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Research article

There is a place for every animal, but not in my back yard: a survey on attitudes towards urban animals and where people want them to live

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Abstract

Animals are a constant presence in urban environments. While there is a handful of studies that have addressed which urban animals people like, there is little knowledge on where in the city people want them to be. There is the risk of a misalignment between human urban inhabitants' specific desires for more nature in cities and the results of urban renaturing initiatives. We conducted an online survey on inhabitants of Munich (Germany) to investigate their attitudes towards 32 different urban animals and where they want them to occur. These places ranged from their own home or garden, to different places within the city, and to outside of the city. In total, 10 000 flyers were distributed in houses surrounding 40 city squares, and 305 people participated. We found that people rather placed animals further away than close to home. There were clear differences between different animal species in where they were placed by people, from species being placed close to home, to species wanted only outside the city. There were also clear differences in attitude towards the different animals, and participants on averaged placed animals closer to home if they liked them more. People have clear preferences for the placing of different animals in an urban context. Knowledge on these preferences can help to design targeted conservation actions and environmental education programs.

Key words: animals, attitudes, cities, Munich, NIMBY, sense of place

Introduction

Worldwide, people have many different relationships with plants, animals, and the broader landscape they find themselves in (Bradley 2000; DeMello 2021). Researchers in various fields have investigated different aspects of these human-nature relationships, from instrumental, intrinsic, and relational values (Chan, Gould, and Pascual 2018), to historical changes in these relationships (Philo and Wilbert 2000; Wolloch 2019). There are, however, still many unknowns with respect to people's perception of nature, and in this study, we investigated one of the non-material aspects of human-nature relationships: the place and acceptance of animals in cities.

The idea of places for animals in human environments, and which animals should and should not be in such environments, has been a contentious issue for a long time. 'Animal geography', ie the study of ' human-animal relations with space, place, location, environment and landscape', is an active field of research, albeit mostly in the Humanities (Gibbs 2020; Philo and Wilbert 2000). A central topic in this field of research is the right place of an animal, both with respect to its relation to the human society, and with respect to the physical place to which a particular species is considered to belong. Ever since humans started congregating and building their own environment, certain animals have been either welcomed, tolerated, or expelled from those spaces, with differences between cultures and regions (Philo and Wilbert 2000; Herzog 2011; Oma 2013). Based on Said's 'imaginative geography' (Said 1979). Philo and Wilbert (2000) pointed out that humans tend to "position them ('animals') relative to us ('humans') in a fashion that links a conceptual 'othering' (setting them apart from us in terms of character traits) to a geographical 'othering' (fixing them in worldly places and spaces different from those that we humans tend to occupy)", whereby this 'imaginative geography' differs among people and human societies. The advent of the landscape concept in the 18th century idealized these different functional spaces, distinguishing between the human-urban, rural-agricultural, and wild space (Deliège 2019). Thus, companion animals such as dogs are allowed into the sphere of humans, i.e. the city, whereas livestock such as cows or sheep belong to the countryside, the agricultural area managed by humans, while wildlife such as bears or wolves belong to the areas with little influence of humans, i.e. the wilderness. As animals do not adhere to this spatial order, they often create their 'beastly places' (Philo and Wilbert 2000) in the vicinity of humans, from which they are expelled by force, as in the case of rats or city pigeons. A better understanding of this placing of animals, i.e. where people would like to place what animal and why, is important for species conservation, in particular in cities,

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as city dwellers are more likely to accept urban conservation measures that help to support animals in their 'right' spaces, than those that put animals into the perceived wrong places. Unfortunately, given that many animal species may live in cities, e.g. up to 50% of the regional species pool—with numbers varying between taxa—(Sweet et al. 2022), the classification of animals into just three or four species types, and a similar classification of spaces into a small number of categories, is too simple to be directly applicable for urban conservation projects. More detailed investigations that consider both the different types of spaces in the urban environment and the variety of animals that can occur in the city are needed.

Attitudes towards animals in Europe, and arguably the rest of the western world, shifted significantly during the Enlightenment and the Industrial Revolution, from the view of animals as 'beast machines', to a greater sensitivity towards animal suffering, and hence a more differentiated view of distinct types of animals (Wolloch 2012, 2019). Our attitudes toward animals are conceptually often framed based on 'those that are useful to us', as companions, workers, or resources, and 'those that are useless, damaging, or ugly', such as big predators, agricultural pests, or disease carrying animals (Philo and Wilbert 2000). They are also strongly influenced by a number of other factors, including cultural symbols and history, and this alters human acceptance of animal species in their proximity (e.g. Sumner et al. 2018; Landry Yuan et al. 2019; deMello 2021; Izaguirre and Montiel, 2021). Today, we know that human attitudes towards different animal species and how they should be treated differ strongly between species (Herzog 2011; DeMello 2021). Comparisons between multiple species, however, are rarely considered in studies investigating the relationships between humans and animals.

Over the past two decades, following Kellert's earlier work (e.g. Kellert 1984b), there have been a number of studies on attitudes of urban inhabitants towards different animals and the various factors that affect them (e.g. Bjerke, Østdahl, and Kleiven 2003; Bjerke and Østdahl 2004; Baharuddin, Karuppannan, and Sivam 2013; Ambarli 2016; Hosaka, Sugimoto, and Numata 2017; Rupprecht 2017). This has led not only to an increased number of animal species that were investigated, but also to a more detailed understanding of why a particular species is viewed positively and under which circumstances. So far, however, there has been little work on the question of how the attitude towards an animal is related to where it could occur in the city. One of reasons for this is that much of the work was conducted within the framework of human-animal studies (DeMello 2021), where the focus was on companion animals, or on mammals bred and/or killed in larger number by humans, such as livestock or game. One exception is the work by Rupprecht (2017), who investigated urban residents' willingness to coexist with animals in neighbourhoods in Sapporo (Japan) and Brisbane (Australia). Rupprecht showed that there are large differences between urban wildlife species in whether people wanted them in their neighbourhood, how strong those sentiments were, and where animals were supposed to live. In another study, Hosaka, Sugimoto, and Numata (2017) indicated that there is a relationship between Japanese urban residents' willingness to coexist with animals and their liking for them, and Muslim et al. (2018) indicated that urban and suburban residents in Malaysia were more willing to live closer to animals that they liked than those that they did not, and that this willingness for coexistence was also directly or indirectly mediated by childhood nature experience with the animals, as well as by gender, age, and ethnicity. In these studies, participants could choose one out of several places for the animals (e.g. 'nowhere', 'distant park or forest', 'park or nearby forest', and 'anywhere'), but the different distance measures were mutually exclusive and had the implicit assumption that any place closer to the human than the indicated place in the questionnaire was considered inappropriate by the participant. This is not necessarily the case though, as humans might find various places appropriate for an animal, e.g. both a park within the city and the countryside outside the city.

Moreover, in an urban environment, scale—and hence proximity—is not necessarily a purely physical, but rather a relational measure. It has been shown that place attachment, and values with regard to different urban scales—notably 'home', 'neighbourhood', and 'city'—do not scale linearly with physical distance, ie spatial scale (Hidalgo and Hernández 2001; Atkinson, Dowling, and McGuirk 2009; Lewicka 2010). Thus, a space only slightly more distant than another geographically may be conceived as being much further away. For example, private gardens and public greenspaces differ in function and meaning, even if they are at the same spatial distance to a house, as the former is treated as an extension of the house, while the latter is part of the surrounding environment (Coolen and Meesters 2012).

Considering these findings, we asked whether the attitudes of urban inhabitants affect the placement of animals in the city. In contrast to previous studies, we gave participants the option to place animals at different locations from close to their home to far away, and we test for a larger number of species (32). A survey was conducted among inhabitants of Munich, Germany, that was designed to answer the following questions:

1. What are the urban places where people want different species of animals to occur?
2. Are there differences in placement between different species of animals?
3. Is there a relationship between how close to home people place animals and how much they like them?

Methods

Sampling and participants

The survey was conducted in the city of Munich, in the federal state of Bavaria in Germany. Munich is the third largest city in Germany. On 31 December 2019, it had ~1.56 million inhabitants and a total urban area of 310.7 km^2 (Statistisches Amt der Landeshauptstadt München 2021). We designed flyers (Supplementary Appendix I) to be distributed to residents in which our project was briefly described, and that had a link (both a web address and a QR code) towards the online survey (Supplementary Appendix II). Ten thousand flyers were distributed among the houses and residential buildings surrounding the 40 squares in the city (Supplementary Appendix III) from 16 June 2021 to 20 June 2021. These squares were chosen from an ongoing research project in Munich, wherein the focus lies on how the design of city squares affects the richness, abundance, and activity of urban animals (Mühlbauer et al. 2021). The chosen squares were spread over different parts of the city, and had variable levels of greenness and building density, as to gain a representative overview of the living conditions in Munich. The survey administration period of the survey was between 14 June 2021 and 11 July 2021 and the survey was conducted in German.

At the end of the administration period, 305 people from 38 squares had completed the questionnaire. The participants included 126 men (41.3% of participants), 175 women (57.4%), and

4 people who identified differently (1.3%). Women were overrepresented in our sample in comparison to the general population of Munich (50.6% in Munich, Statistisches Amt der Landeshauptstadt München 2021). Age ranged from 18 to 85 years old (Mean = *45.1, Std* = *14.7*), which was slightly higher than the mean age of the general population of Munich (41.3 years old, Landeshauptstadt München, Referat Für Stadtplanung und Bauordnung 2021). Additionally, while 89.5% of our respondents had finished at least secondary education in 'Sekundarbereich II', similar to the 88.7% in all of Bavaria (Blaeschke, Freitag, and Reinhard 2021), 64.6% of our respondents had also finished some form of tertiary education, which is almost double that of the general population of Bavaria (33.8%, Blaeschke, Freitag, and Reinhard 2021). The questionnaire was on average finished in 10 min and 50 s [±4.5 min].

Questionnaires

The questionnaire started with a short explanation of the survey and an informed consent form, informing readers of the voluntary basis of the questionnaire, the anonymity of data, and laying out ways to contact us. Only people who answered that were 18 years or older could proceed with the questionnaire.

The questionnaire had four main types of questions: (1) basic and relevant demographics, (2) questions on the participants' general relationship and habits with regards to nature and animals, (3) questions on the attitude towards a number of different animals on a five-point Likert scale, (4) questions on where the respondents wanted different animals to occur, along a relational proximity gradient. Question types (3) and (4) were of highest interest to the current study that focussed on the relationship between preferred proximity and participants' attitudes towards the animals, and we did not consider demographics and habits in our analyses.

We selected 32 animal 'species' that the researchers considered to be known to most people, because they are common sights in German cities. These animals were chosen based on familiarity and attitudinal responses from prior research (Sweet et al. 2023). No photos were provided with the animal names and the taxonomic level varied across them, from species (e.g. squirrel) to genera (e.g. firefly), to family/order (e.g. dragonfly). Species groups included nine arthropods (*wasp, spider, ladybug, firefly, dragonfly, cricket, cockroach, bumblebee, ant*), eight birds (*woodpecker, tit, stork, owl, duck, crow, common kestrel, city pigeon*), three reptiles/amphibians (*snake, lizard, frog*), 10 mammals (*squirrel, rat, rabbit, mouse, mole, marten, housecat, hedgehog, fox, beaver*), and two gastropods (*snail, slug*).

The demographics asked for in the questionnaire were age, gender, and highest finished education. Questions relating to participants' general relationships and habits with regards to animals and nature as a whole are laid out in Supplementary Appendix II.

Questions on the attitude towards animals were answered on a five-point Likert scale (1 = do not like at all; 5 = like very much). This was answered for each animal by every participant, and participants could only choose one option per animal. Questions on where the respondents want different animals to occur had the following possibilities along a gradient of both spatial and relational proximity: at their home, on their balcony, in their garden, in their neighbourhood, in city parks, somewhere else in the city, outside of the city, or nowhere at all. These locations were not mutually exclusive choices, and participants could choose multiple locations. The option 'nowhere' was taken as an indication that the respondent would not like to see the animal anywhere, neither within the city nor outside, implying that the respondent would be happy if this animal either occurred somewhere very far away or if it did not exist. Participants were required to choose at least one place where the animal should be.

Data processing

Data was imported into R through the SoSciSurvey API (see data availability section). Columns were renamed from the factor names supplied in SoSciSurvey (format: 'XXXX_XX_XX') to searchable and understandable names that related to the variables investigated (see code supplied with this paper).

We converted the places that participants could choose for the different animals into distances from home on an ordinal scale. We then established a relational measure of scale from home (Fig. 1). Here, we distinguished three relational distances from home (Fig. 1). The first was the *homezone (ordinal value 0)*, which included the categories 'Home', 'Balcony' and 'Garden'. The second was the *neighbourhood scale (ordinal value 1)*, which included the categories Neighbourhood and City park, and the third zone was the *city-wide scale (ordinal value 2)*, that included both the built-up area of the city ('city') and the surroundings of the city ('outside') (Fig. 1). 'Nowhere' was excluded from the analyses relating to the relational scale.

Statistical analysis

Analyses were divided into two main themes: (1) the placement of animals, and (2) the relationship between the relational scale where people placed the animals on and attitudes towards the animals. Analyses are described in detail in the following paragraphs. Linear mixed-effect models and Generalized linear mixed effect models were used for statistical analyses, with the participant ID number as random effect to account for the fact that each participant answered the questions about each individual animal. Tukey post hoc tests were done with the 'emmeans' (Lenth 2022) R-package to extract group means and contrasts from the model estimates.

Placement of animals

To investigate whether there were significant differences between animals in the number of locations that were selected by the participants, a repeated measures ANOVA was conducted using the 'lme4' and 'lmerTest' R-packages with

$$\begin{aligned}&Model\ 1 <- lmerTest : lmer\\&(number\ of\ locations\ chosen\ \sim\ Animal + (1|participant\ ID))\end{aligned}$$

i.e. the number of locations chosen was the response variable, animal was a fixed effect (factor), and the participant identifier was used as the random effect to account for the fact that each participant rated all animals. Satterthwaite's method was used to estimate degrees of freedom and P-values for the ANOVA.

To investigate differences among animals and locations in whether an animal was placed there, two different models were used because of perfect separation in some of the animal*location combinations. For the animals where there was no instance of perfect separation, a mixed effect logistic regression was conducted using the 'glmmTMB' R-package with

$$\begin{aligned}Model\ 2a\ &<- glmmTMB\ (Location\ chosen\ (TRUE\ or\ FALSE)\\&\sim Animal * Location + \ (1\ |participantID),\ family\\&= binomial)\end{aligned}$$

For the animals where there were instances of perfect separation, a Bayesian mixed effect logistic regression with

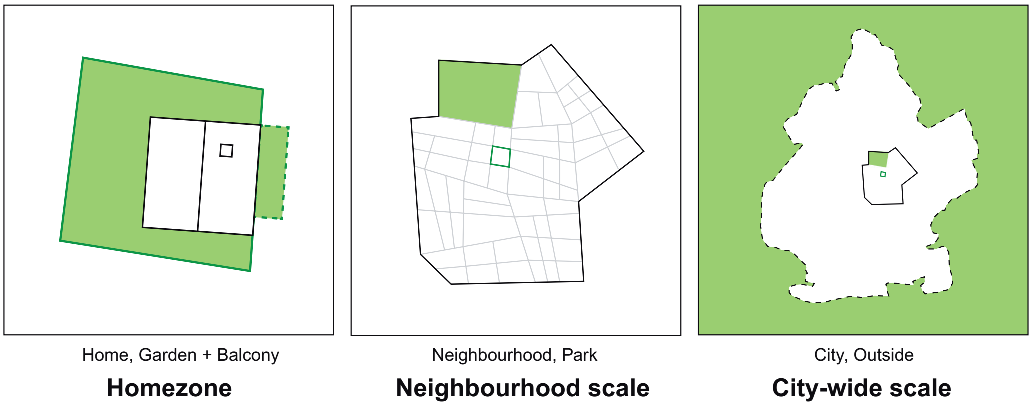

Figure 1: Relational scale groupings of the locations in this study. Green shaded areas indicate (urban) green spaces. Black shaded areas indicate traditionally human dominated locations. Home, garden, and balcony were set in the homezone; the neighbourhood and city park were set on that the neighbourhood scale; the whole city and the outside of the city were set on the city-wide scale. Drawing: Clara Kessler, Thomas E. Hauck (TU Wien).

a weak normal prior was conducted using the 'blme' R-package with

$$\begin{aligned} Model\ 2b\ <-\ & bglmer\ (Location\ chosen\ (TRUE\ or\ FALSE) \\ & \sim Animal * Location + (1\ |participantID),\ family \\ & = binomial,\ fixef.prior \\ & = normal(sd\ =\ c(10,\ 2.5)),\ control \\ & = lme4\ ::\ glmerControl(optimizer = bobyqa, optCtrl \\ & = list(iter.max = 2e6, eval.max = 2e6,\ maxfun\ =\ 2e6))) \end{aligned}$$

i.e. binomial models with whether people placed an animal somewhere as the response variable, the animal in question and the location in question as the fixed effects, as well as the interaction between these factors, and the participant identifier as the random effect to account for repeated measures. The 'Anova' function in the 'car' R-package was used to test whether any of the fixed effects and the interaction significantly affected the probability that someone would place an animal at a location. These probabilities were then visualized in a boxplot to show the differences in how often animals were placed at the different locations and scales, and Tukey post hoc tests were conducted to test whether there were significant differences in probability of placement between locations and relational scales.

With the probabilities that people would place any given animal at a given location (predictors of *Model 2a and 2 b*), a PCA was executed to understand possible relationships between animals and locations. The animals were used as subjects and the probability that people would place an animal at a certain location was used as within subject scores on the locations as factors. The data was not rescaled since all data in this data frame were already on the same scale. With the PCA, associations between the locations and animals could be visualized. The first two principal components were kept, with an explained variance of 74.4 and 14.4% respectively. Positively correlated dimensions (factors/axes) were visualized as arrows pointing in the same direction, while negatively associated dimensions point in opposite directions and dimensions with weak or no correlations are at a 90° angle in relation to each other. Individuals (in this case, the animals, as points) were then placed in the collapsed dimension-space with the same rules in relationship to the arrows: animals that were positively associated with a certain location or group of locations were placed in the same direction that the arrow was pointing at, and animals that were negatively associated with these locations were placed in the opposite direction of that location's respective arrow.

To investigate whether there was a difference in the relational scale on which participants placed the animals, we calculated an average scale level for each animal and participant, within the statistical model. To do so, only locations chosen for each animal and participant combination remained in the dataframe and locations were transformed the scale level. A repeated measures ANOVA was conducted using the 'lme4' and 'lmerTest' R-packages with

$$\begin{aligned} Model\ 3\ <-\ & lmerTest\ ::\ lmer(Scale\ level \\ & \sim Animal\ +\ (1\ |\ Participant\ ID)) \end{aligned}$$

i.e. the ordinal relational scale level served as the response variable, the animal in question and whether people placed an animal on one of the locations comprising the scale level as the fixed effect, and the participant identifier as the random effect. For example, if a particular participant chose three locations for a particular animal, each of these choices (locations translated into relational scale) stayed in the dataframe. Satterthwaite's method was used to estimate degrees of freedom and *P*-values for the ANOVA.

Relationship between animal placement and attitude

To investigate whether attitudes towards the different animals differed significantly, firstly the attitudes on the five-point Likert scale were rescaled from 1–5 to 0–4, and then a repeated measures ANOVA was conducted using the 'lme4' and 'lmerTest' R-packages with

$$\begin{aligned} Model\ 4\ <-\ & lmerTest\ ::\ lmer\ (Attitude\ value \\ & \sim Animal\ +\ (1\ |\ Participant\ ID)) \end{aligned}$$

ie the attitude value was the response variable, the animal in question was the fixed effect, and the participant identifier as the random effect. Satterthwaite's method was used to estimate degrees of freedom and *P*-values for the ANOVA.

To investigate whether the relational scale on which people placed the animals was influenced by how much they liked the animals, again, only locations chosen for each animal and participant combination remained in the data frame. A linear mixed effect model using the 'lme4' and 'lmerTest' R-packages was fitted with

$$Model\ 5 <- lmerTest :: lmer(Scale\ level \sim Attitude\ value * Animal + (1 \mid Participant\ ID))$$

i.e. the ordinal relational scale level as the response variable, the attitude value from each person to each animal and the animal in question as the fixed effects, and the participant identifier was the random effect. In this analysis, an ANOVA using Satterthwaite's method was used to test whether the variables significantly affected the scale on which people placed animals. The 'ggeffect' function of the 'ggeffects' R-package was then used in combination with the 'ggplot' R-package to visualize the mean marginal effect of attitude on the scale level on which people placed the animals.

To test the relationship between current attitudes towards the animals and the scale that people wanted them to be on, Pearson's correlation coefficient between these values was calculated.

Finally, to complement these results, we tested whether the number of locations where people placed the animals was influenced by how much they liked the animals with

$$Model\ 6 <- lmerTest :: lmer(number\ of\ locations\ chosen \sim Attitude\ value * Animal + (1 \mid Participant\ ID))$$

Following that, the relationship between current attitudes towards the animals and the number of locations that people placed them on was tested using Pearson's correlation coefficient.

Maps were made with Esri's ArcGIS Pro v2.7.2. Data processing and statistics were done in R v4.0.2 (R Development Core Team 2008), with the RStudio IDE v1.4.904 (Rstudio Team 2015). Survey data was imported directly into R with the SoSciSurvey API. The 'Tidyverse' (Wickham et al. 2019) and 'reshape2' (Wickham 2007) R-packages were used to reshape the data into usable formats, 'glmmTMB' (Brooks et al. 2017), 'blme' (Chung et al. 2013; Dorie 2022), 'lme4' (Bates et al., 2015), 'lmerTest' (Kuznetsova, Brockhoff, and Christensen 2017) and 'car' (Fox and Weisberg 2019) R-packages were used for data analysis, the 'performance' (Lüdecke et al. 2021) R-package was used to calculate marginal ($R^2_{GLMM(m)}$) and conditional ($R^2_{GLMM(c)}$) R^2 for (generalized) linear mixed effect models (Nakagawa and Schielzeth 2013; Johnson 2014), the 'ggeffects' (Lüdecke 2018) R-package was used to calculate marginal effects for linear models, the 'factoextra' (Kassambara and Mundt 2020) R-package was used to execute and visualize the PCA, and the 'ggplot2' (Wickham 2016) R-package was used for the construction of plots.

Results

Placement of animals

On average, the respondents placed animals on 3.05 ± 1.85 (mean $\pm$ std) locations ($n = 9760$ number of person * animal combinations) and there were differences among animals in the number of locations where they were placed (*Model 1:* $F_{31,9424} = 132.49$, $P < 0.001$, $R^2_{GLMM(m)} = 0.151$, $R^2_{GLMM(c)} = 0.640$). The mean number of locations where people placed an animal ranged from 1.59 for cockroaches—for which the most common location was 'nowhere' – to 4.36 for ladybugs (Supplementary Appendix Fig. IV).

There were significant differences between the locations in whether animals were placed, and the predominant location differed among different animals. In *Model 2a* ($R^2_{GLMM(m)} = 0.576$, $R^2_{GLMM(c)} = 0.733$), both the location (*Wald* χ^2 (7) = 6336.7, $P < 0.001$) and the animal (*Wald* χ^2 (22) = 1931.1, $P < 0.001$), as well as the interaction between location and animal (*Wald* χ^2 (154) = 3556.5, $P < 0.001$) significantly affected whether a participant placed an animal at a certain location. This was also true for *Model 2b* ($R^2_{GLMM(m)} = 0.633$, $R^2_{GLMM©} = 0.763$), where the location (*Wald* χ^2 (7) = 2224.6, $P < 0.001$), the animal (*Wald* χ^2 (8) = 1372.0, $P < 0.001$), and interaction (*Wald* χ^2 (56) = 1522.7, $P < 0.001$) significantly affected the outcome. People placed the animals more readily at locations further away than they did close to their homes. The most probable locations where people placed a given animal were outside of the city and the city park, followed by the neighbourhood and (anywhere in) the city, then the garden, and least probably the balcony, nowhere at all, and people's homes (Fig. 2). For few animals, however, 'nowhere' was chosen. Within these general patterns, there was variation between animals, notably visible with the cockroach, which was not often placed, and the ladybug, which was often placed at most locations (outliers in Fig. 2). The estimated probabilities that people placed a given animal at a given location can be found in Supplementary Appendix Fig. 5.

When the relational scales were considered, the respondents places animals less often in the locations of the homezone than in the neighbourhood- or city-wide scales. There were no significant differences in how commonly the respondents placed the animals in the neighbourhood- or city-wide scales.

Differences among animals in where they were placed

Different animals were positively and negatively associated with different locations (Fig. 3). *Dragonflies, fireflies, crickets*, and *squirrels* were positively associated with, neighbourhood, garden, and the city; *bumblebees, spiders*, and *ladybugs* were positively associated with balconies and gardens; *housecats* were positively associated with home and balcony; *woodpeckers, hedgehogs, ants, snails, crows, duck, lizards, owls, kestrels, mice, frogs*, and *storks* were positively associated with the outside of the city; and *martens, snakes, foxes, beavers, moles*, and *rabbits* were especially negatively associated with home, balcony, garden, neighbourhood, or the city itself, while being positively associated with being outside of the city. Finally, *cockroaches, rats, city pigeons, slugs*, and *wasps* were positively associated with being nowhere, and negatively associated with being almost everywhere else.

When locations were grouped together on a relational scale, some animals were placed on a more local relational scale level compared to others (*Model 3:* $F_{31,28789} = 49.6$, $P < 0.001$, $R^2_{GLMM(m)} = 0.047$, $R^2_{GLMM(c)} = 0.125$). For example, ladybugs (0.97), bumblebees (0.99) and spiders (1.02) were placed on a relatively low relational scale level (i.e. closer to home), while rats (1.62), cockroaches (1.56), and beavers (1.5) were placed on a higher relational scale level. The mean relational scale on which people placed each animal is visualized in Supplementary Appendix Fig. 6.

Relationship between animal placement and attitude

The different animals were not equally liked (*Model 4:* $F_{31,9424} = 304.14$, $P < 0.001$, $R^2_{GLMM(m)} = 0.429$, $R^2_{GLMM(c)} = 0.556$). Squirrels (score 3.66 on the Likert scale from 0–4, where 4 was the maximum after re-scaling), hedgehogs (3.63), and owls (3.58), for example, were very liked, while cockroaches (0.60), slugs (1.13), and rats (1.18) were severely disliked (Supplementary Appendix Table VII-1, Supplementary Appendix Fig. VII-1).

In the analyses considering how attitudes affected how far from home people wanted the animals to be, the ordinal values

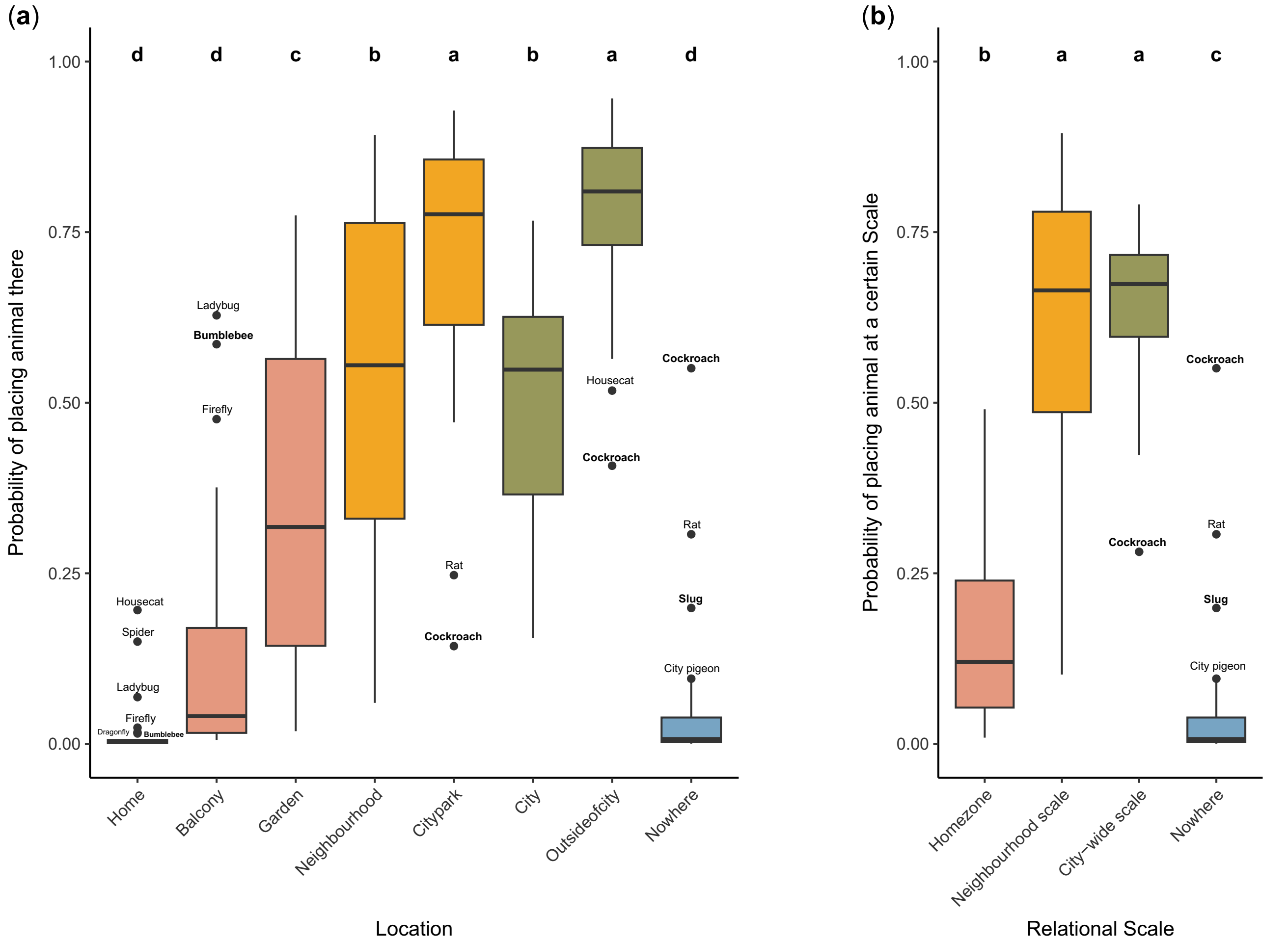

Figure 2: (**a**) Probability that people placed animals on particular locations within the city or outside. Datapoints are the estimated mean probabilities for the 32 animals, i.e. that an animal is placed at a particular location (see Supplementary Appendix Fig. 5). Locations are coloured by the relational scale level they are classified in. (**b**) Mean probability that people place animals on the different relational scales. Datapoints are the averages of locations in each relational scale for each of the 32 animals. Boxplots contain the datapoints between q0.25 – 1.5 * IQR and q0.75 + 1.5 * IQR (Interquartile range), and points outside of that are considered outliers. Outliers are indicated with the name of the animal. Graphs created with output of Model 2a and Model 2 b. Values of animals indicated in bold were calculated with Model 2 b. See text for further explanations.

for the relational scales were used. People's attitudes towards animals significantly affected the scale on which they placed them. In *Model 5* ($R^2_{GLMM(m)} = 0.062$, $R^2_{GLMM(c)} = 0.136$), the interaction between animals and attitudes was significant ($F_{31,28907} = 1.71$, $P = 0.008$) as well as the main effects attitude ($F_{1,26459} = 312.49$, $P < 0.001$)) and animal ($F_{31,28897} = 7.77$, $P < 0.001$). On average, with every point increase in attitude scores, the relational scale level on which people placed the animals decreased by 0.09 points, ie people placed animals on a lower relational scale if they liked them more (*Fig. 4a*). There was, however, also variation in the slope and intercept of this pattern, i.e. some animals were generally placed on a more local scale than others (e. g. ladybugs are on average placed closer than foxes), and for some animals the difference between how close people that like them and people that don't like them place them is bigger than for others (e.g. housecats vs. dragonflies, see Supplementary Appendix VIII). The most liked animals were the animals that people wanted closest to their homes (*correlation between outputs of Model 3 and Model 4*; $r(30) = 0.49$, $P = 0.004$; Fig 4b).

Complementing this, people's attitudes towards animals also significantly affected the number of locations on which they placed them, ie the more an animal was liked, the higher the number of locations where it was placed (*Model 6* ($R^2_{GLMM(m)} = 0.220$, $R^2_{GLMM(c)} = 0.683$), attitude $F_{1,9517} = 1041.56$, $P < 0.001$, animal ($F_{31,9401.8} = 11.63$, $P < 0.001$), interaction $F_{31,9402} = 5.77$, $P < 0.001$). On average, with every point increase in attitude scores, the number of locations on which people placed the animals would increase with 0.43, i.e. people placed animals on more locations if they liked them more (Supplementary Appendix Fig. 9a). Additionally, the most liked animals were also the animals that people placed on the highest number of locations ($r(30) = 0.64$, $P < 0.001$; Supplementary Appendix Fig. 9b).

Discussion

In this study, we investigated where inhabitants of Munich (Germany) placed different animals and how that was related to how much they like them.

The first question we investigated was where people placed different animal species. There were differences between the locations in how often animals were placed in them. Participants placed animals more often in locations belonging to the neighbourhood- (neighbourhood, city park) and city-wide scale (city, outside of city) than in the homezone (garden, balcony, home). The second question was whether there were differences between animals in where they were placed. We found that some

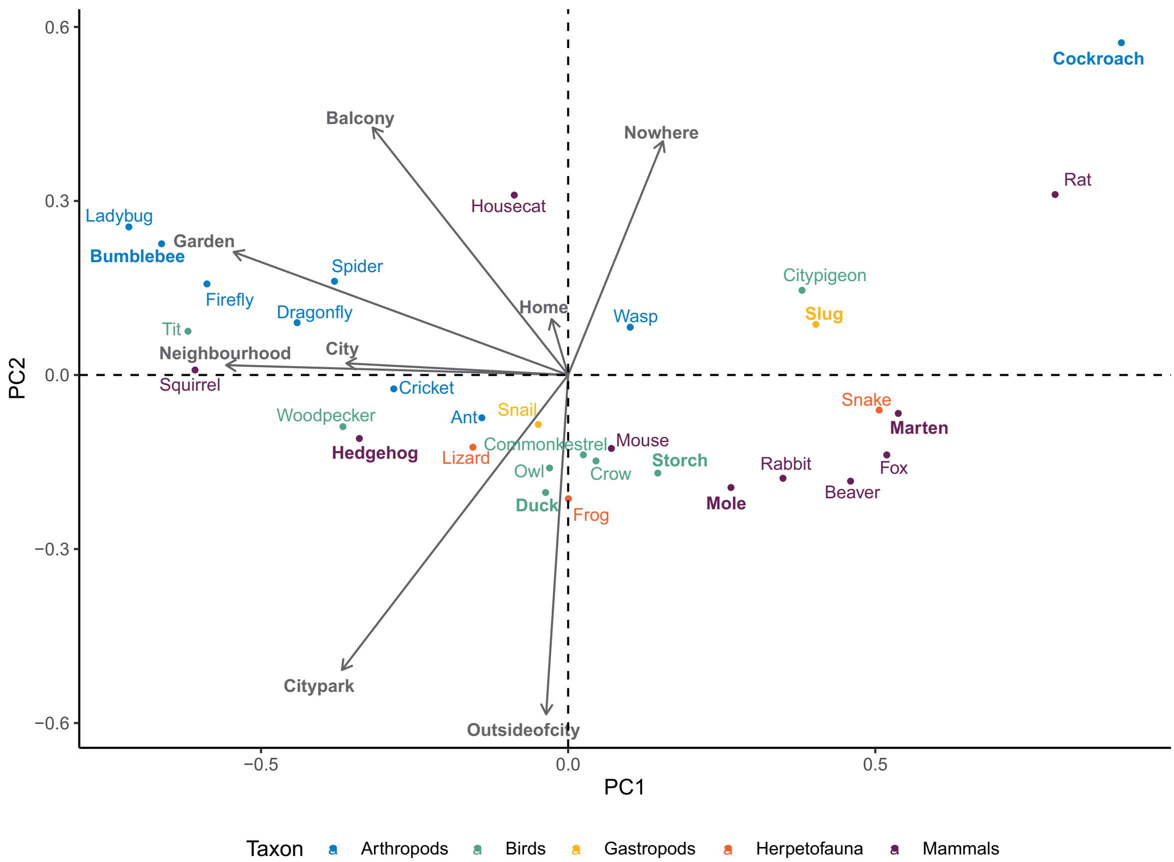

Figure 3: Principal component analysis (PCA) of the eight locations where the people of Munich placed different animals in the questionnaire. The animals were used as subjects and the probability that people would place an animal at a certain location was used as within subject scores on the locations as factors. Probabilities were derived from Model 2a and Model 2 b, see Supplementary Appendix Fig. 5. The first dimension explained 74.4%, the second axis 14.4% of the variance. Black arrows represent locations, coloured points represent investigated animals, split by taxon. Values of animals indicated in bold were calculated with Model 2 b.

animals were placed on all or almost all locations by the participants (e.g. squirrels and ladybugs), many species were placed in several locations, and three species were often placed 'nowhere' (cockroaches, rats, and slugs). Animals that were placed close to home were generally also placed in locations that were further away. Thus, there were multiple places for every animal, but few animals were accepted close to home. The third question was whether there was a relationship between how close to home people placed animals and how much they liked them. There were large differences in the attitudes of people towards different animals. The animals that were on average more liked were also the animals that were on average placed closer to home. In addition, analysis of individual animals showed that people that liked a certain animal more placed them closer to home than people that liked that animal less. Overall, our results show that there are clear preferences of people to where different animals should occur and that these preferences are broadly linked to the attitudes people have towards the animal.

Differences between locations and relational scale levels

The inhabitants of Munich clearly differentiated between the different locations as places for animals. People were most willing to let animals occur outside of the city and in the city parks, followed by the neighbourhood and the city, the garden, the balcony, nowhere, and at home, in descending order. 'Nowhere' was a rare choice for most animals, with only cockroaches, rats, and slugs having a probability score of more than 0.15 for people choosing it as one of the 'locations' for them. The only location where participants placed even fewer animal species than 'nowhere' was in their homes. The locations with the highest probability that people placed an animal were the city park and outside of the city. In the homezone, participants rarely placed animals in their homes, and while they were slightly less unwanted on balconies, the probability of placement there was still low. Animals that were placed on locations close to home were often also placed in locations that were further away. This was not true the other way around.

When relational scales are considered, the pattern emerges that as an average across animals, the participants were most, and equally, probable to place animals on the neighbourhood- and city-wide scale levels, while they were less probable to place the animals in the homezone. This indicates that people were unlikely to place animals in their homes and the structures directly connected to them. Wild animals are classically excluded from human households, even if their domestic counterparts are sometimes allowed to be there (Oma 2013). This notion has hence been corroborated by the findings in this paper.

Our finding that the garden (as part of the homescale) is seen as a place where people accept fewer animals than in a park or in neighbourhood is interesting, because as shown by several studies, e.g. Loram et al. (2008), urban gardens contribute

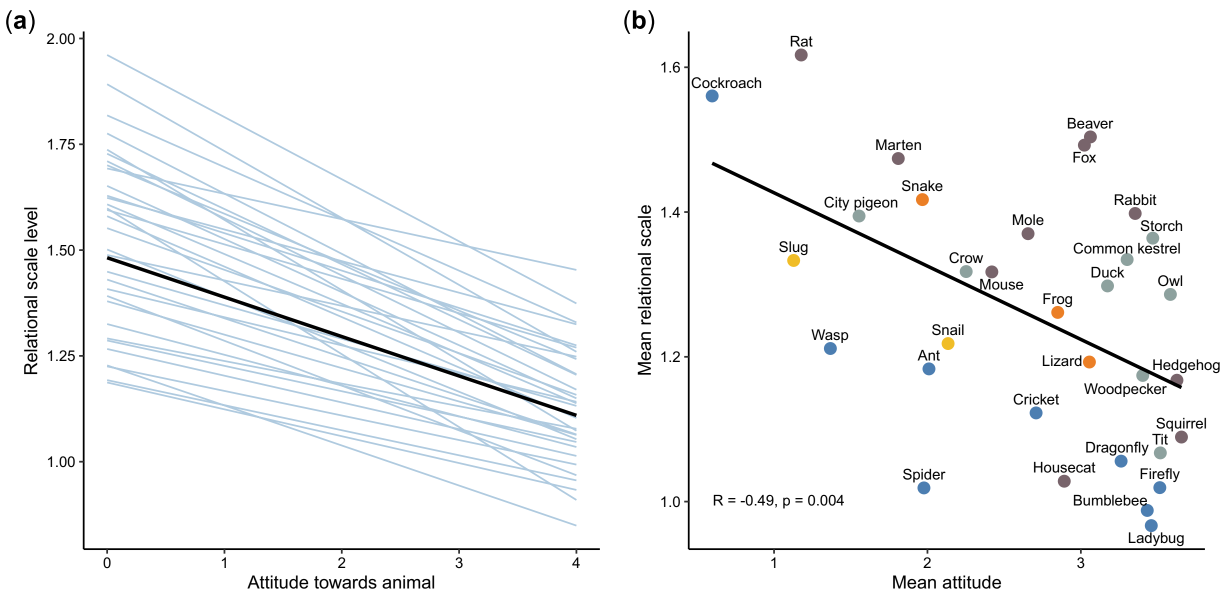

Figure 4: (**a**) The relationship between attitudes towards an animal (0-very disliked to 4-very liked, every animal was judged by each participant), and where the animal was placed, on the relational scale (0- homezone to 2-city-wide scale). Output of Model 5. Each blue line shows the predicted values for one particular animal, and the black line indicates the mean marginal effect of the relationship. (**b**) Correlation between mean attitude and mean relational scale for the different animals (averages across people). Correlation between output of Model 3 and Model 4. Pearson's correlation coefficient and significance level in the lower left of the figure. Animal names are indicated next to their respective datapoints, and points are coloured by their respective taxon.

substantially to the biodiversity of a city, and they can be a space for urbanites to experience nature (Lin, Egerer, and Ossola 2018). Even though people rather placed animals in the garden than in any other location in the homezone, the mean probability of placement was still lower than even the built-up areas of the higher scale levels, i.e. further away from their home. This could be a potential source of conflict between potential options to promote biodiversity in cities and what the human inhabitants of the city want, and attitudes towards potential garden animals should be further investigated.

Differences in how liked animals were

The animals in this study were not equally liked by the participants. Most animals were liked, i.e. 23 out of 32 had a mean attitude score significantly over 2, while only six were disliked (attitude score < 2), and the attitude towards three, ants, spiders, and snakes, was neutral (attitude score not significantly different from 2).

Overall, the attitudes towards the different species in our study corresponded to what has been reported before. Birds and mammals were generally very well liked, as indicated in other studies (Hosaka, Sugimoto, and Numata 2017; Rupprecht, 2017; Sweet et al., 2023; but see Muslim et al. 2018), with the notable exception of the city pigeon, the crow, marten, and rat. The negative attitudes towards pigeons and crows have been documented and discussed extensively in other studies (Kellert 1984a; Bjerke, Ødegårdstuen, and Kaltenborn 1998; Bjerke and Østdahl 2004; Hosaka, Sugimoto, and Numata 2017; Capoccia, Boyle, and Darnell 2018; Muslim et al. 2018; Jakoby et al. 2019), and for a more extensive discussion on attitudes towards pigeons, readers are referred to Capoccia, Boyle, and Darnell 2018. The dislike for martens might be because they are known to climb into and damage cars (Herr, Schley, and Roper 2009), and rats are a known pest species that is commonly shunned and eradicated (Baker et al. 2020).

Many arthropods were generally well-liked, with exceptions such as the mosquito. The rating of arthropods in our study strongly corresponds with Shipley and Bixler (2017) study on attitudes towards 'bugs'. Cockroaches, for example, were, as in Shipley and Bixler's study, the most disliked animals in our survey. Similarly, fireflies and ladybugs score high in both the current and Shipley and Bixler's study, and in their study mostly positive experiences—in the form of stories about 'bugs' – were recalled with regards to these animals.

Lizards and frogs were well liked. Lizards have been previously reported to be well-liked (Schlegel and Rupf 2010), even though they have also been classified as fear-relevant animals (Davey 1994). While frogs were well liked in this study, other studies show that frogs tend to be considered more ambivalently (Schlegel and Rupf 2010), or even unfavourably (Hosaka, Sugimoto, and Numata 2017). Snakes, however, fell within the category of animals for which the mean attitude was neutral. For snakes, the biggest group of participants had a neutral opinion, while there was a similar number of people liking and disliking them. Snakes often evoke fear and were to be less liked than other animals in other studies (Davey 1994; Fredrikson et al. 1996; Schlegel and Rupf 2010).

Snails were liked just a little bit better than neutral, while slugs were the second most disliked animal in the survey, corresponding to other studies (Driscoll 1995; Bjerke, Østdahl, and Kleiven 2003: 20; Bjerke and Østdahl 2004), that also discussed plausible reasons for this attitude, such as mucus production (Davey 1994) and that they are considered important garden pests (Brace, Gange, and Clover 2020).

Difference between animals in placements

Animals were not equally placed on the different locations. As indicated by Fig. 3, only one animal, the housecat, was associated with being placed in people's homes. Certain animals, such as ladybugs, spiders, and squirrels were strongly associated with gardens and neighbourhood related areas while many of the mammals are especially *not* accepted in those areas, but rather placed more outside of the city. Known animal pests and strongly disliked animals such as cockroaches, rats, and wasps, were associated with being placed 'nowhere', ie people would be happy if those animals simply did not exist, even outside of the city. This does not mean that the associated locations for any animal in Fig. 3 were the only locations where the animals were placed; it indicates that these are the strongest animal-location associations. Here lies a key difference between the current study and studies like, for example, Rupprecht's (2017) paper: while he asked where 'animals' are supposed to be able to live, in this study, we ask this question for various animals specifically, since there can be quite some variation in attitudes toward the accepted places of different animals.

The relationship between attitudes towards the animals and the relational scale in which they are placed

Our study reports for the first time that people that liked an animal more placed it closer to home than those that liked it less. Additionally, the animals that were on average liked more were also on average placed on a relational scale closer to home. Previous studies have shown that measures for willingness to coexist or proximity, and attitudes towards the animals, are positively correlated (Hosaka, Sugimoto, and Numata 2017; Muslim et al. 2018). Because participants could place animals at multiple places in our questionnaire, we were able to show that more liked animals were placed on more locations, and that animals placed close to home were also placed further away from home.

Caveats

One should note that findings of studies such as ours may be dependent on the animals presented. If, for example, primarily well-loved animals that people want close to their homes are presented (e.g. songbirds or squirrels), the across-animal trends on attitudes towards and desired proximity of the animals could be more positive and in closer proximity. That also brings limitations to the generalizability of studies. Nevertheless, we believe this approach is an improvement compared to studies that simply ask where people think 'animals' should be, because of the greater specificity of the answers in the identification of what people consider right and wrong locations for different animals. We selected animals that are familiar to the people in our study system and believe, based on prior research, that we made a well-considered choice of which ones to present, relevant to the time and place that we work in. The animals that were chosen ranged from very liked to very disliked and included various taxa.

Note that while we now have an indication of where people in Munich want the different animals to be, we do not know what exactly the reasons are for people placing them in the different locations. This manuscript focuses on where animals are placed and how they are liked, rather than why people have these attitudes about them. The question of why people have certain attitudes toward various animals is relevant and interesting, and have already been addressed in a number of papers (e.g. Herzog 2011; Sumner et al. 2018; Landry Yuan et al. 2019; deMello 2021; Izaguirre and Montiel, 2021). These papers show that attitudes not only vary among animals, but are also strongly influenced by culture and sex, age, or previous experiences. Examples of the variability of attitudes over space and culture are shown in Ambarli's (2016) paper that showed differences on attitudes of brown bears between urban and rural students in Turkey and Rupprecht's (2017) comparison between Brisbane and Sapporo, and examples of changes over time are shown in Basak et al.'s (2022) longitudinal study and Wolloch's (2019) historiographical book on the changes on views of animals during the 18th century. For example, snakes are generally recorded to evoke fear and are less liked in other studies, but are viewed with a neutral opinion in our study, potentially because there are few dangerous and venomous snakes in Germany (Montag 2018). In addition to demography, the place where people live may also affect their placement of certain animals, e.g. if they live in the city centre or close to the outskirts of Munich. Finally, because Munich has a sizable migrant population (Statistisches Amt der Landeshauptstadt München 2023), future studies on the topic might benefit from being conducted in multiple languages, in order to lower the barrier of participation for these inhabitants and potentially draw in a larger proportion of the population. While the age and gender distributions of the participants in this study was similar to the general populace, there seems to be a participation bias towards higher educated individuals in the survey. Higher education levels have been shown to be correlated with a more positive attitude towards (Bjerke and Østdahl 2004) and a higher willingness to coexist with animals (Rupprecht 2017). Thus, investigating why people place an animal at a particular location and why they like or dislike a particular species is a complex question that needs to be investigated separately in a targeted approach which probably requires narrowing down the number of animal species considered to a lower number than in our study (e.g. Sumner et al. 2018).

Finally, while our findings give a contemporary insight into the place-related attitudes towards urban animals, it is important to consider that the sense-of-place of animals is not static and has been very often shown to be dynamic, as exemplified in 'A wolf in the garden', where Alec Brownlow discusses the transformation of the wolf in the American imagination (Brownlow 2000). This is not unique to large predators, but is very clear even for nowadays more commonly welcomed animals such as bees, who up until not too long ago would be considered unwanted in cities (e.g. Bjerke and Østdahl 2004) and are nowadays considered a significantly more positive view (e.g. Sumner et al. 2018). Longitudinal studies, taken every decade, or even every few years, could indicate significant shifts in contemporary attitudes towards sense-of-place of animals in cities, and would more readily elucidate their current-day trajectories.

Planning for humans and animals

The insights gained from this study have implications for urban planning and wildlife conservation. Animals do not ask where they are allowed to go, but inhabit urban habitats that satisfy their niche needs, often resulting in human-wildlife conflicts (Soulsbury and White 2015). However, often their niche requirements are not met, and urban planning can help making places suitable for certain animal species. If we know where people want certain animals to be or not to be, we can anticipate potential conflict places, and can identify places where urban wildlife conservation is accepted by people. Approaches like ours will help to identify these places. For example, our results show that conflicts are less likely in city parks, because they were considered appropriate locations for most animals by the vast majority of people. Conversely, wildlife conservation close to people's living spaces may generate little acceptance, unless those species are selected as targets that are readily accepted closer to home. Because the choices, needs, and wants of human inhabitants dictate, or at least strongly affect, the urban environment and can lead to the creation, conservation, or destruction of potential habitats, knowledge of both the human inhabitant's attitudes towards animals is important to promote animal conservation in cities. This needs to be combined with knowledge on the ecology of these animals to inform planning and design that promotes animal conservation in cities while avoiding the most obvious human-animal conflicts.

Conclusion

Our study showed that people clearly differentiate between animals in where they place them and place animals closer to their home if they like them more. Because of the non-exclusive location-choices for each animal in our questionnaire, we also found that when people like an animal more, they place it on more locations, progressing from bigger to smaller relational scales. An important next step would be to try to establish how demographics, exposure to animals, and people's habits influence attitudes towards these animals in cities and where the urbanites want them to be. This also should also include where people live in the cities. The living environment could be an important determinant of place-related attitudes towards urban animals, because differences in types of housing, types and amounts of surrounding green space, and the presence of animal species in the surroundings will affect exposure and day-to-day experiences with animals, which in turn may affect people's attitude to particular species and animals in general.

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Author contributions

Fabio S.T. Sweet (Conceptualization [lead], Data curation [lead], Formal analysis [lead], Investigation [lead], Methodology [lead], Project administration [lead], Supervision [equal], Visualization [lead], Writing—original draft [lead], Writing—review & editing [lead]), Anne Mimet (Investigation [equal], Supervision [equal], Writing—original draft [equal], Writing—review & editing [equal]), Md Noor Ullah Shumon(Conceptualization-Equal, Formal analysis [supporting], Investigation [supporting], Methodology [equal], Writing—review & editing [supporting]), Leonie P. Schirra (Conceptualization [equal], Formal analysis [supporting], Investigation [supporting], Methodology [equal], Writing—review & editing [supporting]), Julia Schäffler (Conceptualization [equal], Formal analysis [supporting], Investigation [supporting], Methodology [equal], Writing—review & editing [supporting]), Sophia C. Haubitz (Conceptualization [equal], Formal analysis [supporting], Investigation [supporting], Methodology [equal], Writing—review & editing [supporting]), Peter Noack (Investigation [equal], Writing—original draft [equal], Writing—review & editing [equal]), Thomas E. Hauck (Conceptualization [equal], Investigation [equal], Visualization [equal], Writing—original draft [equal], Writing—review & editing [equal]), and Wolfgang W. Weisser (Conceptualization [equal], Funding acquisition [lead], Investigation [equal], Supervision [equal], Writing—original draft [equal], Writing—review & editing [equal])

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Conflict of interest statement

None declared.

Supplementary Data

Supplementary data are available at *JUECOL* online.

Data availability

Data is available for import via: Data: https://www.soscisurvey.de/Mensch_und_Tier/?act=IMi5eCZjVX4cyzkNtHRkbM40 R script: https://www.soscisurvey.de/Mensch_und_Tier/?act=IMi5eCZjVX4cyzkNtHRkbM40&rScript.

Ethics approval and consent to participate

Ethical approval was waived for this study by Ethikkommission der Technischen Universität München, code 2022-593-S-KH KH, on 17 November 2022. To be able to participate with the survey, participants were required to sign an informed consent form at the beginning of the questionnaire.

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