skeptical about animal consciousness and emotional experiences than experts, a sample of behavioral ecologists, evolutionary biologists, and other professional animal behavior researchers.

Lay Beliefs in Animal Minds

Because we lack direct access to other minds, we risk attributing either more or less sophisticated mental states and capacities than truly exist. This challenge is both serious and consequential (de Waal, 2016). Underestimating animals' inner lives carries obvious moral costs. Treating them as if they do not feel pain, grief, or boredom, even though they do, risks inflicting unintentional harm (Birch, 2017). Overestimation may seem the lesser error, but could still come with significant costs

(e.g., expensive policies that do not address animals' actual needs). This raises the question: Does the public tend to err in one way or the other?

The public may be inclined to overestimate animal consciousness and emotional experiences. Scholars across disciplines have long observed a tendency to attribute mental states and emotions to non-human entities, including animals (for a historical overview, see Serpell, 2003). This inclination is evident in the animistic beliefs of many cultures, as well as in modern examples such as the attribution of intentionality to weather events (Waytz et al., 2010) and simple geometric shapes (Douglas et al., 2016; Heider & Simmel, 1944). Closer to home, our relationships with pets and domestic animals may be enhanced when we perceive them as having rich inner lives (Serpell, 2003), and people are especially likely to attribute intentions to their pets when their social needs human relationships are unmet (Epley, Waytz, et al., 2008). This anthropomorphic tendency is pervasive enough that some researchers have flagged it as a challenge to the objective scientific study of animal minds (Burghardt, 2004; Wynne, 2004). Overall, these examples suggest a consistent pattern of overattribution.

Other research suggests that the inverse mistake—underestimating animal consciousness and emotional capacities—may be equally widespread. Research on intergroup conflict and discrimination indicates that people tend to downplay the minds of others when doing so serves their personal or group interests (Castano & Giner-Sorolla, 2006; Haslam et al., 2005; Leyens et al., 2000). Many individuals consume animal products and endorse a worldview reminiscent of the Great Chain of Being (Lovejoy, 1937), positioning humans as morally and cognitively superior to animals (Caviola et al., 2018; Gray et al., 2007). Viewing animals as less mentally sophisticated supports both these positions. Indeed, scholarship on the "meat paradox" (Bastian & Loughnan, 2017) demonstrates that the psychological tension between caring about animals yet eating them motivates people to minimize animals' mental sophistication (Bastian et al., 2012; Bratanova et al., 2011; Leach et al., 2022). Taken together, this work suggests that the public may be prone to underestimating animals.

Assessing the accuracy of public beliefs about animals is challenging (see Leach et al., 2023a; Leach et al., 2023b). Most fundamentally, the relevant facts themselves are not yet settled. Although research on animal cognition is advancing rapidly, it remains subject—like all scientific inquiry—to uncertainty and revision as new evidence emerges and standards of inference evolve (e.g., Browning & Birch, 2020). These uncertainties are amplified by the inherent difficulties of studying animal consciousness and emotional experience. Morphological and behavioral diversity across species complicates the development of methods that can fairly test and compare cognitive capacities (de Waal, 2016). Moreover, much existing research does not permit firm conclusions about the accuracy of public beliefs. In many studies, beliefs are elicited using broad questions about general capacities (e.g., whether animals are "intelligent"), typically rated on subjective scales (e.g., agreement–disagreement). Neither the cognitive constructs under consideration nor the response scales used are sufficiently tied to the empirical facts. As a result, such approaches

seemingly cannot determine whether public perceptions are broadly accurate or inaccurate. How to move forward?

In the absence of clear facts and established benchmarks against which to evaluate public beliefs, one promising strategy is to examine scientific consensus—the prevailing agreement among experts assessed formally through surveys. Such consensus-gauging efforts have been undertaken in areas such as climate science, vaccine safety, and biodiversity loss (e.g., Funk & Rainie, 2015). They are especially valuable in domains where definitive empirical answers remain elusive—such as questions about animal consciousness—because they represent the most informed interpretation of the current data. The guiding assumption is that experts, working within transparent and self-correcting scientific systems, are best positioned to evaluate complex evidence, identify methodological limitations, and gradually converge on well-supported conclusions. Although consensus is not infallible, it does indicate where the preponderance of evidence presently lies. Accordingly, scientific consensus provides a defensible and pragmatic benchmark against which the beliefs of laypeople can be compared.

Expert Beliefs in Animal Minds

The fundamental barrier to scientific study of animal emotions and consciousness has long been the lack of access to the inner workings of animal minds (Nagel 1974; Rollin 1990; Williams 1992; de Waal 2011). For much of the 20th century, the consensus response to this barrier was either a rejection of the importance of the inner lives of animals or to ignore them as being scientifically intractable (Rollin 1990). Because these “private phenomena” were beyond the reach of our measurement, they were not appropriate topics of scientific study regardless of whether they existed (Williams 1992). This consensus led to a paradox, where “a widely recognized aspect of animal behavior is deliberately ignored or minimized” (de Waal 2011).

In recent decades, however, this consensus within non-human animal researchers has fractured. Both observational and manipulative neurophysiological data point to animals displaying behaviors consistent with emotional experiences facilitated by subcortical brain regions and that are either homologous to humans or have convergently evolved in other mammals, birds, and potentially invertebrates (Panskepp 2011, Anderson and Adolphs 2014, Öner 2018, Zych and Gogolla 2021, Malezieux et al 2023). Two prominent public declarations from scientists regarding animal consciousness have followed—the Cambridge Declaration on Consciousness (Low, 2012) and the New York Declaration on Animal Consciousness (Andrews et al., 2024). Both declarations, signed by dozens and hundreds of scientists, respectively, state that there is strong evidence that humans are not unique in their conscious experiences and that the neuroanatomy of all vertebrates and potentially many invertebrates support the possibility of widespread consciousness in non-human animals.

A recently published study quantified the emerging scientific consensus that emotions and consciousness are widespread in animals (Zipple et al 2024). A sample of 100 animal behavior experts (e.g., behavioral ecologists, evolutionary biologists) indicated their beliefs that eight different groups of animals are (a) conscious and (b) have emotional experiences. An overwhelming majority (>90%) of respondents attributed both consciousness and emotional experiences to most or all non-human primates. Large majorities said the same of other mammals, birds, and cephalopods (specifically octopus, squids, and cuttlefish). And majorities attributed the same to at least 'some' insects and other invertebrates. Thus, there is a clear expert consensus to the question of whether emotions and consciousness are a uniquely human experience—they are not. The 20th century expert consensus that animal emotions and consciousness represent possibly real but permanently inaccessible aspects of animal existence has undergone a dramatic shift, with experts both attributing these phenomena to many non-human animals and expressing confidence that they will ultimately be measurable.

The Present Study

The main goal of the present study is to test whether laypeople are more or less skeptical about animal consciousness and emotional experiences than scientific experts. Our study builds on a recent survey of 100 behavioral ecologists, evolutionary biologists, and other animal researchers who, among other things, indicated their beliefs in the consciousness and emotional experiences of eight groups of animals (Zipple et al., 2024). Based on our review of the literature, this study represents the largest and most detailed survey of expert beliefs on this topic. In the present study, we ask the same questions to a representative sample of the U.S. population (n = 600), which will allow us to compare the beliefs of the two populations. In both the expert survey and the present study among laypeople, participants also indicate how confident they are in their beliefs. Research across various domains has shown that people are often overconfident, and that this effect is particularly pronounced among those with the lowest levels of knowledge and skills (Kruger & Dunning, 1999; McIntosh et al., 2022). We therefore test whether laypeople are less confident than experts in their beliefs (as they arguably should be).

We also examine which sociodemographic characteristics predict laypeople's belief in animal consciousness and emotions (and their confidence in these beliefs). Specifically, we test for associations with gender, age, political orientation, education, diet, religiosity, and pet ownership.

Methods

Participants

For our primary analysis (see the Analysis Approach section for a detailed description), comparing beliefs in animal consciousness and emotions between experts and laypeople, we will estimate multilevel logistic regression models with random intercepts per participant and animal group in which a binary belief variable is regressed on a binary variable indicating whether participants' expert vs. layperson status. We used G*Power (Faul et al., 2007) to approximate the required sample size for such a design. This showed that, given the fixed sample of 100 experts, a sample of 599 laypeople is required to detect a small-to-medium difference between the two groups (Cohen's $h = 0.3$) with 80% power (and $\alpha = 5\%$) with a z-test. This is a conservative approximation because it ignores the additional power afforded by collecting eight observations per participant (i.e., beliefs for eight animal groups).[2]

We recruited a nationally representative sample (along the dimensions of gender, age, race, and political ideology) of 600 U.S. participants via the online platform Prolific. Participants received £0.75 to complete the survey (in line with the suggested rate of £9/hour). At the start of the survey, participants were asked to provide informed consent and to promise to complete the survey carefully without the help of large language models. Only participants who made the promise were forwarded to the main survey. The survey was completed by a total of 645 participants We excluded participants who indicated that they had studied animal cognition or behavior as part of an advanced university degree or their profession ($n = 19$, 2.95%) and, in line with the exclusion criteria by Zipple and colleagues (2024), participants who did not identify that most, nearly all, or all humans have consciousness ($n = 17$, 2.64%) and emotion experiences ($n = 14$, 2.17%; whose response are more likely an indicator of careless responding rather than a genuinely held belief).

This left a final sample of 600 participants for analysis ($M_{age} = 45.36$, $SD_{age} = 15.90$; 47.83% men, 50.00% women, 2.17% preferred to self-describe or to not state their gender). Educational levels were varied: 28.83% of participants indicated a high school diploma as their highest attained degree, 14.50% selected an associate's degree, 38.00% a bachelor's degree, 14.83% a master's degree, and 2.83% a doctoral or professional degree. On an 11-point political orientation scale that ranged from 1 (very liberal) to 11 (very conservative), the average score was 5.61 ($SD = 2.90$), with 257 participants (42.83%) indicating a left-of-center position, 131 participants (21.83%) indicating a centrist position, and 212 participants (35.33%) indicating a right-of-center position. Half of all participants described themselves as religious (49.50%, 2.50% preferred not to say). The majority of participants followed an omnivorous diet (83.83%), whereas 7.5% described themselves as restricted omnivores (e.g., meat-reducer, pescetarian), 3.5% as vegetarian, and 2.67% as vegan (2.5% did not indicate their preferred diet). Almost all participants (95%) had lived together with a pet.

Measures and Procedure

Our measures were taken from the expert survey by Zipple and colleagues (2024). To facilitate comparisons between the two samples, we copied the questions as closely as possible, only implementing two substantive changes, which are described below.

We first measured participants' beliefs that different animal groups are conscious and have emotional experiences. For consciousness beliefs, participants first read a definition of consciousness ("some animals display consciousness, meaning that they are aware of their own existence") and were then asked to rate "how widespread consciousness is in different groups of animals". Compared to the expert survey, we replaced the term "taxa" with "groups of animals" because the former may not be clear for some laypeople. The four response options were: (1) no members of this group display this phenomenon, (2) some members of this group display this phenomenon, (3) most members of this group display this phenomenon, and (4) all or nearly all members of this group display this phenomenon. Similarly, for emotion beliefs, participants rated "how widespread emotional responses are in different groups of animals" on the same scale. The order in which the two types of beliefs are measured was randomized.

Participants indicated their beliefs for eight groups of animals. As in the expert survey, we included humans as a ninth group to identify likely cases of careless responding. We expected that, unlike experts, laypeople might not know which specific animals fall into which broader group. We therefore decided to provide participants with specific examples for each animal group. We provided examples of animals that are relatively common and that we expected to be well-known among our U.S. American participants. It is possible that participants would anchor on any specific animal example that is provided, which means that their stated beliefs for the broader groups of animals that we are interested in may instead reflect their beliefs for the specific animal example. To prevent this, we provided five examples per group (except for the cephalopod group which will be shown with the same three examples that were also provided in the expert survey). Within each group, we sampled animals that are likely to span the full range of cognitive complexity in the group. The included groups and examples were: (1) *non-human primates* (e.g., chimpanzees, baboons, capuchins, lemurs, tarsiers), (2) *other mammals* (e.g., foxes, dolphins, mice, zebras, bats), (3) *birds* (e.g., pigeons, geese, woodpeckers, hummingbirds, parrots), (4) *fish* (e.g., salmon, sharks, anglerfish, minnows, eels), (5) *amphibians and non-avian reptiles* (e.g., frogs, salamanders, snakes, turtles, lizards), (6) *octopuses, squids, and cuttlefish* (i.e. cephalopods not including nautilus), (7) *insects* (e.g., beetles, crickets, ants, bees, butterflies), and (8) *other invertebrates* (e.g., worms, centipedes, corals, spiders, starfish).

After indicating a specific belief for a specific group of animals, participants were also asked to indicate how confident they are in their assessment on a scale that ranged from 1 (not confident at

all) to 5 (certain). Participants first rated humans and then the other eight animals groups in the order in which they are listed above, as in the expert survey.

Finally, participants completed several questions on their sociodemographic characteristics. Participants indicated their gender, age, whether they consider themselves religious, their highest level of education (high school diploma or equivalent, associate degree, bachelor's degree, master's degree, doctorate or professional degree), their political orientation (on an eleven-point scale ranging from very liberal to centrist to very conservative), their diet (omnivore, restricted omnivore such as pescetarian, vegetarian, vegan), and whether they have ever lived together with a pet (currently or in the past). We also measured whether participants ever studied animal cognition or behavior as part of an advanced university degree or their profession in order to exclude those who did because our goal is to recruit a sample of laypeople without such expert knowledge.

Analysis Approach

We merged the data from the current study among laypeople with the data from the of experts conducted by Zipple and colleagues (2023). All planned data preparation steps, analyses, and graphs can be reproduced with the analysis code shared on the OSF (*https://osf.io/9v3rh/*), which includes the expert data and simulated data for the laypeople sample. Our main analyses will address four questions.

First, we address the main question of the study by comparing the beliefs of laypeople and experts. Following the approach from the study among experts, we created a binary variable indicating whether people believe that most, nearly all, or all members of a group of animals possess a certain characteristic, consciousness or emotions (i.e., whether participants indicated a 3 or 4 on the 4-point scale). We then estimated a multilevel logistic regression model with random intercepts per participant and animal group, in which the binary consciousness belief variable is regressed on a binary variable indicating which sample participants belonged to (experts vs. laypeople; see Q1a in Table 1). We ran the same analysis to test for differences in emotion beliefs (Q1b).

Second, we compared laypeople's and experts' confidence in their beliefs. We estimated a multilevel linear regression model with random intercepts per participant and animal group, in which participants' confidence in their consciousness beliefs are regressed on the binary sample variable (experts vs. laypeople; see Q2a in Table 1). Another model was run to test participants' confidence in their emotion beliefs (Q2b).

Third, we examined which sociodemographic characteristics are associated with attribution of consciousness and emotions in our sample of laypeople. We estimated a multilevel logistic regression model with random intercepts per participant and animal group, in which the binary belief in consciousness variable is regressed on participants' gender, age, political orientation, education, diet (coded 0 for restricted or unrestricted meat eaters and 1 for vegetarian and vegan),

current or previous pet ownership (vs. no pet ownership), and religiosity (see Q3a in Table 1). The same model was run with attributions of emotions as the outcome (Q3b).

Fourth, we examined which sociodemographic characteristics are associated with confidence in consciousness and emotion beliefs in our sample of laypeople. We estimated a multilevel linear regression model with random intercepts per participant and animal group, in which confidence in consciousness beliefs is regressed on the same sociodemographic variables listed above (see Q4a in Table 1). The same model was run with confidence in emotion beliefs as the outcome (Q4b).

Declarations

The study design has been approved by the ethics review board of the first author (protocol code: TSB_RP1173).

Study registration: A previously published Research Plan (Jaeger et al., 2026) serves as the registration for the study. There was one minor deviation from this plan, which we mention in the Discussion. Materials: The study materials are available at: *https://osf.io/9v3rh/*. Data: The data from the expert survey and simulated for the planned study among laypeople are available at: *https://osf.io/9v3rh/*. Analytic code: The analysis code is available at: *https://osf.io/9v3rh/*.

The authors declare that no conflicts of interest exist.

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Results

All deviations from the registered analysis plan for the primary research questions are explicitly highlighted. The same applies to secondary research questions and analyses that were not included in the registered analysis plan.

Attributions of Consciousness and Emotion Experiences

Laypeople are Less Likely Than Experts to Attribute Consciousness and Emotions to Animals (Registered Analyses)

We first tested whether laypeople were more or less skeptical than scientific experts about the existence of consciousness among non-human animals (Q1a; see Figure 1 top panel). We estimated a multilevel logistic regression model with random intercepts per participant and animal group, in which a binary variable indicating whether participants attributed consciousness to a specific animal group was regressed on a binary variable indicating which sample participants

belonged to (0 = experts, 1 = laypeople). This revealed a significant difference in consciousness attributions between the two samples, b = –1.247, SE = 0.422, OR = 0.29, 95% CI [0.12, 0.72], p =.003. Across all animal groups, laypeople were less likely to attribute consciousness (45%, 95% CI [26%, 66%]) than scientific experts (53%, 95% CI [30%, 74%]).

We took the same approach to test whether laypeople were more or less skeptical than scientific experts about the existence of emotional experiences among non-human animals (Q1b; see Figure 1 bottom panel). Running the same multilevel logistic regression model but with emotion attributions as the outcome revealed a significant difference between the two samples, b = –2.262, SE = 0.338, OR = 0.10, 95% CI [0.05, 0.21], p <.001. Across all animal groups, laypeople were less likely to attribute emotion experiences (43%, 95% CI [23%, 68%]) than scientific experts (64%, 95% CI [36%, 83%]).

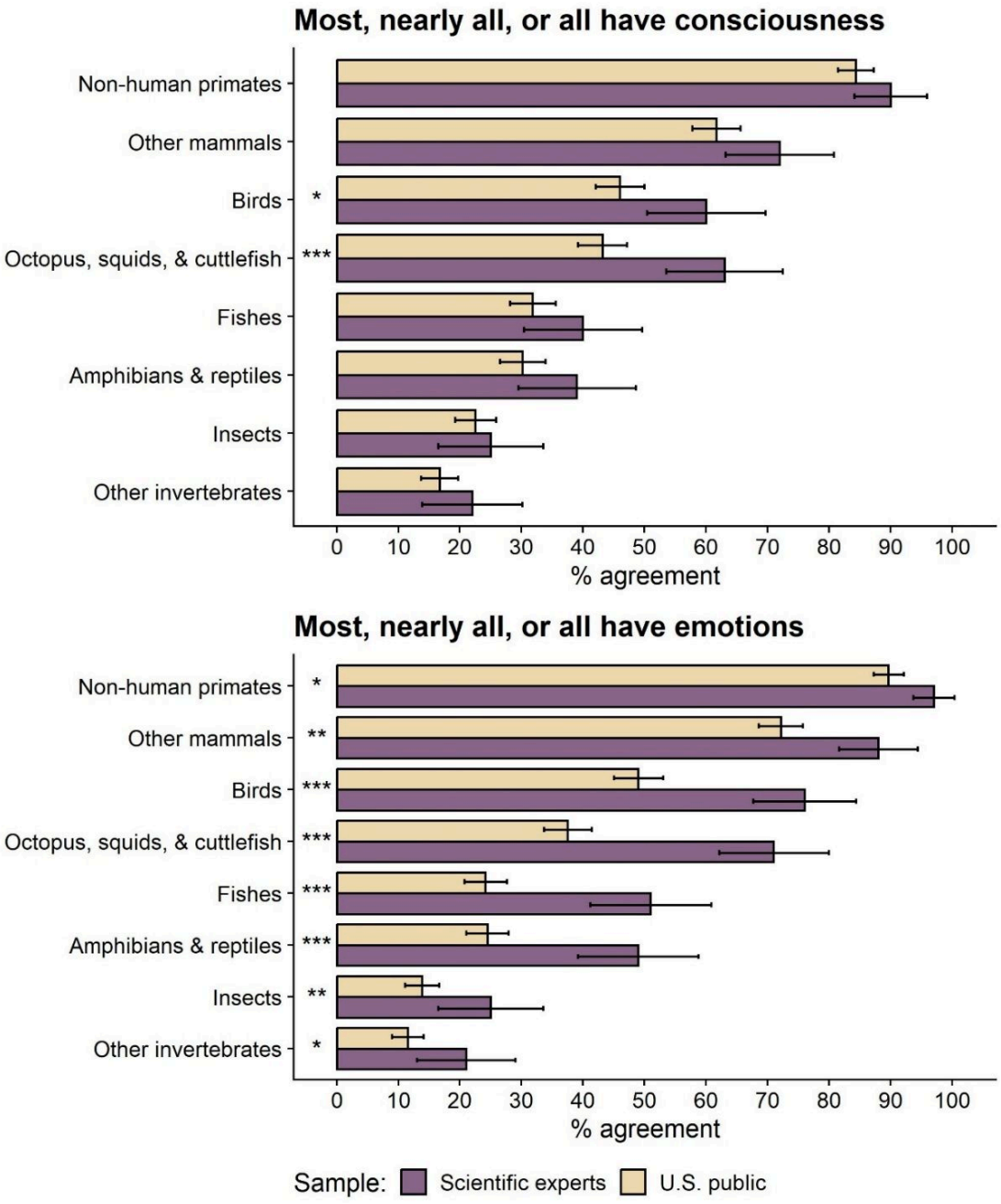


Figure 1. Members of the U.S. public are less likely to attribute consciousness (top panel) and emotions (bottom panel) to non-human animals compared to scientific experts. Error bars indicate 95% confidence intervals. Asterisks indicate a significant difference when comparing attributions for the specific animal group with a Chi-square test.

* = p <.05, ** = p <.01, *** = p <.001.

Table 2. Differences in attributions of consciousness and emotions to specific animal groups between laypeople and scientific experts.

	Consciousness attributions					Emotion attributions			
Species	Experts	Laypeople	$\chi^2(1)$	*p*		Experts	Laypeople	$\chi^2(1)$	*p*
Non-human primates	90%	84%	1.75	.189		97%	90%	4.64	.031
Other mammals	72%	62%	3.50	.061		88%	72%	10.47	.001
Birds	60%	46%	6.18	.013		76%	49%	24.00	<.001
Octopus, squids, & cuttlefish	63%	43%	12.79	<.001		71%	38%	38.06	<.001
Fishes	40%	32%	2.23	.136		51%	24%	29.30	<.001
Amphibians & reptiles	39%	30%	2.71	.100		49%	25%	24.32	<.001
Insects	25%	23%	0.18	.673		25%	14%	7.36	.007
Other invertebrates	22%	17%	1.34	.246		21%	12%	6.08	.014

Differences in Attributions Per Animal Group (Exploratory Analyses)

We conducted a series of exploratory Chi-square tests to examine differences in attributions between scientific experts and laypeople for each of the eight animal groups (see Table 2). Experts were significantly more likely to attribute consciousness to birds and to octopus, squids, and cuttlefish. We did not find significant differences in consciousness attributions to non-human primates, other mammals, fishes, amphibians and reptiles, insects, and other invertebrates. Experts were significantly more likely to attribute emotions to all eight animal groups.[3]

Predictors of Consciousness and Emotion Attributions (Registered Analyses)

Next, we examined whether various characteristics were associated with a higher likelihood of attributing consciousness (Q3a) or emotion experiences (Q3b) to non-human animals in our sample of laypeople. We estimated a multilevel logistic regression model with random intercepts

per participant and animal group, in which a binary variable indicating whether participants attributed consciousness to a specific animal group was regressed on participants' gender (0 = female, 1 = male), age, political orientation (with higher scores representing more conservative views), education level, a binary variable indicating whether participants consider themselves religious, diet (coded as 1 for vegetarian or vegan and 0 for restricted or unrestricted omnivores), and pet ownership (coded as 1 if they had ever lived together with a pet). The only significant predictor was participants' diet, with vegetarian and vegan participants being more likely to attribute consciousness than restricted or unrestricted omnivores, b = 1.69, SE = 0.676, OR = 5.41, 95% CI [1.45, 18.60], p =.012.

We estimated the same model, but with attribution of emotion experiences as the outcome. Diet was again a significant predictor, with vegetarian and vegan participants being more likely to attribute emotions than restricted or unrestricted omnivores, b = 1.82, SE = 0.52, OR = 6.17, 95% CI [2.10, 16.64], p <.001. Participants with more conservative political views were less likely to attribute emotions, b = –0.128, SE = 0.048, OR = 0.88, 95% CI [0.80, 0.97], p =.007. None of the other variables predicted emotion attributions. The full results for both models are reported in the Supplemental Materials.

Confidence in Consciousness and Emotion Beliefs

Laypeople are More Confident in Their Consciousness and Emotion Beliefs Than Experts (Registered Analyses)

Next, we tested whether laypeople were more or less confident in their beliefs about the consciousness of non-human animals than scientific experts (Q2a; see Figure 2 top panel). We estimated a multilevel linear regression model with random intercepts per participant and animal group, in which confidence ratings were regressed on a binary variable indicating which sample participants belonged to (0 = experts, 1 = laypeople). This revealed a significant difference between the two samples, with laypeople being more confident in their consciousness beliefs (M = 3.70) than scientific experts (M = 3.17), b = 0.525, SE = 0.10, 95% CI [0.335, 0.714], p <.001.

We took the same approach to test whether laypeople were more or less confident in their beliefs about emotions in non-human animals than scientific experts (Q2b; see Figure 2 bottom panel). Running the same multilevel linear regression model but with emotion attributions as the outcome again revealed a significant difference between the two samples, with laypeople being more confident in their emotion beliefs (M = 3.65, 95% CI [3.34, 3.96) than scientific experts (M = 3.28, 95% CI [2.94, 3.62]), b = 0.372, SE = 0.088, 95% CI [0.202, 0.556], p <.001.

Differences in Confidence Per Animal Group (Exploratory Analyses)

We conducted a series of exploratory independent-samples t-tests to examine differences in laypeople's and experts' confidence in their attributions for each of the eight animal groups (see

Table 3). The pattern of results was very similar for attributions of consciousness and emotions. Laypeople were significantly more confident than scientific experts for octopus, squids, and cuttlefish, fishes, amphibians and reptiles, insects, and other invertebrates. We did not find significant confidence differences for non-human primates, other mammals, and birds.[4]

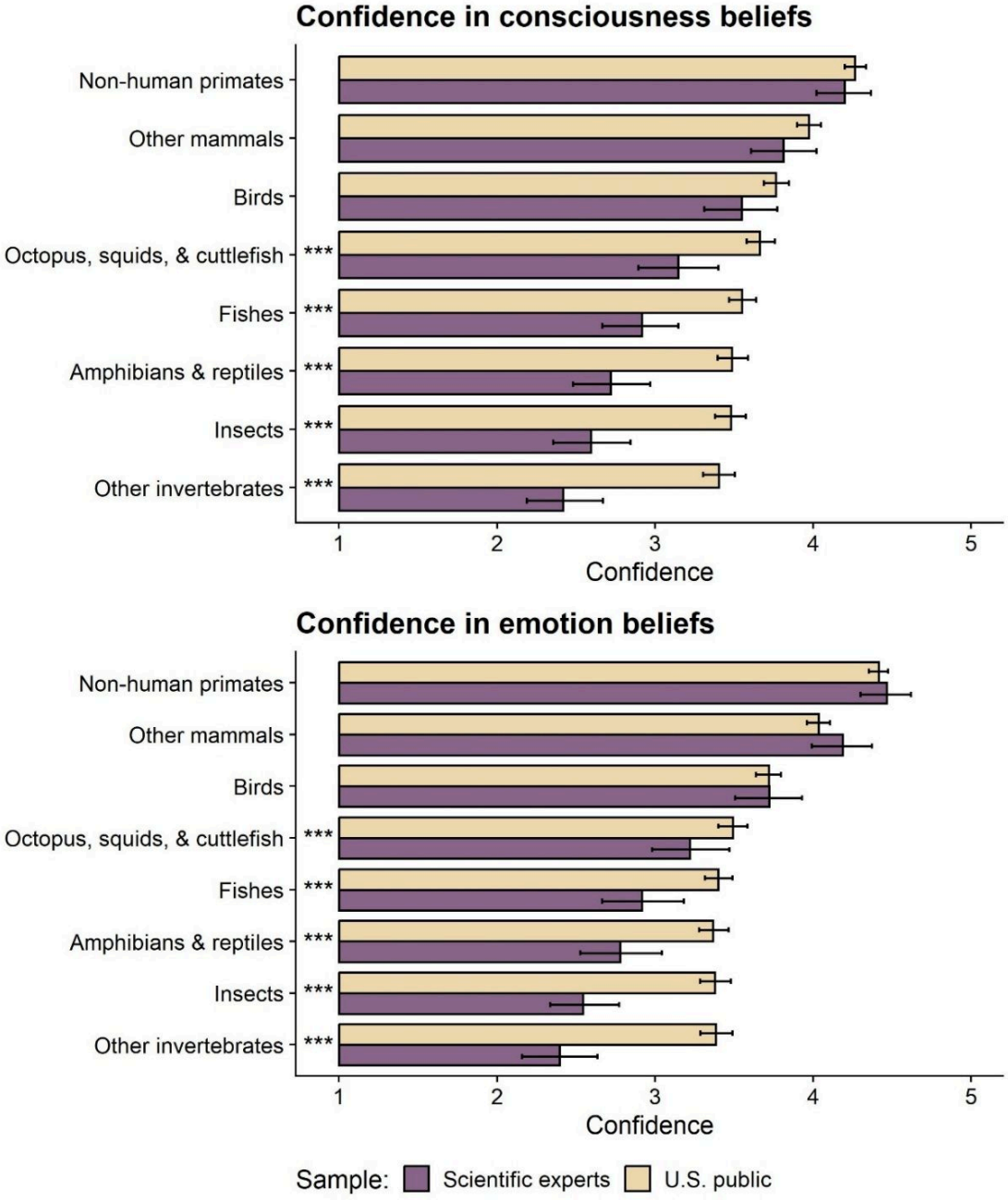


Figure 2. Members of the U.S. public are more confident than scientific experts in their beliefs on the prevalence of consciousness (top panel) and emotions (bottom panel) among non-human animals. Error bars indicate 95% confidence intervals. Asterisks indicate a significant difference when comparing confidence for the specific animal group with a *t*-test.

* = p <.05, ** = p <.01, *** = p <.001.

Table 3. Differences in laypeople's and experts' confidence in their attributions of consciousness and emotions to specific animal groups.

	Confidence in consciousness attributions						Confidence in emotion attributions				
Species	Experts *M* (*SD*)	Laypeople *M* (*SD*)	*t*	*p*	*d*		Experts *M* (*SD*)	Laypeople*M* (*SD*)	*t*	*p*	*d*
Non-human primates	4.20 (0.90)	4.27 (0.85)	0.68	.497	0.08		4.46 (0.80)	4.42 (0.77)	0.56	.577	0.06
Other mammals	3.81 (1.04)	3.97 (0.96)	1.41	.162	0.16		4.19 (0.94)	4.04 (0.92)	1.47	.144	0.16
Birds	3.55 (1.14)	3.77 (1.05)	1.78	.078	0.21		3.72 (1.10)	3.72 (1.01)	0.03	.978	0.003
Octopus, squids, & cuttlefish	3.15 (1.23)	3.66 (1.15)	3.82	<.001	0.44		3.22 (1.22)	3.49 (1.15)	2.06	.042	0.23
Fishes	2.92 (1.24)	3.55 (1.13)	4.71	<.001	0.55		2.92 (1.29)	3.40 (1.07)	3.47	<.001	0.44
Amphibians & reptiles	2.72 (1.25)	3.49 (1.18)	5.60	<.001	0.64		2.78 (1.27)	3.37 (1.15)	4.22	<.001	0.50
Insects	2.59 (1.28)	3.48 (1.25)	6.33	<.001	0.71		2.54 (1.09)	3.38 (1.21)	6.85	<.001	0.70
Other invertebrates	2.42 (1.25)	3.40 (1.26)	7.19	<.001	0.78		2.40 (1.11)	3.38 (1.26)	7.92	<.001	0.79

Predictors of Confidence in Consciousness and Emotion Beliefs (Registered Analyses)

Finally, we examined whether various characteristics were associated with stronger confidence in laypeople's beliefs about the consciousness (Q4a) or emotion experiences (Q4b) of non-human

animals. We estimated a multilevel linear regression model with random intercepts per participant and animal group, in which confidence was regressed on participants' gender (0 = female, 1 = male), age, political orientation (with higher scores representing more conservative views), education level, a binary variable indicating whether participants consider themselves religious, diet (coded as 1 for vegetarian or vegan and 0 for restricted or unrestricted omnivores), and pet ownership (coded as 1 if they had ever lived together with a pet). None of the variables significantly predicted confidence in consciousness beliefs. When predicting participants' confidence in their emotion beliefs, we found that religious participants were more confident in their beliefs about (the lack of) emotion experiences among non-human animals, b = 0.253, SE = 0.075, 95% CI [0.100, 0.412], p <.001. Older participants were also more confident, b = 0.004, SE = 0.002, 95% CI [0.0005, 0.009], p =.032, while more conservative participants were less confident, b = –0.029, SE = 0.013, 95% CI [–0.055, –0.003], p =.024. None of the other variables predicted confidence in beliefs regarding animal emotions. The full results for both models are reported in the Supplemental Materials).

Discussion

Both scientists and philosophers have highlighted the central roles of consciousness and sentience in determining the moral status of individuals (Andrews et al., 2024; Birch, 2024; Jaworska & Tannenbaum, 2021; Mazor et al., 2022). This view also seems to be shared by laypeople, as various studies have found strong relations between the perceived sentience of non-human animals and their perceived moral standing (Gray et al., 2007; Jaeger & Bosten, 2026). The *actual* mental capacities of non-human animals are famously difficult to study, but ongoing research programs continue to provide new insights. However, it is also important to understand whether (and which) animals are currently *perceived* to be conscious and sentient, as these beliefs may motivate individual actions (e.g., meat consumption) and support for public policies (e.g., animal welfare legislation) that affect the experiences of animals. In this registered report, we examined laypeople's beliefs about the prevalence of consciousness and emotions among various animals. In the absence of an objective benchmark against which laypeople's beliefs could be evaluated to determine their veracity, we compared laypeople's beliefs against the beliefs of 100 behavioral ecologists, evolutionary biologists, and other scientific experts. There was one minor deviation from our registered study design (Jaeger et al., 2026). Although we specified to measure (a) whether participants had ever lived or are currently living together with a pet, (b) whether they had a pet or another animal they felt close to when growing up, and (c) if they did, how close they felt to the animal, we later decided to shorten the survey and to only measure (a).

Compared to scientific experts, laypeople were less likely to attribute consciousness to animals (–8 percentage points). This gap was most pronounced for consciousness attributions to octopus, squids, and cuttlefish (–20 percentage points) and to birds (–14 percentage points). Differences were even larger for attributions of emotions. Compared to scientific experts, laypeople were much

less likely to attribute emotions (–21 percentage points) to animals. This gap was most pronounced for emotion attributions to octopus, squids, and cuttlefish (–31 percentage points), to birds (–27 percentage points), and to fishes (–27 percentage points). In short, we find that, compared to scientific experts, the U.S. public is substantially less likely to believe that various non-human animals are conscious and that they have the capacity to experience emotions.

We measured participants' attributions with scales that asked them to indicate whether they believe that (1) no, (2) some, (3) most, or (4) all or nearly all members of an animal group have consciousness or emotions. In line with Zipple and colleagues (2023), and to make our results more easily interpretable, we created a binary variable in which the first two and the last two categories were aggregated (creating contrasts between most, nearly all, or all member vs. some or no members). To test the robustness of our findings, we also estimated Bayesian multilevel ordinal regression models with the untransformed attribution scores as the outcome variable. The results, reported in the Supplemental Materials, were in line with the results from our primary analysis approach, showing that laypeople were more skeptical than experts about consciousness and emotions among animals.

Our findings are in line with perspectives that predict heightened skepticism about the mental capacities of non-human animals. For example, research on motivated mind denial has shown that some people are motivated to deny that animals have certain mental capacities to justify their meat consumption (Bastian & Loughnan, 2017; Leach et al., 2022). Our findings are not in line with the opposite predictions that could be derived from work on anthropomorphism, which highlights that people very readily attribute mental states to various entities. The present results should only be treated as indirect evidence for or against these accounts, whose predictions are about the under- or overattribution of mental states to different entities, relative to the *actual* presence of these mental states. The currently available evidence does not permit definitive inferences about the actual mental capacities of various animals, and the results from the current study only provide insights into people's relative tendency to attribute consciousness and emotions compared to scientific experts. That is, laypeople are more skeptical of consciousness and emotionality in non-human animals than experts—but whether they are correct or incorrect in this assessment remains unknown.

We also assessed both laypeople's and experts' confidence in their beliefs. Laypeople's confidence in their beliefs was surprisingly high. Given the inherent difficulties of understanding others' minds, especially the minds of highly dissimilar animals like bees, spiders, and octopuses, confidence was arguably high in absolute terms, with an average score of 3.7 on a 5-point scale where 5 represented certainty. Laypeople's confidence was certainly high in relative terms, as they were more confident in their beliefs than scientific experts on the topic. These results are in line with extensive work on overconfidence. Previous work on expertise and confidence (e.g., Kruger & Dunning, 1999; Moore & Healy, 2008) typically showed that people overestimate their performance, and that this overestimation is more pronounced among people with less expertise.

Still, in these studies, people with low expertise typically express less confidence overall compared to people with high expertise (e.g., Kruger & Dunning, 1999; McIntosh et al., 2022). This was not the case in the present study, where laypeople were more confident in their beliefs than scientific experts on the topic. Moreover, this confidence difference was large for many animal groups. For consciousness and emotion attributions to insects and other invertebrates, laypeople were more confident by a full scale point on our 5-point scale ($d \approx 0.75$). While we cannot make definite inferences about the accuracy of laypeople's beliefs, this pattern of results suggests that laypeople are overconfident in their consciousness and emotion attributions, given the much lower confidence levels of scientific experts.

Limitations and Future Directions

One limitation of the current study was the operationalization of participants' beliefs. Despite decades of scientific research on both consciousness and emotions, the terms are famously difficult to define with commonly adopted definitions and conceptualizations varying across fields and (meta-)theoretical perspectives (De Waal, 2011; Sattin et al., 2021; Zipple et al., 2023). It was necessary to provide participants with (a) concrete definitions to avoid heterogeneous interpretations of the constructs, and to (b) select relatively short and easily understandable definitions to ensure that laypeople understand the terms. Arguably, the definitions chosen here neither commit to a narrow and/or uncommon view of consciousness and emotions, but it was inevitable that participants' responses would only reflect one of many justifiable perspectives. One priority for future research should be to examine attributions with an improved measure that strikes a good balance between being relatively easily understandable by laypeople while reflecting scientific theories and conceptualizations (Chiarella et al., 2026). Recent frameworks for studying animal consciousness have advocated for multidimensional approaches that map variation in the mental states of animals across a profile of different characteristics (e.g., Birch et al., 2020). Other frameworks are categorizing the types of evidence that should be considered and integrated to make inferences about animal consciousness (Andrews, 2024; Crump et al., 2022). Both types of frameworks could be leveraged to devise more insightful measures of consciousness and emotion attributions by laypeople, as the underlying dimensions of the frameworks are likely more concrete easier to understand than the higher-order constructs.

Our goal was to map differences in beliefs between laypeople and scientific experts, but there were also small differences in the study design of the two surveys, which may have contributed to the observed differences in beliefs. While the scientific experts only saw an overarching label for a specific animal group (e.g., birds, fishes), laypeople also saw five specific examples of species (e.g., pigeons, geese, woodpeckers, hummingbirds, and parrots for the bird category). It is possible that participants anchored their responses on these specific species. We deemed this change to be necessary given that some laypeople might not know which specific animals fall into which broader group, or they might think about one particularly salient species when giving estimates for the entire group. To steer participants toward thinking about a diverse set of species within each

group, we provided them with multiple examples and we avoided an overrepresentation of cognitively complex or charismatic animals. Although we cannot rule out that this difference had some influence on the results, we also do not have reasons to suspect that the specific examples that were chosen lead to the observed pattern of underattribution by laypeople.

It is also possible that the fixed order in which the animals were presented to participants contributed to differences in attributions. This order was implemented in the study that measured experts' beliefs (Zipple et al., 2023), and we decided to replicate it here to keep our results more comparable. Animals that are (presumably) more cognitively complex were listed earlier, and participants' responses reflected this pattern with lower attributions for animals presented later. This was not true in all cases though. For example, experts were more likely to attribute consciousness to cephalopods compared to fish, or amphibians and non-avian reptiles, even though cephalopods were listed later.

Finally, the generality of our inferences is constrained by the specific populations from which both laypeople and experts were sampled. Although we recruited a sample of laypeople that was a relatively large and nationally representative on key demographic variables, all participants were from the United States. More research is needed to examine to critically examine how common the underattribution of consciousness and emotion experience is on a global scale. Perceptions of animal sentience across various countries have already been examined in some prior studies (e.g., Jaeger & Bosten, 2026; Mata et al., 2022), but without expert beliefs as a benchmark, these results are arguably less informative. Similar arguments apply to the expert sample. Most experts identified as behavioral ecologists or evolutionary biologists who primarily worked with non-human primates, other mammals, or birds. Future studies could recruit a larger and more diverse sample of experts (e.g., also including philosophers with relevant expertise) to ensure that the experts' beliefs reflect the diversity of views that characterize research on consciousness and emotions.

Practical Implications

The capacity to consciously experience affectively valenced states like pain and pleasure is often a determining factor when deciding how we should treat an individual (Birch, 2024; Dullaghan, 2026). For example, the European Union's Lisbon treaty recognizes animals as sentient beings and requires members to "pay full regard to the welfare requirements of animals". While more research is needed to understand the mental capacities of various animals, reviews by experts on the topic can be used to understand the state of the evidence and to inform decision-making (Birch, 2024). The present results suggest that expert-led policy initiatives may face public backlash. At least in the present sample of U.S. Americans, laypeople were substantially more skeptical (and confident in their skepticism) about consciousness and emotion experiences among many animal groups. A majority of voters might not agree with animal welfare initiatives that impose significant restrictions on industry or individual consumers (e.g., a ban on octopus farming, higher welfare

standards for farmed fish which could lead to higher prices) because they do not believe that the affected animals are conscious or experience emotions. Initiatives targeting animal groups where experts and the public agree (e.g. non-human primates) may avoid this risk.

Framed more optimistically, our results suggest that the public is, perhaps unsurprisingly, not aware of recent scientific developments that underpin researchers' views on the widespread presence of consciousness and sentience in the animal kingdom. It remains to be tested how easily laypeople would change their views when learning more about the scientific evidence on animal consciousness and emotions. Differences were especially large for beliefs about the sentience of birds, octopus, squids, cuttlefish, fishes, amphibians, and reptiles. Science communication efforts that present the latest scientific evidence for these species in an accessible way may be particularly effective in shifting laypeople's beliefs.

Conclusion

While scientists continue to provide new insights into the mental life of non-human animals, which animals we currently treat as likely candidates for consciousness and sentience has important policy implications (Birch, 2024). Here, we found that the U.S. public is substantially less likely than scientific experts to view various species as conscious and sentient, and that they are also more confident in their views than scientific experts. Keeping track of this gap is worthwhile, as it indicates how much the views of laypeople, which might influence support for animal welfare policies and other consequential outcomes, diverge from the current scientific consensus.

Table 1. Study design overview.

Question	Hypothesis	Sampling plan	Analysis Plan	Rationale for deciding the sensitivity of the test for confirming or disconfirming the hypothesis	Interpretation given different outcomes	Theory that could be shown wrong by the outcomes
1a. Do laypeople hold weaker or stronger beliefs about the prevalence of consciousness among						

non-human animals compared to experts?	No specific hypothesis.	A power analysis in G*Power showed that, given the fixed sample of 100 experts, a sample of 599 laypeople is required to detect a small-to-medium difference between the two groups (Cohen's h = 0.3) with 80% power (and α = 5%) with a z-test. This is a conservative approximation because it ignores the additional power afforded by collecting eight observations per participant (i.e., beliefs for eight animal groups).	Multilevel logistic regression model with random intercepts per participant and animal group, in which the binary consciousness belief variable is regressed on a binary variable indicating which sample participants belonged to (laypeople vs. experts).	Given financial constraints, this sampling and analysis plan still allowed us to detect a small-to-medium effect (Cohen's *h* = 0.3) with what is a common and realistic level of statistical power.	If laypeople score higher than experts in our study, we will conclude that they are less skeptical about animal consciousness. If laypeople score lower than experts in our study, we will conclude that they are more skeptical about animal consciousness. If we don't find a significant difference, we will conclude that we did not find evidence for different levels of skepticism in animal consciousness.	This study was not designed to test a specific theoretical prediction, although different theories suggest that laypeople will be more skeptical (motivated mind denial) or less skeptical (anthropomorphism) about animal consciousness and emotions compared to experts.
1b. Do laypeople hold weaker or stronger beliefs about the prevalence of emotions						

among non-human animals compared to experts?	Same as above.	Same as above.	Same as above, but with emotion beliefs as the outcome variable.	Same as above.	Same as above, but with animal emotions as the key outcome.	Same as above.
2a. Are laypeople more or less confident in their beliefs about animal consciousness compared to experts?	Same as above.	The sampling plan was determined by research questions 1a and 1b.	Multilevel linear regression model with random intercepts per participant and animal group, in which participants' confidence in their consciousness beliefs are regressed on the binary sample variable (experts vs. laypeople)	The sampling plan was determined by research questions 1a and 1b.	Same as above but with confidence in animal consciousness beliefs as the key outcome.	-
2b. Are laypeople more or less confident in their beliefs about animal consciousness compared to experts?	Same as above.	Same as above.	Same as above, but with emotion beliefs as the outcome variable.	Same as above.	Same as above but with confidence in animal emotion beliefs as the key outcome.	-
3a. Which demographic characteristics are associated with belief in animal						

consciousness?	Same as above.	Same as above.	Multilevel logistic regression model with random intercepts per participant and animal group, in which the binary belief in consciousness variable is regressed on participants' gender, age, political orientation, education, diet (coded 0 for meat eaters and 1 for vegetarian and vegan), current or previous pet ownership (vs. no pet ownership), and religiosity.	Same as above.	We will conclude that a certain sociodemographic characteristic is associated with beliefs in animal consciousness if the variable shows a significant association in our regression model.	-
3b. Which demographic characteristics are associated with belief in animal emotions?	Same as above.	Same as above.	Same as above, but with emotion beliefs as the outcome variable.	Same as above.	We will conclude that a certain sociodemographic characteristic is associated with beliefs in animal emotions if the variable shows a significant	

					association in our regression model.	-
4a. Which demographic characteristics are associated with confidence in animal consciousness beliefs?	Same as above.	Same as above.	Multilevel linear regression model with random intercepts per participant and animal group, in which confidence in consciousness beliefs is regressed on participants' gender, age, political orientation, education, diet (coded 0 for meat eaters and 1 for vegetarian and vegan), current or previous pet ownership (vs. no pet ownership), and religiosity.	Same as above.	We will conclude that a certain sociodemographic characteristic is associated with confidence in animal consciousness beliefs if the variable shows a significant association in our regression model.	-
4b. Which demographic characteristics are associated with confidence in animal emotion beliefs?	Same as above.	Same as above.	Same as above, but with confidence in emotion beliefs as the outcome variable.	Same as above.	We will conclude that a certain sociodemographic characteristic is associated with confidence	

					in animal emotion beliefs if the variable shows a significant association in our regression model.	-

Supporting Information

Supporting information files related to this work can be found here: *https://osf.io/xaes5/files/5ugnv*

References

Anderson, D. J., & Adolphs, R. (2014). A framework for studying emotions across species. *Cell, 157(*1), 187–200. *http://dx.doi.org/10.1016/j.cell.2014.03.003*

Andrews, K. (2024). "All animals are conscious": Shifting the null hypothesis in consciousness science. *Mind & Language,* 1–19. *https://doi.org/10.1111/mila.12498*

Andrews, K., Birch, J., Sebo, J., Allen, C., Anokhin, K., Barron, A., Brown, C., Burghart, G. M., Chittka, L., Clayton, N. S., & Edelman, D. B. (2024). *The New York Declaration on Animal Consciousness. https://sites.google.com/nyu.edu/nydeclaration/declaration*

Bastian, B., & Loughnan, S. (2017). Resolving the meat-paradox: A motivational account of morally troublesome behavior and its maintenance. *Personality and Social Psychology Review, 21(*3), 278–299. *https://doi.org/10.1177/1088868316647562*

Birch, J. (2024). *The edge of sentience: Risk and precaution in humans, other animals, and AI.* Oxford University Press. *https://doi.org/10.1093/9780191966729.001.0001*

Birch, J., Schnell, A. K., & Clayton, N. S. (2020). Dimensions of animal consciousness. *Trends in Cognitive Sciences, 24(*10), 789–801. *https://doi.org/10.1016/j.tics.2020.07.007*

Chiarella, S. G., Laurenzi, M., D'Onofrio, M., Gallagher, S., & Raffone, A. (2026). Attribution of consciousness to non-human animals: Insights from AI and multidimensional frameworks. *Frontiers in Psychology, 17,* 1716363. *https://doi.org/10.3389/fpsyg.2026.1716363*

Crump, A., Browning, H., Schnell, A., Burn, C., & Birch, J. (2022). Sentience in decapod crustaceans: A general framework and review of the evidence. *Animal Sentience, 7(*32). *https://doi.org/10.51291/2377–7478.1691*

De Waal, F. B. M. (2011). What is an animal emotion? *Annals of the New York Academy of Sciences, 1224(*1), 191–206. *https://doi.org/10.1111/j.1749–6632.2010.05912.x*

Dullaghan, N. (2026). *The compassion mandate.* Books of change.

Gray, H. M., Gray, K., & Wegner, D. M. (2007). Dimensions of mind perception. *Science, 315,* 619. *https://doi.org/10.1126/science.1134475*

Jaeger, B., & Bosten, M. (2026). The relation between attributions of mental capacities and moral standing across six diverse cultures. *Psychological Science, 243–254, 37(*4). *https://doi.org/https://doi.org/10.1177/09567976261425576*

Jaeger, B., Leach, S., & Zipple, M. (2026). *Consciousness and emotions in non-human animals: Are laypeople more or less skeptical than experts?* Lifecycle Journal. *https://doi.org/10.71240/lcyc.238674*

Jaworska, A., & Tannenbaum, J. (2021). The grounds of moral status. In *Stanford Encyclopedia of Philosophy.*

Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology, 77(*6), 1121–1134.

Leach, S., Piazza, J., Loughnan, S., Sutton, R. M., Kapantai, I., Dhont, K., & Douglas, K. M. (2022). Unpalatable truths: Commitment to eating meat is associated with strategic ignorance of food-animal minds. *Appetite, 171,* 105935. *https://doi.org/10.1016/j.appet.2022.105935*

Leach, S., Sutton, R. M., Dhont, K., Douglas, K. M., & Bergström, Z. M. (2023). Changing minds about minds: Evidence that people are too sceptical about animal sentience. *Cognition, 230,* 105263. *https://doi.org/10.1016/j.cognition.2022.105263*

Mata, F., Jaeger, B., & Domingues, I. (2022). Perceptions of farm animal sentience and suffering: Evidence from the BRIC countries and the United States. *Animals, 12(*23), 3416. *https://doi.org/10.3390/ani12233416*

Mazor, M., Brown, S., Ciaunica, A., Demertzi, A., Fahrenfort, J., Faivre, N., Francken, J. C., Lamy, D., Lenggenhager, B., Moutoussis, M., Nizzi, M.-C., Salomon, R., Soto, D., Stein, T., & Lubianiker, N. (2022). The scientific study of consciousness cannot and should not be morally neutral. *Perspectives on Psychological Science, 18(*3), 535–543. *https://doi.org/https://doi.org/10.1177/17456916221110222*

McIntosh, R. D., Moore, A. B., Liu, Y., & Della Sala, S. (2022). Skill and self-knowledge: Empirical refutation of the dual-burden account of the Dunning–Kruger effect. *Royal Society Open Science, 9(*12), 191727. *https://doi.org/10.1098/rsos.191727*

Moore, D. A., & Healy, P. J. (2008). The trouble with overconfidence. *Psychological Review, 115(*2), 502–517. *https://doi.org/10.1037/0033–295X.115.2.502*

Sattin, D., Magnani, F. G., Bartesaghi, L., Caputo, M., Fittipaldo, A. V., Cacciatore, M., Picozzi, M., & Leonardi, M. (2021). Theoretical models of consciousness: A scoping review. *Brain Sciences, 11(*5), 535. *https://doi.org/10.3390/brainsci11050535*

Zipple, M. N., Hazelwood, C., Webster, M. F., & Benítez, M. E. (2023). Animal emotions and consciousness: Researchers' perceptions, biases, and prospects for future progress. *Royal Society Open Science,* (11), 241255. *https://doi.org/10.1101/2023.10.12.562087*

Notes

[1] Due to the complexity of understanding and conceptualizing both consciousness and emotions (in both human and non-human animals), there is also a debate on how these constructs should be defined. Reviewing this debate is beyond the scope of the present paper. Given our goal of assessing and comparing beliefs by both laypeople and experts on this topic, we adopt definitions that are commonly adopted among scientists but that also reflect common ways of thinking about the constructs by laypeople. By consciousness we mean the capacity for any type of subjective experience. In the words of Nagel (1974), an animal is conscious if "there is something that it is like to *be* that organism". In contrast, emotional experiences refer to a specific subset of subjective experiences that tend to be characterized by various features (de Waal, 2011; Tsuchiya & Adolphs, 2007): they are (1) elicited by a specific stimulus or event, (2) characterized by various changes in an organism's body (e.g., flushed cheeks, widened eyes) and mind (e.g., the activation of certain appraisals, thoughts, and motives), and (3) these responses often have an adaptive function.

[2] We only provide an approximation because a power analysis for our analysis approach would require a simulation-based power analysis for multilevel logistic models, which requires the specification of random effect variance parameters, which are unknown and difficult to estimate confidently.

[3] We also applied a Benjamini-Hochberg correction to control the false discovery rate for the eight exploratory tests of differences in consciousness,. The difference for consciousness attributions to octopus, squids, and cuttlefish was still significant (p = .003), but the difference for attributions to birds was not (p = .052). For the eight tests of differences in emotion attributions, all results remained significant after the correction (non-human primates: p = .031, other mammals: p = .002, birds: p < .001, octopus, squids, and cuttlefish: p < .001 fishes: p < .001, amphibians and reptiles: p < .001, insects: p = .009, other invertebrates: p = .016).

[4] We also applied a Benjamini-Hochberg correction to control the false discovery rate for the eight exploratory tests of confidence differences in attributions of consciousness and emotions. All significant differences regarding consciousness significant after the correction (octopus, squids, and cuttlefish: p < .001, fishes: p < .001, amphibians and reptiles: p < .001, insects: p < .001, other invertebrates: p < .001). For the eight tests of confidence differences in emotion attributions, all but one significant difference remained significant after the correction (octopus, squids, and cuttlefish: p = .067, fishes: p < .001, amphibians and reptiles: p < .001, insects: p < .001, other invertebrates: p < .001).

Declarations

Ethics

The study design has been approved by the ethics review board of the first author (protocol code: TSB_RP1173).

Competing Interests

The authors declare that no conflicts of interest exist.

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Author Contributions

BJ: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. SL: Writing – original draft, Writing – review & editing. MZ: Methodology, Writing – original draft, Writing – review & editing