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The positive experience of encountering wolves in the wild

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Abstract

Large carnivores often impact human livelihoods and well-being. Previous research has mostly focused on the negative impacts of large carnivores on human well-being but has rarely considered the positive aspects of living with large carnivores. In particular, we know very little on people's direct experiences with large carnivores like personal encounters and on people's awareness and tolerance toward their exposure to large carnivores. Here, we focus on the wolf (*Canis lupus*), and report on a phone survey in Germany. We examined whether encounters with wolves were positive or negative experiences and quantified people's awareness and tolerance related to their exposure to wolves. We found that the majority of people reported positive experiences when encountering wolves, regardless of whether wolves were encountered in the wild within Germany, in the wild abroad, or in captivity. The frequency of encounters did not affect the probability to report positive, neutral, or negative experiences. Moreover, people in Germany expressed a high tolerance of living in close vicinity to wolves. These findings are novel and important because they highlight the positive aspects of living in proximity with large carnivores in human-dominated landscapes.

KEYWORDS

attitudes, emotions, human-wildlife interactions, social survey

1 | INTRODUCTION

There is a growing recognition that ecosystems affect human well-being by providing benefits (i.e., ecosystem services) and incurring costs (i.e., ecosystem disservices), also recently termed positive and negative nature contributions to people (Díaz et al., 2018). Personal experiences and connections with nature can indeed affect physical, mental, or spiritual health and contribute to one's inspiration and identity (Russell et al., 2013; Sandifer, Sutton-Grier, & Ward, 2015). Large carnivores like lions (*Panthera leo*), tigers (*Panthera tigris*), or wolves (*Canis lupus*) are charismatic animals and can generate both positive and negative experiences for humans with whom they share the landscape. For instance, large felids raise safety issues for humans and livestock (Eklund, López-Bao, Tourani, Chapron, & Frank, 2017), yet are one of wildlife tourists' favorite sightings during a safari (Arbieu, Grünewald, Martín-López, Schleuning, & Böhning-Gaese, 2017; Di Minin, Fraser, Slotow, & MacMillan, 2013). Thus, differences in personal experiences with large carnivores, as well as cultural differences in the perception of large carnivores (Heberlein & Ericsson, 2005; Skogen & Thrane, 2007) have led to the emergence of disagreements in management objectives related to the return of large carnivores like wolves to the human-

dominated landscapes of Europe (Chapron et al., 2014; Redpath et al., 2013). However, research on human-carnivore relations has, to date, mostly focused on these conflicts but has largely neglected the positive aspects of coexistence (Lozano et al., 2019).

Here, we investigate personal experience, exposure, and tolerance toward wolves in Germany, as a way to evaluate positive and negative aspects of human-carnivore interactions in a single framework. Personal experiences with large carnivores can be in the form of direct encounters (e.g., observing an animal), indirect interaction (e.g., observing someone else's interaction with the animal), or information (e.g., through reading or hearing about the animal) (Johansson, Ferreira, Støen, Frank, & Flykt, 2016). We focus on personal experiences, in the form of self-reported personal encounters. These direct experiences are tightly connected to people's exposure that characterizes the likelihood of an encounter with large carnivores, expressed as a distance between people and carnivore territories (Karlsson & Sjöström, 2007).

People's personal experiences, attitudes, and behavior are closely linked to one another, as demonstrated over the last decades within the theory of planned behavior (Ajzen, 1985) and subsequent frameworks (e.g., Yzer, 2012). Attitudes (e.g., tolerance toward wildlife) are mental processes involving affective components (e.g., emotions) and cognitive components (e.g., values, beliefs), which can, together with social norms and individual control over a situation, affect behavioral intentions and actions (Struebig et al., 2018). Personal experiences with a specific object often generate more stable attitudes toward this object, whereas people without direct experience will be more prone to radical changes in attitudes (Browne-Nuñez, Treves, MacFarland, Voyles, & Turng, 2015; Doll & Ajzen, 1992). Thus, personal experiences are critical in contexts of conservation conflicts and human-wildlife coexistence because they can contribute to the formation of attitudes toward co-existing with wildlife (Vaske, Roemer, & Taylor, 2013). For instance, previous studies have shown that personal experience can decrease concerns of living in proximity to large carnivores and reduce risk perception (Carter, Riley, & Liu, 2012; Siemer, Hart, Decker, & Shanahan, 2009). On the other hand, increased exposure to large carnivores has been associated with increased fear (Johansson, Karlsson, Pedersen, & Flykt, 2012), decreased tolerance, and negative attitudes toward large carnivores (Ericsson & Heberlein, 2003; Eriksson, 2016; Treves, Naughton-treves, & Shelley, 2013; Williams, Ericsson, & Heberlein, 2002). Understanding the nature of encounters with large carnivores and knowing how these experiences relate to attitude and behavior is therefore urgent, because policy choices upon which large carnivore populations depend (Chapron et al. 2014, Dressel, Sandström, & Ericsson, 2015; Heberlein & Ericsson, 2005) can be influenced by public opinion. To date, research on people's experiences with large carnivores has mainly focused on either positive or negative aspects of coexistence, with the vast majority of studies focusing on the latter. Here, we seek to investigate both aspects simultaneously, to better understand the breadth of people's experiences with large carnivores.

To accurately depict the broad spectrum of interactions people can have with these animals, it is important to not only consider negative but also positive experiences (O'Bryan et al., 2018; Treves et al., 2013). For instance, concerning emotions involved in personal experiences with large carnivores, recent studies have investigated a broader range of emotional dispositions than just fear, and showed that, for example, joy could be an important predictor of people's attitudes toward wolves and their management (Jacobs, Vaske, Dubois, & Fehres, 2014). Research on the links between experiences with large carnivores and positive feelings associated to these experiences remains, however, particularly scarce with contradicting results. More importantly, the comparison of emotional responses to wolves between Dutch and Canadian respondents showed that relationships between emotions and attitudes are context-specific (Jacobs et al., 2014). Depending on people's values and livelihoods, personal experiences with large carnivores can be perceived very differently, and in the case of human-wolf relationships, being, for example, a hunter or farmer seems to have a strong influence on emotions and attitudes toward wolves (Ericsson & Heberlein, 2003). Social identity can also be a strong driver of divergence over large carnivore conservation debates, as shown by the differences in attitudes between rural and urban communities (Eriksson, 2017). Social and cultural factors are therefore critical components to evaluate the context and personal relevance of encounters with large carnivores (Sjölander-Lindqvist, 2008).

To date, experiences with large carnivores have often been expressed as a measure of damage (i.e., attacks on humans or livestock depredations) (Naughton-Treves, Grossberg, & Treves, 2003), which does not include the full variability of people's direct encounters with large carnivores (Dressel et al., 2015; Kansky & Knight, 2014). Furthermore, there is only limited knowledge on the contexts of encounter and their influence on personal experiences. We here define three types of contexts: in the wild in a familiar environment (own country), in the wild in an unfamiliar environment (abroad), and in captivity. In addition, exposure to large carnivores is often used as a predictor of people's attitudes toward large carnivores

(Kansky & Knight, 2014; Karlsson & Sjöström, 2007) but rarely compared against people's actual awareness of exposure and tolerance toward this exposure. Finally, there is a geographical bias in studies on direct experiences with large carnivores, and with wolves in particular, with most reports from North America (Naughton-Treves et al., 2003; Treves et al., 2013; Williams et al., 2002) or Scandinavia (Eriksson, Sandström, & Ericsson, 2015; Johansson, Ferreira, et al., 2016; Johansson, Støen, & Flykt, 2016). Very little research exists in other regions with human-wolf coexistence like the human-dominated landscapes of Central Europe. These landscapes are of particular interest, because wolf recolonization took place recently (Chapron et al., 2014; Hindrikson et al., 2017) and people's tolerance can differ between regions affected differently by wolf return in a single country like Germany (Arbieu et al., 2019). However, we do not know how the recent return of the wolf affects personal experiences.

Here, we address these knowledge gaps by presenting results of a phone survey conducted in 2017 in Germany. In Germany, wolves were extirpated and have been naturally recolonizing from Poland since 2000 (Reinhardt, Kluth, Nowak, & Mysłajek, 2013). We were specifically interested in doing a survey in a country that wolves are currently recolonizing. In addition to the survey at the national scale, we repeated this survey in the region where wolves have been present the longest in Germany (i.e., since 2000), namely the Görlitz region ("wolf region" hereafter). We thus provide a comparison of wolf experiences at national and local scales. We had four main research objectives:

1. We quantified how experiences associated with wolf encounters change in different contexts of encounters. In particular, we investigated how the nature of self-reported encounters with wolves (i.e., negative, neutral, or positive encounters) could differ depending on the context of encounters (i.e., in the wild within or outside Germany and in captivity).
2. We identified the factors potentially influencing the self-reported experiences with wolves. To do so, we tested whether background factors such as the context and frequency of encounters with wolves, knowledge on the wolf situation in Germany, history of coexistence with wolves and other sociodemographic factors (e.g., age, gender, being a livestock owner or hunter, etc.) could determine to what extent encounters with wolves are experienced as negative, neutral, or positive.
3. We investigated the relationship between people's awareness and tolerance relative to their exposure to wolves. In addition, we investigated whether these relationships differed between both population samples (i.e., Germany vs. wolf region).
4. We tested whether experiences with wolves influenced people's tolerance toward wolves. The underlying assumption behind this objective was that people reporting positive experiences with wolves would express higher tolerance for living in proximity to wolf territories.

2 | METHODS

2.1 | Study area and population sample

We surveyed a representative sample of the whole German population (Germany hereafter, $n = 1{,}000$) and of the population in the specific region in eastern Germany (see Figure S1) where wolves have been present the longest (wolf region hereafter, $n = 250$). The representativeness of the population samples (Germany and wolf region) was based on the demographic structure of the respective population (age, sex, household size, city size, and region of residence).

2.2 | Questionnaire and phone survey

The phone survey was conducted in June–July 2017 and included landline and mobile phone of adults. The survey was executed by a company specialized in public surveys (Aproxima Gesellschaft für Markt- und Sozialforschung Weimar mbH), to ensure fast and reliable data delivery. The response rate for this phone survey was 34.4%. Further details of the phone survey protocol can be found in the supporting information of an earlier study (Arbieu et al., 2019).

The questionnaire consisted of five sections and included 51 questions in total (see Supporting Information Methods S1). Here, we focused on 18 questions pertaining to knowledge on wolf situation in Germany (questions A1-7), previous experiences with wolves (questions C1-5), tolerated distance to wolves (question D4), and respondents' sociodemographic backgrounds (questions E1-2-4-8-9). We explain below how we treated the answers to these questions for our analyses.

2.3 | Variable description

2.3.1 | Frequency of encounters

Frequency of encounters was measured as the number of times the respondent had seen wolves in the three proposed contexts (i.e., in the wild inside and outside

Germany, captivity, see Supporting Information Methods S1). To check for the plausibility of encounters, we asked where they occurred, and discarded answers that were obviously incorrect from the data set ($n = 3$ in the entire data set). This frequency could be expressed by respondents as "never," "once," "5 times," "10 times," and "100 times." The rationale behind these categories was to get an estimation for the order of magnitude of the frequency of wolf observations, for example, 1 time, 10 times, 100 times. We added one category (i.e., 5 times) to get an estimation of occasional encounters.

2.3.2 | Experience

Experience associated with wolf encounters in the three contexts was measured with a 5-points Likert scale (from "very negative" to "very positive"). Due to low sample sizes in some categories, we reduced the variable to three ordered categories (negative, neutral, positive). This reduction did not affect the results of our analyses.

2.3.3 | Knowledge on wolves in Germany

We calculated a knowledge score based on questions A1–7, by aggregating the correct answers (see Supporting Information Methods S1); the knowledge score thus ranges from 0 to 7.

2.3.4 | Distance to wolves

We estimated the distance between respondents and the closest wolf territory (monitoring year 2015/2016), that is, exposure, by calculating the distance between the center of the respondent's city of residence (using respondents' ZIP code) and the center of the closest wolf territory. We asked respondents to estimate this distance according to their knowledge ("estimated distance" hereafter), and according to what they would tolerate ("tolerated distance" hereafter).

2.3.5 | Background factors

To understand how different factors describing people's livelihoods influence experiences with wolves, we asked whether the respondents (question C4) or a relative (C5) had lost an animal due to a wolf attack, how much time, on average, respondents spend in nature (E4), if they were hunters (E8) or livestock owners (E9), and collected basic demographic determinants such as age (E1) and gender (E2).

2.4 | Data exclusion

We excluded all respondents who did not know that wolves were present in Germany (question A1, $n = 60$) because questions on experience with wolves become irrelevant if respondents did not know wolves were present in the country. We also excluded respondents for whom we could not get a reliable ZIP code and as a consequence, could not estimate distances to wolves. We excluded incomplete questionnaires with missing answers to any of the questions used in this study (see Supporting Information Methods S1).

We excluded responses containing "never" for previous encounters with wolves in the different contexts, as the comparison between people who have seen wolves with those who have not is presented elsewhere (Arbieu et al., 2019). We also excluded the "100 times" category because of very low sample sizes ($n = 49$ in captivity, $n = 2$ in the wild outside and within Germany). Thus, the frequency of encounters was treated as a continuous variable ranging between 1 and 10 encounters with wolves. This exclusion did not affect the overall results and our interpretation. This process of data exclusion resulted in a reduced data set of 1,002 respondents ($n = 797$ out of 1,000 respondents for Germany; $n = 205$ out of 250 respondents for wolf region). We considered implementing multiple imputations using the package "mice" in R (R Core Team, 2017) to address the issue of missing data; as the results based on the imputed data set were overall similar to those based on the reduced data set, we preferred to adopt a conservative approach and present here the results associated with the reduced data set.

2.5 | Statistical analyses

We used Chi-square tests of independence for each context of encounter separately to test the balance between positive and negative experiences with wolves. We used a two-factorial Chi-square test with an interaction between experience and context, to test the influence of context on respondents' self-reported experiences. We used Cumulative Link Mixed Models (CLMMs) and the dedicated package "ordinal" to test the influence of the background factors on the experience associated with wolf encounters. We fitted one CLMM with experience as the ordinal response variable, with the frequency of encounters, age, gender, livestock owner, hunter, previous attack to self or relative's animal (damage), time spent in nature, knowledge and the interaction between the context of encounter and the population sample as predictor variables, and the respondents' ID as a random factor.

We calculated the difference between exposure and the respondents' estimated distance to evaluate people's awareness of their exposure to wolves. We also calculated the difference between the estimated distance and the tolerated distance, to understand their tolerance toward exposure. We used *t* tests to check for significant differences between respondents of Germany and of the wolf region in both cases.

Finally, we used answers from people reporting encounters in the wild inside Germany ($n = 103$) to investigate if encounters with wild wolves in Germany could affect respondents' tolerance toward their exposure. We used a linear model with the natural logarithm of tolerated distance log(tolerated distance + 1) as the response and the population sample (Germany vs. wolf region) and respondents' experience as predictors.

3 | RESULTS

The two population samples differed in their characteristics, as shown by the differences in sex ratio (more even in Germany), proportion of hunters (not sampled in the wolf region), and livestock owners (higher in wolf region) (Table 1). In particular, the population sample of the wolf region was slightly older and seemed to spend time in nature more frequently than respondents from the German population sample (Table 1).

For a majority of respondents in Germany and in the wolf region, seeing a wolf, regardless of the context of encounter, was a positive experience. In total, a high number of respondents ($n = 103$, 10.3% of 1,002 total sample size) reported to have seen wild wolves within Germany (Figure 1), and the majority of respondents expressed positive feelings associated with these encounters (57.28%, $\chi^2 = 29.44$, $df = 2$, $p < .001$) (Figure 2). There were 79 (7.9%) respondents who reported to have seen wild wolves abroad and the majority of them also reported positive experiences (67.09%, $\chi^2 = 45.37$, $df = 2$, $p < .001$). Finally, a vast majority (82.0%) of respondents reported seeing wolves in captivity, also mainly reporting positive experiences (63.63%, $\chi^2 = 416.11$, $df = 2$, $p < .001$). In the wild within Germany, in the wild abroad and in captivity, negative experiences only accounted for 14.56%, 6.33%, and 5.72%, respectively. Across the three contexts of encounters, the proportions of positive, neutral, and negative experiences were slightly different (two-factorial Chi-square test, $\chi^2 = 12.07$, $df = 4$, $p = .017$), owing to the slightly higher proportion of negative experiences in the wild within Germany than in the other two contexts (Figure 2).

People's experiences with wolves were affected differently by the set of predictors. The interaction term between the context of encounter and the population

TABLE 1 Sociodemographic characteristics of respondents from Germany and wolf region population samples

Sociodemographic characteristics	Germany ($n = 797$)	Wolf region ($n = 205$)
Age	52	56
Gender (M/F %)	49/51	45/55
Hunters (%)	2.1	0.0
Livestock owners (%)	7.4	16.1
Time spent in nature (%)		
Never	1.0	0.5
Couple of times a year	1.3	2.9
Couple of times a month	7.6	3.9
Couple of times a week	41.3	36.1
Couple of hours per day	48.8	56.6

Note: Average Age and the proportion of Males/Females, Hunters and Livestock owners, and the Time spent in nature are presented for both population samples.

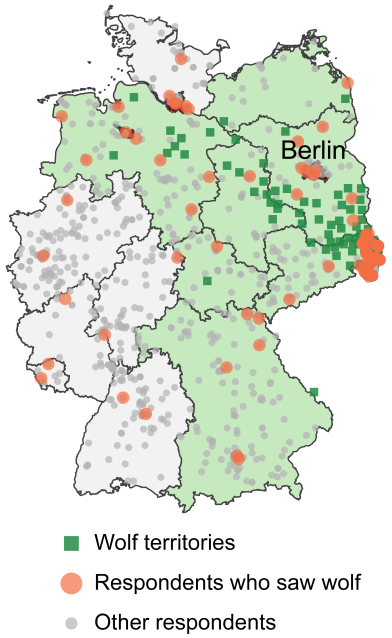

FIGURE 1 Map of Germany showing the household location of respondents of the phone survey included in the analysis ($n = 1,002$, gray circles), and of respondents who claimed to have seen wolves in the wild in Germany ($n = 108$, orange circles). Locations of wolf territories as of the monitoring year 2015/2016 are also displayed (green squares). German Federal States hosting wolf territories are displayed in green color, those without wolf territories are displayed in gray color

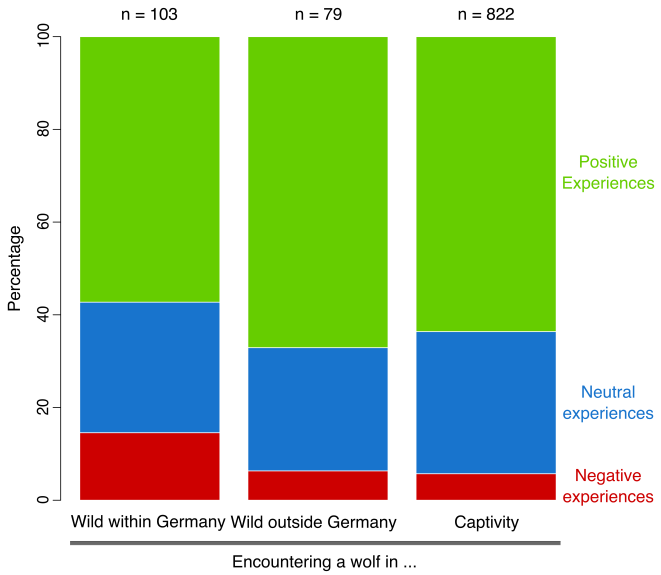

FIGURE 2 Proportions of people reporting positive (green), neutral (blue), and negative (red) experiences with wolves after self-reported encounters that occurred in the wild in Germany (left), in the wild outside Germany (middle), or in captivity (right). Sample size is indicated at the top of the figure and is a subset of respondents from a phone survey of people living in Germany and in the region where wolves have been present the longest (n = 1,002 in total). The proportion of positive experiences was significantly higher than the proportion of neutral and negative experiences across the three contexts (two-factorial Chi-square test, $\chi^2 = 10.18$, $df = 4$, $p = .038$)

TABLE 2 Results of the cumulative link mixed model with experience as the ordinal response variable

Predictors	Model estimate β (SE)	p value
Frequency of encounters	.068 (0.082)	.41
Knowledge score	**.26 (0.085)**	**<.01**
Population sample (wolf region)	**−.68 (0.21)**	**<.01**
Encounter context (in Germany)	—	—
Abroad	.39 (0.37)	.29
In captivity	.24 (0.26)	.37
Damage	**−.63 (0.29)**	**.027**
Age	−.022 (0.079)	.78
Gender (female)	**−.41 (0.16)**	**.012**
Livestock owner	**−.53 (0.27)**	**.048**
Hunter	−1.03 (0.54)	.055
Time spent in nature (never)	—	—
x times a year	−.63 (1.19)	.60
x times a month	−.91 (1.03)	.38
x times a week	−.64 (0.99)	.52
x times a day	−.57 (0.99)	.57

Note: Population sample is a factor with German population sample as a reference and wolf region population sample as comparison; reference for Gender is "male." In bold, factors with significant effects on the response.

sample was not significant (β[abroad vs. within Germany] = 1.23, p = .16; β[captivity vs. within Germany] = 0.69, p = .18); furthermore, based on an analysis of variance test between the model with and the model without the interaction term (Likelihood Ratio = 2.47, df = 2, p = .29), the overall effect of the interaction term was not significant and thus removed from the model. Neither the context of encounter (abroad vs. within Germany or captivity vs. within Germany) nor the frequency of encounter had an influence on people's experiences with wolves (Table 2). Respondents from the wolf region had a slightly higher probability to report negative experiences with wolves than respondents of Germany as a whole (β = −.68, p < .01). Similarly, females and respondents who reported damage to their own or a relative's animal had a higher probability to report negative experiences with wolves. Livestock owners and hunters tended to report more negative experiences with wolves than respondents without livestock and respondents who did not hunt (Livestock owner: β = −.53, p = .048; hunter: β = −1.03, p = .055). Respondents with a high knowledge about the wolf situation in Germany reported more positive experiences with wolves than respondents with low knowledge about the wolf situation in Germany (Table 2).

The distance tolerated by respondents between their place of residence and the closest wolf territory was short (35 km in Germany, 33 km in wolf region). In Germany (and in wolf region, respectively), the average distance between respondents and the closest wolf territory was 128 km (14 km, respectively), and the mean estimated distance was 159 km (32 km, respectively). Both population samples tended to underestimate exposure (see the right skew of the histogram in Figure 3a). Interestingly, respondents from the German sample would tolerate wolves 125 km closer than their own estimation (Figure 3b), while respondents from the wolf region sample seemed to tolerate the current exposure to wolves (Figure 3b) (t test, p < .001).

Finally, previous encounters with wolves within Germany affected respondents' tolerance: tolerated distance decreased with positive experiences (linear model, adjusted-R^2 = 0.37, β = −.68, p < .01). There was no significant difference between both population samples after accounting for the effect of previous encounters (β = −.47, p = .074).

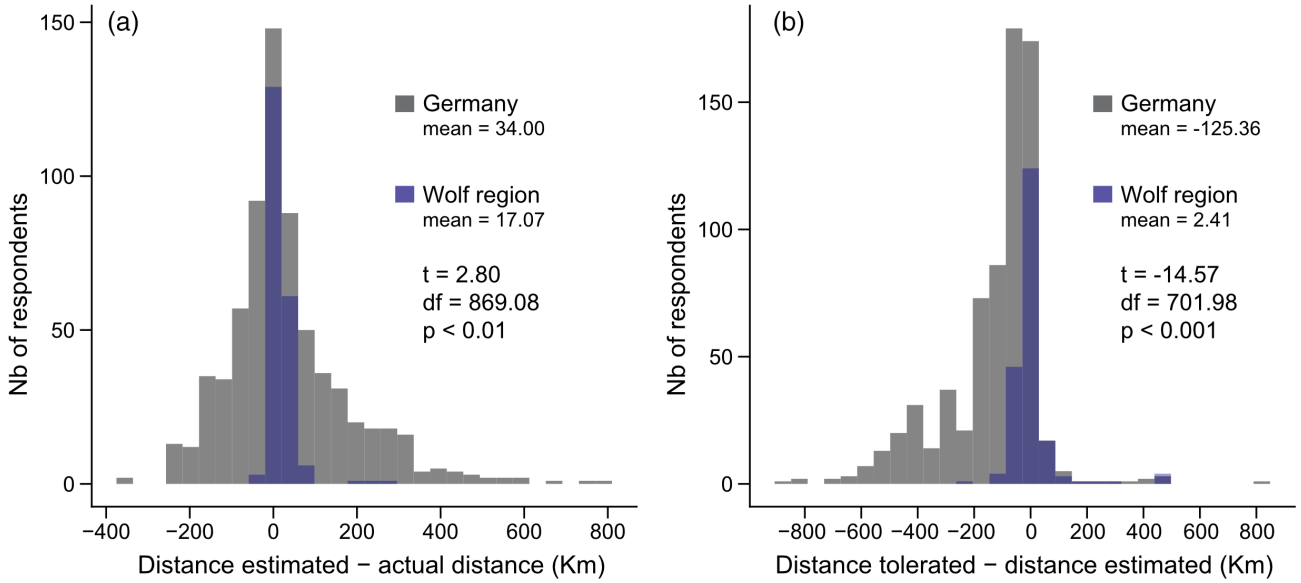

FIGURE 3 Differences between (a) the actual distance between respondents' residence and wolf territories and the respondents' estimation of this distance and (b) the estimated distance and the respondents' tolerated distance to the closest wolf territory. Respondents belong to a representative sample of the German population (gray color, $n = 797$) and of the specific wolf region (blue color, $n = 205$). Mean differences and t tests between both population samples are shown in the figure. Respondents tended to (a) slightly underestimate their proximity with wolves and (b) expressed a very high tolerance for increased proximity with wolves

4 | DISCUSSION

Our results document that direct encounters with large carnivores in human-dominated landscapes, and especially wild wolves, are more often a positive than a negative experience for people. People predominantly reported positive experiences with wolves, regardless of the context of encounters. Contradictory to expectations, a higher frequency of encounters with wolves was not associated with more negative feelings. Knowledge about the wolf situation in Germany seemed to increase the probability of reporting positive experiences with wolves. Finally, respondents of both population samples expressed a high tolerance for a close proximity of wolves (Figure 3). This tolerance was higher for people having reported positive experiences with wolves.

4.1 | Experiences with large carnivores in human-dominated landscapes can be positive

Previous studies on personal experiences with large carnivores mentioning positive experiences are mainly related to contexts of wildlife tourism, where people actively look for such encounters (Di Minin et al., 2013; Gallagher et al., 2015). On the opposite, in regions where large carnivores are a part of people's everyday life, personal experiences are often reported as negative. For instance, a recent study documenting large carnivore sightings in Alberta, Canada, reports on people's complaints about wolves, cougars (*Puma concolor*), grizzly bears (*Ursus arctos*), and black bears (*Ursus americanus*) (Morehouse & Boyce, 2017), ignoring potentially positive interactions with the animals. In Tanzania, human-carnivore interactions were quite frequent as 80% of the sample population had seen at least one large carnivore species, and the majority of respondents expressed negative experiences with these animals (Dickman, Hazzah, Carbone, & Durant, 2014). Our study is therefore unique in that it considers both positive and negative experiences. In this context, the fact that respondents from a population living in close proximity to a large carnivore species more frequently expressed positive experiences than negative experiences is novel.

The proportion of respondents reporting that they had seen wild wolves in Germany was unexpectedly high (10.5%), especially for the broad public and given the elusive nature of wolves. In comparison, a survey of Canadian hunters reported between 7.2 and 12.5% of sightings (Ausband & Bassing, 2016), while a similar survey in Idaho, United States, reported that between 15 and 25% of hunters observed wolves (Ausband et al., 2014). First, people who had seen wild wolves could be more interested in being interviewed. However, the main reason for refusing to take part in our survey was a general lack of interest in surveys. Second, respondents could have confused wolves with dogs or other animals. Nevertheless,

respondents still believed they had seen a wolf, and associated either positive or negative emotions to these encounters. Third, obviously erroneous reports based on the spatial location of the reported sighting were extremely rare in the data set. One way to improve these findings would be to investigate people's experiences directly after they report sightings to the relevant authorities (as in, e.g., Morehouse & Boyce, 2017).

4.2 | Factors affecting experiences with wolves

Our results also challenge the notion that higher frequency of encounters with large carnivores increases the probability of negative experiences (Johansson et al., 2012; Treves et al., 2013). Moreover, this pattern seemed consistent across contexts, as shown by the absence of major differences across the three contexts (57%, 67%, and 64% of positive experiences in Germany, abroad, and captivity, respectively). Thus, making people aware of their own reactions in controlled encounters (e.g., in captivity, in guided tours within large carnivore territories) would be a promising way forward, to reduce risk perception and prevent future negative experiences with large carnivores (Johansson, Støen, & Flykt, 2016; Karlsson & Sjöström, 2007). The appraisal of a situation of encounter with a wolf involves emotions, which are instinctive reactions that do not necessarily require prior knowledge (Jacobs, 2012). Here, increased knowledge on local wolf populations was positively related to the likelihood of reporting positive experiences with wolves. This demonstrates the potential importance of education and communication on wolf ecology and behavior to decrease risk perception and fear of wolves. More generally, further studies on the importance of emotions involved in human-wolf interactions should help understand better people's reactions to large carnivores (Jacobs, Vaske, & Roemer, 2012) and provide recommendations for appropriate behavior in case of encounters with large carnivores. Previous studies on environmental attitudes have recommended that educators should focus on beliefs and emotions in order to have an impact on attitude and behavioral change (Pooley & O'Connor, 2000). In particular, there is ample room for investigating in more detail how the contexts of encounters with wolves (e.g., encounter while hiking, driving, farming, hunting, etc.) generates various experiences and changes people's appraisals of wolves, as we focus here only on three, very general contexts.

Negative experiences were expected to be reported more frequently by farmers or hunters (Jacobs et al., 2012), given the higher potential for conflicting situations with wolves (probability of depredation for farmers, or increased competition for game species or attacks on hunting dogs for hunters). Conflicts over wolf management often illustrate urban–rural divides, owing to different cultural factors and power asymmetries (Eriksson, 2016, 2017). Here, trust is a critical issue as increased personal experience with carnivores can lead to decreased trust and stronger feelings of fear (Johansson et al., 2012). In agreement with these expectations, we found that livestock owners and hunters tended to report more negative experiences with wolves than respondents without livestock and those that did not hunt (Table 2). Yet, these effects were only marginally significant, because of the high uncertainty in the estimates, which might be partly related to the fact that these groups made up only a minor portion of the data set ($n = 92$ livestock owners and $n = 17$ hunters out of 1,002 respondents, respectively). We did find a significant difference in the expression of positive or negative experiences between Germany as a whole and the local wolf region. Since neither the frequency of encounters, respondent's age, nor time spent in nature had a significant effect on the response, we can assume that the slightly higher probability of reporting negative experience with wolves in the wolf region owes to longer history of coexistence and indirect factors. Indirect experiences (e.g., interactions with other people, exposure to media and various information sources, etc.) can critically influence people's opinions and attitudes (Arbieu et al., 2019; Dickman, 2010; Liu et al., 2011). These indirect experiences are expected to increase during the recolonization of large carnivores, as the increased media coverage during the process of wolf recolonization in several countries shows (Chandelier, Steuckardt, & Mathevet, 2018; Fernández-Gil et al., 2016; Houston, Bruskotter, & Fan, 2010). This increased media coverage and the biases it contains may affect people's risk perceptions and increase fear (Bombieri et al., 2018). Indirect experiences are also expected to be important in regions where wolves have been present for a long time, with more reports on depredation events, on wolf ecology and other topics related to human-carnivore coexistence. The fact that wolf attacks on one's own animals or those of relatives increased the probability of reporting negative experiences with wolves (Table 2) tends to confirm this hypothesis.

4.3 | People are aware of their exposure to wolves, and tolerate close proximity

We quantified exposure by geographic distance and found that the majority of respondents would tolerate wolf territories in closer proximity than their own

estimation of the situation (mean tolerated distance was 35 km for the German population sample). Regardless of whether respondents lived close or far from wolf territories, they seemed to accept a relatively high proximity with wolves. This is a positive sign for human-carnivore coexistence. Interestingly, respondents from the wolf region could have expressed a reject of wolves, yet the mean tolerated distance was small (32 km). This indicates that despite longer wolf presence and potential issues related to fear of this large carnivore (Johansson et al., 2012; Karlsson & Sjöström, 2007) or costs associated with depredation (Widman & Elofsson, 2018), people and wolves can coexist. Finally, our results highlight the link between experience with and exposure to wolves (Kansky & Knight, 2014). Indeed, respondents who reported positive experiences with wild wolves tended to express a desire for closer proximity with wolves. These results concur with previous findings showing that excitement to see a wolf (i.e., a positive experience) could be a strong driver of positive attitudes (Røskaft, Händel, Bjerke, & Kaltenborn, 2007). Together these results tend to demonstrate the importance of positive interactions for improved coexistence with large carnivores. As such results are often context-specific, they would benefit from cross-cultural comparisons, to understand how exposure to, experiences with and attitudes toward large carnivores relate to each other in different cultural contexts (Struebig et al., 2018).

4.4 | Further consideration on direct and indirect experiences with wolves

Direct personal experiences are expected to play an important role in shaping attitudes toward large carnivores (Browne-Nuñez et al., 2015; Doll & Ajzen, 1992) and while it has been postulated that direct experience of wolves would decrease support of wolf policy (Eriksson, 2016), our results highlight the existence and potential importance of positive experiences. Nevertheless, large carnivores do incur costs to human activities and pose specific conservation problems where they occur (Eklund et al., 2017; Widman & Elofsson, 2018), but they can also provide benefits for human well-being (O'Bryan et al., 2018). It is therefore fundamental to consider positive aspects of large carnivore occurrence and recolonization to design management measures that consider all aspects of coexistence. Furthermore, the positive or negative nature of the indirect experiences with large carnivores, such as the various sources of information like the print and online media, social networks, or the exchange people have with their relatives can play a pivotal role in shaping people's attitudes toward large carnivores (Arbieu et al., 2019). Understanding positive and negative as well as direct and indirect experiences related to large carnivores and their influence on people's attitudes is a necessary step in paving the way toward long-term coexistence with large carnivore species.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

U.A., M.M., N.B., I.R., and T.M. were involved in the conceptual development of the manuscript. U.A. and J.A. conducted the statistical analysis. U.A. produced the first draft of the manuscript and led the writing. All coauthors significantly contributed to the writing and approved the final version of the manuscript.

ETHICS STATEMENT

All respondents to the phone survey agreed to its terms and were informed about the scope and length of the survey. Their participation was anonymous and voluntary. We did not collect any personal data leading to the potential identification of respondents.

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