

Measuring the Psychological Markers of Birds Encounter Using Virtual Reality Environments

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ABSTRACT

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Interactions between humans and animals benefit human health and well-being. There has been little study on the effects of bird encounters on people. This study addresses this conceptual gap by analyzing the results of a between-subjects experiment with 136 undergraduate students who were randomly assigned to experience one of four 360 stereo panorama virtual environments representing four encounters, namely "bird depicted in images," "Birds in a Cage," "Watching Birds in Nature inside a path," and "Birds in nature." Following their encounter in a virtual environment, participants assessed their experience in terms of spatial awareness, emotions, psychological well-being, and connection to nature through the use of an online survey. Standard descriptive statistics, correlation, Kruskal–Wallis, and post hoc Bonferroni analysis are used in data analysis. The findings suggested that experiences with birds in open surroundings were more likely to affect participants' spatial perception, emotions, psychological health potentials, and connection to nature than encounters with birds in confined places. This study is critical for environmental awareness since maintaining biodiversity and wildlife is inextricably linked to the potential well-being and quality of life of the human population who are part of the ecosystem.

1. INTRODUCTION

According to researchers and theorists in biophilia theory, individuals seek meaning in their life via their interactions with their surroundings [1]. Nature experiences and interactions with animals have been proven to satisfy a person's innate needs for nurturing, bonding, and well-being [2-4]. Interactions with nonhuman animals may be very beneficial and significant for many individuals due to the emotional reactions elicited and the resulting well-being [5]. When individuals spend time outdoors and interact with animals, they build stronger emotional ties, which may increase empathy, compassion, and involvement in environmental-friendly actions [6, 7]. Interactions with animals may fulfill various functions in terms of fulfilling human needs [7, 8]. Animals may assist people in meeting fundamental physiological and safety requirements (farming, housing, transportation, safeguarding, and resource collection) as well as higher psychological need (feelings of affection, belonging, respect, and fulfillment) [7]. Additionally, it is argued that human-animal interactions (HAIs) may aid in linking individuals to nature and be more connected to other creatures. In other words, animal care and affection may help people reconnect with nature and come to the feeling that they are a part of a broader ecosystem [9, 10]. This increased awareness of nature causes individuals to alter their focus from a human-centered to an other-centered viewpoint, which results in the reduction of the earth's harm [11]. Thus, examining the emotions and perceptions elicited by human-animal interactions (HAIs) may aid in deconstructing what

these experiences mean for humans and the impacts on nature and animals.

Human life intersects with nonhuman animal life in many ways, and as a result, human-animal interactions (HAIs) are wide and varied. In addition to their position as companion animals in the home, animals such as cattle for which we graze for food, insects and birds in our backyards, and wildlife we witness in the wild or zoos all play important roles in human existence, as previously stated. Human-animal encounters, particularly those involving birds, take place in a variety of settings: at home, in the wild, and as part of organized programs or tours. Each interaction between birds and humans results in significant experiences with varying positive or negative consequences. For instance, when human-animal interactions in nature are compared to interactions with captive animals, it is noted that interactions with captive animals are less meaningful, attractive, and pleasant [12].

Given the distinctions between human encounters in the wild and captivity, a thorough investigation of both circumstances is important for a complete understanding. According to Curtin and Kragh [13], a notable trend in wildlife tourism is a rise in the number of species seen in a wider variety of habitats. For instance, animals formerly exclusively available in zoos are now accessible in their natural habitat. This is due to a rise in the desire for encounters with wild animals in their native habitats rather than those kept in captivity or semi-captivity [14, 15]. The rising importance placed on wildlife in its natural habitat may be a result of people's growing knowledge of the environment and interest in the idea of ecology [13-15].

The architectural components and spaces enclosures create a setting for human-bird interactions and enrich these interactions [16]. A comprehensive embodied perspective has been paid to the relationship between the body and the immediate environment in which it is situated [17-19]. Previous research on the association between varying degrees of enclosure and human psychological indicators points to the fact that exposure to open spaces has restorative benefits and has been demonstrated to be critical in stress reduction [20, 21]. Theories, such as the ecological psychology [22], and environmental preference framework [23], consider enclosure contributes significantly to how humans perceive space and generate feelings of well-being, security, and even survival [20, 21, 24]. The environmental preference framework developed by Kaplan, et al. [23] includes four indications of environmental preferences: coherence, legibility, complexity, and mystery. Coherence, according to the framework, relates to the degree to which a scene "hangs together." Increased coherence results in increased preference. Legibility refers to the ease with which an environment may be "read." Environments that are more readable are preferred over those that are less legible. Complexity is a measure of the quantity and diversity of components in a situation. Increased complexity increases liking as long as it does not become excessive. Finally, mystery suggests the possibility of obtaining further information by delving deeper into the situation. The mystery is discovered in situations that offer fresh information with a change in vantage point and so satisfy the knowledge-hungry condition of developing creatures [23].

Simultaneously, it has been shown that human connection with the surrounding environment results in favorable sensations. Human interactions in open spaces, for example, elicit sensations of pleasure, persistent attention or interest, relaxed wakefulness, and a decrease in negative emotions such as wrath and worry [25]. According to the World Health Organization's constitution, mental health is "a state of complete physical, mental, and social well-being" [26]. Positive emotions, a sense of belonging, love, and meaningful relationships are just a few signs of well-being [27]. Furthermore, well-being comprises the desire for personal growth and satisfaction [28]. According to Seligman's PERMA model, individuals need a balance of five factors to flourish: good emotions, engagement, connections, meaning, and accomplishments [29]. Recent neurophysiological research indicates that spatial experiences are so critical for interpreting the visual world that it activates a unique section of the brain (the parahippocampal "place" area) (Epstein & Kanwisher, 1998). Under such circumstances, people's perceptions and preferences for various locations may change depending on the layout of enclosing barriers, the contents of the spaces, and the natural interactions with space inhabitants, whether human or nonhuman. Thus, the purpose of this study was to elicit the effects of various types of bird experiences (as depicted in images, in captivity, observed in nature while inside a path, and interaction with birds in nature) on subjective attitudes, such as spatial experiences, feelings, well-being, and connection to nature.

2. MATERIALS AND METHODS

This research employs a descriptive, between-subjects design and quantitative evaluation of various bird encounters in 360-degree panoramas of modeled virtual reality

environments. Undergraduate students evaluated the four distinct virtual conditions, and a survey was utilized to capture user feedback. Approval for this study was received from the university's institutional review board, and all participants signed the consent form before the experiment. The study's overarching research question was, "What do bird interactions mean to humans, and how do they influence people's relationship to and knowledge of nature?" This research paper is based on data collected about the type of encounter or experience with the birds (referred to as the 'condition'), participants' subjective evaluations of the experience's subjective meaning, and participants' subjective evaluations of whether they felt an increase in their well-being and connection to nature (quantity).

2.1 Study participants

One hundred thirty-six undergraduate students participated in this study and were randomly assigned to explore one of the four virtual environments. The sample size was decided with the assistance of power analysis introduced by Cohen [30]. Based on a G*Power calculation for the ANOVA test with an alpha level of .05, a power of 0.90, and a 0.35 effect size, a total of 120 participants were needed. Participants were recruited for the study via social media posts (Facebook and Twitter), and participation in the study was voluntary. We published the study's summary information without revealing the study's objectives to minimize the possibility of self-selection bias. According to Table 1, the majority of participants (64.7%) were between the ages of 18 and 20 (n=88); 60.3 percent were female (n=82); most were senior (fourth to sixth-year) students, and 58.8 percent were not architecture students (n=80).

Table 1. Participant demographics

Demographics	Code	n	%
Gender	1) Male	54	39.7
	2) Female	82	60.3
Academic Major	1) Architecture	56	41.2
	2) Not architecture	80	58.8
Age	1) 18-20	88	64.7
	2) 21-23	24	17.6
	3) 24-26	24	17.6
Academic year	1) First year	22	16.2
	2) Second year	32	23.5
	3) Third year	34	25.0
	4) Fourth year	24	17.6
	5) Fifth year	20	14.7
	6) Sixth year	4	02.9

n = Number of respondents; %= Percentage

2.2 Stimuli and VE development

For this study, the stimuli were presented in virtual Reality environments of different scenarios. The virtual environments were created and rendered using Revit software. In the format of a 360 stereo panorama which the participant can control, this study examines how participant outcomes differ when they experience four different settings of encountering nature and birds, as seen in Figure 1.

1. "Birds' Gallery" (BG) features depicted encounters, presenting birds in pictures (closed experience).

2. "Birds in a cage" (BC) features captive encounters -where animals are confined to an artificial setting- in which the birds

are not free (semi-close experience).

3. "Birds in nature observed inside a path" (BP) featuring controlled encounters, which refers to a tour in which the birds are free; however, the experience is controlled (semi-open experience).

4. "Birds in nature" (BN) features natural encounters, which refers to encounters that occur in the wild (an open experience).

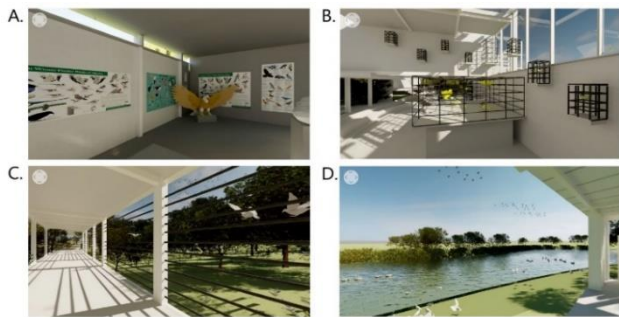


Figure 1. Four virtual conditions (A) Birds' Gallery, (B) "Birds in a cage, (C) "Birds in nature observed inside a path, (D) Birds in nature

The photographs of the spaces were shot from a height of 1.75 m at the main entrance to create a horizontal panorama of each. The photographic process was conducted when there were no people to minimize anthropogenic distraction on perception. Moreover, earlier research had shown that images depicting people elicited higher emotional reactions than those without humans, particularly when the images were unpleasant [31, 32]. The stimuli virtual environments were incorporated into a survey format and published online through the Qualtrics platform to the targeted audience. After reading and signing an informed consent form, each participant was instructed to demonstrate one of four virtual reality environments and traverse it carefully before being subjected to a questionnaire.

2.3 Questionnaire design and measures

The online questionnaire is divided into three sections: the first portion contains demographic questions. The second section assesses individuals' spatial experiences using psychological and well-being indicators. These questions applied a Likert seven-point scale. The third section delves into views of one's connection to Nature.

Psychological and well-being measures

The research measures attitudes about spatial experiences using psychological and well-being variables divided into three groups.

The first group was concerned with the perception of Kaplan's four spatial attributes. The phrases "harmonious-dissonant" were used to measure coherence; "legible-illegible" was used to measure legibility; "complex-simple" was used to measure complexity, and "mysterious-plain" was used to measure mystery.

The second group was concerned with feedback on feelings, including safety, relaxation, peace, refreshment, calmness, and pleasure. The terms "safe-dangerous were used to measure safety; " relaxation was measured using the terms "relaxed-tense," peace was measured using the terms "peaceful-fretful," refreshment was measured using the terms "refreshed-weary," calmness was measured using the terms "calm-excited," and

pleasure was measured using the terms "pleased-unpleased."

The third group was concerned with subjective well-being discussed in Seligman's PERMA model. The model was developed to measure: Positive emotions (general tendency to feel contentment and joy, "feeling positive and pleasure-not feeling positive and pleasure"), (Engagement (being absorbed or interested in an activity, state of flow, "feeling engaged with the environment-not feeling engaged with the environment), Relationships (feeling loved, supported, and valued by others "feeling with positive connection with the environment-feeling with negative connection with the environment"), Meaning (sense of direction and purpose in life "Meaningful Experience and increase of awareness about the environment -not Meaningful Experience"), and accomplishment (feelings of achievement "Improved sense of activity and vitality- a reduced sense of activity and vitality, "and "Improved sense of well-being- a reduced sense of well-being."

In all word pairs, left poles were assigned with one, and right poles were assigned with 7.

2.4 Analysis

The questionnaire items were designed to elicit discrete ordered ratings on each semantic differential. Consequently, the data analysis incorporated descriptive statistics, including mean, median, standard deviations, and correlation scores. Kruskal–Wallis and post hoc Bonferroni were used to analyze variations among four virtual environments. Statistical analyses were carried out in IBM SPSS Statistics 24.

3. RESULTS

3.1 Participants' demographics

A positive correlation was identified between the age of the participants and the point averages of the "Perception of spatial attributes" ($r = .253, p = .003$), "feedback on feelings" ($r = .276, p = .001$), and "Subjective wellbeing" ($r = .237, p = .006$). Thus, it was determined that increasing age was associated with the level of a positive attitude toward the studied conditions (Table 2). Additionally, students with a higher academic year had a more favorable opinion of the studied conditions. Females had more positive views than males ($r = .277, p = .001$ and $r = .328, p < 0.001$, respectively). There was no association between being an architectural student or not and having a positive attitude toward the studied conditions.

Table 2. Spearman correlations analysis

Factor \		1-	2-	3-
		Perception of spatial attributes	Feedback on feelings	Subjective wellbeing
Gender	r_s	0.162	.277**	.328**
	p	0.060	0.001	0.000
Major	r_s	0.074	0.103	-0.044
	p	0.389	0.232	0.614
Age	r_s	0.253**	0.276**	0.237**
	p	0.003	0.001	0.006
Academic Year	r_s	0.374**	0.361**	0.315**
	p	0.000	0.000	0.000

Rs: Spearman's rho correlations; p = significance level value

** Correlation is significant at the 0.01 level (2-tailed).

After comparing the academic years of the participants against the three factors, the "Perception of spatial attributes, Feedback on feelings, and Subjective well-being was statistically significantly different among the six academic-year groups ($p < .001$; $p=0.002$, and $p=0.006$ respectively, Table 3). A post hoc Bonferroni test was used to assess this difference, which indicated that freshmen (first-year) students had a more unfavorable attitude toward studied conditions than subsequent academic years students.

Table 3. Independent samples Kruskal Wallis test for the main factors

Grouping Variable: Academic Year			
Factor	1- Perception of spatial attributes	2- Feedback on feelings	3- Subjective wellbeing
X^2	27.132	19.177	16.298
df	5	5	5
p	0.000	0.002	0.006
Pairwise Comparisons	After Bonferroni correction, there was a significant difference between the first and academic-year groups (3,4,5,6).	After Bonferroni correction, there was a significant difference between the first and fifth academic-year groups.	After Bonferroni correction, there were no significant differences between academic-year groups.

3.2 Comparing ratings of experiences

Overall, experiences with birds in the natural environment (Open and Path conditions) were perceived as significantly different from other experiences (Figure 2). On average, participants described their experience with birds in natural conditions (open and path) as considerably more legible, harmonious, mysterious, safe, calm, peaceful, pleased, pleasurable, engaged, and positive than their encounters with birds in cages or as shown in photos.

The study attempted to capture participants' views of the environment during their interaction with birds using the four spatial elements specified in Kaplan and Kaplan's framework. The open condition with more exposure to the outside ($m=1.88$), according to the participant, this condition was perceived as the simplest of the four conditions (BG $m=2.82$; BC $m=2.88$; and BP $m=2.24$). However, analysis of variance (Table 4) revealed no significant difference in users' ratings of conditions as simple or complex ($X^2 = 6.525$, $p = 0.089$). Additionally, participants reported that their spatial experience and contact with birds in the open environment were much more mysterious. The variance test revealed a statistically significant difference ($X^2 = 16.214$, $p = 0.001$) across the four conditions, particularly between the path, open, and gallery conditions (pairwise comparisons: Path-cage and Open-gallery, $p < 0.001$). Observing birds in their natural habitat inside a path was deemed to be the most legible and harmonious of the four. The variance test revealed significant differences in the four conditions ($X^2 = 16.560$, $p = 0.001$) and ($X^2 = 35.169$, $p < 0.001$) respectively.

In evaluating the five features associated with emotional feedback, it was indicated that encountering birds in an open

environment produced more relaxed, calm, peaceful, and delighted sentiments than the other three situations. On the other hand, encountering birds along while on a path increased emotions of safety. The difference in feelings of safety, relaxedness, calmness, peacefulness, and happiness across the conditions was validated by analysis of variance ($p < 0.001$, Table 4). Additionally, pairwise analyses revealed statistically significant differences between conditions, most notably the open and birds depicted in picture conditions ($p < 0.05$).

The third group was particularly interested in subjective well-being assessment in Seligman's PERMA model. The findings indicated that interactions with birds in their natural habitat had a favorable impact. The findings suggested that interacting with birds in a natural setting boosts participants' positive feelings and engagement ($m=2.00$ and $m=1.76$). Participants rated this encounter to be more meaningful and strengthened their sense of awareness of nature ($m = 2.06$ and $m=1.59$) compared to other conditions. Finally, the participants evaluated their encounters with the birds in their natural surroundings boosted their sense of activity and vitality and their perceptions of health and well-being compared to other conditions. The difference in subjective well-being ratings across the four conditions was validated by analysis of variance ($p < 0.001$, Table 4).

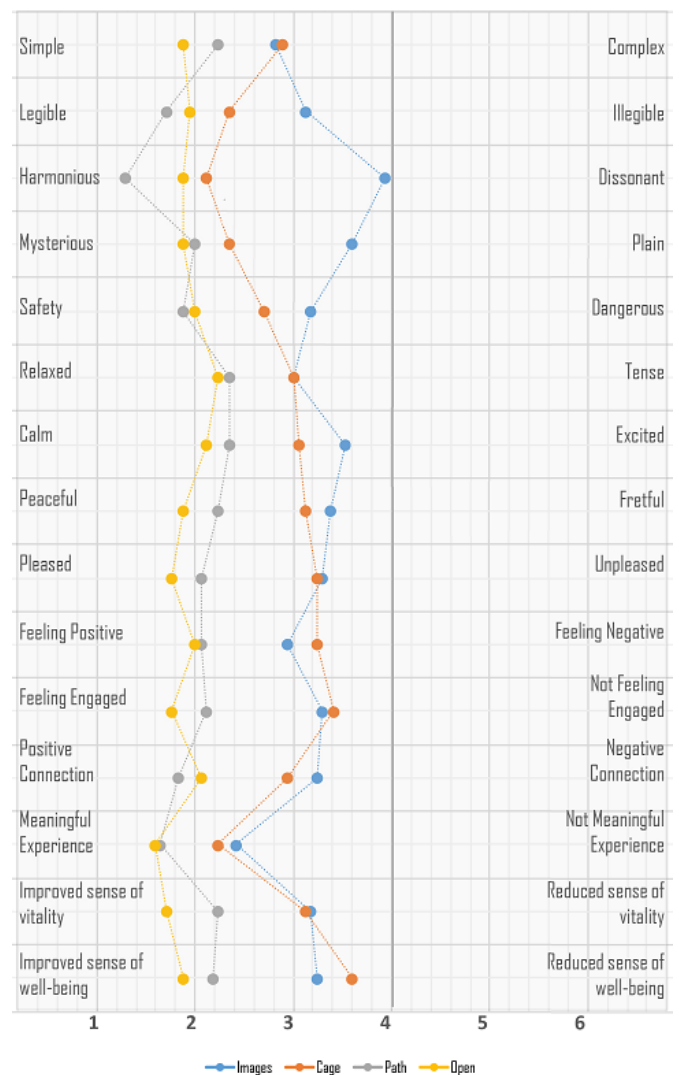


Figure 2. Semantic differential profile for the four virtual conditions. Points represent mean scores for each tested item

Table 4. Kruskal–Wallis analysis of variance and pairwise comparisons

Factor	Sub-Factor	X ²	p	Pairwise Comparisons (Bonferroni correction p-value)			
1- Perception of spatial attributes	Simple _Complex	6.525	0.089				
	Legible _Illegible	16.560	0.001	Path-Images (0.001)	Open-Images (0.019)		
	Harmonious _Dissonant	35.169	0.000	Path-Cage (0.030)	Path-Images (0.000)	Open-Images (0.001)	Cage-Images (0.015)
	Mysterious _Plain	16.214	0.001	Path-Images (0.002)	Open-Images (0.006)		
2- Feedback on feelings	Safety _Dangerous	11.082	0.011	Path-Images (0.027)	Open-Images (0.049)		
	Relaxed _Tense	5.399	0.145				
	Calm _Excited	12.977	0.005	Path-Images (0.008)	Open-Images (0.048)		
	Peaceful _Fretful	18.184	0.000	Open-Cage (0.045)	Open-Images (0.001)	Path-Images (0.02)	
	Pleased _Unpleased	17.570	0.001	Open-Cage (0.008)	Open-Images (0.006)	Path-Images (0.048)	
3- Subjective wellbeing	Feeling Positive _ Feeling Negative	13.555	0.004	Path-Cage (0.028)	Open-Cage (0.035)		
	Feeling Engaged _ Not Feeling Engaged	21.967	0.000	Open-Images (0.003)	Open-Cage (0.001)	Path-Cage (0.018)	
	Positive connection _ Negative connection	17.705	0.001	Path-Cage (0.022)	Path-Images (0.002)	Open-Images (0.023)	
	Meaningful Experience _ Not Meaningful Experience	23.629	0.000	Open-Cage (0.039)	Open-Images (0.000)	Path-Images (0.001)	
	Improved sense of vitality _ Reduced sense of vitality	20.905	0.000	Open-Cage (0.004)	Open-Images (0.000)		
	Improved sense of well-being _ Reduced sense of well-being	24.350	0.000	Open-Images (0.002)	Open-Cage (0.001)	Path-Images (0.014)	Path-Cage (0.004)

3.3 The relationship between perceptions of experiences and connectedness to nature

There was a statistically significant association between spatial experience and evaluating one's sense of connection to nature and awareness of its value, with a correlation coefficient of 0.516 (p<0.001) between the two variables. Positive emotions were shown to increase one's connection to nature (Spearman rs = 0.540, p <0.001). The findings also indicate that a higher subjective sense of well-being is associated with a stronger sense of connection to and awareness of nature (rs =0.624, p <0.001). Statistical analysis found a statistically significant difference between the four conditions and the assessment of nature connection (at the 5% level of significance). The mean values for the four conditions are as follows: Images (M=2.53), Cage (M=2.12), Path (M=1.65), and Open (M=1.41), where lower numbers imply a greater degree of agreement. Indicating that individuals who interacted with birds in their natural habitat appreciated their connection to nature and recognized its worth compared to other conditions.

Participants provided some insights regarding the experience and what affected them cognitively, and their connection to nature after these experiences. While a few could have answered the open question, we can review some answers. For example, some responses indicated that the experience led to an increase in connection with nature. For example, one participant stated: “Being close to birds has made me more aware of the relationship we share as members of the earth.” (open condition). “it makes me feel connected to the natural environment and helps increase our understanding

of how we all get along” another added.

Participants' notes also included references to awareness of human impacts on nature and wildlife, for example: “*When you see birds or sparrows in their environment, you realize that we have to protect the environment so that they can have the best life possible.*” Another added: *I am more aware of the fragility of our planet with an increasing number of people and less space for wildlife and nature.* Additionally, one noted: “*this experience reminds us of how everything is interconnected, the beauty of nature and wildlife, and that humans are only a small part of it. Also, our actions affect nature and wildlife.*”

When a participant was able to gain new information and expand it to include a new insight, for example: “*Learning about animals, nature, and the ecosystem made me understand how we all relate and the role we play in each other's lives. It made me more interested in wanting to learn about nature, and the experience made me more aware of the dangers to these animals.*”

Participants in this study, especially those with experiences with birds in the cage, talked a lot about human relationships and bonding with animals, often due to perceived closeness and shared experiences. One of them said: *I have deepened my personal relationship with birds, and I own one at home, and thus I have strengthened my connection and my passion for the welfare of the environment and animals, as well as my interest and fear of nature.* Additionally, comments in the captive condition indicated feeling connected to the animals because of the closeness but acknowledging that they are less connected to nature than those with wild experiences. For example, one noted: “*happy to see them up close but sad that*

they are not free, and we take them from their families and their environment. We destroy their homes. Another stated: "It is obviously great to see a live animal in the cage, but the element of connection to nature is not present in these places."

4. CONCLUSIONS

The goal of this study was to explore the variation in responses to four common types of human-bird interactions from an individual's viewpoint. Humans engage in a variety of ways with nonhuman animals, and as a result, human-animal interactions (HAIs) offer a number of physiological, psychological, and moral benefits. We set out to compare different forms of human-bird interaction from an individual's perspective, with a focus on four categories: birds shown in photographs, "Birds in a Cage," and "Watching Birds in Nature Along a Trail," and "Birds in nature."

Our findings show that birds' encounter in open spaces induces positive feelings, a sense of well-being, and a sense of connectedness to nature. However, there was considerable variation in the reactions of individuals to each of the four interactions. While part of this variability may be a result of the experience itself, a significant portion of the variation in reactions is attributed to individual differences. Based on our findings, participant age was shown to be connected with an increase in positive ratings regarding the conditions tested. Participants in a more advanced academic year had a more positive view regarding the conditions investigated. Additionally, females exhibited a greater degree of optimism than males.

Individuals' attitudes about spatial experiences were evaluated using Kaplan and Kaplan's framework of spatial qualities perception. The results found that the human-bird interactions in the open environment and path condition were more simple, legible, harmonious, and mysterious. In general, encounters with birds in a closed environment were shown to be less emotionally pleasurable. This is consistent with past studies demonstrating that natural encounters produce greater favorable sentiments of security, calm, serenity, and happiness [20, 21, 24].

Feedback on emotions and Seligman's PERMA model of subjective well-being indicators were used to evaluate participants' experiences. The study found that positive sentiments in the natural environment contribute to an increased sense of well-being, which has been verified by earlier research [17, 19, 29, 33]. Additionally, the researchers reported that interactions with birds in conditions (in this case, nature or route) result in a stronger human-nature connection. Furthermore, increased degrees of interconnectedness in nature-related experiences are consistent with previous studies on connectedness and literature on the significance of nature to psychological well-being [34-36].

The exploratory investigation described in this work has a number of limitations. The current research demonstrated that the four human-bird interactions addressed here provide a fascinating reference point for assessing how individuals respond to diverse forms of human-bird encounters. While nature experiences were generally described as more pleasurable and elicited more positive feelings, the results were inconclusive. As a result, further study on this subject is required. Finally, due to the fact that we asked participants to concentrate on a particular event, we have no way of knowing how representative this one event is of their portfolio of

responses to either category question. This problem should be addressed in a future study that will go further into some of these limitations. The present study established that the four human-bird interactions examined here serve as an enthralling baseline for analyzing how people react to various other types of human-bird encounters. While nature encounters were consistently rated as more pleasurable and evoked more positive emotions, the findings were ambiguous. As a consequence, further research on this issue is necessary.

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