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Choosing images to create awareness of soil biodiversity: lessons from emotions aroused by photographs of Collembola

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Abstract

Soil contains a high level of biodiversity, estimated at around 60% of known terrestrial life. Yet life in the soil is largely unknown by non-specialists: a case in point are springtails (Collembola), millimetric hexapods whose abundance can be tens of thousands of individuals per square meter. This lack of knowledge can compromise soil conservation, despite this being increasingly urgent due to the detrimental impact of human activities. Since an emotional response – for example, to charismatic species – is known to be valuable for species conservation, this study aimed to evaluate the emotional perceptions (positive or negative, and low or strong intensity) of young adults when shown photographs of Collembola. Indeed, Collembola seemed a good candidate for a perception study regarding soil fauna as they are very common in most soils at all latitudes and altitudes. The results show that the morphology of the individuals presented was decisive, in particular a visible eye patch (the presence was perceived as positive, while absence was perceived as negative) and body shape (spherical was perceived as positive, while elongated was perceived as negative). The color of the taxon and the number of individuals in the photograph could also modulate the perception of the viewers: blue and green were perceived as positive, while more than two individuals in the photograph provoked negative emotions. The artistic choices made in the photographs, such as background color, also had a significant influence on emotions. These results are of interest for education and outreach efforts on soil biodiversity; this pilot study with young adults and Collembola could help inform future communication campaigns for soil conservation.

Keywords Springtails | emotions | soil | education | photography

1 Introduction

Life in the soil (fauna, microorganisms, plants) represents almost 60% of the Earth's biodiversity and plays a pivotal role within soil ecosystems (Anthony et al., 2023). Of these organisms, arthropods, particularly hexapods (Insecta and Collembola), dominate soil fauna. Consequently, they are essential in many soil processes, including organic matter decomposition and soil formation. This role has long been ignored or underestimated in policy measures. However, following well-documented studies in recent decades on soil concerns due to pollution and erosion (García-Ruiz et al., 2015; Guerra et al., 2021), there is growing interest in soil arthropods as good candidates for monitoring soil biodiversity (Bispo et al., 2009). The Directive on Soil Monitoring and Resilience, adopted in 2025 by the European Parliament, following the proposition of the European Commission (European Commission, 2023), includes a framework for soil fauna sampling at the European scale to assess soil health. However, as mentioned by the European Commission in the EU soil

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strategy for 2030, to make this directive effective at a local level (“districts” in Wadoux et al., 2024), it will be necessary to strengthen education on soil organisms, particularly soil fauna, in order to raise awareness in society of the need to support public policies related to soil, and to address the lack of knowledge about soil biodiversity (European Commission, 2021). In this context, understanding how non-specialists perceive soil fauna—particularly visually and emotionally—becomes a vital step toward effective outreach and conservation communication strategies.

The public’s perception of arthropods is primarily shaped by personal encounters rather than formal education (Shipley & Bixler, 2017). Invertebrates, particularly insects, are frequently disliked across cultures (Kellert, 1993; Lemelin et al., 2016). Generally, “bugs” that are perceived as beautiful or beneficial due to their pollination, decomposition, or predatory activities tend to be favored, while those with the potential to cause harm or those that have caused harm in the past, such as invasive or dangerous species, are less well liked (Kellert, 1993; Lockwood, 2013; Shipley & Bixler, 2017). Moreover, people’s tolerance of hexapods can vary significantly depending on where they are encountered: human-dominated spaces, such as houses and gardens, are preferred to be bug-free, while in parks and natural habitats, bug encounters are more positively perceived (Lemelin et al., 2016).

Despite the abundance of arthropods, entomological knowledge, or “insect literacy,” lags behind vertebrate literacy. For instance, in an exercise conducted in France, young adults struggled to name even ten insects, and the taxonomic level and perception of those named were both poorer and more negative compared to those named for vertebrates (Leandro & Jay-Robert, 2019). This discrepancy suggests that humans’ typical perception and representation of hexapods in western cultures are influenced not only by personal experiences and values, but lack of knowledge. While approximately 80 % of Earth’s animal species are hexapods, there is a failure to adequately understand their remarkable diversity and significance.

The lack of visibility of organisms under the surface of the soil no doubt means the public is even less knowledgeable about them, but this has been little studied. It can be argued that a better understanding of the soil and its organisms would foster appreciation for the fundamental significance and vulnerability of subterranean life forms – an awareness we could call soil biodiversity literacy (Xylander, 2020). This literacy – which could be developed through hands-on activities, artistic expression, and shared group experiences that increase knowledge but also call on the imagination and emotions – can serve as a foundation for cultivating interest in entomology and connection to nature’s “weird jewels” (Shipley & Bixler, 2019; Decker et al., 2024).

In this study, we aimed to gauge how soil organisms are perceived and the emotions they arouse in non-specialists. We chose to focus on young adults, as according to van de Wetering et al. (2022), environmental education has the potential to improve students’ environmental knowledge, attitudes, intentions, and promote protective behavior regarding soil fauna. To this end, identifying which environmental education materials are most effective is a crucial step. We investigated the positive or negative emotions (valence) and their intensity (arousal) experienced while looking at photographs of different species of springtails (Collembola).

Collembola seemed a good candidate for a perception study regarding soil fauna as they are very common in most soils at all latitudes and altitudes, with several thousand individuals per square meter and several species per site (Potapov et al., 2023). Ecologically, this class of hexapods belongs to the mesofauna, as their length is measured in millimeters and they live in the open spaces between soil particles. Some species live preferentially in topsoil and others in deeper layers, leading to various adaptations such as long cylindrical or spheric morphological shapes, hairy or colored species in topsoil, to small, white, eyeless species in deeper soil. Overall, Collembola species have relatively high morphological variability, and they are considered good indicators of soil health (Bispo, 2009; Joimel, 2017).

To our knowledge, this is the first study to examine questions of the public perception of and emotional responses to Collembola when observing them. Its purpose is to help identify the most effective tools that could be used in environmental education programs to encourage the development of soil biodiversity literacy and, ultimately, to promote soil conservation.

2 Materials and methods

2.1 Population studied

The sample included 68 university students (15 males and 53 females; age range 19 to 49, mean age = 22.3, SD = 4.3) with no visual impairments nor colorblindness. These young adults were studying for a bachelor’s (N=43) or a master’s degree (N=25); 37 % had taken at least one university course in environmental science, but none were doing a soil science course. All gave their explicit consent to participate in the study and were informed of their right to withdraw their answers at any time according to the EU General Data Protection Regulation. All responses were anonymized.

2.1 Images and methodology

The photographs were selected from Cortet and Lebeaux's book *Planète Collemboles – La vie secrète des sols* (Biotope Editions, 2015), and were taken by Philippe Lebeaux, who is a professional photographer (https://www.animailes.com/). To assess the emotional responses these photographs elicited in human subjects, we used the arousal–valence model of emotions, a vector model commonly used by researchers. In our case, valence was a measure of the perception of each photograph, varying from negative (unpleasant) to positive (pleasant). Arousal was an evaluation of the level of emotional intensity (low or high) a photograph made the viewer feel (see Ottavi et al., 2021; Alarcão & Fonseca, 2017).

In line with previous studies that tested a set of nature photographs (e.g. Dal Fabbro et al., 2021; Ottavi et al., 2021), the photographs selected from the source (Cortet & Lebeaux, 2015) were evaluated first using the judges' method (e.g. Axelsson, 2007). Following this method, three "judges" (students randomly recruited from a psychology course) who were naive about the objective of this evaluation were asked to spontaneously attribute an emotional valence (positive vs. negative) to the different photographs in the book without reading the associated text. This was carried out individually and required an average of 35 to 45 minutes per judge. After each photograph was assessed as eliciting positive or negative emotions by each judge, disagreements between judges (less than 10 %) were resolved in a joint working session to end up with two sets of photographs (positive vs. negative).

Following this first blind evaluation, the judges were asked to express their preferences by selecting from the two sets nine photographs they considered the most positive, and nine they considered the most negative. Each of the 18 photographs showed one species predominantly, noted hereafter as the subject(s) (Appendix A.1). Then they were asked to describe the content of each photograph to determine three main types of information (which were coded): a description of the subject(s), a description of the background surrounding the subject(s), and information about the framing. The latter two were included because the artistic aspects of a photograph can modify the perception of the content itself (Joshi et al., 2011) (Table 1). For example, the rule of thirds is a composition principle that divides an image into thirds and places key elements off-center to naturally draw the viewer's eye and make the visual more compelling. Other visual techniques regarding composition, color, etc., can evoke emotions or suggest meanings in an image (Joshi et al., 2011), so we also included these aspects in our investigation.

The valence (positive or negative emotion) and arousal (the degree of emotional intensity) elicited by a photograph were measured using the SAM scale (Bradley & Lang, 1994). In the first stage, participants were instructed to evaluate each photograph regarding its emotional valence on an analogue scale ranging from 1 (very positive) to 9 (very negative). The degree of the emotion felt by looking at each subject was also noted based on a 1 to 9 scale, from very low to very high intensity (for a similar procedure, see Prete et al., 2022). In the arousal–valence method, emotional arousal is seen as independent from valence since it refers to the spontaneous activation of the brain elicited by the stimuli of seeing a photograph. In the second stage, participants had to explain the associated emotion and intensity by describing the elements that explained these (e.g. traits of the species, the number of individuals, and/or the background of the photograph). The photographs were presented in four sessions with respectively 15, 10, 33 and 10 students. In each group, the order of presentation

Table 1. Features in the selected photographs used for the analysis: taxonomic characteristics of the Collembola, the background, and the framing.

Photo feature	Trait	Categories	References for the use of the photo features in this study
Subject (species)	General aspect (shape)	Cylindric; spherical	Lockwood, 2013; Elliot et al., 2014; Stokes et al., 2007; Shipley & Bixler, 2017
	Visible ocelli	Yes; no	
	Visible hair	Yes; no	
	Dominant color	Primary and secondary colors	
	Number of individuals (swarm effect)	One; two; group	
Background	Recognizable objects	Yes; no	Joshi et al., 2011; Elliot & Maier, 2014; Vissers & Wagemans, 2024
	Dominant color	Primary and secondary colors	
Framing of the subject	Position according to the rule of thirds (image divided into three vertical and three horizontal sections)	Up, down, left, right, center (and all combinations possible)	
	Distance	Close up; medium; long; full	

was randomly chosen; in the first two sessions, the first photograph presented to students was expected to elicit negative emotions, while in the last two sessions, the first photograph was expected to elicit positive emotions.

In this study, we did not aim to investigate the ability of respondents (young adults enrolled as university students) to identify the species, their knowledge about its biology, their opinion about environmental issues, or their relationship to nature, but simply their emotional responses (in the defined terms) to the photographs.

2.3 Statistical analysis

To investigate the relationship between the different aspects of the image (of the photograph itself and the species traits) and the emotions and their intensity felt by the observers, a statistical analysis was conducted using the chi-square test with a significance level of α=0.05. This non-parametric statistical method was chosen because of its suitability for examining associations between categorical variables. Additionally, we employed Cramér's V test, which quantifies the effect size of the relationship based on the chi-square statistic; the values range from 0 (no association) to 1 (perfect association).

Following this, a factorial analysis of mixed data (FAMD) was used to identify which photograph characteristics elicited which emotions (i.e. valence and arousal). The FAMD is a multivariate statistical technique for analyzing a dataset containing both quantitative and qualitative variables (Pagès, 2004), allowing for the analysis of similarity between individual subjects in a study by considering mixed variables, which is commonly used in sociological and psychological studies.

Statistical analyses were performed in R 4.2.1 (R Development Core Team, 2022). We used the R packages *corrplot* (Wei & Simko, 2021), *FactoMinR* (Lê et al., 2008), and *factoextra* (Kassambara & Mundt, 2020).

3 Results

Although two groups were presented with a negative photograph first (N=25) and two others with a positive photograph first (N=43), we analyzed all the responses (N=68) as one single sample, as mean emotional valence and arousal level per photograph were not significantly different per treatment.

Each feature was tested to determine if there was a significant relationship with the valence or arousal felt by the participants. We observed that all characteristics related to the species traits and abundance as well as the photographic background and framing were statistically important in differentiating positive and negative emotions. The highest effect size was related to species shape (Cramér's V = 0.45) and the visibility of ocelli (Cramér's V = 0.43) (Table 2). For emotional arousal, which was low overall (mean 2.5 out of 9), artistic choices on the part of the photographer were relevant. However, overall, the effect sizes were very low (mean, 0.114).

The photographs elicited different valences and arousal levels among the participants (Figure 1). Photographs 13 and 17 had the most negative mean valence (3.29 and 3.34 respectively); both obtained a medium score for arousal: 4.6 and 4.5 (out of 9) respectively and showed many individuals with different shapes. Photographs 14 and 12 had the most positive mean valence (7.25 and 6.69 respectively, out of 9) and high arousal levels (5.07 and 4.40 out of 9). Both photographs presented one or two individuals with a spherical shape.

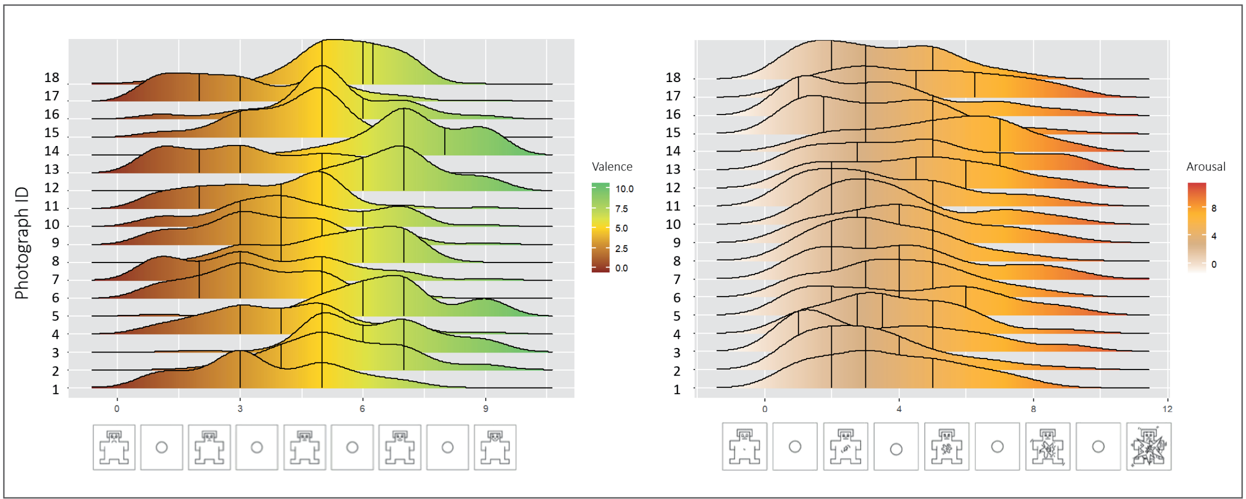

Figure 1. (**Left**) Distribution of participant emotions elicited by each photograph, from very negative (1) to very positive (9). (**Right**) Distribution of the emotional arousal level felt by the participants, from very low (1) to very high (9).

The FAMD analysis showed that the variables that contributed to the distribution of the photographs across the main dimensions of the multifactorial plan (1 and 2) were the number of individuals, species shape, certain colors for the species (yellow) or the background (blue), visible hair, visible ocelli, and subject placement in relation to the rule of thirds. All variables that characterized the subject (general shape, visible ocelli in an eye patch, visible hair, and dominant color; number of individuals in the photograph) and the photographic composition had a significant influence (chi² p-value < 0.01) with Cramér's V going from 0.06 to 0.45 (mean = 0.26). Therefore, to avoid auto-correlation, we kept in the second analysis only the most contributive variables, except for color of the individuals. The first dimension (24.4 % of variance explained) of the FAMD was related

Table 2. Results of the chi² and Cramér's V tests showing the effect size of the different subject characteristics and photographic descriptors on the emotions (valence: positive or negative) and arousal (low or high) felt by the study participants (N=68). Chi test: <0.05 *, <0.01**, <0.001***

	Characteristic	Valence		Arousal	
		Chi²	Cramér's V	Chi²	Cramér's V
Subject (species)	Visible ocelli	***	0.432	NS	
	Species shape	***	0.455	NS	
	Hairiness	**	0.0584	NS	
	Color	***	0.236	NS	
	Number of individuals	***	0.243	**	0.116
Photographer's artistic choices	Framing	***	0.254	**	0.119
	Background color	***	0.248	**	0.124
	Recognizable background	***	0.236	*	0.108
	Subject's position in relation to the rule of thirds	***	0.213	***	0.107

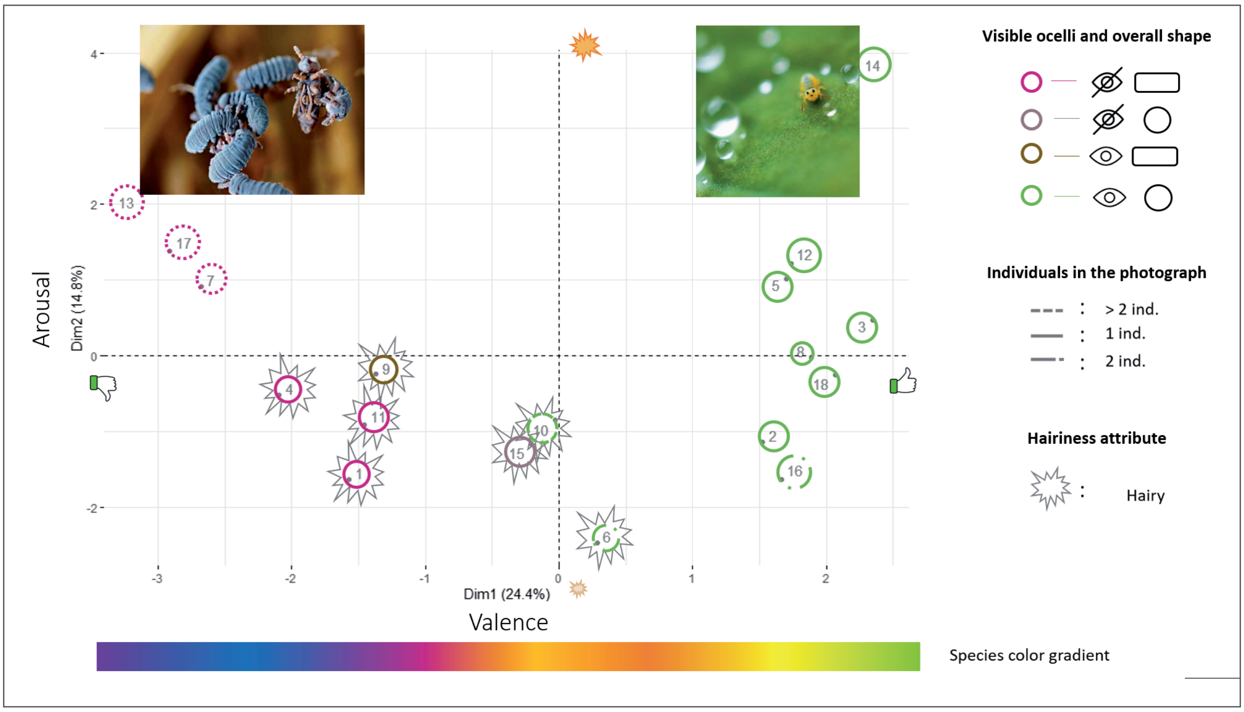

Figure 2. Factorial analysis of mixed data (FAMD). The colored circle around the photograph ID indicates the organism's shape and overall visibility of ocelli of the most represented taxon in the photograph, while the line (dotted, solid or mixed) indicates the number of individuals in the photograph. A star shape indicates that individuals are hairy. Points 13 and 14 are illustrated by the correspondent photographs by P. Lebeaux, as they had the highest mean values for the valence and arousal measures.

to valence (positive or negative emotion), whereas the second (14.8 %) to arousal (low or high intensity); the third dimension (11.8 %) was mostly explained by the number of individuals in the photograph. Composition contributed to the three dimensions, but the first dimension was mostly explained by an individual's shape and ocelli visibility (Figure 2 and Appendix A.2).

4 Discussion

To our knowledge, this is the first study to evaluate the emotional valence and arousal generated in viewers by a group of soil organisms (Collembola) in a context in which human attitudes toward soil organisms are rarely the subject of studies.

In our results, Collembola photographs (source: P. Lebeaux) did not elicit the same emotional response from one image to another. This in part reflects the variability of the morphological characteristics of this highly diverse taxonomic class, which is also an observation that has been made by researchers working on humans' broader perception of insects (Kellert, 1993; Shipley & Bixler, 2017; Leandro & Jay-Robert, 2019).

We found that species-specific morphological features significantly influenced the emotions felt by participants toward the different photographs. Of these characteristics, color, for instance, is known to play a role in human preference: invertebrate taxa with colors such as blue and green are favored as they have positive associations for viewers (Hook, 1997; Leandro et al., 2017). Jonauskaite and Mohr (2025) highlighted that light colors such as yellow and orange could induce positive, excited emotions, whereas blue and green could induce positive, calming emotions. This was reflected in our results (Figure 2), as the gradient of the dominant color of taxa seems to correspond to emotional valence and arousal levels. Concerning ocelli, depending on the species, Collembola can have zero to eight ocelli, generally grouped together in an eye patch, which humans perceive as eyes. Our results showed more positive emotions when ocelli were visible. It has been demonstrated that animals can induce positive emotions in humans due to anthropological proximity: i.e. if they share features that are close to those of humans (Lorimer, 2007; Batt, 2009). Another morphological feature that appeared to play a role in viewers' emotional response was hairiness – hairy arthropods provoked negative emotions. This seems to be in line with a study that has found that smooth animals could induce positive emotions (Fisher et al., 2023).

Beyond morphology, we found that if there were more than two individuals in the photograph, this was perceived negatively. The multiplicity of animals is another parameter that is known to induce negative emotions, particularly in the context of Orthoptera and invasions (Lockwood, 2013) and, more generally, in small organisms, as they are potentially perceived as vectors of pathogens, therefore inducing fear and disgust (Blanc, 2007; Fukano & Soga, 2023). It has also been demonstrated that while nature-related images are preferred by inexperienced observers when presented with a variety of photographs and themes, unappealing or gruesome images will generally create a negative emotion toward an image (Vissers & Wagemans, 2024).

In terms of the composition of the photograph itself, we found that the overall artistic impression significantly influenced the emotional valence and arousal level felt by the participants. In Koliska and Oh (2023), the placement of the main subject according to the rule of thirds and the image's overall composition directs the viewer's eye, helping to make sense of the image. However, in our case study, no clear pattern was observed between the positioning of the springtail in the photo and the valence–arousal scale. This might be explained by the fact that all the characteristics of the photograph – the framing, colors in the image, and species traits – were significantly correlated between themselves as well as with taxa characteristics. Therefore, the viewer's emotional response (positive or negative, with low or high intensity) could be a response to the overall image, or a congruent evaluation of different aspects of the image, rather than an attitude toward the individual in the photograph.

Indeed, perception is based on a combination of stimuli. The principles of Gestalt psychology can help understand how people respond to visual aesthetics. Gestalt theory suggests that an individual's visual perception is not simply a collection of single sensory elements, but a perception of the whole (Koffka, 1922). This theory is highly applicable to how a photograph is perceived and the reactions to it (Chuang et al., 2023; Lu, 2010; Vissers & Wagemans, 2024; Wagemans et al., 2012). In our findings, the perception of the characteristics of the subject and of the image were highly correlated. For example, there was a negative emotional reaction to Photograph 13 of *Podura aquatica* (top left in Figure 2), in which this specimen is blue, elongated rather than round, ocelli is not visible, and multiple individuals are present. In terms of composition, the subject is at the center. While our analysis found that blue was typically positively perceived, here this might not have counteracted the negative perception of less round forms and multiple arthropods, leading to an impression of a "swarm." In future research, it might be useful to design an experiment to independently test the different features in an image, whether related to the taxon or the background on which it is presented.

However, one limitation should be mentioned, which refers to a possible sex difference in the perception of animals, with women experiencing more intense negative feelings (i.e., fear, disgust) than men (e.g., Schienle et al., 2005). Although this effect had not be considered in our study, which, like most previous studies (e.g., Dal Fabbro et al., 2021; Ottavi et al., 2021), included more women than men in their sample, this limitation calls for caution and invites further consideration of whether the emotional evaluation of photographs should systematically include rigorous control of this characteristic of participants in future studies.

Another important point to mention regarding our study concerns the fact that soil itself was not visible in the images presented, which could limit their ability to promote soil conservation. While it may be obvious to soil fauna specialists that Collembola organisms live in soil, the association may not be clear to non-specialists. Future experiments on the topic could make this link more explicit. Nonetheless, this experiment was able to show that certain characteristics in the photographs could arouse positive or negative emotions of varying intensity. Based on our findings, to promote interest in soil organisms such as Collembola, we recommend using photographs that prioritize round and glabrous forms, with clear eye patches, and showing one to two individuals. In future, it may be useful to test whether including photographs that arouse different types of emotions – including negative – can improve the process of education about soil conservation. Until then, choosing photographs that elicit a positive reaction seems a good strategy (Avero & Calvo, 2006; Budimir & Palmović, 2017). Using photographs of hexapods that are visually pleasing may help trigger positive emotions and motivation by activating the brain's reward system, which plays a key role in how we evaluate what we see (Nadal & Skov, 2024).

In conclusion, as images can influence viewers' emotions and behaviors (Chang et al., 2019; Koliska & Oh, 2023; Vissers & Wagemans, 2024), carefully chosen images of soil organisms could be used to encourage soil biodiversity literacy. Educating younger generations about arthropod diversity in soil can foster a deeper connection with nature, inspire scientific curiosity, and promote conservation efforts. More broadly, increased appreciation for the importance of soil biodiversity should help in addressing wider global challenges related to biodiversity decline, food security, pest management and habitat loss.

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Online Supplemetary Material

Appendix A1. Photographs used which come from J. Cortet and P. Lebeaux's book "Planète Collemboles – La vie secrète des sols" (Biotope Editions, Mèze (France) 2015) and specifically taken by P. Lebeaux.
Appendix A2. Complementary results of the Factor Analysis of Mixed Data (FAMD)

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References

Alarcão, S. M., Fonseca, M. J. (2018). Identifying emotions in images from valence and arousal ratings. *Multimedia Tools and Applications* **77**, 17413–17435. https://doi.org/10.1007/s11042-017-5311-8

Anthony, M. A., Bender, S. F., & van der Heijden, M. G. (2023). Enumerating soil biodiversity. *Proceedings of the National Academy of Sciences, 120*(33), e2304663120.

Avero, P., & Calvo, M. G. (2006). Affective priming with pictures of emotional scenes: The role of perceptual similarity and category relatedness. *The Spanish Journal of Psychology, 9*(1), 10–18.

Axelsson, Ö. (2007). Individual differences in preferences to photographs. *Psychology of Aesthetics, Creativity, and the Arts, 1*(2), 61–72. https://doi.org/10.1037/1931-3896.1.2.61

Batt, S. (2009). Human attitudes towards animals in relation to species similarity to humans: A multivariate approach. *Bioscience Horizons, 2*(2), 180–190.

Bispo, A., Cluzeau, D., Creamer, R., Dombos, J. M., Graefe, I. U., Krogh, P. H., Sousa, J. P., Peres, G., Rutgers, M., Winding, A., & Römbke, J. (2009). Indicators for monitoring soil biodiversity. *Integrated Environmental Assessment and Management, 5*(4), 717–719.

Blanc, N. (2007). Cockroaches, or worlds as images. *Contemporary Aesthetics, 5*, Article 10.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25*(1), 49–59. https://doi.org/10.1016/0005-7916(94)90063-9

Budimir, S., & Palmović, M. (2017). Emotional priming with IAPS pictures. *Oeconomicus*, (4).

Chuang, H. C., Tseng, H. Y., & Tang, D. L. (2023). An eye tracking study of the application of gestalt theory in photography. *Journal of Eye Movement Research, 16*(1), 5. https://doi.org/10.16910/jemr.16.1.5

Cortet, J. & Lebaux, P. (2015). *Planète collemboles: la vie secrète des sols*. Editions Biotope, Mèze, France.

Dal Fabbro, D., Catissi, G., Borba, G., Lima, L., Hingst-Zaher, E., Rosa, J., Victor, E., Bernardes, L., Souza, T., & Leão, E. (2021). e-Nature Positive Emotions Photography Database (e-NatPOEM): affectively rated nature images promoting positive emotions. *Scientific Reports*, 11(1):11696. doi: 10.1038/s41598-021-91013-9.

Decker, B. L., Chaney, S. C., Angus, J., Chalmers, C., Edgerly, J., Lindemann, A., ... & Snyder, T. (2024). Art is science is art: Strengthening connections between entomology and the arts. *American Entomologist*, 70(1), 50-59.

Elliot, A. J., & Maier, M. A. (2014). Color psychology: Effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology, 65*, 95–120.

European Commission. (2021). *EU Soil Strategy for 2030: Reaping the benefits of healthy soils for people, food, nature and climate (COM/2021/699 final).* European Commission, Brussels, Belgium.

European Commission. (2023). *Proposal for a directive of the European Parliament and of the Council on soil monitoring and resilience (Soil Monitoring Law)*. European Commission, Brussels, Belgium.

Fisher, J. C., Dallimer, M., Irvine, K. N., Aizlewood, S. G., Austen, G. E., Fish, R. D., ... & Davies, Z. G. (2023). Human well-being responses to species' traits. *Nature Sustainability, 6*(10), 1219–1227.

Fukano, Y., & Soga, M. (2023). Evolutionary psychology of entomophobia and its implications for insect conservation. *Current Opinion in Insect Science, 59*, 101100.

García-Ruiz, J. M., Beguería, S., Nadal-Romero, E., González-Hidalgo, J. C., Lana-Renault, N., & Sanjuán, Y. (2015). A meta-analysis of soil erosion rates across the world. *Geomorphology, 239*, 160–173.

Guerra, C. A., Bardgett, R. D., Caon, L., Crowther, T. W., Delgado-Baquerizo, M., Montanarella, L., ... & Eisenhauer, N. (2021). Tracking, targeting, and conserving soil biodiversity. *Science, 371*(6526), 239–241.

Hook, T. van. (1997). Insect coloration and implications for conservation. *Florida Entomologist, 80*, A193–A210.

Joimel, S., Schwartz, C., Hedde, M., Kiyota, S., Krogh, P. H., Nahmani, J., ... & Cortet, J. (2017). Urban and industrial land uses have a higher soil biological quality than expected from physicochemical quality. *Science of the Total Environment, 584*, 614–621.

Jonauskaite, D., & Mohr, C. (2025). Do we feel colours? A systematic review of 128 years of psychological research linking colours and emotions. *Psychonomic Bulletin & Review*, 1–30.

Joshi, D., Datta, R., Fedorovskaya, E., Luong, Q. T., Wang, J. Z., Li, J., & Luo, J. (2011). Aesthetics and emotions in images. *IEEE Signal Processing Magazine, 28*(5), 94–115.

Kassambara, A., & Mundt, F. (2020). *Factoextra: Extract and visualize the results of multivariate data analyses* (Version 1.0.7) [R package]. https://CRAN.R-project.org/package=factoextra

Kellert, S. R. (1993). Values and perceptions of invertebrates. *Conservation Biology, 7*(4), 845–855.

Koffka, K. (1922). Perception: an introduction to the Gestalt-Theorie. *Psychological Bulletin*, 19(10), 531.

Koliska, M., & Oh, K. (2023). Guided by the grid: Raising attention with the rule of thirds. *Journalism Practice, 17*(2), 354–373.

Lê, S., Josse, J., & Husson, F. (2008). FactoMineR: A package for multivariate analysis. *Journal of Statistical Software, 25*(1), 1–18. https://doi.org/10.18637/jss.v025.i01

Leandro, C., Jay-Robert, P., & Vergnes, A. (2017). Bias and perspectives in insect conservation: A European scale analysis. *Biological Conservation, 215*, 213–224.

Leandro, C., & Jay-Robert, P. (2019). Perceptions and representations of animal diversity: Where did the insects go? *Biological Conservation, 237*, 400–408.

Lemelin, R. H., Harper, R. W., Dampier, J., Bowles, R., & Balika, D. (2016). Humans, insects and their interaction: A multi-faceted analysis. *Animal Studies Journal, 5*(1).

Lockwood, J. (2013). *The Infested Mind: Why Humans Fear, Loathe, and Love Insects*. Oxford University Press.

Lorimer, J. (2007). Nonhuman charisma. *Environment and Planning D: Society and Space, 25*(5), 911–932.

Lu, W. Y. (2010). Research into the application of gestalt theory in photographic education using weekly records. *Research in Arts Education, 20*(1), 37–64. http://dx.doi.org/10.6622/RAE

Nadal, M., & Skov, M. (2025). The sensory valuation account of aesthetic experience. *Nature Reviews Psychology, 4*, 49–63. https://doi.org/10.1038/s44159-024-00385-y

Ottavi, S., Roussel, S., & Syssau, A. (2021). The French Affective Images of Climate Change (FAICC): A Dataset with Relevance and Affective Ratings. *Frontiers in Psychology.* 12:650650. doi: 10.3389/fpsyg.2021.650650

Pagès, J. (2004). Analyse factorielle de données mixtes. *Revue Statistique Appliquée, 4*, 93–111.

Potapov, A. M., Guerra, C. A., Van den Hoogen, J., Babenko, A., Bellini, B. C., Berg, M. P., ... & Scheu, S. (2023). Globally invariant metabolism but density-diversity mismatch in Collembola. *Nature Communications, 14*(1), 674.

Prete, G., Laeng, B., & Tommasi, L. (2022). Environmental risks to humans, the first database of valence and arousal ratings for images of natural hazards. *Scientific Data, 9*, 303. https://doi.org/10.1038/s41597-022-01370-x

Schienle, A., Schäfer, A., Stark, R., Walter, B., & Vaitl, D. (2005). Gender differences in the processing of disgust-and fear-inducing pictures: an fMRI study. Neuroreport, 16(3), 277-280

Shipley, N. J., & Bixler, R. D. (2017). Beautiful bugs, bothersome bugs, and FUN bugs: Examining human interactions with insects and other arthropods. *Anthrozoös, 30*(3), 357–372.

Shipley, N. J., & Bixler, R. D. (2019). An unconventional approach to fostering entomological literacy. *American Entomologist*, 65(1), 19–23.

Stokes, D. L. (2007). Things we like: Human preferences among similar organisms and implications for conservation. *Human Ecology, 35*, 361–369.

van de Wetering, J., Leijten, P., Spitzer, J., & Thomaes, S. (2022). Does environmental education benefit environmental outcomes in children and adolescents? A meta-analysis, *Journal of Environmental Psychology*, 81, 101782. https://doi.org/10.1016/j.jenvp.2022.101782.

Vissers, N., & Wagemans, J. (2024). Photographs that repulse or entice: Sense-making and emotional experiencing of artistic photographs. *Psychology of Aesthetics, Creativity, and the Arts.* https://doi.org/10.1037/aca0000594

Wadoux, A.M.J.C., Courteille L., Arrouays, D., De Carvalhi Gomes, L., Cortet, J., Creamer, R.E., Eberhardt, E., Greve, M.H., Grüneberg, E., Harhoff, R., Heuvelink, G.B.M., Krahl, I., Lagacherie, P., Miko, L., Mulder, V.L., Pásztor, L., Pieper, S., Richer-de-Forges, A.C., Sánchez-Rodríguez A.R., Rossiter, D., Steinhoff-Knopp, B., Stöckhardt, S., Szalmári, G., Takács, K., Tsiafouli, M., Vanwalleghem, T., Wellbrock, N., Wetterlind, J. (2024). On soil districts. *Geoderma* 452, 117065. https://doi.org/10.1016/j.geoderma.2024.117065

Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., & von der Heydt, R. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure-ground organization. *Psychological Bulletin, 138*(6), 1172–1217. https://doi.org/10.1037/a0029333

Wei, T., & Simko, V. (2021). *corrplot: Visualization of a correlation matrix* (Version 0.92) [R package]. https://github.com/taiyun/corrplot

Xylander, W. E. (2020). Society's awareness for protection of soils, its biodiversity and function in 2030–We need a more intrinsic approach. *Soil Organisms, 92*(3), 203–212.