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## **Positivity and Negativity Biases about Animals revealed through Emotions, Attitudes and Cognitive Salience in a French National Park**

**Authors:** Théo Descours<sup>1,2</sup>, Stéphanie M. Carrière<sup>1</sup>, Clémence Moreau<sup>1</sup>, Valentine Boudjema<sup>3</sup>, Julien Blanco<sup>1,\*</sup>

### **Author affiliations:**

<sup>1</sup> SENS, IRD, CIRAD, Univ Paul Valéry Montpellier 3, Univ Montpellier, Site St Charles, Route de Mende, 34199 Montpellier Cedex 5, France

<sup>2</sup> UR ADI-Suds (Agrodéveloppement et Innovation aux Suds), Istom, College of International Agro-Development, 4 rue Joseph Lakanal, 49000 Angers, France

<sup>3</sup> Espace-DEV, IRD Nouméa, Univ de la Nouvelle-Calédonie, 101 Promenade Roger Laroque, 98 848, Nouméa, Nouvelle-Calédonie

### **\*Corresponding author:**

Email address: [julien.blanco@ird.fr](mailto:julien.blanco@ird.fr)

## **Abstract**

Human cognition is subject to a plethora of cognitive biases, including positivity and negativity biases, that impact human relationships with non-human life forms but remain largely underexplored. To address this gap, this study introduces an interview-based method to investigate positivity and negativity biases in people's perceptions of animal species. Conducted in France's Cevennes National Park, the study comprised 100 interviews to evaluate (i) the cognitive salience of animals via free-listing tasks and (ii) individuals' attitudes and emotions towards the listed animals. Respondents identified 154 animals, predominantly associating them with positive attitudes and emotions. Interestingly, animals evoking positive emotions displayed greater cognitive salience, while those perceived negatively ranked second in salience. These findings, consistent with other studies, underscore the significance of emotions and suggest the presence of both positivity and negativity biases. Reinforcing research on cognitive biases could help conservation practitioners better orient their action and communication with the public.

**Keywords:** Free-listing, Ethnobiology, Environmental psychology, Human-nature relationships, Mixed-methods, Nature's contributions to people

## 1. Introduction

Decades of research and practices on biodiversity conservation and sustainable management have underscored the critical need to reconcile ecosystem's and people's well-being in so-called 'social-ecological systems' (Cumming, 2016). This social-ecological perspective recognizes the intricate connections between biodiversity and ecological dynamics, and people and socio-cultural dynamics. Consequently, understanding people's values, attitudes and behaviors towards non-human life forms has become imperative for disciplines interested in the conservation and management of natural resources (Christie et al., 2017; Schultz, 2011), especially in regions where human-wildlife interactions pose challenges to both people's livelihoods and wildlife conservation (e.g. Engel et al., 2016).

This paper aims to engage with this challenge, and in particular addresses the role of cognitive biases in how people interact with non-human beings. Recent studies have highlighted the impact of cognitive biases on people's decision-making and behavior, influencing societies' ability to address sustainability and biodiversity conservation issues (Buijs & Jacobs, 2021; Cinner, 2018; Engler et al., 2018). For instance, the framing bias, where the presentation of a message affects how people respond, and the status quo bias, favoring familiar options over change, significantly shape perceptions and actions (Engler et al., 2018; Kusmanoff et al., 2020).

In the domain of people's relationships with wildlife, understanding the negativity bias becomes crucial due to its influence on people's attitudes and behavior towards non-human beings (Blanco et al., 2019; Kansky & Knight, 2014). This bias stands for the fact that humans give greater weight to negative entities such as negative events, objects or traits (Rozin & Royzman, 2001). As a result, people tend to better recall "bad things" than "good things", and to learn from and use negative information far more than positive information (Baumeister et al., 2001). Some recent studies have explored this bias in the context of sustainability and conservation sciences. In a meta-analysis, Kansky & Knight (2014) found that the perceived costs of human-wildlife coexistence were more significant than the perceived benefits to explain people's attitudes towards wildlife. They concluded in the evidence of a negativity bias in a context where human-wildlife conflicts were explicit. Similarly, based on a selection of scholars, Blanco et al. (2019) hypothesized that people's behaviors towards ecosystems might be more influenced by ecosystem disservices (or detriments) than services (or benefits). Finally, Buijs & Jacobs (2021) stressed the need for a "positive ecology" that would emphasize positive human-wildlife interactions to compensate negativity bias and strengthen public support for conservation.

Despite its significance for conservation practitioners working on strategies to lessen human-wildlife conflicts and strengthen synergies, research on cognitive biases, particularly the negativity bias, remains nascent. This gap partly stems from methodological challenges: while neurosciences and economics quantify cognitive biases based on experiments (e.g. measuring brain activity or conducting choice experiments under controlled environments), these methods are rarely suited to environmental and sustainability sciences that mostly rely on non-experimental methods such as interviews and observations.

Against this background, this article first aims to devise an interview-based approach to assess the existence and magnitude of a potential negativity bias (or its counterpart, the positivity bias) in the domain of human-wildlife coexistence. The approach relies on a combination of concepts and methods from the social sciences, which we further describe in the background and methods sections. Second, by applying the approach in the Cevennes National Park (CNP) in France, this paper aims to enhance understanding of the role of cognitive biases in people's relationship with the fauna. More specifically, our research question in this case study was: is there any evidence of a negativity bias (or, on the contrary, of a positivity bias) in people's minds regarding animals of the CNP? Finally, after detailing our case study results, we discuss the potential and limits of our approach to assess cognitive biases in the domain of biodiversity conservation planning and management.

## **2. Background**

Different definitions and theoretical approaches to cognitive biases exist, necessitating clarity for practical methodological applications. Cognitive biases are sometimes understood as systematic errors in reasoning stemming from heuristics, i.e., mental shortcuts or rules of thumb that people use to make decisions and solve problems quickly (Das & Teng, 1999; Tversky & Kahneman, 1974). In economics, they rather refer to deviations from rational-agent models in observed human behavior (Kahneman, 2003). In this paper, we adopt a neuroscience's understanding where cognitive biases denote the human brain's tendency to disproportionately react to specific stimuli or events, making these more salient and potent than other stimuli or events (Norris, 2021; Rozin & Royzman, 2001).

This definition illustrates the proximity between the concept of cognitive biases and the concept of cognitive salience utilized across multiple social science disciplines such as linguistics, neuroscience, anthropology, and ethnobiology (Caduff & Timpf, 2008; Robbins et al., 2017; Smith & Borgatti, 1997). Cognitive salience refers to the prominence of information in cognitive processing, influencing perception, memory, and decision-making

(see Caduff & Timpf, 2008). When something is cognitively salient, it stands out and captures a person's attention more readily than other, less salient information. In other words, differences in the salience of items, such as plants or animals, would imply that certain items capture people's attention more or are more prevalent in their memory than others. Thus, differences in cognitive salience may indicate cognitive biases.

Different methods are operational to assess cognitive salience, but a standard and widely used one is free-listing or free-recall tasks that consist in asking people to cite as much as items they can relative to a given topic (Albuquerque et al., 2005; Dany et al., 2015). Free-listing tasks rely on two assumptions about the cognitive salience of cited items: frequently cited items are more prominent to interviewed people than unfrequently cited items; and items ranked first in the lists are more familiar to people than items ranked last (Quinlan, 2005). From this background, we developed a methodology linking animal cognitive salience and people's attitudes and emotions towards cited animals aiming at assessing positivity and negativity biases regarding animals. Based on the theory of planned behavior (Ajzen, 1991), we here define people's attitudes towards an animal as the degree to which a person has a favorable or unfavorable evaluation or appraisal of the animal. On this basis, we propose that higher salience scores for negatively-judged animals would suggest a negativity bias, and vice versa for positively-judged animals.

### **3. Methods**

#### ***3.1. Study Area***

The Cevennes National Park (CNP), established in 1970, stands as the oldest French National Park, nestled in the southern expanse of the Massif Central Mountain range. Encompassing roughly 3,000 square kilometers, with a core zone spanning 938 km<sup>2</sup>, it spans four distinct biogeographical areas: the Causses, Cévennes, Aigoual, and Mont Lozère. Situated at the juncture of Mediterranean and Atlantic climates, and boasting elevations ranging from 200 to 1,500 meters above sea level, the CNP boasts a diverse and endemic-rich biodiversity.

Recognized as a UNESCO World Heritage site since 2011, the park ardently preserves both its ecosystems and the traditional human activities integral to its landscapes (PNC, 2021). Consequently, even within the core area housing permanent residents, practices like hunting and specific agricultural methods are integral to the park's management ethos (Larrère, 2009). Moreover, CNP serves as a pivotal tourist destination, offering an array of outdoor pursuits such as hiking, canyoning, and biking. Visitors also have the opportunity to delve into the

region's botanical, zoological, and geological wonders, as well as immerse themselves in the cultural heritage of CNP's inhabitants, spanning silk production and chestnut cultivation. For this study, our focus turned to the Val d'Aigoual commune, nestled within the southern fringes of CNP's buffer zone (*aire d'adhésion* in French; see supplementary material Figure S1). Characterized by its rugged terrain sculpted by the Hérault and Tarn rivers, the valley encompasses hamlets, pastures, forests, and terraced agricultural lands. While historically renowned for its silk industry (Cabanel, 2013), the region has witnessed a gradual transition to forested landscapes since the late 19th century. This transformation, driven by reforestation initiatives and rural depopulation, has resulted in the dominance of chestnut, holm oak, and beech trees across former grazing areas and cultivated terraces (Cornu, 2003). Despite this shift, traditional pastoral systems persist, buoyed by local goat cheese markets and the area's appeal to tourists seeking its rich heritage and natural beauty.

### **3.2. *Sampling Design and Respondent Selection***

Using convenience and quota sampling, we recruited 100 respondents to capture a diversity of profiles in terms of age, gender, place of residence and origin. First, we went to different locations, including villages, hiking trails and rivers, which allowed us to recruit 75 respondents. As interviews progressed, respondents were selected to obtain a balanced sample of age and gender. Yet, as this approach was not suited to grasp local residents, an additional set of 25 respondents was recruited through visits to farms and other habitations. Our final sample of 100 informants was well-balanced in terms of gender and status (local residents vs tourists), while variables such as age class, people's origin (native vs non-native from Cevennes) and professional activity were not homogeneously distributed (see supplementary material Table S1). Yet each modality was sufficiently represented to allow statistical analyses.

### **3.3. *Interview Procedure and Ethics***

Interviews were structured around three successive steps that aimed at (i) assessing animal cognitive salience via free-listing tasks, (ii) collecting respondents' emotions and attitudes towards cited animals, and (iii) gathering explanations from respondents regarding their emotions and attitudes (Figure 1).

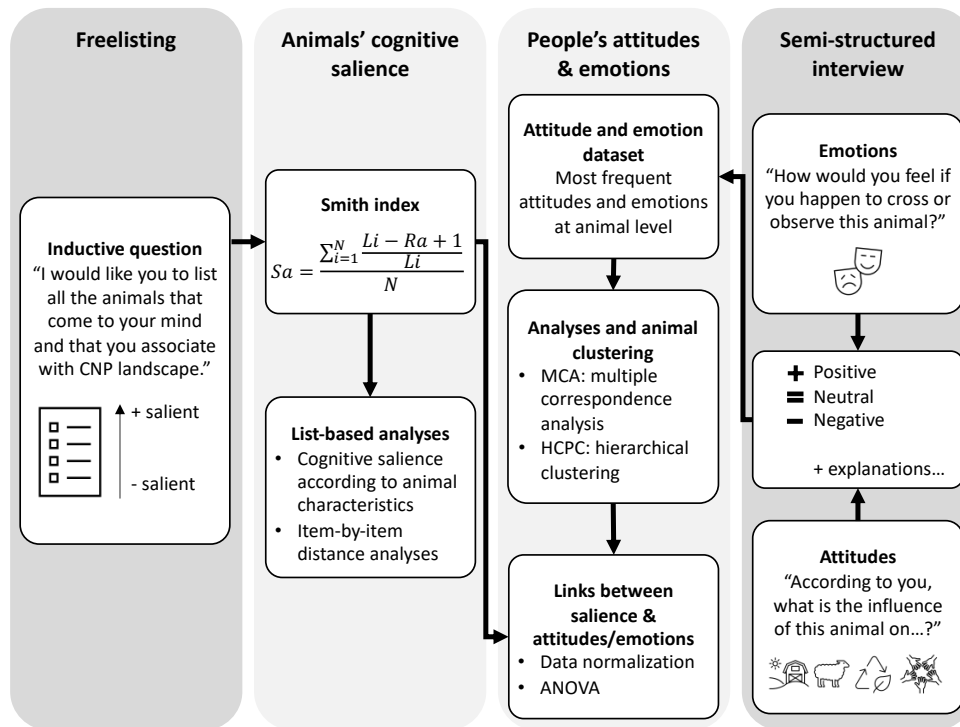


Figure 1: Synthesis of the methodology used to (i) assess animal cognitive salience through free-listings, (ii) evaluate people's attitudes and emotions towards animals through semi-structured interviews, and (iii) explore the relationships between the two with multivariate and bivariate analyses.

We initiated free-listing tasks with the statement: "*I would like you to list all the animals that come to your mind and that you associate with Cevennes landscapes.*" No time limit was set and the listing was stopped when respondents had no more animals to add.

The semi-structured interview step (see supplementary material Interview guideline) was meant to gather respondents' attitudes and emotions towards animals, as well as explanations about these (Figure 1). For attitudes, we acknowledged the multidimensionality of people judgement about an animal, which could be seen as positive for some aspects (e.g. wolves positive for tourism) and negative for other (e.g. wolves negative for livestock farming). As a consequence, respondents were asked to identify from their list the beneficial, detrimental and neutral animals to five central domains to CNP landscapes and management policies: (i) crop cultivation, (ii) livestock farming, (iii) ecosystem functioning and preservation, (iv) CNP touristic interest and (v) CNP heritage value. Respondents were asked to explain their responses for each animal and domain, and 'no opinion' answers were welcome. To collect emotions induced by animals, respondents were asked about how they would feel to cross or observe them. Here again, we welcomed all kinds of emotions as expressed by people.

Finally, we asked respondents for socio-demographic details, including their age, gender, profession, origin and status regarding CNP (i.e., permanent resident, temporary resident, or tourist). Interviews were strictly anonymous as we did not collect people’s names nor record them. Consequently, no personal data as defined in the European General Data Protection Regulation was collected. Furthermore, while it is not mandatory under French law to obtain an ethics approval for such research, we complied with ad-hoc ethics standards. After explaining the study’s context and objectives, we obtained the Free Prior and Informed Consent of respondents orally and made sure our research did not put them at risk. Depending on people’s willingness to discuss and availability, interviews lasted between 20 and 40 minutes. All interviews were conducted by the first author from August to September 2021.

### 3.4. *Free-list Analysis and Cognitive Salience*

All statistical analyses were conducted under the R environment (R Core Team, 2023). First, we cleaned free-lists by checking for synonyms and spelling mistakes, and translating the cited items from French to English. Instead of using scientific taxonomy, we kept the items as cited by people to remain as close as possible to their representations. For example, items such as ‘stag’ (*cerf* in French) and ‘hind’ (*biche*) were kept separate instead of merging them into a unique ‘deer’ item corresponding to *Cervus elaphus*.

Second, we classified cited items to facilitate result interpretations. A first grouping (animal status) was meant to distinguish wild vs domestic animals. A second grouping (animal group) was meant to distinguish amphibians, arthropods, birds, fishes, mammals, reptiles and fungi. Third, we processed the 100 free-lists and calculated the most common cognitive salience indexes with FLARES (Free List Analysis under R Environment using Shiny, Wencelius et al., 2017). Because the three indices were highly correlated, we will focus here on the Smith salience index given by the following formula (Smith & Borgatti, 1997):

$$S_a = \frac{\sum_{i=1}^N \frac{L_i - R_{ai} + 1}{L_i}}{N}$$

$S_a$  = Smith cognitive salience index for animal  $a$

$L_i$  = length of the list of respondent  $i$

$R_{ai}$  = rank of citation of animal  $a$  in the list  $i$

$N$  = total number of lists (or respondents)

Finally, we used the Henley index to calculate the distance between the different items based on the average difference of citation ranks for every pair of items (Henley, 1969).

Multidimensional scaling was processed using the distance matrix to explore item citation patterns. Because of analytical limitations regarding the management of rare items, this analysis focused on the items mentioned by at least 5% of the respondents.

### **3.5. Analyzing Attitudes, Emotions, and Cognitive Biases**

Based on semi-structured interviews, each emotion and attitude expressed by each respondent for each animal was classified as positive (e.g. pleasure, interest, curiosity, amazement) negative (e.g. annoyance, fear, disgust), or neutral. For attitudes, we also had a ‘no opinion’ category. We then summarized the dataset at animal level by summing the number of respondents based on their answers for each domain.

In a preliminary step, we calculated from this dataset an index of positivity for each animal (ratio between positive opinions and the number of respondents asked about the animal) and for each domain (i.e., emotions, crop cultivation, livestock farming, ecosystems, tourism, heritage value). Yet, this led to a dataset with many zero values because for a specific domain (e.g. tourism), many animals were considered neutral (e.g. beetles, spiders, slow worms). To solve this problem, we switched to a categorical approach and classified each animal as positive, neutral or negative for a given domain based on the most frequent respondents' attitudes and emotions. As a result, each animal was characterized by six categorical variables (each variable corresponding to a domain: emotions, crop cultivation, livestock farming, ecosystems, tourism, heritage), with three modalities: positive, negative, and neutral. On the basis of this dataset, we computed a Multiple Correspondence Analysis (MCA) and a Hierarchical Clustering on Principal Components (HCPC) with the *FactoMineR* package (Lê et al., 2008). The MCA was used to synthesize the data and better understand the most discriminating emotions and attitudes. The HCPC then allowed identifying five clusters of animals based on people's emotions and attitudes.

Finally, to analyse the relationships between animal cognitive salience and people's emotions and attitudes, we processed a one-way ANOVA and Tukey post-hoc analyses between Smith salience indexes and the clusters identified by the HCPC (Kassambara, 2023). Before processing the ANOVA, we operated a logarithmic transformation of the Smith salience index to meet normality and homogeneity of variance assumptions, confirmed with the Shapiro test (see supplementary material Figure S2,  $p=0.43$ ) and the Levene test ( $p=0.27$ ).

## 4. Results

### 4.1. *Cognitive Salience and Proximity of CNP Animals*

Respondents cited a total of 154 animals, of which 53 were mentioned by at least 5% of the respondents (see supplementary material Figure S3). On average, one respondent cited  $9.2 \pm 5.3$  (SD) animals, with a maximum of 26 animals and a minimum of 3 animals. Data saturation, i.e., the minimum number of respondents required to get the full list of 154 animals, was obtained after 36 respondents (see supplementary material Figure S4). The most cognitively salient animals were ‘wild boar’ ( $S=0.55$ ), ‘bird’ ( $S=0.34$ ), ‘fox’ ( $S=0.28$ ), ‘roe deer’ ( $S=0.22$ ) and ‘goat’ ( $S=0.18$ ). Yet, cited animal names referred to different taxonomic categories: they either referred to a taxonomic class (e.g. ‘bird’, ‘insect’), family (e.g. ‘eagle’, ‘ant’), genus (e.g. ‘buzzard’, ‘earthworm’), species (e.g. ‘Bonelli’s eagle’, ‘boxwood borer’), or an infraspecific category (e.g. ‘stag’ and ‘hind’ distinguishing the male and female deer). The most represented groups of animals were birds ( $N=56$  items), mammals ( $N=48$ ), and arthropods ( $N=34$ ), while reptiles ( $N=7$ ), amphibians ( $N=5$ ) and fishes ( $N=3$ ) were the least represented. Smith salience index significantly differed between these groups (ANOVA,  $p=0.015$ ). Tukey post-hoc analyses revealed that the difference was significant between mammals ( $S=0.056 \pm 0.094$  SD) and birds ( $S=0.023 \pm 0.052$  SD) (see supplementary material Figure S5). In addition, item-by-item proximity analyses focused on the 53 most-cited animals revealed that people tended to cite mammals together and arthropods together (see supplementary material Figure S6). This was not the case for birds and reptiles that were overlapping with other animal groups.

Finally, respondents listed 138 wild animals and 16 domestic animals. We found no significant effect of animal status on Smith salience index (ANOVA,  $p=0.54$ , see supplementary material Figure S5).

### 4.2. *Respondents’ Emotions and Attitudes toward CNP Animals*

We collected data on people’s attitudes and emotions for 153 animals (out of the 154 cited by respondents). Overall, respondents mainly expressed neutral and positive emotions towards cited animals (Figure 2). An equal number of 114 animals was associated with positive and neutral emotions by at least one respondent, whereas 31 animals were associated with negative emotions (Figure 2a). For example, wild boars were associated with positive, neutral, and negative emotions by 22, 25 and 32 respondents, respectively. Foxes were associated with positive, neutral, and negative emotions by 26, 26 and 4 respondents, respectively. On the contrary, animals such as raptors, fishes, and rabbits were never

associated with negative emotions; and animals such as rodents, scorpions, and earthworms were never associated with positive emotions.

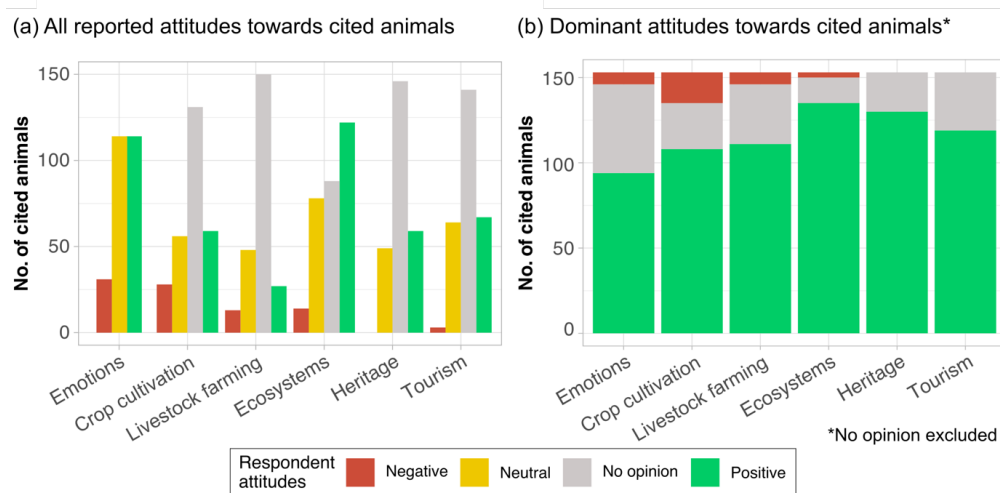


Figure 2: Respondent attitudes toward cited animals with regard to their emotions, crop cultivation, livestock farming, ecosystem functioning, heritage value and tourism attractiveness. (a) Each bar represents the number of animals associated by at least one respondent to the corresponding attitude (as respondents provided differing answers, one animal could be associated with several attitudes). (b) The graph summarizes most frequent respondents' attitudes for the 153 animals listed by respondents, after excluding "no opinion" responses.

Animal classification according to the most frequent emotion (Figure 2b) revealed 94 animals that dominantly generated positive emotions, 52 that dominantly generated neutral emotions and seven that dominantly generated negative emotions. The latter included maggot, mole cricket, mosquito, rodent, scorpion, tick, and wild boar.

For all domains, respondents mainly had no opinion on the role of cited animals, except for ecosystem functioning that was dominated by positive attitudes ( $N=122$  animals, Figure 2a). In addition, neutral attitudes were well represented, at a similar level as positive attitudes except for livestock farming and ecosystem functioning. Negative attitudes were largely minoritarian, and no respondent considered any animal negative for CNP heritage value (Figure 2a). Finally, animal classification based on the most frequent attitudes revealed a similar pattern, with a dominance of positive animals for all domains and a limited number of negatively-judged animals (Figure 2b).

Crop cultivation was the domain for which the largest share of negative animals was identified ( $N=18$  negative animals based on dominant respondents' attitude, or 11.8% of all cited animals, Figure 2b). Among the most cognitively salient animals, wild boar, roe deer, stag, badger, and mosquito were dominantly reported as negative for crop cultivation. On the

contrary, goat, fish, sheep, insect and eagle were the animals with the highest cognitive salience seen as positive for crop cultivation. For livestock farming, a total of 13 animals were considered negative by at least one respondent (Figure 2a), and eventually, seven of them were dominantly considered as negative (Figure 2b). The latter included fox, mouflon, vulture, wolf, fly, Asian hornet and pig. On the contrary, among the most salient animals, goat, raptor, dog, rabbit, and sheep were dominantly reported as positive for livestock farming. Interestingly, several animals were considered negative for ecosystem functioning: 14 negative animals were cited by at least one respondent, while negative attitudes dominated for three of these (including cattle, elephant, and gorilla that all come from other regions and/or continents). Whereas no animal was dominantly considered as negative to CNP touristic attractiveness and heritage value (Figure 2b), some respondents considered dog ( $N=1$  respondent), wild boar ( $N=3$ ) and wolf ( $N=1$ ) negative for tourism.

Considering these results, wild boar (*Sus crofa*, or *sanglier* in French) appeared to be a particularly salient and problematic species in CNP, dominantly associated with negative emotions and a negative influence on agriculture. No other cognitively salient animal received so negative viewpoints. For many respondents, the situation with wild boar was effectively alarming: "*The wild boar destroys terraces and enters into home gardens*" (respondent 80) and is "*very harmful for agriculture because it uproots everything and eats earthworms*" (respondent 12). Consequently, most respondents owning a home garden reported they already witnessed wild boars turning over the soil, and farmers generally fence their fields to protect crops specifically from this animal. Some respondents yet tempered this alarming diagnosis, highlighting that even if wild boars were "*developing at great speed*" (respondent 15) because of the absence of "*predators apart from man*" (ibid.), they are not necessarily problematic as long as local hunting allows to regulate populations properly. Finally, wild boar was mentioned positively in rare cases, particularly for the services it provides as a game reserve – it was seen as "*useful as a source of food for people far away*" (respondent 2) – or as an emblematic animal of CNP: "*Coming back from an evening out, there is much chance of running into a wild boar. The boar is part of us*" (respondent 43).

#### **4.3. Links between Animal Cognitive Salience and People's Emotions and Attitudes**

MCA and HCPC led to grouping animals into five clusters (Figure 3). Along its first dimension, the MCA tended to distinguish (i) animals associated with neutral attitudes concerning their contribution to cropping and livestock activities and CNP touristic attractiveness and heritage from (ii) animals seen as positive to crop cultivation and

associated with neutral emotions. The second dimension was mainly structured by people's negative emotions and negative attitudes related to the agricultural domain (Figure 3). This distinction was well-evidenced by the HCPC that distinguished five clusters of animals (detailed cluster description available in supplementary material Table S2):

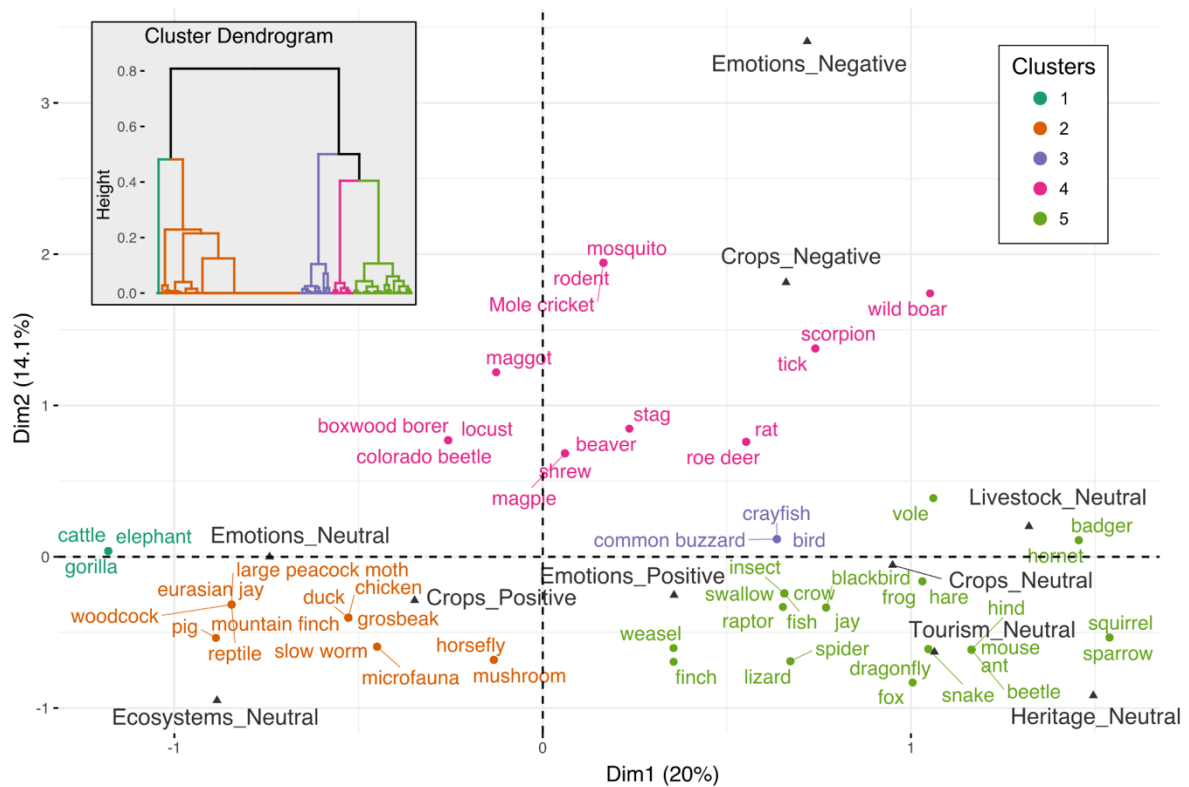


Figure 3: Biplot of the Multiple Correspondence Analysis (MCA) with active variables (black triangles) and individuals (colored circles) and dendrogram of the associated Hierarchical Clustering on Principal Components (HCPC). Individuals are colored according to the clusters obtained by the HCPC. Only the 60 most contributing individuals and 10 most contributing variable categories are represented for visibility.

- Cluster 1 – *exogenous animals* ( $N=3$  animals): this cluster gathered the three animals that were perceived as negative to ecosystems, i.e. the exogeneous/exotic animals;
- Cluster 2 – *neutral animals* ( $N=14$ ): regrouped the animals that were considered as neutral to ecosystem functioning and maintenance;
- Cluster 3 – *positive animals to CNP landscapes* ( $N=86$ ): regrouped the largest number of animals, associated with positive attitudes, including for cropping and livestock activities, and CNP tourism and heritage value. People's emotions did not shape this cluster;
- Cluster 4 – *negative and disliked animals* ( $N=18$ ): gathered animals that generated negative emotions to respondents, as well as animals considered as negative to agriculture. This cluster tended to over-represent arthropods;

- Cluster 5 – *neutral and liked animals* ( $N=32$ ): this last cluster gathered animals that were considered as neutral to CNP landscapes by respondents, but that still generated positive emotions to respondents.

In sum, the HCPC revealed that animals that received positive attitudes (Cluster 3) differed from those that people would appreciate to cross and/or observe (Cluster 5). On the contrary, animals considered as negative to agriculture were also animals that people disliked (Cluster 4). The ANOVA revealed a significant relationship between people’s attitudes and emotions, and animal cognitive salience ( $p < 0.0001$ , Figure 4). In particular, animals in Cluster 5 (neutral and liked animals) were significantly more salient ( $S = 0.052 \pm 0.057$  SD) than animal in clusters 2 (neutral animals,  $S = 0.010 \pm 0.015$  SD) and 3 (positive animals to CNP landscapes,  $S = 0.025 \pm 0.047$  SD). Tukey post-hoc analyses revealed no other significant difference between groups (Figure 4). Yet, we note that animals in Cluster 4 (negative and disliked animals) had the highest Smith salience index on average ( $S = 0.058 \pm 0.134$  SD).

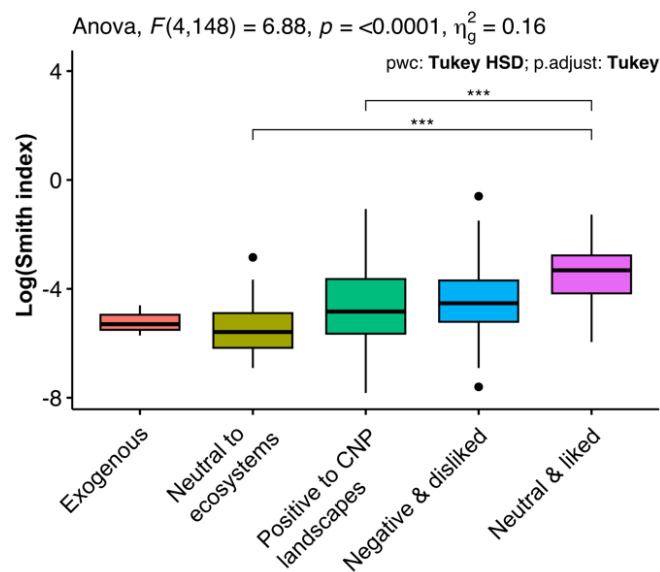


Figure 4: Boxplot and ANOVA results showing the relationship between animals’ cognitive salience (after logarithmic transformation of the Smith index to meet normality assumption) and clusters of animals obtained with the HCPC and based on people’s attitudes and emotions. Inter-group significant differences were obtained through Tukey post hoc analyses.

## 5. Discussion

Initially focused on positivity and negativity biases, this study also reveals a third bias—taxonomic bias. After addressing this bias and related methodological challenges, we will discuss our findings on positivity and negativity biases, along with the potential and limitations of our approach for future research.

### 5.1. *A Taxonomic Bias in Animal Cognitive Salience*

By blending methodologies from ethnobiology and environmental psychology, this study yielded somewhat divergent results depending on the analytical level examined. At a broad taxonomic level, respondents tended to cite more animals from bird, mammal, and arthropod categories compared to amphibians, fish, and reptiles. This result aligns with other studies that evidenced a taxonomic bias depicting people's preferences towards certain species (Czech & Krausman, 2001; Kansky et al., 2014; Troudet et al., 2017). This bias might come from the human ability to be empathic and communicate with certain species rather than others (Harrison & Hall, 2010). It could also be explained through the ecological apparency hypothesis, which assumes that people preferentially know non-human entities that are more easily visible and/or accessible (Blanco & Carrière, 2016).

However, at item level, cited reptiles, amphibians, and fish did not exhibit higher cognitive salience scores than cited birds, mammals, and arthropods ([see supplementary material Figure S5](#)). This discrepancy between the two analytical levels may be attributed to differences in the taxonomic levels at which animals were named, with broad categories like 'fish' and 'insect' encompassing fewer items but that individually received higher salience scores. This challenge, common to free-listing tasks, could be addressed through a two-level analysis (which we did here) or by standardizing cited items based on scientific taxonomy (Atran, 2003). However, the latter approach tends to homogenize respondents' answers and reduce nuances in their perceptions.

Finally, notwithstanding these methodological considerations, our results on taxonomic bias illustrate that human cognition is simultaneously affected by numerous biases (more than 200 have been identified so far, Engler et al., 2018) that could hardly be disentangled in non-experimental research settings, challenging result interpretations.

### 5.2. *The Complexity of Navigating Positivity and Negativity Biases*

Our results about positivity and negativity biases further showed contrasted patterns according to the analytical level. At a broad taxonomic level, respondents tended to associate

species with positive and neutral emotions and attitudes more frequently than negative ones, resulting in a higher prevalence of positively-perceived animals across all domains investigated. This finding suggests an overall positivity bias toward non-human entities. However, a finer analysis uncovered nuances: animals evoking positive emotions were notably more salient than those eliciting neutral responses, while negatively perceived animals exhibited heightened salience, albeit not significantly so. The latter finding hints at the presence of a potential negativity bias. Though seemingly contradictory, these results mirror established findings in psychology that suggest that the human brain is suited to a world dominated by positive experiences but where rarer negative experiences requires specific attention from people (Rozin & Royzman, 2001). In our case, the CNP was dominated by positively-judged animals, indicating a positivity bias at broad level. Still, the few negatively-judged animals captured more people's attention, resulting in high salience scores for these animals at item level. Similarly, neuroscience research suggested the coexistence of positivity and negativity biases (Norris et al., 2011). For instance, studies have shown that both highly positive and highly negative messages about wildlife conservation can elicit strong reactions from individuals, indicating the complex nature of human responses (Jain et al., 2019). Thus, our results align with the literature on positivity and negativity biases, but stresses the need for further research to confirm our conclusions. Another key lesson can be drawn from our results showing that cognitive salience was more linked to positive emotions than attitudes, underscoring the significance of affective responses in human/non-human interactions and conservation efforts (Schaffner et al., 2015). This aligns with recent calls in sustainability science to consider emotions and sensory experiences in understanding human behavior (e.g. Woiwode et al., 2021).

### ***5.3. Key Watchpoints and Limits about the Method***

Our methodological proposal relies on widely used interviewing techniques, demonstrating their value and transferability to diverse contexts. However, some aspects of the method should be carefully considered before its application elsewhere.

First, the method relies on the assumption that differences in cognitive salience indicate cognitive bias. Yet, we acknowledge that other factors and phenomena could explain such differences and that further research would be required to consolidate this positioning.

Second, free-listing tasks have well-known inherent limitations (see Brewer, 2002; Dany et al., 2015; Quinlan, 2017). We note in our case that the high number of respondents helped reduce some of these limitations, but that additional techniques exist to attenuate them further

(e.g. Brewer, 2002). Furthermore, due to the characteristics of free-listing tasks, our approach can only capture cognitive biases at collective level and would be unsuited to the assessment of cognitive biases at individual level. Finally, the outcomes of free-listing tasks utterly depend on the inductive question. In our study, we chose to focus people's attention on the fauna from the CNP landscape, which was the most suited option considering our research question. We yet note that the few persons who cited exotic species could have misunderstood the question and that not restricting the geographical range of our investigation could have produced entirely different results.

Second, applying our method in CNP revealed that positive attitudes and emotions towards animals predominate, leading to an unbalanced sampling between positively- and negatively-judged animals. This unbalance posed a key statistical challenge and hindered our ability to confirm the existence of a negativity bias. Alterations of the method could therefore be necessary to obtain a more balanced sample of animals.

Third, we note that emotions and attitudes are part of a two-way relationship between people and other entities that is not necessarily accessible in absolute terms. This relationship is diverse according to individual education and experience and highly dynamic according to age and emotional state (Ochsner & Gross, 2005). The quantitative orientation of our method does not allow entering such complexity; it would require more in-depth and qualitative approaches. Another methodological challenge is that emotions are not universal across human societies and cultural groups and are felt and expressed differently in different cultures (Wierzbicka, 1992). In this sense, emotions are a cultural product and specific approaches have been proposed to take into account this inter-cultural variation (e.g. Oettingen & Seligman, 1990). In particular, verbal language is not necessarily the best entry point to emotions for certain categories of persons or cultures and alternative approaches relying on art (e.g. drawing, painting, photography, film, theatre) showed helpful to reveal things that are hardly said (Fache et al., 2022).

Finally, whereas our method seeks to explore the cognitivist aspects of people's relationships with non-human entities, taking into account socio-political, historical, and cultural aspects remains important. This could be illustrated in our case with wild boar, which was close to an outlier in our analyses (Figure 3). Cognitivist arguments alone cannot fully explain this result that rather reflects an interplay of cognitive processes and social representations that altogether shape people's perceptions of this species. Indeed, wild boar's association with protected areas has stirred controversy, as its presence is linked to crop damage and road collisions, leading to criticism of conservation policies (Mathevet & Bondon, 2022).

However, unlike more charismatic species such as wolves, wild boar garners little interest from conservationists, despite its impact on certain bird species. Moreover, its proliferation in the CNP symbolizes broader societal shifts, including forest encroachment, declining hunter populations, and rural depopulation (Blanco et al., 2020). Thus, its presence in the CNP represents a broader discourse on environmental conservation, rural livelihoods, and historical land use practices.

#### ***5.4. Key Lessons and Perspectives***

While focused on a case study, our results aligned with the existing literature on cognitive biases, demonstrating the potential of our method for future research in addressing this critical gap. Our findings highlighted that people tend to exhibit a positivity bias toward animals, which could foster greater support for biodiversity conservation efforts. However, despite problematic species being rarer, they appear to be particularly salient to people. This negativity bias suggests that conservation managers will need to overcompensate for conservation costs and overcommunicate the benefits of conservation to enhance further public support and adherence (Buijs & Jacobs, 2021).

Future research with larger sample sizes, targeted species analyses, or cross-site comparisons could provide valuable insights for refining these results and conclusions. In particular, further exploration of how positivity and negativity biases are influenced by factors such as gender, age, and cultural background could be especially insightful.

### **6. Conclusion**

Biodiversity management and conservation, as other sustainability challenges, is increasingly considered a social issue more than a biophysical one. Consequently, a vast range of research in social sciences and the humanities would be relevant to better address sustainability and biodiversity conservation challenges. In this perspective, this study aimed at investigating how cognitive biases influenced people's perceptions of animal species. In the Cevennes National Park in France, results suggested a simultaneous influence of positivity and negativity biases, and highlighted emotions as a key driver of these. This study adds arguments on the need to reinforce research on the complexity of human cognition, which could help foster more effective wildlife conservation and management.

## 7. Acknowledgements

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# Supplementary material for

## Positivity and Negativity Biases about Animals revealed through Emotions, Attitudes and Cognitive Saliency in a French National Park

**Authors:** Théo Descours<sup>1,2</sup>, Stéphanie M. Carrière<sup>1</sup>, Clémence Moreau<sup>1</sup>, Valentine Boudjema<sup>3</sup>, Julien Blanco<sup>1,\*</sup>

<sup>1</sup> SENS, IRD, CIRAD, Univ Paul Valéry Montpellier 3, Univ Montpellier, Site St Charles, Route de Mende, 34199 Montpellier Cedex 5, France

<sup>2</sup> UR ADI-Suds (Agrodéveloppement et Innovation aux Suds), Istom, College of International Agro-Development, 4 rue Joseph Lakanal, 49000 Angers, France

<sup>3</sup> Espace-DEV, IRD Nouméa, Univ de la Nouvelle-Calédonie, 101 Promenade Roger Laroque, 98 848, Nouméa, Nouvelle-Calédonie

### \*Corresponding author:

Julien Blanco, SENS, IRD, CIRAD, Univ Paul Valéry Montpellier 3, Univ Montpellier, Site St Charles, Route de Mende, 34199 Montpellier Cedex 5, France

Email address: [julien.blanco@ird.fr](mailto:julien.blanco@ird.fr)

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## Interview guideline

**Freelist question:** *I would like you to list all the animals that come to mind and that you associate with CNP landscapes. Go ahead, and I'll take notes at the same time.*

Code	Cited item	Code	Cited item	Code	Cited item	Code	Cited item
1		11		21		31	
2		12		22		32	
3		13		23		33	
4		14		24		34	
5		15		25		35	
6		16		26		36	
7		17		27		37	
8		18		28		38	
9		19		29		39	
10		20		30		40	

### Emotions:

*Which of the animals you have just listed would you be happy to cross or observe?*

*On the contrary, which ones would you be unhappy to cross or observe?*

*Which of these animals scare or disturb you?*

*Can you explain why?*

Positive	Negative	Neutral

### Attitudes:

*Which of these animals are harmful to agriculture/ breeding/ Cevennes ecosystems/ Cevennes touristic attractiveness/ Cevennes cultural heritage?*

*Which of these animals are beneficial to agriculture/ breeding/ Cevennes ecosystems/ Cevennes touristic attractiveness/ Cevennes cultural heritage?*

*Which of these animals are neutral to agriculture/ breeding/ Cevennes ecosystems/ Cevennes touristic attractiveness/ Cevennes cultural heritage?*

	Harmful	Beneficial	Neutral
Agriculture			
Breeding			
Ecosystem			
Tourist appeal			
Cultural heritage			

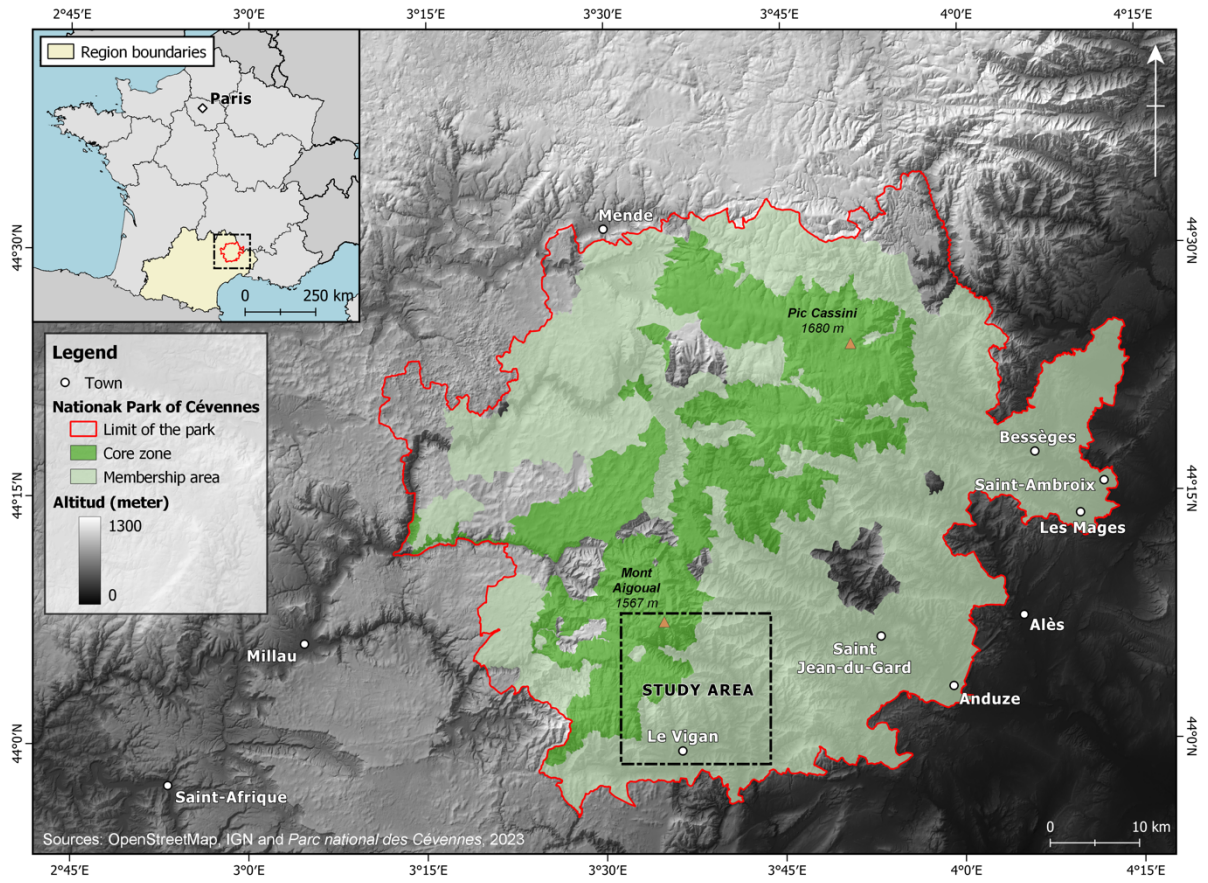
**Table S1: Description of respondents' socio-demographic characteristics.**

Socio-demographic variables	Variable modalities	No. of respondents
GENDER	Woman	47
	Man	53
AGE CLASS (years)	18-29	24
	30-44	15
	45-59	31
	60-74	22
	75-91	8
STATUS	Local	52
	Tourist	48
ORIGIN	Native from Cevennes	19
	Not native from Cevennes	81
JOB	Farmers	4
	Craftsmen, traders, and entrepreneurs	7
	Executives and higher intellectual professions	9
	Intermediate professions	15
	Employees	11
	Workers	5
	Retirees	23
	People with no formal job	26

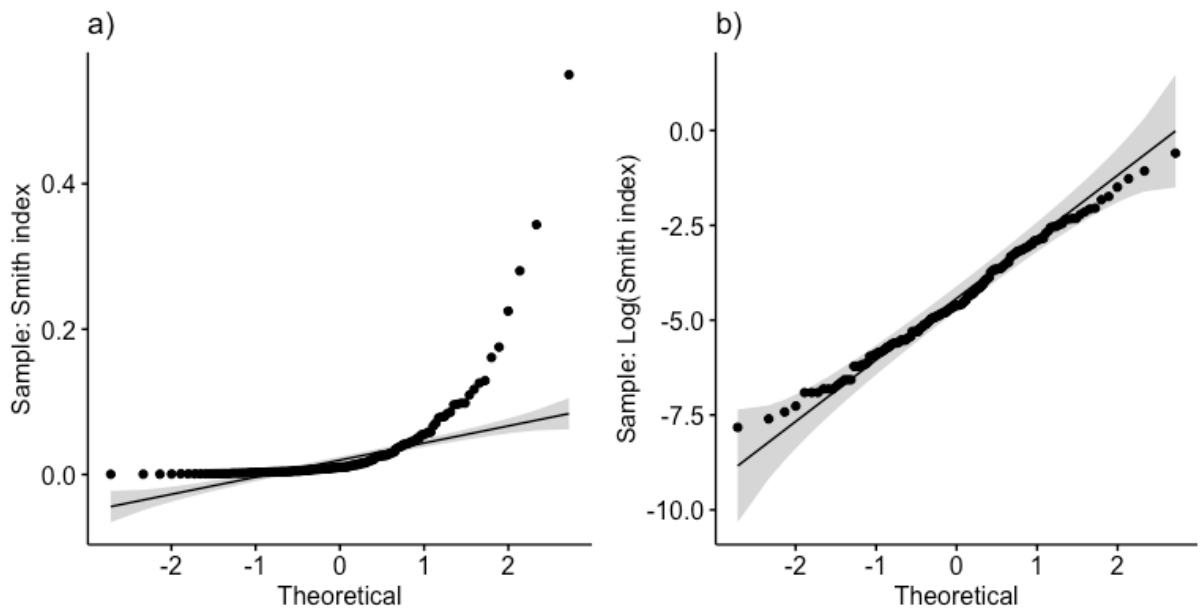
**Table S2: Descriptors\* of the five clusters obtained with the HCPC function of the FactoMineR package (Lê et al., 2008).**

	Cla/Mod	Mod/Cla	Global	p.value	v.test
\$`1`					
Ecosystems=Ecosystems_Negative	100.000000	100	1.960784	1.708596e-06	4.785150
Category=Mammal	6.250000	100	31.372549	2.955187e-02	2.176045
Emotions=Emotions_Neutral	5.769231	100	33.986928	3.775996e-02	2.077451
Ecosystems=Ecosystems_Positive	0.000000	0	88.235294	1.394214e-03	-3.195846
\$`2`					
Ecosystems=Ecosystems_Neutral	93.333333	100.000000	9.803922	6.267238e-19	8.887192
Category=Mammal	2.083333	7.142857	31.372549	3.566731e-02	-2.100700
Breeding=Breeding_Neutral	0.000000	0.000000	22.875817	2.179950e-02	-2.293843
Ecosystems=Ecosystems_Positive	0.000000	0.000000	88.235294	1.278517e-16	-8.275562
\$`3`					
Tourism=Tourism_Positive	69.747899	96.511628	77.777778	1.083406e-10	6.454830
Heritage=Heritage_Positive	65.384615	98.837209	84.967320	2.032242e-08	5.609234
Ecosystems=Ecosystems_Positive	63.703704	100.000000	88.235294	8.040209e-08	5.366224
Agriculture=Agriculture_Positive	66.666667	83.720930	70.588235	6.524721e-05	3.992983
Breeding=Breeding_Positive	62.162162	80.232558	72.549020	1.775697e-02	2.370647
Breeding=Breeding_Neutral	34.285714	13.953488	22.875817	3.464475e-03	-2.923206
Emotions=Emotions_Negative	0.000000	0.000000	4.575163	2.566880e-03	-3.015344
Ecosystems=Ecosystems_Neutral	0.000000	0.000000	9.803922	1.559058e-06	-4.803513
Agriculture=Agriculture_Negative	0.000000	0.000000	11.764706	8.040209e-08	-5.366224
Heritage=Heritage_Neutral	4.347826	1.162791	15.032680	2.032242e-08	-5.609234
Tourism=Tourism_Neutral	8.823529	3.488372	22.222222	1.083406e-10	-6.454830
\$`4`					
Agriculture=Agriculture_Negative	83.333333	83.333333	11.764706	2.833074e-15	7.898047
Emotions=Emotions_Negative	100.000000	38.888889	4.575163	9.393269e-08	5.338086
Category=Arthropod	27.272727	50.000000	21.568627	5.019773e-03	2.805762
Heritage=Heritage_Positive	13.846153	100.000000	84.967320	4.391953e-02	2.014858
Heritage=Heritage_Neutral	0.000000	0.000000	15.032680	4.391953e-02	-2.014858
Emotions=Emotions_Positive	6.382978	33.333333	61.437908	1.243735e-02	-2.499486
Category=Bird	1.785714	5.555556	36.601307	2.105139e-03	-3.074984
Agriculture=Agriculture_Positive	0.925925	5.555556	70.588235	1.052263e-09	-6.101274
\$`5`					
Heritage=Heritage_Neutral	95.652174	68.750	15.03268	6.551181e-18	8.622493
Tourism=Tourism_Neutral	70.588235	75.000	22.22222	1.155414e-13	7.421797
Emotions=Emotions_Positive	31.914894	93.750	61.43791	6.731435e-06	4.502008
Breeding=Breeding_Neutral	48.571429	53.125	22.87582	2.311493e-05	4.232460
Status=Wild	23.357664	100.000	89.54248	1.870152e-02	2.351428
Agriculture=Agriculture_Neutral	37.037037	31.250	17.64706	3.419180e-02	2.117802
Status=Domestic	0.000000	0.000	10.45752	1.870152e-02	-2.351428
Breeding=Breeding_Positive	12.612613	43.750	72.54902	1.123263e-04	-3.862296
Emotions=Emotions_Neutral	3.846154	6.250	33.98693	6.982498e-05	-3.976881
Tourism=Tourism_Positive	6.722689	25.000	77.77778	1.155414e-13	-7.421797
Heritage=Heritage_Positive	7.692308	31.250	84.96732	6.551181e-18	-8.622493

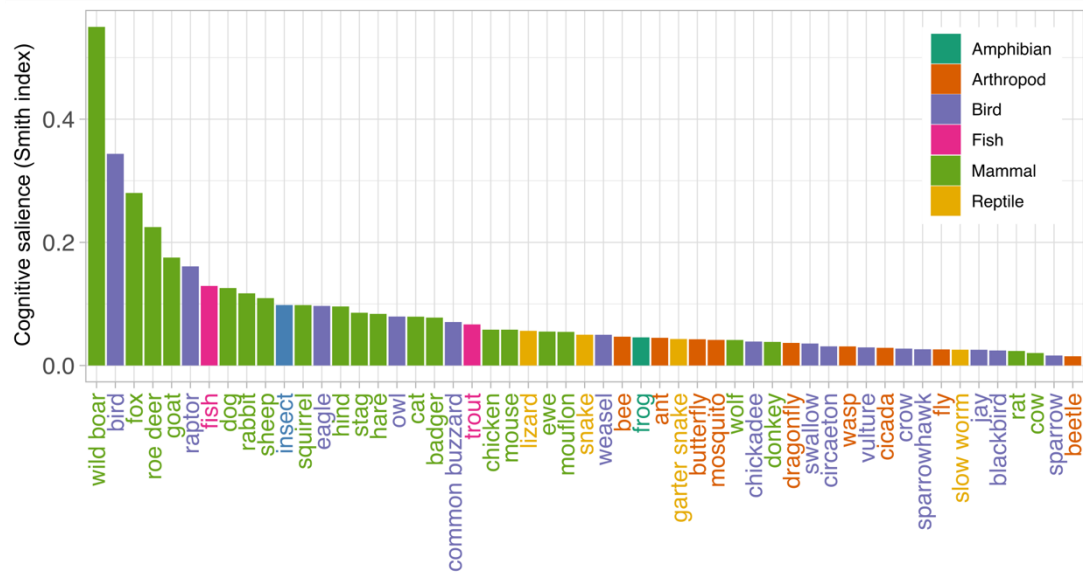
\**Cla/Mod* is the proportion of animals with the corresponding modality that are included in the cluster (e.g. all animals perceived are negative for ecosystems are in Cluster 1). *Mod/Cla* is the proportion of animals in the cluster with the corresponding modality (e.g. 96.5% of the animals in Cluster 3 are perceived as positive to tourism). *Global* is the proportion of animals with the corresponding modality in our full sample of animals (e.g. 31.37% of all cited animals were mammals). Finally, *p.value* and *v.test* are statistics that allow to test whether a given variable modality is significantly associated with a given cluster.



**Figure S1: Localization of the study site and illustration of the diversity of Cévennes Landscapes.**

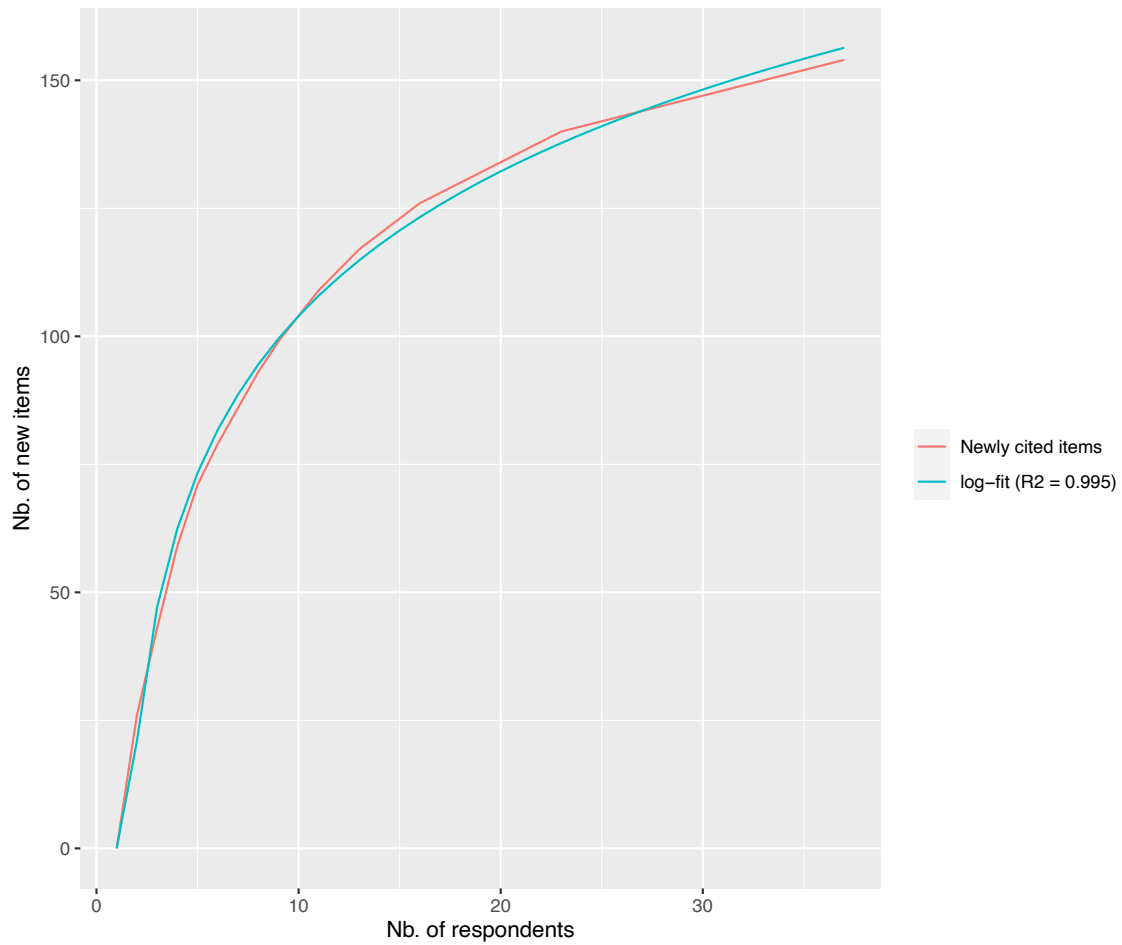


**Figure S2: Quantile-quantile plot comparing the realized distribution of (a) the Smith cognitive salience index, and (b) the logarithm of Smith salience index with the theoretical normal distribution. The b graph visually confirms the normal distribution of the logarithmic transformation of the Smith index.**



**Figure S3: Smith cultural salience indices for the 53 items cited by at least 5% of the respondents and colored according to their group.**

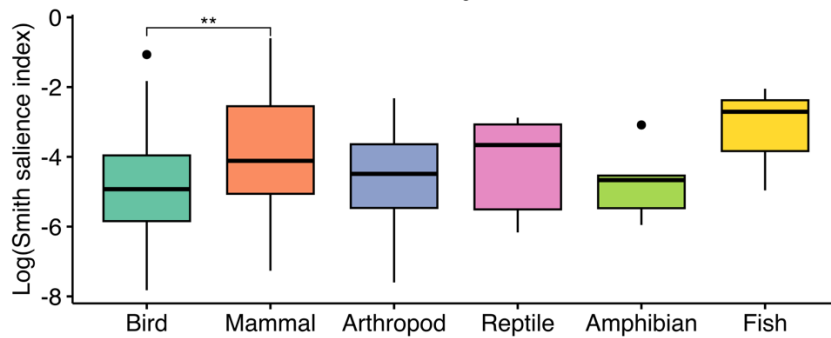
Cumulative sum of newly cited items across respondents  
36 respondents have cited all of the 154 items.



**Figure S4: Data saturation graph illustrating the evolution of the total number of cited items with the increasing number of respondents. Graph obtained with FLARES (Wencelius et al., 2017).**

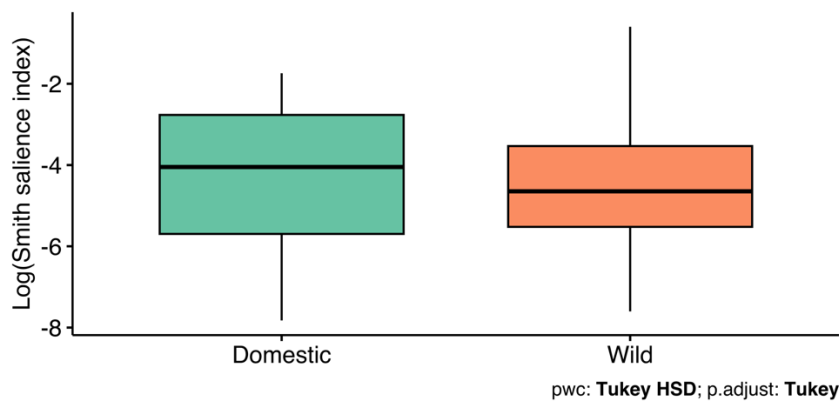
(a) Cultural salience by animal groups

Anova,  $F(5,147) = 2.94$ ,  $p = 0.015$ ,  $\eta_g^2 = 0.09$

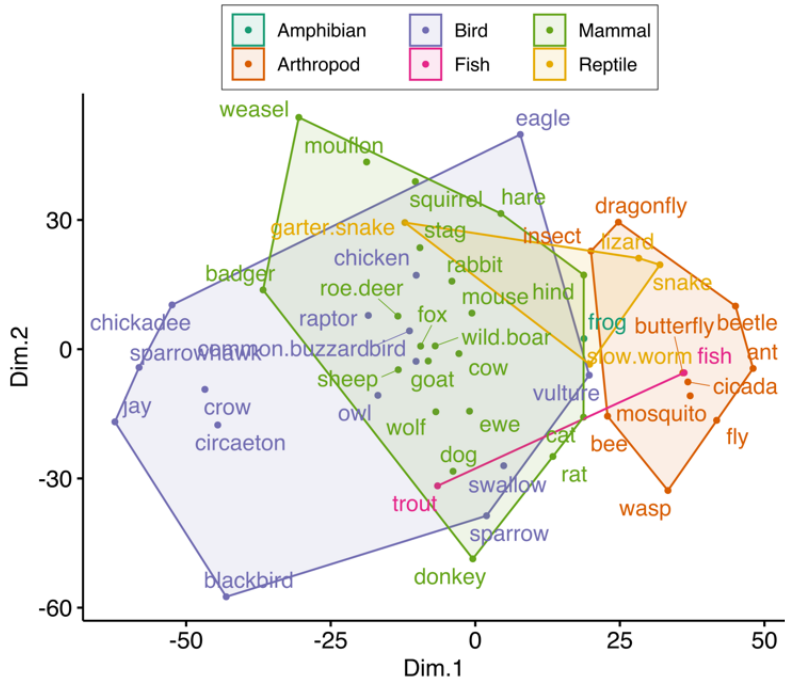


(b) Cultural salience by animal status

Anova,  $F(1,152) = 0.37$ ,  $p = 0.54$ ,  $\eta_g^2 = 0.002$



**Fig. S5: Boxplots showing the distribution of the Smith cognitive salience index (after logarithmic transformation) between (a) animal groups, and (b) animal status. Results from the associated ANOVA and Tukey post-hoc analyses highlight significant differences between groups. Logarithmic transformation of Smith index was done to meet the ANOVA's normality assumption.**



**Figure S6: Multidimensional scaling of item-by-item proximity clustered according to animal groups (amphibian, arthropod, bird, fish, mammal, and reptile). Distance between items (animals) was calculated with Henley index. Only the 53 animals mentioned by at least 5% of the respondents are plotted.**

## Cited References

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