RESEARCH ARTICLE

Emotional states elicited by wolf videos are diverse and explain general attitudes towards wolves

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Abstract

1. Emotions are short, intuitive mental processes that are important components of people's cognitions. They can influence attitudes (i.e. positive or negative evaluations of objects), and they are involved in decision-making processes. In the context of human-wildlife coexistence, mostly emotional dispositions have been studied (i.e. people's decontextualized, stable tendencies to react in a certain way towards wildlife), in contrast to emotional states (i.e. quick reactions elicited in specific contexts), which have been overlooked. This limits our understanding of emotional states and the role of emotional diversity in shaping attitudes towards wildlife species.

2. Here, we quantified emotional states elicited by context-specific wolf encounters featured in a set of YouTube videos. We conducted a social survey in rural populations of 24 randomly selected cities in France ($n = 795$) to (i) quantify emotional diversity and (ii) test the relationship between emotional states and attitudes towards wolves, accounting for individual and regional factors.

3. We found that emotional states that were most expressed across the six contexts of encounter were surprise, interest and fear, in this order. Emotional diversity was highly context-specific, with significantly different emotional identity, dispersion and extremization across the six contexts of encounters. Most variance in attitudes was explained by emotional factors alone (28%) and the best model including all three groups of predictors (emotional, individual and regional factors) explained 57% of the variance. The strongest effects of emotional states on attitudes were those of anger and joy. Fear had only half the effect of joy on attitudes.

4. *Synthesis and applications*: Our results highlight the importance and context-specificity of emotional diversity for human-carnivore coexistence. Complementary to previous studies focusing on single emotions and on decontextualized emotional dispositions, quantifying diverse, context-dependent emotional states can be helpful to improve decision-making in three different ways: (i) address relevant contexts triggering anger, which is a feeling rooted in perceived injustice, (ii) reduce emotional biases involving fear of carnivores given the extremely low probability of risks to human life and (iii) promote positive

emotions like joy to better reflect costs and benefits of sharing landscapes with large carnivores.

KEYWORDS
attitudes, *Canis lupus*, emotional space, emotions, environmental psychology, fear, human-wildlife conflicts

1 | INTRODUCTION

Research on the human dimensions of large carnivore return to rural landscapes in Europe is critical to understand the challenges and opportunities for human-carnivore coexistence (Bennett et al., 2016, 2017; König et al., 2020). Studies of human attitudes (i.e. the tendency to evaluate something as good or bad) have dominated the field of human dimensions of wildlife conservation but have comparatively overlooked the role of emotions (Castillo-Huitrón et al., 2020). The diversity of emotions is critical to understand because emotions can shape the direction (negative to positive) and intensity (weak to strong) of attitudes towards species (Jacobs & Vaske, 2019; Landon et al., 2020; Lehnen et al., 2022; Slagle et al., 2012; Straka, Miller, et al., 2020). However, research on human emotions towards wildlife has overlooked the importance of specific situations of encounters with wildlife in eliciting short-term emotional reactions (i.e. emotional states) and has mostly focused on emotional dispositions, that is the general, decontextualized tendency to react in a certain way towards wildlife. Hence, we have a limited knowledge of the diversity of emotional states potentially associated with wildlife encounters, and its relation to attitudes towards wildlife (Jacobs et al., 2014). Our study therefore assesses a diverse range of emotional states associated with a human-carnivore encounters and explores the relationships between those emotional states and attitudes towards one of the most contentious carnivore species, the wolf (*Canis lupus*).

1.1 | The importance of basic emotional states in relation to human-wildlife encounters

Research on human emotions towards wildlife is fragmentary, despite their universal yet diverse structure across human societies (Jackson et al., 2019). They reflect a basic mental capacity that strongly influences other mental processes, for example memories, motivation, decision making and behaviour (Rozin & Cohen, 2003). In that respect, they are expected to play an important role in contexts of interactions with wildlife (Jacobs et al., 2012; Jacobs & Vaske, 2019). In this study, we focus on a discrete perspective that entails a categorization of qualitatively different emotions (e.g. the seven so-called basic emotions of joy, surprise, interest, sadness, anger, disgust and fear) (Ekman, 1999; Izard, 2007; Jacobs et al., 2014). We acknowledge that the concept of basic emotions has been increasingly contested recently (Lindquist et al., 2022; Ortony, 2021) and that

constructionist theories of emotions give more weight to the complex interplay of cultural, social, biological conditions and evolutionary processes underpinning the diversity of emotional expressions (Lindquist et al., 2022). Our choice to focus on a specific set of basic emotions is motivated by (i) our intention to build upon previous literature on emotions towards wildlife (Arbieu et al., 2021; Jacobs et al., 2012, 2014; Thommen et al., 2021), (ii) to expand this literature by looking at specific contexts of encounters with wildlife, and by the fact that (iii) discrete emotions are well-understood and facilitate quantitative evaluation of contextual experiences (Lindquist et al., 2022). Basic emotions theorists argue that they stem from evolutionary adaptations to solve problems in various environments (e.g. fear and disgust as a defence mechanism against risks for human life) and from the various cultural contexts that shape our interactions with others and the environment (e.g. collective experiences, perceptions, meanings) (Castillo-Huitrón et al., 2020). Furthermore, basic emotions encompass both long-term emotional dispositions and short-term emotional states. Emotional dispositions represent general tendencies to react to stimuli and are rather stable through time, whereas an emotional state is an affective emotional reaction with short duration (Jacobs et al., 2012). Most studies in wildlife conservation have focused on emotional dispositions towards species (Castillo-Huitrón et al., 2020; Frynta et al., 2023; Jacobs et al., 2014), which restricts our understanding of people's reactions to specific contexts of interactions with wildlife (Johansson et al., 2021). Given the increasing disconnection between people and nature (Soga & Gaston, 2016), leading to profound transformations of experiences with wildlife (Clayton et al., 2017), it is increasingly difficult to predict how people react to situations of encounters with wildlife, and therefore critical to also study emotional states. This study attempts to address this important knowledge gap by looking at the diversity of emotional states in relation to specific contexts of human-wildlife encounters.

1.2 | The diversity of emotional states associated with wildlife

Recent studies have investigated the links between emotions and connectedness to nature (Lumber et al., 2017), looking at emotions towards rewilding (Wynne-Jones, 2022), and emotional dispositions towards wildlife species in particular (Jacobs, 2012), like bats (Straka, Greving, et al., 2020), spiders (Rinck & Becker, 2007), wolves (Landon et al., 2020), pumas (Dechner, 2021) and other large

carnivores (Moures-Nouri et al., 2023; Perry et al., 2022). Studies on emotional dispositions towards wildlife have primarily focused on the evolutionary perspective underpinning our reactions towards species (Öhman, 2007, 2009) and in the context of coexistence with large carnivores, mainly focused on fear and disgust (Flykt et al., 2013; Frynta et al., 2023; Johansson, Sandström, et al., 2016; Mammola et al., 2020). This narrow focus on negative emotional dispositions towards wildlife has been flagged as problematic (Jacobs et al., 2014) and two limitations of these studies should also be addressed in the study of emotional states. First and foremost, positive emotions have hardly been addressed, although positive feelings are necessarily involved in aesthetic appreciation of, for example coral reef fish (Tribot et al., 2019) or birds (Lišková & Frynta, 2015), and have been shown to be associated with some insects like bees (Sumner et al., 2018) or with wolves (Arbieu et al., 2020). Second, the range of emotions expressed ought to vary depending on the context of interaction with wildlife species (Jacobs & Vaske, 2019). The combination of possible human-wildlife interactions (e.g. a large carnivore fleeing away from human interaction vs. the same animal running towards a person) and the contexts in which they occur (e.g. forested area vs. urban settlement) indeed represent as many opportunities to understand the diversity of emotional states associated with human-wildlife interactions. Thus, the time is ripe for further investigations on the importance of emotional diversity to better understand human-wildlife relations.

1.3 | A multidimensional approach to evaluate emotional diversity

The contexts of encounter with wildlife involve various cognitive, affective and motivational pathways leading to a diversity of emotional expressions (Barrett et al., 2011; Scherer, 2016). This multidimensional concept of emotions has been explored and described in psychology (Bigand et al., 2010; Gratz & Roemer, 2004; Nook et al., 2017; Russell, 1980; Verma & Tiwary, 2017) but remains to be applied to studies on human-wildlife relations. A recent study demonstrated that multidimensional approaches can be used to evaluate the diversity of attitudes at the individual and population level, and introduced the 'attitudinal space' (Arbieu et al., 2023) that originated in functional ecology (Mouillot et al., 2013; Villéger et al., 2008). Here, we extend this multidimensional approach to emotions. This proposed 'emotional space' (i.e. the distribution of emotional states in a multidimensional space) allows the quantification of emotional diversity at the individual and population level, as well as within and across contexts of encounters with wildlife, as opposed to classic, unidimensional assessments of emotional dispositions. In particular, this multidimensional analytical framework involves, among other metrics, three indices that help quantify emotional diversity across specific contexts of encounter with wildlife, namely emotional identity, dispersion and extremization. First, emotional identity, measures the emotional signature of each context of encounter (e.g. a context elicits mostly positive and intense emotions). Second,

emotional dispersion measures the extent to which emotions elicited by a specific context of encounter are heterogeneously distributed in the multidimensional space. Third, emotional extremization, describes how the reactions to a specific context of encounter are driven by extreme responses in the emotional pace. Taken together, these three measures allow us to develop a better understanding of the diversity of emotional states in relation to specific contexts of interaction with wildlife, and a better understanding of functional relations between emotions and attitudes towards wildlife.

1.4 | The role of emotional states in shaping attitudes towards wildlife

The current scientific understanding of emotions is that they act in synergy with, rather than in opposition to reason (Batavia et al., 2021), and that cognitions and emotions operate in a complex and dynamic way (Stinchcomb et al., 2022). Understanding these relations is therefore important in a context of human-wildlife coexistence because emotions are expected to influence behaviours (Lerner et al., 2015) and decision-making (Ghasemi et al., 2021; Wieczorek Hudenko, 2012). For instance, negative emotions have been shown to affect willingness to pay for wolf protection, and these relations between emotions and attitudes are modulated by contextual situations (Notaro & Grilli, 2022). However, we still have a limited understanding of the differential effects of other emotional states like joy, interest or anger on attitudes and we can reasonably expect diverging strategies for managing human-wildlife encounters and coexistence in fear-, anger-, or joy-dominated contexts. Hence, looking at a diversity of emotional states (and not only fear) in relation to attitudes towards wildlife should help us understand the importance of specific contexts of human-wildlife encounters in shaping attitudes. In particular, this study strives to understand these relationships while accounting for other factors known to influence attitudes, like individual factors (e.g. age, owning livestock, knowledge) and regional factors (e.g. distance to wolves).

1.5 | Study objectives

In this study, we focused on emotions associated with different contexts of encounters with wild wolves (*Canis lupus*) in France. Our objective was twofold. First, we investigated the diversity and intensity of emotional states expressed upon watching videos intended to simulate different contexts of encounters with wolves. We expected that the nature and intensity of emotions expressed by respondents would vary greatly across these contexts, resulting in emotional diversity associated with wolf encounters. Second, we tested the relationship between emotions and attitudes, while accounting for individual characteristics and regional characteristics. We expected that emotions would be an important predictor of attitudes, and that negative emotions would be the ones with the strongest effects on attitudes, in line with previous findings of negative relations between

negative emotions and intention to protect wolves (Dervişoğlu & Menzel, 2023). We expected that among individual characteristics, age and being a livestock owner or a hunter would be negatively associated with attitudes. Among the regional characteristics, we expected that the presence of wolves in the respondent's region and the distance to the closest wolf territory would significantly influence attitudes.

2 | METHODS

2.1 | Study area

We investigated emotional states and attitudes in France, where wolves have naturally recolonized from Italy since 1992, after more than 50 years of absence (Marboutin & Duchamp, 2005). Officially, at the end of winter 2018–2019, the French wolf population was >500 individuals, distributed in 92 zones where they were considered permanently settled ("Zones de Présence Permanente") (Office Français de la Biodiversité 2023, https://professionnels.ofb.fr/fr/node/1089). The presence of wolves is mostly problematic in rural landscapes for traditional sheep husbandry practices, as illustrated by the ca. 12,000 livestock killed by wolves in 2017 (Meuret et al., 2017). We therefore decided to target rural landscapes, which are the ones where the relevance of the wolf topic, and hence emotions associated with wolf encounters, would be the strongest.

To randomly select villages and cities, we used the urban–rural typology for Europe NUTS 3 regions. This typology identifies three types of regions based on the share of rural versus urban populations, namely rural, intermediate and urban regions (Eurostat, 2018). Rural regions refer to regions where at least 50% of the population live in rural areas (typically areas where population density is below 300 inhabitants per km^2); intermediate regions refer to regions where 50% to 80% of the population live in urban clusters (population density above 300 inhabitants per km^2); urban regions refer to regions where >80% of the population live in urban clusters. In this study, we focused on rural and intermediate regions. We further stratified the sampling design according to the presence of wolves in these regions (as of 2018 distribution, Office Français de la Biodiversité, 2023). Wolf regions refer to regions where at least three evidences of wolf presence were found in two consecutive winters. Control regions refer to regions where wolves were not considered as permanently settled. We originally designed this study to conduct interviews in 30 cities with three representative samples (10 cities each) of control regions (further divided into rural and intermediate regions, $n > 400$), of wolf rural regions ($n > 400$) and of wolf intermediate regions ($n > 400$). However, we managed to conduct the social survey only in 24 of the 30 cities for logistic reasons. As a result, although we are confident in the robustness of our results (with 795 respondents out of the planned 1000), we cannot claim representativity of our population samples. All data were collected between November 2018 and May 2019.

2.2 | Survey questionnaire

We conducted a face-to-face survey, adopting an opportunistic, door-to-door approach to maximize the number of respondents in each city. We covered the entire geographic area of each city (which can be quite important in rural landscapes) in order to cover not only city centres, but also isolated hamlets. We only interviewed one adult (>18 years old) per household after we had confirmation that the person was residing in the city. People interested in participating in the survey were administered a declaration of consent. Only if they confirmed their consent in oral and digital form did the interviewer commence the survey (see Methods S1). The survey addressed all ethical issues related to the involvement of human participants and abided by the rules of the EU Charter of Fundamental Rights and the Treaty of the Functioning of the European Union. It was anonymous (no personal data were collected), conducted in a voluntary basis, and participants were informed of the goal of the study and had the possibility to opt out at any moment. The survey was conducted by two of the authors (LT and UA) and seven field assistants. The survey team adopted a common design and methodology for the social survey during a 2-day workshop, in order to guarantee a consistent quality in data collection across the different populations surveyed.

We used a structured quantitative questionnaire using Google Forms and digital tablets, which lasted ca. 15 min (Methods S1). It included seven sections: (i) knowledge on wolves, (ii) sources of information on wolves, (iii) baseline individual emotional valence and emotional intensity, (iv) emotional states in the form of seven basic emotions and emotional intensity associated with six types of simulated encounters with wolves, (v) personal experience with wolves, (vi) attitudes towards wolves and (vii) socio-demographic parameters. In particular, the baseline individual emotional valence and intensity was evaluated using a selection of images from the Open Affective Standardized Image Set (OASIS; Kurdi et al., 2017) in order to control for respondents' overall tendency to react in a certain way, and to investigate the specificity of emotional states elicited by wolf encounters. Furthermore, we used a set of six video clips extracted from Youtube, capturing encounters with wolves in different contexts (Figure 1). The six encounters included interactions with: (1) a wolf on a hiking path, (2) two wolves attacking a deer, (3) a pack of wolves on the road, (4) a howling wolf in the forest, (5) a wolf roaming in a cattle enclosure and (6) a pack of wolf crossing an agricultural field. The main criteria for the selection of these clips were that they reflected different types of interactions with wolves, and were filmed by amateurs as opposed to professional-quality videos, with the objective to enhance respondents' immersion in these contexts of encounters. Each clip was trimmed to 10 s, and the sound was removed, except for Context 4 (wolf howling in the woods). After each video, the respondents were asked which of the seven emotions (joy, interest, surprise, disgust, sadness, fear and anger) they had felt while watching the videos (multiple answers were possible), and with what intensity (from 0 to 7).

Context 1

"You encounter a wild wolf while hiking in the woods."

https://youtu.be/9cSCv6MaYtk

Context 2

"You observe two wolves attacking a deer."

https://youtu.be/w6rUEH5mbdU

Context 3

"You see a pack of wolves on the road."

https://youtu.be/GwowapVLJyM

Context 4

"You observe a howling wolf."

https://youtu.be/LrGb41HVL_w

Context 5

"You observe a wolf roaming in a cattle enclosure."

https://youtu.be/x_jlpGyUoPo

Context 6

"You observe a wolf passing through an agricultural field."

https://youtu.be/Es9SdZgSwF0

FIGURE 1 Screen captures of the six videos clips displaying specific contexts of encounters with wild wolves. The videos were extracted from Youtube, trimmed to 10 s and we removed the sound, except for Context 4. Scan the QR code or use the URL link provided below each screen capture to watch the respective video clips.

2.3 | Statistical analyses

All statistical analyses were done using the R Software (version 4.2.2; R Core Team, 2022). To test the specificity of emotional states associated with wolf encounters, we used correlation tests between baseline individual emotional intensity and emotions expressed towards wolves. The underlying assumption was that if we did not find a strong correlation, then the intensity of emotional states elicited by the wolf videos would be specifically associated with encounters with wolves, and not with the general tendency of an individual to react in a certain way. To this end, we randomly selected three pictures in the OASIS database (Kurdi et al., 2017) corresponding to low, medium and high emotional intensity, respectively (rated on a seven-points Liker scale). We obtained the baseline individual emotional intensity by calculating the average of the three values obtained. We obtained the intensity of emotions towards wolves by calculating the average intensity of discrete emotions expressed within each context of encounter with wolves. We used Bonferroni-adjusted p-values for multiple correlation tests.
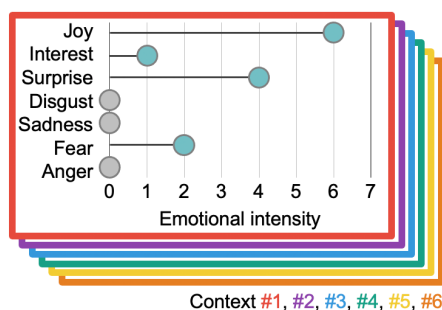
To test how the intensity of each emotion differed across contexts of encounters and regions (i.e. wolf vs. no-wolf), we used a set of ordinal regressions using cumulative link mixed models with emotional intensity as the dependent ordinal variable, and with the context of encounter, wolf presence in the region and their interaction as fixed effects, and individual ID as a random factor (using package "ordinal"; Christensen, 2022).

To investigate emotional diversity across the six contexts of encounter, we constructed and emotional space inspired from functional ecology (Figure 2) (Arbieu et al., 2023). We conducted a principal component analysis (PCA) with a *varimax* rotation and a polychoric correlation structure (using package "psych"; Revelle, 2022). Emotional diversity corresponds to the distribution of respondents in the emotional space, based on the nature and intensity of emotions they expressed after viewing the six videos. To determine the appropriate number of emotional components in the emotional space, we evaluated how many factors had a higher Eigen value than expected by chance. Then, similarly to functional ecology studies using different metrics to quantify functional diversity (Mammola et al., 2021; Mouillot et al., 2013; Villéger et al., 2008), we measured emotional diversity in several ways. First, we quantified emotional identity, which is the mean value of the main components resulting from the PCA, for each context of encounter. Second, we calculated emotional dispersion, which is the mean distance of each respondent to the centroid of responses in a specific context of encounter. Third, we calculated emotional extremization, which is the mean distance of each respondent to the centroid of all responses across all contexts of encounter. Then, to obtain confidence intervals for each of the three metrics and for context of encounter, we used a bootstrap subsampling approach (1000 iterations): each metric was calculated with a random subsample of $n = 500$ individuals in each context of encounter.

To test the relationship between emotional states and attitudes, we used linear mixed models, accounting for individual factors and regional factors. Emotional factors included emotional states in the form of the average value of each discrete emotion (i.e. joy, interest, surprise, disgust, sadness, fear and anger) over
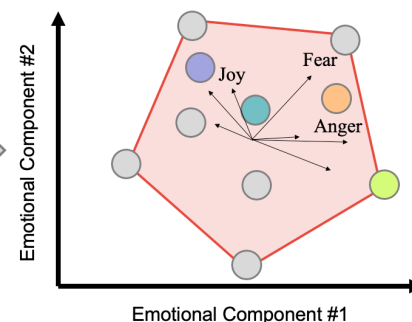
FIGURE 2 Flowchart describing the process of building an emotional space. After watching each video, respondents were asked to self-report which emotion they had felt while watching, and with what intensity (left panel). These emotional states are then organized in an emotion x individual matrix (middle panel). This matrix is used to map each individual onto a multidimensional space and within a context of encounter (right panel). This multidimensional emotional space allows to calculate distance-based metrics (identity, dispersion and extremization) and quantify emotional diversity.

the six contexts of encounter, and the baseline emotional valence and intensity (from the OASIS image elicitation), for each individual respondent. Individual factors included a set of predictors that were expected to influence attitudes (marked with +, − or * according to their expected positive, negative and uncertain effect on attitudes, respectively), that is information sources, trust in information(+) and frequency of information(+), previous encounters with wolves(*), losing livestock to depredation(−), age(−), gender, knowledge of wolves(+), education level(+), being a hunter⁻ and a livestock owner⁻ (Arbieu et al., 2019, 2020; Eriksson et al., 2015; Kansky et al., 2014; Majić & Bath, 2010; Piédallu et al., 2016). Regional factors included predictors describing the wolf-related situation of the city, namely the permanent presence of wolves(−) (wolf region), the actual(+) and estimated(+) distances to the closest wolf territory and the rural(−) versus intermediate(+) categorization of the region (Arbieu et al., 2019; Heberlein et al., 2005; Karlsson & Sjöström, 2007; Zscheischler & Friedrich, 2022). To quantify attitudes, we also used a PCA with *varimax* rotation and polychoric correlation structure, and retained factors that had a higher Eigen value than expected by chance for analysis. Questionnaire items related to attitudes were described in a previous study conducted in Germany (Arbieu et al., 2019), and a subset of these questions were used again in this study. In particular, we selected items that pertained to people's positive and negative evaluation of human–wolf coexistence (enjoyment to perceive, negative influence on leisure), reflected a diversity of values (e.g. right to live, protection for future generations), and a desire for wolf control (acceptance of lethal control). Altogether, these items were previously demonstrated to provide an accurate account of people's overall attitudes towards wolves in a similar context of human–wolf coexistence as the one in France (Arbieu et al., 2019). We did a model selection based on the Akaike information criterion (using package "MuMIn"; Bartoń, 2022) with a set of seven models corresponding to all possible combinations of the three groups of predictors (emotional, individual and regional factors). We used these seven models to conduct a variance partitioning in order to understand the relative share of each of the three groups of predictors in explaining attitudes. We kept the best model to interpret the influence of each predictor variable in the model.

3 | RESULTS

We collected a total of 795 responses across the 24 cities that we surveyed, with a response rate of 42.8%. We excluded five respondents from the analysis because they opted out before the end of the interview. We collected 485 responses from wolf regions and 305 from control regions (Table S1). We obtained a sex ratio slightly biased towards female respondents (55%), an average respondent age of 50.2 years and an average education level corresponding to secondary education diploma. In our survey sample, 6.58% declared being hunters and 9.75% owning livestock (sheep, goat, cow, horse or pig; Table S2).

Baseline emotional intensity (Table S3) was only weakly correlated with the average emotional intensity expressed by individual respondents across the six situations of encounters (all <15%, Table 1, Figure S1). In other words, the intensity of emotions expressed after watching the videos of wolf encounters were wolf-specific, and not correlated to an individual general tendency to emotionally over- or under-react (Table 1).

The emotional states that were expressed most often across the various contexts of encounter were surprise, interest and fear, in this order (Figure 3). We found significant relationships between the context of encounter and the intensity of each emotional state, meaning that emotional intensity was strongly context-dependent (Table 2). The presence or absence of wolves in the region only affected the three emotions surprise, sadness and anger through an interaction with the context of encounter.

The emotional space built with the seven basic emotions across the six contexts of encounter (Figure 4a) was best described by two emotional components (Figure S2) that together explained 62.8% of the variance (Table S4). The first emotional component (42.9% of variance explained) was positively associated with anger, disgust and sadness, and negatively associated with joy and interest (Table S4). The second emotional component (19.9% of variance explained) was positively associated with fear and surprise. We found significantly different emotional identities along the two emotional components (Figure 4b,c). The contexts that triggered the highest values for the first emotional component involved wolves' predatory behaviour (i.e. 0.49 for Context 2—wolves attacking deer— and 0.33 for Context 5—wolf roaming in a cattle

enclosure; Figure 4b). The highest values of the second emotional component were associated with contexts where wolves were close to humans (i.e. 0.62 for Context 1—wolf in forest—0.35 for Context 3—wolves on road—and 0.21 for Context 6—wolves in agricultural field; Figure 4c).

The estimates of emotional dispersion and extremization varied across the six contexts of encounter (Figure 4d,e). Emotional dispersion estimates were slightly lower for Context 1—wolf in forest—and Context 4—wolf howling (0.33 and 0.31, respectively), meaning that emotions expressed in these situations tended to be more homogeneous among respondents. Differences were more pronounced concerning emotional extremization, which was highest in Context 2—wolf attacking deer—and Context 1—wolf in forest (0.29 and 0.26 respectively)—meaning that the emotional diversity in these two contexts were driven by more extreme emotional responses.

Attitudes were best described by a single factor, according to the PCA (54% of variation explained) and we integrated this attitudinal factor in the linear models as the response variable (Figures S3 and S4, Table S5). The best model explaining attitudes towards wolves included all three groups of variables (emotional, individual and regional factors), and explained 57% of the variance. The three best models all included emotional factors (i.e. emotional states in the form of the average value of each discrete emotions, and the baseline emotional intensity and valence, Table 3), and the largest proportion of variance in attitudes was explained by emotional factors (28% alone). Individual factors also contributed significantly to the variation in attitudes but only in combination with emotional factors (5% when considered alone, up to 28% with emotional factors; Figure 5). The regional factors, which included a set of variables describing the wolf situation in the region like presence and
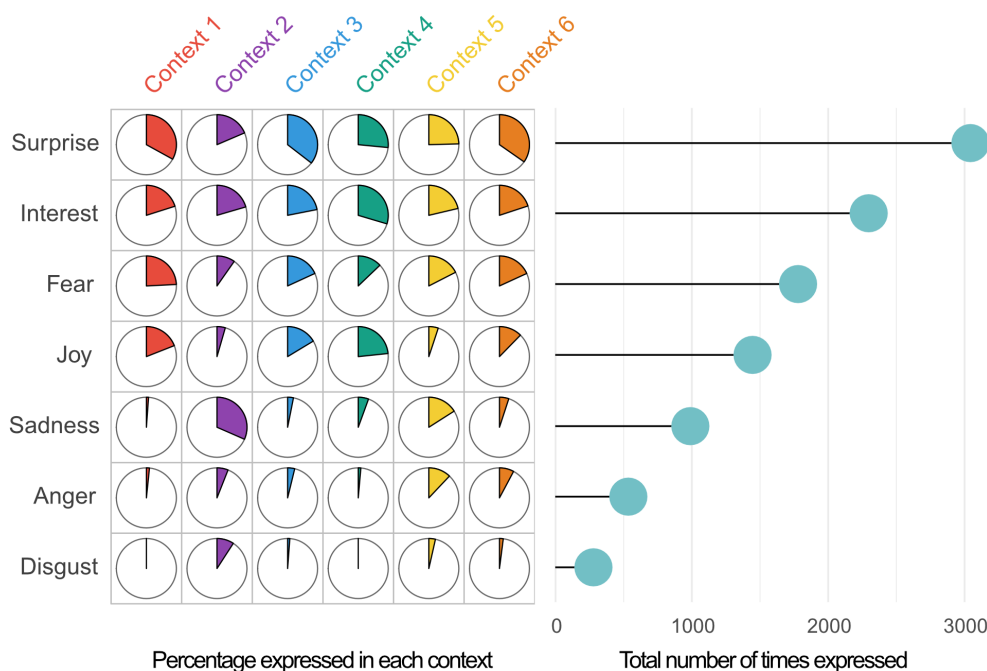
TABLE 1 Results of the correlation test between average intensity elicited by the three baseline images for each respondent and average intensity of emotional responses within each context of encounter with wolves.

	t	df	*p*-value	Coefficient
Context 1	2.82	788	0.005*	0.10
Context 2	3.07	788	0.002*	0.11
Context 3	3.36	788	<0.001*	0.12
Context 4	3.30	788	0.001*	0.12
Context 5	2.97	788	0.003*	0.11
Context 6	3.58	788	<0.001*	0.13

Note: We performed a Pearson correlation test, which significance (*p*-value) is based on the Student's *t*-statistic. The significance level (*α*) was adjusted by applying a Bonferroni correction (0.05/6 = 0.008) to account for multiple comparisons, and *p*-values are flagged with (*) when significant under this adjusted confidence threshold.

FIGURE 3 Distribution of emotions elicited by the six contexts of encounter, expressed as a percentage within each context (left panel), and the total number of times the seven emotions were expressed across the six contexts of encounter (right panel). The minimum value in the left panel was 0.7% (disgust in Context 4) and the maximum value was 35.5% (surprise in Context 3).

TABLE 2 Results of ordinal regressions using cumulative link mixed models with emotional intensity as the dependent variable (ordinal variable), with context, wolf presence and their interaction as fixed effects and individual ID as a random factor.

	df	Likelihood ratio Chi^2	Pr(>Chi^2)
Joy			
Context	5	159.68	<0.001***
Presence	1	0.70	0.40
Context: Presence	5	6.24	0.28
Interest			
Context	5	193.99	<0.001***
Presence	1	0.21	0.65
Context: Presence	5	4.01	0.55
Surprise			
Context	5	188.52	<0.001***
Presence	1	5.50	0.02*
Context: Presence	5	14.80	0.01*
Disgust			
Context	5	25.44	<0.001***
Presence	1	0.05	0.83
Context: Presence	5	3.34	0.65
Sadness			
Context	5	32.85	<0.001***
Presence	1	0.96	0.33
Context: Presence	5	15.59	<0.01**
Fear			
Context	5	26.42	<0.001***
Presence	1	1.43	0.23
Context: Presence	5	9.75	0.08
Anger			
Context	5	51.89	<0.001***
Presence	1	0.04	0.84
Context: Presence	5	15.74	<0.01**

Note: *, ** and *** represent the significance level of each variable $p \leq 0.05$, $p \leq 0.01$ and $p \leq 0.001$, respectively.

distance to wolf territories, did not contribute much to the variance in attitudes (2% overall; Figure 5). Finally, using the best model, we could identify the variables that were significantly related to attitudes (Table S6). Among emotional factors, all but three predictors had a significant effect on attitudes, the strongest being anger (coefficient = −0.32, standard error = 0.04, *p*-value <0.001) and joy (coef. = 0.24, SE = 0.03, *p* < 0.001). Among individual factors, only information sources (with a significant difference between information from the news and from NGOs), age (older respondents had more negative attitudes, coefficient = −0.19, SE = 0.03, *p* < 0.001), gender (males having a significantly less positive attitude towards wolves than females, coef. = −0.13, SE = 0.05, *p* = 0.01) and being a livestock owner (coef. = −0.26, SE = 0.09, *p* < 0.01) had a significant effect on attitudes towards wolves. Among regional factors, only

the distance to the closest wolf territory had a significant, positive effect on attitudes (coef. = 1.4e-3, SE = 0.0, *p* < 0.01).

4 | DISCUSSION

The emotional states that were most often expressed after watching the videos of encounters with wolves were surprise, interest and fear. Anger and disgust were the least often expressed emotional states, even though one of the videos showed a depredation event and one showed wolves roaming in agricultural landscapes. Each context had its own emotional signature, as shown by the statistical differences in emotional diversity metrics (identity, dispersion and extremization). The emotional identities of each context of encounter along the two emotional components varied greatly, demonstrating the diversity of emotional states elicited by the specific contexts of encounter. Emotional factors were the most important predictors of attitudes towards wolves, explaining 28% of the variance alone. Other predictors (e.g. individual, regional) explained parts of the variance only in combination with emotional factors.

4.1 | The diversity of emotional states

The emotions expressed in the survey were specifically associated with wolves rather than with respondents' baseline emotional dispositions. We only found weak correlations between the baseline emotional intensity and the emotional intensity elicited by the wolf videos. The diversity of emotions expressed after watching each of the six videos revealed the importance of the contexts of encounter. While the study of emotional dispositions that have dominated the literature quantify the decontextualized inclinations to react in a certain way towards wildlife (Larson et al., 2016; Slagle & Bruskotter, 2019), emotional states allowed us to better understand the importance and relevance of specific types of encounters (Jacobs & Vaske, 2019; Moors et al., 2013; Scherer, 2016). The result is a great diversity of emotional states expressed, with varying intensities across these contexts of encounters, which confirms what has already been described as a high variability in emotional dispositions towards wildlife in general (Jacobs, 2009; Karlsson & Sjöström, 2007; Vaske et al., 2013) and towards wolves more specifically (Jacobs et al., 2014). Importantly, our study on emotional states complements previous work on emotional dispositions claiming that fear is not the most expressed emotion (Jacobs et al., 2014), although research has overwhelmingly focused on this emotion concerning large carnivores (Castillo-Huitrón et al., 2020; Flykt et al., 2013). Negative emotions, overall, were not the predominant emotional states expressed. Even though we could reasonably expect rural populations to express higher levels of anger as was recently described in Illinois, United States (Vaske et al., 2021), this was, overall, not the case. This finding suggests that the emotion of anger, which is a reaction associated with perceived injustice (Nelson et al., 2016) and often mentioned in the
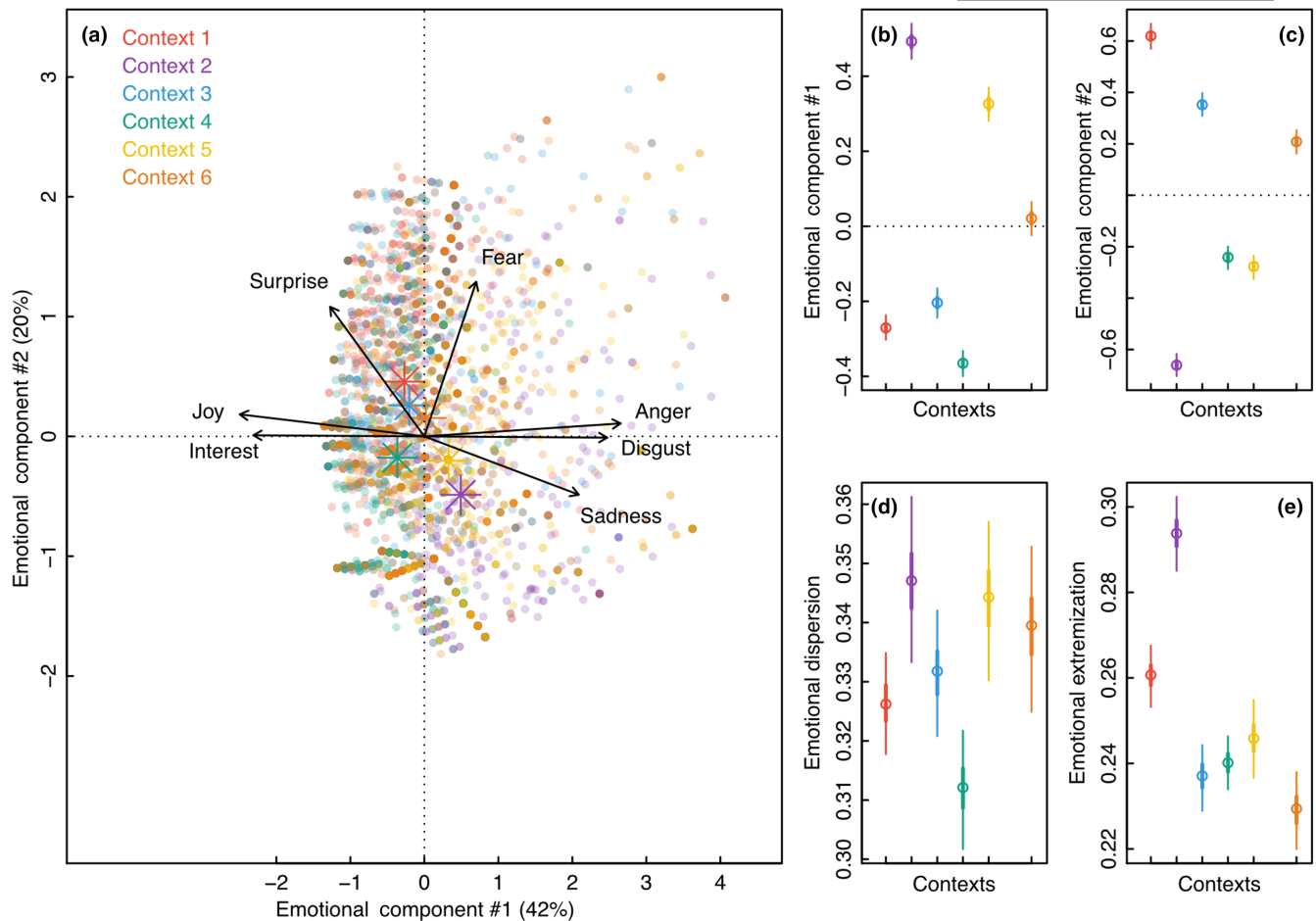
FIGURE 4 Emotional space of the six contexts of encounter (a), representing the distribution of individual emotional states expressed after watching six videos of wolf encounters (a). The coloured stars represent the centroid of each context of encounter (i.e. mean value on both axes). Emotional identity represents the mean value along the first emotional component (b) and the second emotional dimension (c). Emotional dispersion is the mean distance of individual responses to the centroid within a specific context (d). Emotional extremization is the mean distance of individual responses to the centroid of all responses in the emotional space. The thin vertical segments in panels (b–e) represent the 2.5%–97.5% percentiles of the bootstrapped distribution of each metric; the thick vertical segments represent the 25%–75% percentiles.

TABLE 3 Model selection based on Akaike information criteria.

Model	Emotional factors	Individuals factors	Regional factors	AIC	R^2 adj
Model 7	X	X	X	1330.0	0.57
Model 5	X		X	1427.9	0.52
Model 4	X	X		1444.0	0.58
Model 1	X			1585.7	0.51
Model 6		X	X	1666.5	0.29
Model 2		X		1816.0	0.31
Model 3			X	1929.1	0.01

Note: The seven models were designed to include all possible combinations of three groups of predictor variables, namely emotional, individual and regional factors. See Table S5 for details on the variable grouping.

heated debates of wolf conservation, is not strongly associated with the wolf itself, but may rather be the result of human conflicts over wolf management (König et al., 2020). Finally, the prevalence of surprise denotes that even in rural landscapes and in a dynamic state of wolf recolonization in France, people would not expect to encounter wolves in the wild. However, they seemed to remain highly interested in the various contexts of encounter, and taken together, the diversity of emotions expressed did not depict a particularly hostile atmosphere towards the wolf in French rural landscapes (Arbieu et al., 2020).
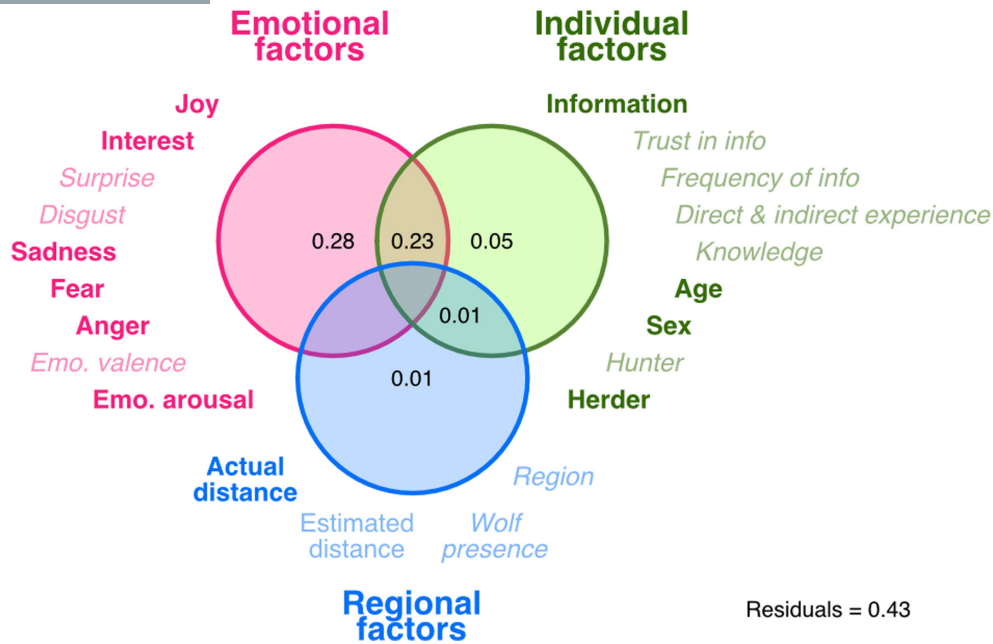
FIGURE 5 Partitioning of the variance in attitudes towards wolves explained by emotional factors, individual factors and regional factors. This is based on seven linear mixed models (see Table 3) with individual ID as a random factor. The total variance explained was 57%. Variables in bold had a significant effect on attitudes (see Table S10 for details on the respective effects).

It is therefore important to consider more than a single emotional state to understand the contexts of wolf encounters (Jacobs et al., 2012, 2014), and our distance-based multidimensional framework provides an important contribution to quantifying emotional diversity (Figure 4). Based on this multidimensional framework and the associated distance-based metrics inspired from functional ecology (Arbieu et al., 2023; Mammola et al., 2021; Mouillot et al., 2013), our results illustrate that each context of encounter had its own emotional signature. Indeed, the emotional identities (i.e. average value) along the two emotional components were significantly different across contexts (Figure 4b,c). Emotional diversity was further quantified by two additional metrics, dispersion and extremization, which demonstrated that the homogeneity of emotional states (dispersion) and the tendency to elicit extreme responses (extremization) were variable across contexts. This high level of detail in the analysis of emotional states is a strong addition to the existing literature on emotions associated with wildlife, which can be applied to both emotional states and emotional dispositions. So far, emotions towards wildlife species have been attributed to various factors such as body shape, coloration, feeding habits, activity patterns, etc. (Castillo-Huitrón et al., 2020; Johansson et al., 2021). In contrast to these cross-species assessments, our study highlighted that for a single species, emotional diversity was strongly influenced by the specific contexts of interaction with this species.

4.2 | Emotional diversity as a key to understand human-wildlife interactions

The depredation event of two wolves attacking a deer (Context 2) stood out as a peculiar encounter (Figure 4). Of all the different encounter contexts, it had the highest value along the first emotional component, in emotional dispersion and extremization, and the lowest value along the second emotional component. Even though predators generally elicit fear, an emotion that has evolved as an antipredator response (Dickman et al., 2013; Öhman, 2007), the high negativity expressed in this encounter was rather related to sadness (Figure 3). The representation of distressed wildlife has been shown to increase feelings of sadness (Greving & Kimmerle, 2020), illustrating a certain sense of compassion towards the fate of the deer being attacked. The high dispersion of responses denoted a relative heterogeneity in responses and a wide array of emotions expressed in this context (Figure 3). For instance, some respondents expressed mostly sadness in this situation, while others expressed joy to see the wolf hunting, or interest in the prey–predator relation. On the opposite, Contexts 1, 3 and 4, which were all generally associated with positive emotions of joy and interest (Figure 4b), were the ones with the highest level of homogeneity in emotional responses (Figure 4d). In particular, Contexts 1 and 3 had the highest value along the second emotional component (Figure 4c), owing to intense expressions of surprise in these situations of encounters during daily life activities (i.e. walking in the forest and driving on the road, respectively). First, as wolves are elusive and tend to avoid human settlements and shift to nocturnal activity in human-dominated landscapes (Carricondo-Sanchez et al., 2020; Mancinelli et al., 2019; Rio-Maior et al., 2019), it may mean that people are aware of the low probability of encounters with wild wolves. Alternatively, after the long absence of wolves in France during the 20th century, it could be that people would be surprised to encounter wolves while walking or driving because they think they do not belong

in the landscape. These two contrasting hypotheses for the emotional pattern observed yield important, yet diverging information for human-wolf coexistence. Finally, the two contexts involving agricultural activities (wolf in a cattle enclosure—Context 5—and wolves seen in an agricultural field—Context 6) elicited a relative diversity of emotions, although we expected some homogeneity in the expression of intense, negative emotions. Indeed, wolf recolonization sometimes takes its toll on traditional sheep husbandry in France (Meuret et al., 2017) and depredation events often fuel the conflict over wolf management in the media and public debates. (Arbieu et al., 2019, 2021; Delibes-Mateos, 2020; Killion et al., 2018). However, both contexts yielded heterogeneous emotional responses (high dispersion, Figure 4d) and low extremization values (Figure 4e). While Context 5 was mostly associated with negative emotions (in particular sadness and anger), thereby highlighting once more the problematic predatory nature of wolves, Context 6 where a person witnesses a pack of wolves crossing an agricultural field was rather associated with feelings of fear. Our analysis of emotional diversity in the multidimensional emotional space enabled us to identify predation events as contexts mostly associated with negative and dispersed emotions, and proximity to humans (Contexts 1, 3 and 6) as contexts eliciting intense and, for two of them, positive emotions.

4.3 | Emotions as an important predictor of attitudes towards wolves

The amount of variation in attitudes explained by emotional factors was high in comparison to other factors, and confirms similar recent findings on pumas in Brazil (Dechner, 2021). Most importantly, our results highlight the importance of integrative approaches (i.e. including emotional, individual and regional factors) to explain individual variations in attitudes towards wolves. Indeed, the model which best explained this variation was the one including all three groups of predictors (Table 3). Among emotional factors, the effect of anger on attitudes was three times stronger than that of fear. Similarly, the effect of joy on attitudes was two times that of fear. The effect of interest was equivalent to the one of fear on attitudes. This is a strong illustration that although studies focusing on fear to address issues of tolerance and coexistence with wolves have merits (Johansson, Ferreira, et al., 2016; Johansson & Karlsson, 2011; Mumma et al., 2017), emotional diversity is just as, if not more, critical to quantify in relation to attitudes. Among individual factors, we found fewer predictors having an influence on attitudes than expected. Unlike previous studies (Arbieu et al., 2019; Dressel et al., 2015; Ericsson & Heberlein, 2003; Slagle et al., 2012), we found no significant effect on attitudes towards wolves for trust in information, previous personal experience with wolves, knowledge of wolves or being a hunter. This finding suggests that socio-demographic parameters have idiosyncratic and context-specific effects on attitudes. Similarly, although we expected to find important effects of regional factors on attitudes (Arbieu et al., 2019; Karlsson & Sjöström, 2007;

Notaro & Grilli, 2022), only the distance to the closest wolf territory affected attitudes towards wolves. These results reinforce the strength of emotional factors in shaping attitudes towards wolves, with important implications for wolf conservation and the management of social conflicts.

4.4 | Implications for wolf conservation

The human dimensions of wildlife conservation are gaining increasing interest (Bennett et al., 2016, 2017), in particular to provide guidance for evidence-based decision-making. Emotions have long been overlooked in conservation decisions because they have been wrongly flagged as an obstacle to judgement and decision-making (Larson et al., 2016; Nelson et al., 2016). However, cognitions and decisions involve both effortful, "cold" slow processes and quick, "hot" intuitive processes (Slagle & Bruskotter, 2019). Thus, emotions and decision-making have highly complex interdependencies and shall not be seen as opposed processes (George & Dane, 2016). In fact, emotions represent powerful, predictable, sometimes harmful and sometimes beneficial drivers of decision-making (Lerner et al., 2015). In the case of wolves returning to human-dominated landscapes in Europe (Chapron et al., 2014), two negative emotional states seem to stand out (fear and anger) regarding attitude formation, yet may be addressed differently. On the one hand, the expression of anger was mostly associated with the potential depredation of livestock, and although it was the second least expressed emotional state overall, it had the strongest negative effect on attitudes. This depicts a form of rejection of wolves from a fraction of our population sample, as wolves are sometimes seen as the result of top-down decisions of urban elites with a direct, negative impact on rural way of life (Dickman, 2010; Ericsson & Heberlein, 2003; Skogen & Thrane, 2008). In this case, if the root cause of this emotional response is injustice, then the appropriate response is to address this injustice (Nelson et al., 2016), for instance by improving stakeholder recognition and implementing effective prevention measures and appropriate compensation (Bautista et al., 2019; Eklund et al., 2017; van Eeden et al., 2018). On the other hand, the expression of fear across contexts (from 10% in Context 2 up to 24% in Context 1) requires other responses. Nowadays, in Europe, lethal attacks on humans involving wolves are extremely scarce and wolves do not pose a threat to human safety (Linnell et al., 2002, 2021). Thus, assessments of emotional diversity can be of high importance in cases like this where emotional responses appear inappropriate, to counteract emotional biases and provide science-based evidence for human-wolf coexistence (Nelson et al., 2016). In addition, we found an important dissonance between the diversity of emotions expressed by rural inhabitants and the prevalence of negative emotions in the news (Arbieu et al., 2021; Bombieri et al., 2018; Nanni et al., 2020). This is problematic for carnivore conservation, as news were the primary source of information, and may thus artificially inflate fear towards carnivore species (Chandelier et al., 2018). Finally, our study may hint at a novel pathway towards human-carnivore coexistence.

As we found the effect of joy on attitudes to be twice the effect of fear, perhaps it is time to operate a paradigm shift in not only focusing on interventions to reduce fear about carnivores (Johansson et al., 2019; Johansson, Støen, & Flykt, 2016) but also to enhance joy and interest in these species to better reflect costs as well as benefits of sharing landscapes with them (White et al., 2023).

AUTHOR CONTRIBUTIONS

Ugo Arbieu and Thomas Mueller developed the original idea and social survey design; Ugo Arbieu and Laura Taysse collected and supervised the data collection. Ugo Arbieu conducted the analyses and produced a first outline of the manuscript. All authors contributed significantly to develop and finalize the manuscript.

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CONFLICT OF INTEREST STATEMENT

We declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data and R codes are stored on a public repository (Zenodo) and are available upon request to the corresponding author (UA) at the following: https://doi.org/10.5281/zenodo.10726909.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Figure S1. Visualization of the correlations between baseline and wolf-related emotional intensity.

Figure S2. Eigen values from the factor analysis of the emotional space.

Figure S3. Eigen values from the factor analysis of attitude items.

Figure S4. PCA biplot of attitudes.

Table S1. Description of the 24 selected cities.

Table S2. Description of the overall population sample.

Table S3. Baseline emotional intensity and valence.

Table S4. Factor loadings of the PCA to design the emotional space.

Table S5. Factor loadings of the PCA of attitude items.

Table S6. Results of the multiple linear regression of the best model of attitudes.

Methods S1. Declaration of consent and survey questionnaire.