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Cite this article: Zsido AN, Inhof O, Lau SS, Kiss BL. 2026 Snakes are perceived as more threatening and disgusting in urban compared to natural environments. *R. Soc. Open Sci.* **13**: 260765. <https://doi.org/10.1098/rsos.260765>

Received: 13 April 2026

Accepted: 16 July 2026

Subject Category:

Psychology and cognitive neuroscience

Subject Areas:

behaviour, environmental science, psychology

Keywords:

disease-avoidance model, human–wildlife interactions, nature-relatedness, snake fear, urban wildlife perception, wildlife conflict

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Snakes are perceived as more threatening and disgusting in urban compared to natural environments

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Wildlife in cities is often perceived as ‘out of place’ because urban environments are considered human territory. This can lead to stronger negative emotional responses than encounters in natural habitats. A representative sample of adults ($n = 500$) rated pictures of snakes in urban versus natural environments on five dimensions: positivity, negativity, disgust, threat and approach. We tested contextual differences and the moderating roles of nature-relatedness, disgust propensity/sensitivity and snake fear while controlling for anxiety and depressive symptoms. The emotional appraisal of snakes depicted in urban environments was found to be less positive and more negative, disgusting and threatening than when the same snakes were shown in natural environments. However, approach intentions remain unchanged, indicating that context strongly influences emotional responses. Evaluations were primarily influenced by personality-related factors in natural settings, with higher nature-relatedness predicting more favourable ratings, and greater disgust and snake fear predicting more negative ratings. These individual differences played a limited role in urban settings, suggesting that strong contextual cues can override dispositional variation. The findings demonstrate that perceived ecological congruence is a key driver of how humans perceive wildlife. Effective management and policy should therefore normalize the presence of wildlife in urban areas, provide clear information to distinguish between everyday encounters and genuine risk, and design urban environments that reduce perceived intrusion. This could support coexistence and conservation in increasingly urban landscapes.

Supplementary material is available online at <https://doi.org/10.6084/m9.figshare.c.8627726>.

1. Introduction

Human–wildlife interactions are becoming increasingly common in urban environments, where rapid changes in land use and expanding development are bringing people and animals closer together [1,2]. Many people conceptualize urban environments as organized, predictable and controllable—fundamentally human territory [3]. Consequently, wildlife is often perceived as ‘out of place’ or even as intruders when encountered in cities [4–6]. This psychological framing contrasts with encounters in natural environments, where the presence of wildlife is expected and therefore more readily accepted. This ‘ecological incongruence’ [7], or the mismatch between an animal and its perceived habitat, can elicit threat- and disgust-related responses, even towards species that pose minimal or no risk. Conversely, ecological congruence—the extent to which an organism appears in a context where it is perceived as belonging—may provide a basis for evaluation, as they are more likely to be viewed as normal and acceptable. Empirical studies show that unexpected encounters with wildlife in human-made environments elicit stronger negative emotions and increase perceived danger, amplifying avoidance tendencies compared to comparable encounters in natural environments [8–11]. According to appraisal theories, emotional responses arise from individuals’ evaluations of whether a situation aligns with their expectations, goals and sense of control. When an event violates these expectations—such as encountering an animal in an unexpected place—it is more likely to be appraised as unpredictable or incongruous, which in turn elicits heightened feelings of threat, danger or disgust [12,13]. Consequently, the same animal may be evaluated far more negatively in an urbanized setting than in a natural landscape [8,14,15]. Therefore, the environmental context itself may be a critical determinant of emotional evaluations of an individual’s encounter with a specific animal.

Different species elicit different responses from the public, and snakes are a particularly powerful test case for this theoretical framework [16]. For example, charismatic species such as hummingbirds or Pennant’s red colobus tend to be viewed positively, whereas species associated with conflict, such as gulls and crested porcupines, and species considered threatening, such as snakes, tend to be viewed negatively [17–19]. From an evolutionary perspective, studies suggest that snakes played a significant role in shaping primate perceptual systems, resulting in rapid detection and strong emotional responses [20,21]. Indeed, field studies of hunter-gatherers indicate that snakes were both the prey and predators of humans, as well as ecological competitors [22–24]. This evolutionary significance contributes to the global prevalence of snake-related fears and phobias, which are found across cultures regardless of background or experience [25–27]. Snakes are often perceived as highly threatening and are frequently the subject of strong avoidance, disgust or negative attitudes [28–30]. These characteristics make them an ideal species through which to examine how environmental context shapes human emotional appraisals. Despite the substantial body of literature on snake phobia and human–snake conflict—demonstrating, for example, how fear, disgust and cultural factors shape attitudes towards snakes and predict avoidance or intolerance [26,31,32]—these studies have largely focused on individual or cultural differences. By contrast, few studies have examined how the context in which snakes are presented affects how they are evaluated. If people perceive urban wildlife as intrusive, then photographs of snakes in urban environments should elicit stronger negative reactions than photographs of snakes in natural habitats. This leads to the first hypothesis of the present study: snakes depicted in urban environments will be evaluated as less desirable—as being more negative, disgusting and threatening, and as being more likely to elicit avoidance—than snakes depicted in natural environments, that is, their ecologically true habitats.

However, responses to snakes are far from uniform. Attitudes towards urban wildlife are influenced by personal values, experiences and sociodemographic factors. For example, positive interactions with wildlife can lead to more favourable attitudes, whereas negative experiences can result in wildlife being viewed as problematic [11,33,34]. Previous studies have demonstrated that individual differences significantly impact attitudes towards snakes and other wildlife. For example, nature-relatedness has been shown to predict appreciation, tolerance and prosocial attitudes towards animals and natural environments [35]. Higher levels of nature-relatedness have been associated with more positive attitudes towards wildlife, including snakes [36,37]. Disgust sensitivity and propensity are strong predictors of snake avoidance given the link between snakes and pathogen- or animal-related disgust [38,39]. Those with high disgust sensitivity tend to have more negative attitudes and are more likely to avoid or harm snakes [31,40,41]. Furthermore, disgust propensity is involved in high snake fear and possibly phobia [40], suggesting that it might play a role in shaping general perceptions of wildlife [42]. A fear of snakes is a profound and pervasive trait-like disposition that significantly impacts attitudes and behaviours towards these animals. It is one of the strongest predictors of heightened negativity and perceived threat

[32,43–45]. It can also lead to avoidance behaviours and a lack of support for snake conservation [46]. These personality-linked variables may influence not only baseline evaluations, but also how context (urban versus natural) shapes emotional responses. Furthermore, broader affective dispositions such as anxiety and depressive symptoms can influence attitudes towards wildlife, rendering them essential control variables. General anxiety is inversely related to positive wildlife experiences, suggesting that individuals with higher anxiety may have more negative attitudes towards wildlife, including snakes [36]. Depressive symptoms can also reduce the likelihood of noticing and appreciating wildlife, further contributing to negative attitudes [47]. Thus, in addition to testing context effects, the present study investigates the psychological traits that predict variation in context-dependent evaluations. Specifically, our second hypothesis is that higher nature-relatedness will be associated with more positive evaluations of snakes and less negative, threatening or disgusting evaluations, particularly when they are depicted in natural environments. Conversely, a greater tendency to feel disgust and a greater fear of snakes are expected to lead to more negative, threatening and disgusting evaluations. Importantly, these associations are expected to be stronger in natural environments than in urban ones, in line with a context-first framework in which strong contextual cues in urban settings reduce the impact of individual differences. We expect these effects to be independent of anxiety and depressive symptoms.

This study examines the interaction between environmental context and personality in shaping human–snake evaluations, shedding light on human perceptions of wildlife in an increasingly urban world. It also provides valuable insights for conservation, urban planning and mitigating wildlife conflicts. Accordingly, we examine the associations between individual differences in nature-relatedness, disgust sensitivity, fear of snakes and broader affective dispositions (such as anxiety and depressive symptoms) and the evaluation of snakes in different environmental contexts. This approach integrates contextual and dispositional perspectives to provide a more comprehensive understanding of the psychological processes underlying human–wildlife interactions and their potential implications for conservation and coexistence.

2. Methods

2.1. Participants

We determined the minimum sample size required by calculating the estimated statistical power for repeated-measures ANOVA with a 2×5 design ($f^2 = 0.05$, $\beta > 0.8$, $\alpha = 0.05$, number of predictors = 15) and for linear regression ($f = 0.1$, $\beta > 0.8$, $\alpha = 0.05$) using the G*Power 3 software. The analysis indicated a minimum required sample size of 80 and 389, respectively. However, we aimed to recruit more participants for more robust results and greater variability in participants. Our sample consisted of 500 participants. See [table 1](#) for the detailed descriptive statistics of the sample and the questionnaires used in the study.

The sample was collected in June 2025 through a professional public-opinion research company. Participants were recruited from a national online research panel, and the final dataset was stratified to represent the adult Hungarian population across age, sex, educational attainment, geographical region and settlement size. Participants were incentivized in accordance with standard panel procedures, receiving points for participation that could later be exchanged for entry into prize raffles. Participants who reported having expertise¹ in snakes were excluded from the study.

2.2. Ethical approval and consent to participate

The research was approved by the Hungarian United Ethical Review Committee for Research in Psychology. It was conducted in accordance with the World Medical Association's Code of Ethics (Declaration of Helsinki). Written informed consent was obtained from all participants.

2.3. Questionnaires

We used the short version of the Nature Relatedness Scale (NR) to assess individual differences in cognition, emotion and experience in relation to nature [35,48]. The six-item questionnaire is rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). We calculated scores using

¹This was assessed via self-report: they were asked if they had any relevant expertise, such as formal training or professional involvement with snakes, or extensive self-acquired knowledge.

Table 1. Descriptive statistics on all five rating scales split by the environment of the picture. (Note: ω = McDonald's omega (reliability). NR, Nature Relatedness Scale; SNAQ, Snake Phobia Questionnaire; PHQ, Patient Health Questionnaire).

		count	% of total			
sex	male	236	47.2%			
	female	264	52.8%			
highest education	elementary school	29	5.8%			
	vocational school	143	28.6%			
	high school	176	35.2%			
	BA/BSc	78	15.6%			
	MA/MSc	60	12.0%			
	PhD	14	2.8%			
		mean	s.d.	min	max	ω
age		43.460	12.624	18	65	-
NR total		19.120	4.896	6	30	.81
disgust propensity		23.118	6.481	8	40	.87
disgust sensitivity		19.732	6.624	8	40	.87
SNAQ total		4.790	4.043	0	12	.91
PHQ anxiety		1.810	1.766	0	6	.85
PHQ depression		1.636	1.769	0	6	.87

the sum of the item scores; therefore, the possible scores on the questionnaire range from 6 to 30. Higher scores indicate a stronger connection with nature. In this study, the McDonald's omega² was 0.81, which indicates good internal consistency.

We used the revised 16-item version of the Disgust Propensity and Sensitivity Scale (DPSS) [49,50]. This questionnaire comprises two scales that measure both the frequency of disgust experiences (disgust propensity) and the emotional impact of these experiences (disgust sensitivity). Each item is rated on a scale ranging from 1 ('never') to 5 ('always'). These responses are summed to yield subscale scores; therefore, the possible scores on the questionnaire range from 16 to 80. Higher scores reflect a greater self-reported tendency to experience disgust more frequently (propensity) and to experience these responses as more intense or distressing (sensitivity), respectively. In our study, McDonald's omega value was 0.87 in both cases, indicating good internal consistency.

To measure self-reported fear and phobia of snakes, we used the 12-item short version of the Snake Phobia Questionnaire (SNAQ) [51]. The scale uses a dichotomous response format (true/false). 'True' responses are summed to yield a score ranging from 0 to 12, with higher scores indicating greater fear of snakes. In this study, the McDonald's omega was 0.91, indicating excellent internal consistency.

To assess anxious and depressive symptoms, we used the four-item version of the Patient Health Questionnaire (PHQ) [52]. This brief self-report questionnaire contains two anxiety items and two depression items. Items are rated on scales ranging from 0 ('not at all') to 3 ('nearly every day'). These responses are summed to yield subscale scores, with possible scores ranging from 0 to 12. Higher scores

²Internal consistency was assessed using McDonald's omega, which is a reliability coefficient that estimates the proportion of variance in scale scores that is attributable to a common underlying factor.

indicate greater anxiety or depressive symptoms, respectively. In our study, McDonald's omega values were 0.85 and 0.87, which indicates good internal consistency.

2.4. Picture stimuli

We sourced a total of 30 pictures of snakes from the Internet. Half depicted snakes in urban/domestic environments (e.g. on the street, inside a house or on a balcony), while the other half depicted snakes in natural environments (e.g. on a tree, in the grass). The urban condition encompasses a variety of human-dominated environments, including indoor spaces such as homes and outdoor public areas such as streets and pavements. This reflects the variability of contexts in which human–wildlife encounters may occur. Steps were taken to ensure that the species of snake matched in both conditions to isolate contextual effects. However, exact matching of species and visual characteristics (e.g. coloration and patterning) was not always possible owing to limitations in the available images. None of the snakes included in the study occurs naturally in Hungary. All pictures were cropped and standardized to identical dimensions, with order randomized across participants. Although all images were cropped and standardized to the same dimensions, there was still variation in the visibility, size and prominence of the snakes within the scene (e.g. partial occlusion or differences in lighting), which may have influenced participants' ratings. The pictures included in this study, as well as a list of the species of snakes, are available on the Open Science Framework repository (<https://osf.io/s4gmy>).

Respondents were asked to rate the pictures using five 7-point Likert-type rating scales: positive valence (1—not positive at all to 7—very positive); negative valence (1—not negative at all to 7—very negative); disgust (1—not disgusting at all to 7—very disgusting); threat (1—not threatening at all to 7—very threatening); and whether they would approach the snake in the picture (1—not likely to approach at all to 7—very likely to approach). We then calculated the mean ratings for snake pictures in urban and natural environments over the five dimensions (see the supplementary material S1 for the central tendencies of the ratings).

2.5. Statistical analysis

First, we conducted a 2×5 repeated measures analysis of variance, with environment (natural or urbanized) and rating scale (positive, negative, disgust, threat or approach) as the within-subject factors. This approach was used to avoid family-wise error rates, with the focus being on the interaction and relevant follow-up *t*-tests. Our primary focus was on the interaction between environment and rating scales, as these capture whether evaluations of snakes differ across contexts depending on the type of appraisal (e.g. positivity, threat or disgust). This interaction provides a direct test of the hypothesis that environmental context modulates emotional responses. Follow-up comparisons were therefore conducted to analyse this effect.

Next, we used linear mixed models (LMMs) to test the association between picture ratings and personality-related factors. Five models were tested,³ with one of the rating scales serving as the dependent variable in each. The independent predictors were environment (natural or urbanized), NR total score, DPSS propensity and sensitivity scores, SNAQ total score and PHQ anxiety and depression scores. We also entered sex and age as control variables. Furthermore, we added interaction terms between the environment factor and each questionnaire score. We also used participant ID as a random effects grouping factor. The model terms were tested using the Satterthwaite method. When reporting the results of the LMMs, we provide Vovk–Sellke maximum *p*-ratios (VS-MPRs) to illustrate effect sizes. The VS-MPR value, which is based on a two-sided *p*-value, shows the maximum possible odds in favour of H1 over H0 [53]. The dataset supporting the conclusions of this article is available in the Open Science Framework repository (<https://osf.io/s4gmy>).

3. Results

First, we tested our initial hypothesis that pictures depicting a snake in an urbanized environment would be rated as less desirable than pictures depicting a snake in a natural environment. This question was

³The model term used was 'DV ~ 1 + Sex + Age + Environment + NRtotal + DisgustDP + DisgustDS + SNAQtotal + PHQanxiety + PHQdepression + Environment:NRtotal + Environment:DisgustDP + Environment:DisgustDS + Environment:SNAQtotal + Environment:PHQanxiety + Environment:PHQdepression + (1 | ID)'.

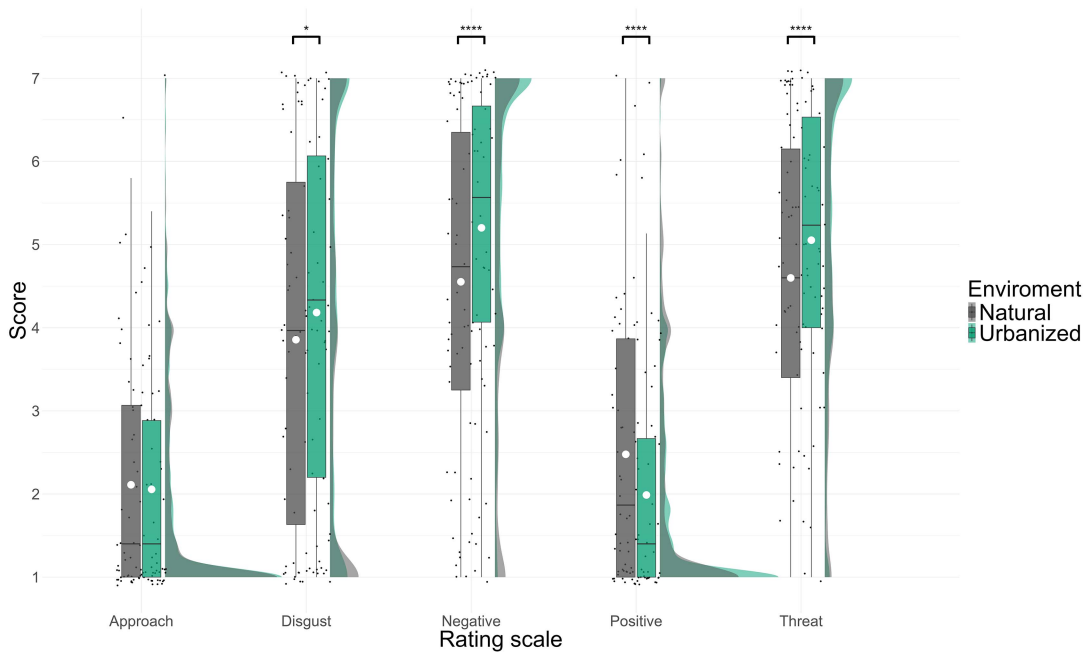


Figure 1. Raincloud plots showing picture ratings for snakes in natural and urbanized environments across five appraisal dimensions: positivity, negativity, disgust, threat, and approach. Higher values indicate stronger endorsement of the given appraisal. Snakes depicted in urban environments were rated as significantly less positive, more negative, and more disgusting than the same snakes depicted in natural environments. However, there was no significant difference in approach intentions between contexts. Each plot displays median values (black lines) and mean values (white dots) within the box plots. To maintain readability, given the large sample size, only 20% of the raw data points are displayed. Significant differences between environments are indicated by connecting black lines (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

Table 2. Results of the pairwise comparisons on all five rating scales for snakes in natural and urbanized environments. (Note: p -values are Bonferroni-corrected to account for multiple comparisons).

	t	d.f.	p	Cohen's d
positive rating	11.08	499	<0.001	0.495
negative rating	−14.19	499	<0.001	−0.635
disgust rating	−11.95	499	<0.001	−0.534
threat rating	−13.16	499	<0.001	−0.588
approach rating	2.41	499	0.322	0.108
	F	d.f.	p	η_p^2
overall model	160	4, 1996	<0.001	0.243

tested via the interaction between environment and rating scale, which was significant (see table 2 for the statistical details). We found that snakes in an urbanized environment were rated as less positive and more negative, disgusting and threatening than snakes in a natural environment (see figure 1 and the supplementary material S1 for descriptive statistics). The difference in whether one would approach them was not significant. In line with our hypothesis, these results suggest that ecological incongruency influences emotional appraisal, but not behavioural intentions. This makes the appraisal more negative and increases the perception of threat.

We then tested our second hypothesis, which was that personality-related factors would be associated with differences in snake ratings in urbanized and natural environments. This question was tested in each

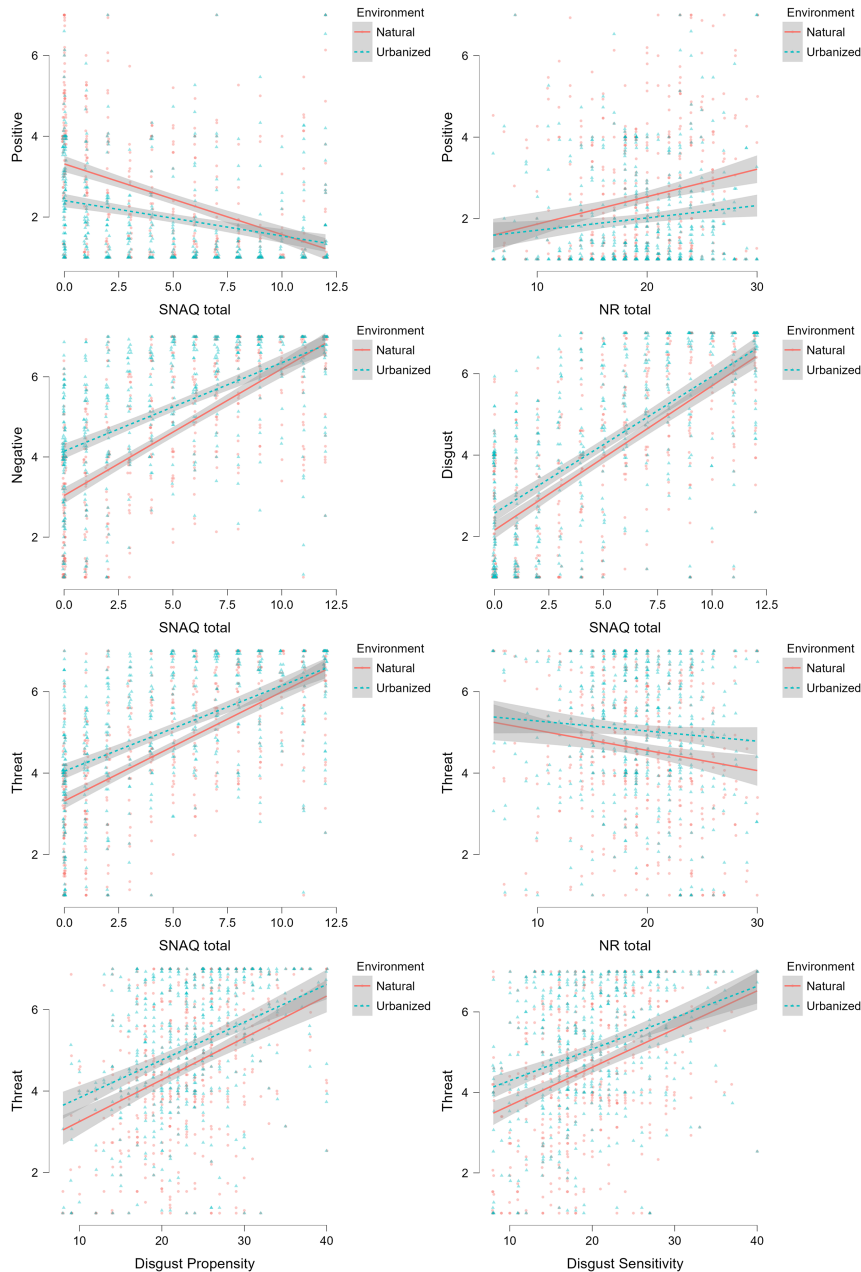


Figure 2. Visualization of the significant interactions between environmental context (natural versus urbanized) and individual difference variables (nature-relatedness, disgust propensity/sensitivity, and snake fear) across the five rating scales (positivity, negativity, disgust, threat, and approach), with 95% confidence intervals. The slopes show that a greater sense of connection to nature is linked to more positive evaluations and less perceived threat in natural environments, whereas higher levels of disgust and snake fear are associated with more negative evaluations. These associations are consistently weaker in urban contexts, suggesting that urban environments elicit more uniform negative responses and reduce the influence of individual differences. Only statistically significant interactions are shown to facilitate interpretability; all tested interactions, including non-significant effects, are reported in [table 3](#).

model via the interactions between environment and the questionnaire scores (for clarity of presentation, [figure 2](#) displays only statistically significant interaction effects, while the full set of tested interactions is reported in [table 3](#))⁴.

For the *positive rating scale*, we found significant interactions between the environment of the picture and NR scores, and SNAQ scores (see [figure 2](#)). Follow-up analysis showed that for snakes presented in the natural environment, people with higher nature-relatedness scores rated snakes more positively,

⁴See the supplementary material S1 for 95% confidence intervals and exact *p*-values for all models and point estimates presented.

Table 3. Detailed statistical results for the linear mixed models tested on the five rating scales, showing main effects, interactions and follow-up tests. (Note: *B* = point estimate, VS-MPR = Vovk–Sellke maximum *p*-ratio. * *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001).

	d.f.	positive			negative			disgust			threat			approach		
		<i>F</i>	<i>B</i>		VS-MPR	<i>F</i>	<i>B</i>	VS-MPR	<i>F</i>	<i>B</i>	VS-MPR	<i>F</i>	<i>B</i>	VS-MPR	<i>F</i>	<i>B</i>
sex	1, 481	2.050	0.083		1.282	<0.001	0.002	1.000	0.801	−0.062	1.000	0.494	−0.042	1.000	5.235	0.134*
age	1, 481	0.666	−0.004		1.000	0.221	0.002	1.000	0.362	−0.003	1.000	0.005	<0.001	1.000	1.429	−0.005
environment	1, 483	2.975	0.186		1.754	15.621	−0.440***	444.43	2.947	−0.123	1.736	3.289	−0.156	1.970	6.546	−0.153*
NR total	1, 481	7.161	0.031**		9.818	0.040	−0.002	1.000	1.429	−0.017	1.084	0.916	−0.012	1.003	3.513	0.022
disgust DP	1, 481	2.209	−0.022		1.347	3.172	0.028	1.885	2.418	0.028	1.442	6.997	0.041**	9.139	5.484	−0.035*
disgust DS	1, 481	2.079	0.021		1.293	1.890	0.021	1.222	0.979	0.018	1.008	0.423	0.010	1.000	8.070	0.043**
SNAQ total	1, 481	63.428	−0.127***		9.8 × 10 ¹¹	215.475	0.246***	3.8 × 10 ³⁷	258.463	0.311***	7 × 10 ⁴³	151.994	0.206***	4.1 × 10 ²⁷	20.858	−0.074***
PHQ anxiety	6, 481	2.697	0.091		1.587	0.170	0.024	1.000	1.222	0.074	1.041	0.993	0.058	1.009	0.199	0.025
PHQ depression	6, 481	0.026	−0.009		1.000	9.097	−0.170**	23.082	3.797	−0.126	2.395	6.982	−0.148**	9.081	0.874	0.051
environment × NR total	1, 483	9.730	**		30.648	1.448		1.089	0.024		1.000	6.994	**	9.128	1.818	1.197
environment × disgust DP	1, 483	1.519			1.107	2.697		1.587	3.490		2.126	4.685	*	3.423	0.544	1.000
environment × disgust DS	1, 483	2.298			1.386	3.812		2.410	1.065		1.017	4.248	*	2.867	1.620	1.135
environment × SNAQ total	1, 483	47.460	***		8.6 × 10 ⁸	57.498	***	7.4 × 10 ¹⁰	8.521	***	17.873	32.279	***	9.1 × 10 ⁵	0.225	1.000

(Continued.)

Table 3. (Continued.)

<i>df</i>	positive			negative			disgust			threat			approach		
	<i>F</i>	<i>B</i>		<i>VS-MPR</i>	<i>F</i>	<i>B</i>	<i>VS-MPR</i>	<i>F</i>	<i>B</i>	<i>VS-MPR</i>	<i>F</i>	<i>B</i>	<i>VS-MPR</i>	<i>F</i>	<i>B</i>
environment × PHQ anxiety	6, 483	<0.001		1.000	1.315		1.059	1.293		1.055	2.533		1.500	0.836	
environment × PHQ depression	6, 483	<0.001		1.000	1.886		1.220	2.036		1.276	1.276		1.051	1.305	
			<i>t</i>	<i>B</i>	<i>VS-MPR</i>	<i>t</i>	<i>B</i>	<i>VS-MPR</i>	<i>t</i>	<i>B</i>	<i>VS-MPR</i>	<i>t</i>	<i>B</i>	<i>VS-MPR</i>	
SNAQ total slope	natural	−9.833	−0.167***	2.9 × 10 ¹⁸	16.374	0.291***	1.1 × 10 ⁴⁷	16.337	0.322***	4.8 × 10 ⁴⁵	13.395	0.232***	4.6 × 10 ³²		
	urbanized	−5.145	−0.088***	68 888	11.275	0.200***	9.7 × 10 ²³	15.201	0.299***	2.6 × 10 ⁴⁰	10.375	0.180***	2.1 × 10 ²⁰		
NR total slope	natural	3.587	0.045***	128.628							−1.634	−0.021	1.573		
	urbanized	1.437	0.018	1.288							−0.209	−0.003	1.000		
disgust DP slope	natural							1.964	0.032				2.454		
	urbanized							3.131	0.051**				31.832		
disgust DS slope	natural							1.186	0.019				1.079		
	urbanized							0.066	0.001				1.000		

while the correlation was not significant for snakes in urbanized environments. Furthermore, while people who were more fearful of snakes rated snake pictures as less positive, the correlation was significantly stronger for snakes presented in a natural environment than those in an urbanized environment. That is, individual differences in nature-relatedness and fear of snakes play a stronger role in shaping positive evaluations when people encounter snakes in their natural habitats. However, these effects are less pronounced in urban contexts.

For the *negative and disgust rating scales*, we found significant interactions between the environment of the picture and SNAQ scores (see figure 2). Individuals who were more fearful of snakes rated snake pictures more negatively and as more disgusting, but the correlations were significantly stronger for snakes presented in a natural environment compared to an urbanized environment. This pattern suggests that fear-based individual differences have a stronger impact when snakes are perceived as ecologically congruent. By contrast, urban contexts elicit more consistent negative responses, regardless of individual variation.

For the *threat rating scale*, we found significant interactions between the environment of the picture and NR scores, disgust propensity, disgust sensitivity, and SNAQ scores (see figure 2). Participants with higher nature-connectedness rated snakes in a natural environment as less threatening than in an urbanized environment. People with higher disgust propensity rated snakes in an urbanized environment as more threatening than in a natural environment. Those with higher disgust sensitivity and people more fearful of snakes rated snakes in a natural environment as more threatening than in an urbanized environment. These results suggest that different dispositional factors contribute to threat perception depending on the context. Disgust-related tendencies play a relatively greater role in urban environments, while fear and nature-relatedness have a stronger influence on responses in natural settings.

We did not find significant interactions between the environment of the picture and questionnaire scores for the *approach rating scale*. Disgust propensity and fear of snakes correlated negatively, while disgust sensitivity correlated positively with the ratings. Overall, intentions regarding approach appear to be relatively stable across contexts and less susceptible to modulation by context, even when emotional appraisals differ.

We found evidence that personality-related factors correlated differently with the picture ratings in urbanized and natural environments; the results differed in magnitude but not in direction. Taken both hypotheses together, we can conclude that snakes are rated as less positive, more negative, threatening and disgusting when presented in an urbanized environment (where they are seen as alien) but individual effects have a lesser effect on the ratings compared to in a natural environment (where they are seen as belonging).

4. Discussion

In the present study, we tested whether wildlife appraisal is context-dependent by investigating whether snakes are evaluated differently when encountered in urbanized versus natural environments. Furthermore, we sought to test whether observer-related factors, such as nature-relatedness, fear and disgust, are associated with this effect. Our results indicate a context-first framework, in which ecological congruence establishes the evaluative baseline. Specifically, people judge snakes more negatively when they appear in urban spaces, where they are perceived as intruders on human territory [54,55]. Then, individual differences influence responses, particularly when snakes are seen in their natural habitat. This highlights the central role of context in how humans perceive and coexist with wildlife.

We found that snakes were perceived as more negative, threatening and disgusting when shown in urbanized settings than in natural ones (hypothesis 1). This finding is consistent with the idea that many people implicitly construe cities as human territory and therefore experience wildlife as intruders when they encounter it there [56]. This pattern aligns with research on human–wildlife interactions in urban areas and the concept of ecological incongruence. This is defined as a discrepancy between an organism's expected habitat and its actual location, that is, animals deemed 'out of place' or 'intruders' in urban environments [4–6]. According to appraisal-based accounts, expectancy violations heighten assessments of danger and disgust [12,13]. This dynamic has been observed previously across taxa [8,14,15] and has been replicated in the present study with snakes.

Snakes are a particularly revealing test case as evolutionary perspectives posit that there is a rapid detection of and a privileged processing of threat for snakes, which should amplify the potency of contextual signals, such as the intrusion of snakes into human spaces [20,21,57]. The present findings

support this notion; within the context of the present study, environment-based expectations appear to be a primary determinant of snake evaluation, with urban contexts imposing a negative bias in affective appraisal. However, this effect is likely to be more nuanced. The visual characteristics of the snakes themselves, such as coloration, patterning and potential aposematic cues, may also influence perception and interact with contextual factors [58]. As these features were not systematically manipulated or controlled in the present study, their contribution is an important area for future research. Connected to this, it should be noted that while we observed a significant difference between the sexes in approach behaviour, approach intentions did not differ by context, even though valence and threat did. The pattern that females report a lower willingness to approach snakes than males is consistent with greater avoidance of potentially threatening animals. It may help to explain why intentions to approach remained consistently low [29,31]. However, the intention to approach is constrained by a high baseline of snake avoidance, which is rooted in preparedness and prior learning [59,60]. Context effectively tunes how unpleasant a snake is perceived to be, but does not readily alter intentions that are already close to avoidance [20,29,31,61]. This context-sensitive affect approach aligns with dual-process perspectives, in which evolutionarily tuned safety priors rapidly shape behavioural readiness, while appraisals modulate perceived risk and affective tone.

Furthermore, we found that individual differences were more significant when snakes appeared in natural environments than in urban ones (hypothesis 2). This suggests that strong situational cues in urban contexts can reduce inter-individual variance, a phenomenon known as ‘context compression’ [62]. According to appraisal theories, salient norm violations (e.g. an animal crossing perceived human space boundaries) can dominate emotional evaluations and reduce the influence of more subtle dispositional tendencies [13,63]. This helps explain why people in urban settings showed a relatively uniform negative attitude towards snakes, whereas in natural settings—where snakes are perceived as ‘belonging’—responses were more differentiated by dispositions such as nature-relatedness, disgust propensity/sensitivity and snake fear.

The pattern of moderators is also consistent with previous studies. A stronger connection to nature is associated with having a more tolerant view of potentially dangerous animals and perceiving them as less threatening when encountered in natural environments. This suggests that such individuals view these encounters as more normative and less aversive. This is consistent with evidence that a connection to nature is linked to more tolerant attitudes towards wildlife [16,35,36]. Disgust propensity accentuates threat, particularly in urban contexts, in line with disease-avoidance frameworks. Here, frequent disgust experiences heighten vigilance to contamination-relevant norm violations in human spaces [38,64]. However, disgust sensitivity and snake-specific fear amplified negativity more strongly in natural contexts. This suggests that fear and the affect-intensity facets of disgust are most evident when the animal is perceived as ecologically appropriate. This is because its agency and unpredictability can easily be imagined [26,28,61]. Importantly, the modelling strategy controlled for anxiety and depressive symptoms, isolating the role of these snake-specific dispositions from broader affective tendencies [36,47].

Taken together, our results support a context-first model of wildlife appraisal across hypotheses. Ecological congruence—whether an animal appears where it is expected—sets the baseline for evaluation, and traits chiefly tune the response when context is congruent. For snakes, a stimulus that is evolutionarily salient, urban contexts act as expectancy-violation cues that elevate perceived threat and disgust. By contrast, natural contexts reveal the psychological diversity of how people construe the same animal. This framework may help clarify why encounters with urban wildlife can feel disproportionately alarming, even with species that pose limited objective risk. In addition to ecological incongruence, the perceived proximity of an encounter and the perceived possibilities for action may further amplify this effect. Encounters in confined spaces (e.g. indoors) may be perceived as more threatening because they reduce opportunities for avoidance or escape, thereby increasing the likelihood of defensive responses [45]. It can also help to explain why interventions that narrowly target species stereotypes (e.g. ‘snakes here are harmless’) often struggle unless they also address environment-based expectations about where wildlife ‘should’ be [6,30].

When interpreting the present findings, some limitations should be considered. First, the study relied on static snake photographs rather than real encounters, which may limit its ecological validity. Although images are frequently employed in the study of human–wildlife interactions, they are unable to fully capture the dynamic, unpredictable nature of genuine snake encounters or the intensity of the emotions they can elicit. Another limitation concerns the level of control over the visual characteristics of the stimuli. Although we attempted to match the snake images across the different conditions, we were unable to achieve perfect matching of species, coloration and patterning, and some systematic differences

remained (e.g. certain colour morphs appeared more frequently in one condition than in another). Additionally, the visibility and prominence of the snakes varied across the images owing to factors such as occlusion, lighting and their relative size within the scene. These factors may have influenced emotional responses independently of environmental context, thereby reducing internal validity. However, such variability also reflects the heterogeneity of real-world encounters with wildlife. Future studies should therefore aim to manipulate contextual and stimulus-level features systematically to determine their respective contributions. Third, the urban environment was not homogeneous, as it included both indoor (e.g. the home) and outdoor (e.g. public spaces) contexts. As these environments may differ in ways that are meaningful from a psychological perspective, such as perceived proximity, controllability and opportunities for escape, they could influence threat and disgust responses differently. Therefore, treating urban environments as a single category could obscure significant variation within contexts. Future research should distinguish more systematically between types of urban encounters in order to examine how specific situational features shape appraisal of wildlife. Finally, the sample consisted of individuals from a specific demographic and cultural context, which limits generalizability. To assess the robustness of these findings and examine how contextual and dispositional influences on wildlife perception may vary across populations, future research should replicate the study across different cultural and demographic groups. Attitudes towards snakes and wildlife in cities vary depending on region, level of urbanization and cultural norms. Cross-cultural studies would help clarify the robustness of these context effects.

Our findings suggest that where a snake is seen can be as important as the snake itself. In urban contexts, snakes can be perceived as intruders, triggering expectancy violations that intensify negative and threat appraisals. By contrast, natural contexts reveal nature-relatedness, disgust and snake fear as key response moderators. Theoretically, this advances a context-first account of wildlife perception, locating ecological congruence as the baseline determinant, with individual differences chiefly modulating reactions under congruent conditions. In practice, this implies that coexistence strategies must address context as well as content. This can be achieved by reframing public expectations about the presence of wildlife in cities, designing green spaces and corridors that facilitate animal movement, using signage and communication that distinguish between routine presence and rare risk, and tailoring education to reduce perceived intrusion and mitigate conflict [54,65]. In natural settings, education should focus on traits, while in urban ones, it should focus on context.

Ethics. The research was approved by the Hungarian United Ethical Review Committee for Research in Psychology and was conducted in accordance with the World Medical Association's Code of Ethics (Declaration of Helsinki). Written informed consent was obtained from all participants.

Data accessibility. The dataset and materials supporting the conclusions of this article are available in the Open Science Framework repository [66].

Supplementary material is available online [67].

Declaration of AI use. We have not used AI-assisted technologies in creating this article.

Author's contributions. A.N.Z.: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, resources, visualization, writing—original draft, writing—review and editing; O.I.: conceptualization, methodology, supervision, validation, writing—review and editing; S.S.L.: investigation, supervision, validation, writing—review and editing; B.L.K.: data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, validation, visualization, writing—original draft, writing—review and editing.

All authors gave final approval for publication and agreed to be held accountable for the work performed therein.

Conflict of interest declaration. We declare we have no competing interests.

Funding. A.N.Z. was supported by the OTKA FK 146604 and NKKP STARTING 152161 research grant provided by the National Research, Development, and Innovation Office. B.L.K. received support from the OTKA K 143254 research grant and EKÖP-25-3-II New National Excellence Programs of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund. A.N.Z. was also supported by the János Bolyai Research Scholarship provided by the Hungarian Academy of Sciences. This study was supported by the Internal Scientific Grant (no. 009_2025_PTE_RK/4) of the University of Pécs.

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