Acta Botanica Brasilica, 2025, 39: e20240236
doi: https://doi.org/10.1590/1677-941X-ABB-2024-0236

Point of View

Reframing Botanical Blindness and Imperception Through Evolutionary Lenses

Ulysses Paulino Albuquerque[1*], Aníbal Silva Cantalice[1], Edwine Soares Oliveira[1], Francisco Igor Ribeiro Santos[1], Hermeson Carlos Santos[1], Ingrid da Silva Lima[1], João Victor Mendes Silva[1], Letícia Elias[1], Marcela Maria Albuquerque-Silva[1], Maria Vittória Alves de Santana[1], Paula Thayanne Mata[1], Rayane Karoline Silva dos Santos[1], Valdir de Moura Brito Júnior[1], Yasmim Antonino Costa Santos[1]

[1] Universidade Federal de Pernambuco, Departamento de Botânica, Laboratório de Ecologia e Evolução de Sistemas Socioecológicos, Recife, PE, Brazil.

*Corresponding author: upa677@hotmail.com

ABSTRACT

In this opinion article, we question the tendency to treat human interactions with plants as a cognitive deficit through terms such as botanical blindness, botanical imperception, or plant awareness disparity (PAD). Rather than denying the existence of the phenomenon these terms attempt to describe, we argue that it should be interpreted as part of a broader and naturally evolved process of differential attention. We contend that naming this perceptual tendency as a distinct and pathological entity disregards the evolutionary basis of human cognition and perception. Cultural and contextual factors modulate interaction with plants, and less attention is paid to them in modern environments, reflecting sociocultural influences rather than cognitive flaws. We advocate for educational approaches that embrace human perceptual plasticity, promoting reconnection with plant diversity without invoking notions of dysfunction.

Keywords: Animacy, cognitive bias, differential attention, plant awareness disparity, ethnobiology, ethnobotany, naturalistic mind.

Introduction

Are people blind to plants, or in other words, do they not notice them? The metaphor of blindness—or its alternatives, such as botanical imperception or plant awareness disparity—has been widely used to describe a phenomenon in which humans pay less attention to plants than animals. However, these metaphors risk suggesting that such attentional patterns result from dysfunctions or deficiencies. In this article, we argue that the phenomenon commonly referred to as plant blindness exists but does not represent a perceptual anomaly. Instead, it manifests a broader and evolved process known as differential attention.

We seek to deconstruct the pathological connotation accompanying terms such as botanical blindness and imperception. These terms describe a natural phenomenon in human beings, shaped by evolutionary and cultural processes. The human mind hierarchizes elements of nature,

Received October 11, 2024; Accepted April 22, 2025
Editor-in-Chief: Thaís Elias Almeida; Associate Editor: Taline Silva

How to cite:
Albuquerque UP, Cantalice AS, Oliveira ES *et al.* 2025. Reframing Botanical Blindness and Imperception Through Evolutionary Lenses. Acta Botanica Brasilica 39: e20240236. doi: 10.1590/1677-941X-ABB-2024-0236

and depending on the context, plants may not become a perceptual priority. This evolved tendency, although modifiable, should not be mistaken for a deficit. As such, educational proposals must consider this natural cognitive inclination rather than pathologize it.

Botanical blindness was initially defined as the inability to notice or recognize plants in the environment and to appreciate their importance in socio-environmental contexts (Wandersee & Schussler, 1999; see also Salatino & Buckeridge, 2016). Metaphors that invoke blindness are not value-neutral—they often suggest a flaw that needs to be fixed, reinforcing ableist stereotypes and upholding a normative and narrow understanding of perception. Despite criticisms of the ableist connotation of the term, newer alternatives such as botanical imperception (Ursi & Salatino, 2022) and plant awareness disparity (see Parsley, 2020) have maintained the same conceptual core. These authors emphasize that they do not describe a total absence of perception but rather a relative inattention, often rooted in sociocultural contexts. While their intentions aim to soften the original metaphor, we argue that the phenomenon should not be isolated from other forms of perceptual prioritization. Instead, it should be understood as one among many expressions of our natural attentional mechanisms.

The term plant awareness disparity (PAD) also appears as an alternative to botanical blindness to unlink it from the ableism implicit in expressions used for many decades (Parsley, 2020). For the author, PAD highlights that plants are not invisible to human beings. Plants occupy a peripheral place in our visual cognitive process — they function like blind spots in perception; as a result, we tend not to notice them as frequently or as vividly as we notice animals (Parsley, 2020). Consequently, if we do not notice plants with the same acuity as animals, we tend to have less interest in and knowledge about them. However, the author emphasizes that this disparity in perception can be reversed through teaching, which does not happen with blindness (Parsley, 2020).

MacKenzie *et al.* (2019) argue that despite the intention to draw attention to the lack of appreciation for plant species, the term botanical blindness itself perpetuates implicit bias, even pointing out prejudice towards plants. Blindness, as a metaphor, suggests a condition to be prevented or cured, implying a sense of inferiority for those labeled as such. This linguistic choice reinforces negative societal stereotypes and disregards the diverse ways individuals perceive and interact with their environment (Schalk, 2013). Consequently, while aiming to raise awareness, the term inadvertently reinforces the prejudices it seeks to address.

Therefore, our goal was to reinterpret the phenomenon related to people's perception of plants from a perspective based on biology and human evolution. In other words, we first propose to unlink the phenomenon's pathological meaning. Subsequently, we prove that inherent biological factors, shaped by human evolution, influence perceptual prioritization. In Chart 1, we highlight words that contain fundamental concepts to understand our line of argument.

The brief history of a phenomenon

Several authors have highlighted the tendency of people to prefer animals over plants, a phenomenon known as zoochauvinism or zoocentrism (Hershey, 1996). An example of this imbalance is the concept of botanical illiteracy, coined by Hershey (1996) to describe widespread neglect and lack of interest in botany, especially among teachers. This phenomenon directly impacts the teaching-learning process at all levels. Experts often criticize the need for more perception about the importance of plants in education, pointing out that teachers without specific training in botany end up teaching biology classes, which perpetuates this neglect of botany (Wandersee & Schussler, 1999). Wandersee & Schussler (1999) introduced botanical blindness to explain why plants are often forgotten or neglected. They emphasized that the roots of this problem lie in both perceptual and cognitive factors, suggesting that the way plants are perceived and taught directly influences their marginal treatment in the educational curriculum and society.

Wandersee & Schussler (2001) identified five factors that contributed to the symptoms of botanical blindness. First, they suggested that humans tend to give little importance to botany, a phenomenon related to inattentional blindness in which plants are ignored because they do not have an immediate meaning. Second, they claimed that the human brain filters certain information, and because of the small visual variation in plants, they end up being neglected. Third, as plants are generally grouped and static, they form the scene's background, whereas animals gain prominence as they are more dynamic. Fourth, plants are not perceived as threatening, which would justify the lack of attention directed towards them, although some species attract attention because of their dangerousness. Finally, the authors argued that humans tend to focus on temporal, spatial, and chromatic patterns, and as plants do not stand out in these aspects, they are commonly ignored.

We can question the previous arguments from different perspectives. First, inattentional blindness may be a natural consequence of a perceptual hierarchy in which humans prioritize what is most relevant for survival or immediate interaction – an efficient evolutionary strategy. The idea that plants exhibit little visual variation does not consider the diversity of plant species in terms of their shape, color, and patterns. The notion that plants form only a "static landscape" is also limited because it disregards the complexity of ecological interactions and subtle movements that can be observed. Finally, the lack of a threat argument ignores the relevance of plants to other organisms and human survival.

Chart 1. Key terms used in this article to discuss the differential attention of humans towards plants.

COGNITIVE AND EVOLUTIONARY CONCEPTS

Adaptive Memory: refers to the human memory system's evolutionary capacity to prioritize, store, and retrieve information relevant to survival and reproductive success. This concept suggests that memory systems have been shaped by selective pressures over time and fine-tuned to solve specific problems faced by our ancestors.

Animacy: Refers to the cognitive and linguistic distinction between entities that are perceived as living (animate) or non-living (inanimate). This classification influences how we conceptualize, predict, and interact with entities in the world, affecting our perception of their behavior and the ways we engage with them.

Biophobia: The evolutionary tendency of humans to develop an aversion to certain animals, such as snakes and insects.

Biophilia: The evolutionary tendency of humans to develop an affinity for other living beings.

Differential Attention: An evolutionary mechanism that causes humans to prioritize attention to certain stimuli, such as animals over plants.

Naturalistic Mind: The naturalistic mind refers to a cognitive structure shaped by evolution, enabling humans to remember, learn, and address challenges in their natural surroundings. For instance, a child who grows up in a rural setting and learns to distinguish plant species early on demonstrates a naturalistic mind shaped by experience.

Perception: The term perception is widely used in the literature across various scientific disciplines, from philosophy to biology, neuroscience, psychology to education. Perception is a biological phenomenon as it strictly depends on the senses. However, when perceiving the external environment, humans interpret what is perceived through various filters, such as cultural and social ones.

Representation: What we communicate and feel from perception are, in fact, representations. Therefore, *representations* would be a more accurate way to express what some studies discuss as perception. Nonetheless, the term perception has become widespread, encompassing various meanings.

CONTESTED METAPHORS AND TERMS

Botanical Blindness: A metaphor coined by Wandersee & Schussler (1999) to describe the human tendency to pay less attention to plants compared to animals. Despite its figurative use, it has been criticized for its ableist implications.

Botanical Imperception: A term proposed by Ursi & Salatino (2022) to replace botanical blindness. It aims to avoid ableist language while referring to the same phenomenon—reduced perceptual acuity toward plants.

Inattentional Blindness: A cognitive phenomenon where individuals fail to notice objects or events in their visual field when their attention is focused elsewhere. This occurs because perception is influenced not only by sensory input but also by the brain's processing and interpretation.

Plant Awareness Disparity: As proposed by Parsley (2020), PAD reframes plant blindness to emphasize that plants are not entirely ignored but are perceived with less frequency and depth than animals. It maintains the core idea of botanical blindness while addressing linguistic and conceptual concerns.

Plant blindness: Plant blindness is used in the literature in the same sense as botanical blindness.

EDUCATIONAL AND SOCIOCULTURAL TERMS

Botanical Illiteracy: The widespread lack of plant knowledge among the public and educators. This reduces classroom focus on botany and the spread of inaccurate botanical information, even from reputable sources.

Traditional Ecological Knowledge: Knowledge accumulated by Indigenous Peoples and Local Communities (IPLC) about the environment and natural resources.

Zoocentrism: Human preference for animals over plants, resulting in greater attention and interest in the former.

Reflections by Wandersee & Schussler (1999; 2001) bring visibility to the botanical blindness. However, many subsequent scientific productions have adopted a pathological approach when dealing with the subject, seeking solutions to cure or prevent symptoms. Several studies have provided evidence of the indicators proposed by Wandersee & Schussler (2001). Among the most common examples are the lower ability of students and the general public to identify plants than animals (Bebbington, 2005; Patrick & Tunnicliffe, 2011; Kaasinen, 2019; Zani & Low, 2022). Furthermore, many people find animals more interesting and attractive than plants (Kinchin, 1999; Nyberg *et al.*, 2021), and knowledge about plants in general is often limited (Kubiatko *et al.*, 2021; Fernández-Díaz, 2022).

Most of these studies adopt a biological perspective to explain the phenomenon of botanical blindness; for example, plants generate distinct stimuli in the human brain owing to their uniform color, grouping, slow movement, and lack of face, which affects the processing of visual information (Kanske *et al.*, 2013; Balas & Momsen, 2014; Achurra, 2022). Furthermore, studies have shown that animal changes are visually detected more frequently and quickly than those in plants (New *et al.*, 2007).

However, there have been contradictory attempts to 'cure' or 'prevent' these symptoms. Let us consider that botanical blindness is largely the result of evolutionary processes in the human brain. These pathological approaches may be trying to alter something deeply rooted in our species' cognitive evolution or described as a defect that is a trend evolved. By classifying these varied ways of perceiving plants, particularly their limitations, as a universal perceptual flaw (Uno, 2018), many approaches ignore the diversity of the cultural, symbolic, and ecological perspectives that influence this perceptual process. By treating this issue as a cognitive and perceptual deficiency inherent to human beings (Knapp, 2019), these analyses risk pathologizing a characteristic resulting from a long process of historically established social and cultural priorities, not a people's intrinsic natural limitation.

A systematic review conducted by Stagg & Dillon (2022), encompassing educational and ethnobiological literature from 1998 to 2020, provides important insights into the phenomenon. The authors argue that the so-called plant awareness disparity is not innate but reflects the sociocultural relevance of plants in different contexts. They demonstrate that urban populations, especially in high-income societies, tend to show reduced perception of plants, whereas traditional and rural communities that maintain daily and symbolic interactions with plant species present higher levels of awareness. Additionally, their study highlights that botanical knowledge varies according to social markers such as age and gender, emphasizing that these differences are not signs of neglect but results of culturally situated learning. Expecting uniform knowledge and perception of plants across different social groups disregards the dynamic and context-dependent nature of botanical understanding. While we agree with their emphasis on the contextual modulation of plant attention, we depart from their claim regarding the non-innateness of the phenomenon.

First argument: our evolution generated differential attention mechanisms in relation to the elements of nature

In the human ancestral past, the first hominids constantly faced the risk of being captured by predators and needed to hunt to survive. Unlike foraging, which involves static plant species, predators and prey move and use both attack and escape strategies. In this context, solving problems related to capturing and escaping predators is crucial for their survival (Barrett, 2005).

Solving these problems requires sophisticated cognitive mechanisms such as identifying movements, detecting the presence of eyes, and inferring intentions. This allows humans to predict the behavior of predators or prey, thereby increasing their chances of survival (Barrett, 2005). Furthermore, emotional responses, such as fear, play a fundamental role in avoiding danger and helping develop escape and protection strategies. These cognitive and emotional processes suggest that attentional selection criteria were selected in response to the challenges faced in the ancestral world (Fig. 1) (New *et al.*, 2007; LoBue, 2012).

The perception of animated beings during this period is essential for the development of human cognition. Evidence shows that animacy — the ability to perceive movements and beings that move — is central to the development of several aspects of cognition (Silverstein, 1976; Caramazza & Shelton, 1998; Pratt *et al.*, 2010; Opfer & Gelman, 2011; Boch *et al.*, 2023). Memory and perception seem inclined to prioritize animate elements or features that evoke ancestral emotional reactions, such as fear and vital responses, to avoid possible threats (LoBue, 2012; Nairne *et al.*, 2013). From an evolutionary fitness perspective, this differential attention is crucial because animated beings can signal threats (such as predators), opportunities (like food sources), or, in social contexts, potential mates or competitors in the pursuit of resources (Nairne *et al.*, 2017).

Another fundamental aspect of human evolution is the emergence of social groups, which requires the development of strategies to maintain cohesion within a group and compete with other groups (Bowles, 2009). In this context, reading facial expressions and interpreting emotions are essential for identifying intentions, forming alliances, and avoiding conflict. This may explain why sensitivity to expressions of anger or fear, which may indicate threats, and expressions of happiness, which signal security and social acceptance, have been selected in human evolution (Windzio, 2023). These skills are vital for social survival, as collaborative groups tend to be more successful in hunting, defending, and raising their offspring (Richerson & Boyd, 1999; Townsend *et al.*, 2023).

Second argument: the functioning of the naturalistic mind is hierarchical

The naturalistic mind (NM) can be understood as a set of cognitive abilities that developed over time in hominid evolution and can deal with the challenges imposed by the environment and the elements found therein (Albuquerque *et al.*, 2015; Albuquerque & Ferreira Júnior, 2017; Albuquerque *et al.*, 2022; Albuquerque, 2024). NM operates as a system tuned to prioritize information with adaptive relevance. It highlights and organizes information directly affecting survival and reproduction, such as identifying threats and searching for resources (Silva *et al.*, 2017; 2020). Silva *et al.* (2019) observed, for example, that human memory is organized to prioritize information regarding medicinal plants that are effective in recurring health situations.

NM also detects and stores information about animate elements, such as predators, in the primacy of inanimate elements. As mentioned above, this makes sense from an evolutionary point of view since detecting living beings, especially those that represent danger, has great relevance

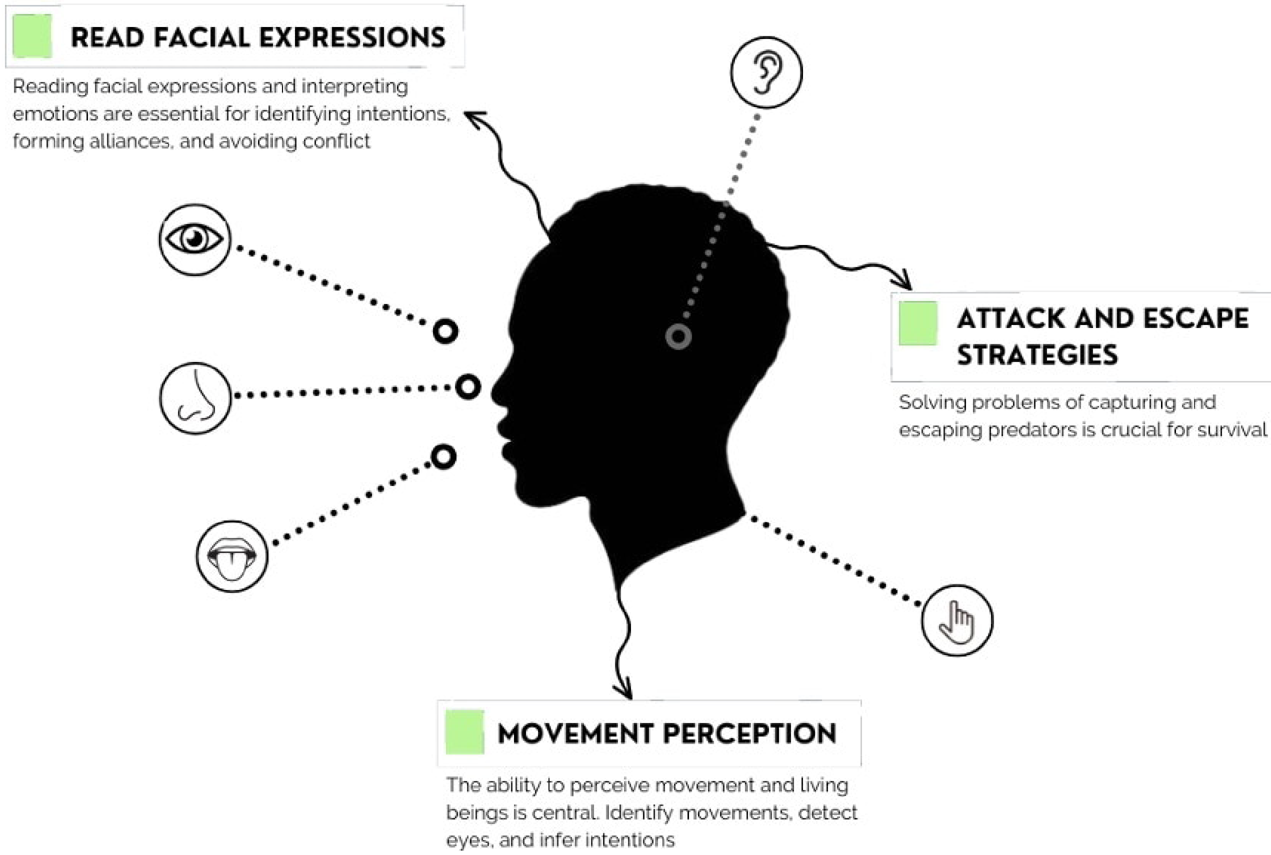

Figure 1. Key aspects of human evolution that contributed to the emergence of differential attention mechanisms toward nature.

for human fitness and survival. Studies have shown that humans have an evolved ability to remember dangerous animals compared with harmless ones. For example, Barrett & Broesch (2012) observed that students remember threatening animals more easily when presented with images and information regarding their names and diets. Similar results were found by Yorzinski *et al.* (2014), who showed that both children and adults are faster at locating images of dangerous animals, such as snakes and lions than of non-threatening animals. These findings suggest that the rapid detection of dangerous animals may be an innate characteristic of the human species (Barrett & Broesch, 2012; Yorzinski *et al.*, 2014; Bertels *et al.*, 2020; Moura *et al.*, 2020).

This preference for animals over other objects is largely due to their ability to move, that is, their animacy (Neuhoff, 2018; Komar *et al.*, 2024). Animals' movement capacity highlights their importance in relation to plants and other environmental factors. Balas & Momsen (2014) reinforced this idea by showing that students identified animals more quickly and accurately than plants when both were displayed in quick succession, suggesting that animals are more easily detected and prioritized by human cognition (Fig. 2).

Despite the tendency to develop an aversion, known as biophobia, to certain animals, which includes everything from invertebrates, especially insects, to predators such as snakes and alligators (Cho & Lee, 2018; Albuquerque & Silva, 2024) — humans also demonstrate an innate affinity for living beings, as described by the hypothesis of biophilia (Wilson, 1986). Biophilia explains why humans develop positive emotions toward certain animals, especially charismatic vertebrates (Castillo-Huitrón *et al.*, 2020). These animals evoke special attention, which may be linked to the ancestral need to protect allies or the perception of similarity with humans themselves (Skibins *et al.*, 2013; Lousley, 2016; Prokop *et al.*, 2021; Albuquerque & Silva, 2024) (Fig. 2).

Although the human mind is strongly inclined to prioritize movement-related stimuli (Leding, 2019; Bugaiska *et al.*, 2019; Yang *et al.*, 2024), information about plants also occupies an important place in our cognitive systems. Wertz & Wynn (2014) investigated social learning in children concerning edible plants and observed that after receiving the same stimuli involving edible plants and inanimate objects, children demonstrated a greater preference for plants compared to objects. Similarly, Prokop & Fančovičová (2014; 2019) found that school-age children better retain information about red and black fruits, which may be related to the perception of ripeness and toxicity, which are crucial aspects for human survival. These children also remembered information about the toxicity of fruits more easily than details such as their name or location.

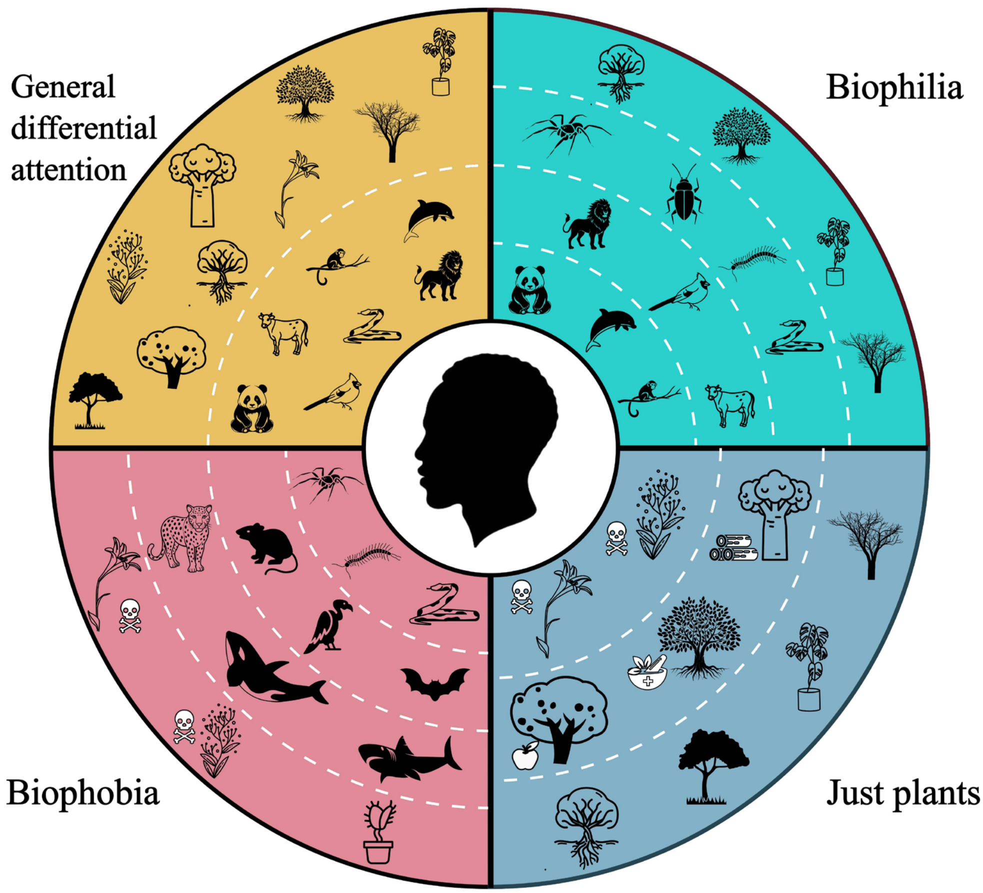

Figure 2. Four potential models of differential attention. The inner circles, closest to the human figure, indicate attentional priority, while the thick sections dividing the larger circle represent the different factors that can influence and modulate (teaching, culture, contact with nature, etc.) this attention. The elements (specific plants and animals) represented in the figure are examples and should not be interpreted as a rigid schema.

Third argument: the relationship with plants can be modulated by different contexts

The NM manifests as an evolutionary tendency capable of being modulated by the environment and context in which people are inserted. The perception of plants and other natural elements is largely influenced by sociocultural, educational, and environmental factors, which explain the perceptual variability between different cultures and within the same culture. For example, the traditional ecological knowledge of Indigenous Peoples and Local Communities is built on continuous interaction with nature. This knowledge represents a vast repository of experiences accumulated throughout human history (see Berkes *et al.*, 2000; Aigo & Ladio, 2016; Zank *et al.*, 2022), which vary according to gender, ethnicity, education, age, contact with natural environments, and degree of urbanization (Albuquerque & Alves, 2016; Albuquerque *et al.*, 2017; Sousa *et al.*, 2022; Silva *et al.*, 2024; Torres-Avilez *et al.*, 2024).

Some studies, such as Amprazis *et al.* (2019), indicate that girls tend to have more favorable attitudes towards plants, while boys often show less interest. A particularly illustrative case of how gender, social marginalization, and educational context shape plant perception is presented by Jager & Moraes (2021), who developed a pedagogical experience with incarcerated women in a prison school in Rio de Janeiro. By integrating botany with the Cultural History of Science, their approach enabled students to reflect on the historical invisibility of women in scientific narratives and to connect these stories with their own experiences of exclusion. This ethnographic study revealed that perceptions of the plant world are socially constructed and deeply entwined with the structural conditions that shape one's access to knowledge and visibility within it. Activities such as botanical drawing, poetry, and discussions about Enlightenment-era science served as means of both cognitive engagement and emotional expression, showing that botany education – when contextualized and attentive to lived experiences—can foster a sense of belonging and agency among individuals historically removed from formal scientific spaces.

Nevertheless, it is necessary to re-evaluate any interpretation that associates variations in knowledge about plants with a deficiency or gap that needs to be corrected. For example, Linderwell *et al.* (2024) found no significant differences in plant knowledge between tribal and non-tribal college students or between Indigenous and white participants. They concluded that PAD is present in diverse demographic groups and not exclusive to specific racial or cultural groups. This highlights the need to improve education and awareness of plants for all groups, highlighting the universal impact of PAD and the role of formal education in filling these gaps.

Blue *et al.* (2023) followed a similar approach and analyzed how the difficulty in recognizing plants contributes to the loss of knowledge and cultural identity based on botanical blindness. They found that, although plants from forests and wetlands were more easily identified, it was more difficult to recognize species from Prairies, especially among young people. According to them, this "loss" of traditional knowledge directly affects the cultural identity of the group studied, suggesting that integrating traditional and scientific teachings in the educational context could mitigate this trend.

However, the problem with Blue *et al.* (2023) and Linderwell *et al.* (2024) is that they start from the premise that the observed differences in knowledge represent a deficiency that needs to be corrected. Ethnobiological studies have already found evidence that points to a different perspective: 1) generational differences in knowledge about plants are expected and are part of a natural phenomenon; 2) assumptions about "loss" of knowledge must be made with caution, as different human groups actively transform, adapt, update and revisit their knowledge over time; 3) knowledge within any social group tends to be naturally heterogeneous, since social roles, for example, can modulate individuals' knowledge (Zarger, 2002; Zarger & Stepp, 2004; Albuquerque, 2006; Alencar *et al.*, 2010; Luczaj & Nieroda, 2011; Demps *et al.*, 2012; Koster *et al.*, 2016; Quinlan *et al.*, 2016; Medeiros *et al.*, 2017; Gallois *et al.*, 2017).

By making these statements, we are not discounting that certain factors, in addition to natural variation, may negatively impact plant knowledge. For example, urbanization significantly influences people's relationships with the natural environment, resulting from several factors, such as the predominance of modern culture, educational models focused on content disconnected from the natural environment, and globalization of trade (see Vandebroek & Balick, 2012; Bruschi *et al.*, 2019). In addition, urban environments offer research and educational opportunities focused on the biocultural diversity that exists within them (Albuquerque *et al.*, 2024a)

Although this trend has been widely observed in urban contexts (Tuan, 2012), studies have shown a decrease in plant knowledge among children in rural areas (Ianni *et al.*, 2015; Díez *et al.*, 2018; Amprazis *et al.*, 2019). Inta *et al.* (2013) identified that younger generations have significantly reduced knowledge about medicinal plants, which is attributable to urbanization and local community development that affects intergenerational transmission. However, these variations, although shaped by changing contexts, should not be viewed exclusively as a loss of knowledge. They can also be interpreted as adaptations to the new conditions and demands of the environment in which individuals reside. In many cases, these changes reflect the ability to adjust knowledge and practices according to context, suggesting an evolutionary dynamic in traditional ecological knowledge that constantly reconfigures itself in response to contemporary challenges (see Albuquerque *et al.*, 2024b).

Implications for school and environmental experience

The defense of education as an essential instrument for transforming the perception of plants is widely supported in the literature (Wandersee & Schussler, 1999; Jose *et al.*, 2019), even in studies that address botanical blindness as a cognitive characteristic (Allen, 2003; Achurra, 2022).

The marginalization of plants in educational settings is not solely a consequence of human perceptual mechanisms. However, it is also rooted in long-standing pedagogical practices that detach botany from meaningful contexts. A documentary analysis conducted by Soares (2020), based on 358 papers presented at major Brazilian congresses on botany and science education between 2013 and 2017, revealed that most teaching approaches remain anchored in traditional models focused on memorizing plant structures and names, with a strong emphasis on morphology and anatomy. Even more experiential strategies, such as school gardens and field studies, often reproduce an anthropocentric view of plants, failing to encourage critical reflection on their ecological or cultural relevance. In doing so, botany teaching reinforces the perceptual hierarchy that privileges animals rather than challenging them.

This diagnosis is reinforced by Ursi *et al.* (2018), who argue that the undervaluation of botany teaching is directly linked to traditional pedagogical approaches that focus on rote memorization and lack connection with students' lived realities. The authors advocate for a contextualized approach to botany education that integrates multiple dimensions of knowledge (environmental, ethical, historical, aesthetic, and medical) and fosters both wonder and student agency. Teacher education is identified as a key area for transformation, particularly through developing pedagogical content knowledge. They also highlight successful experiences that bring universities and schools closer together, such as using art to teach photosynthesis, creating virtual herbaria, and promoting knowledge dialogues with quilombola communities.

How can we approach this phenomenon in formal education if plant perception is modulated by intrinsic and extrinsic aspects of the human mind, such as the cultural environment? There is no single or definitive solution to this challenge, but some central strategies can be implemented to improve the human experience with plants. It is necessary to rethink current educational models to include this diverse perspective of human cognition to promote greater connectivity between students and plant diversity. To this end, we discuss three fundamental topics: (a) improving teaching materials, (b) applying immersive practices, and (c) encouraging contact since childhood.

First, it is important to recognize that part of the difficulty in formally teaching botany derives from a cycle in which botanical content is underrepresented in basic education, which continues to affect future teachers throughout their training (Sanders & Jenkins, 2018; Santos *et al*., 2021; Stroud *et al*., 2022; Aguiar-Dias *et al*., 2023; Kletečki *et al*., 2023). Therefore, the first initiative would be reassessing how botany is taught from basic to higher education. It is necessary to look for an increase in the use of plants as central elements in teaching materials, in addition to encouraging educators to reduce the use of zoocentric materials in classes, bringing new examples that can strengthen students' relationships with botany (Sanders & Jenkins, 2018).

In the educational context, research has shown that younger individuals have less knowledge of plants and tend to show a strong preference for animals (Kose, 2011; Patrick & Tunnicliffe, 2011; Amprazis *et al*., 2019; Pedrera *et al*., 2021; Blue *et al*., 2023). To mitigate this trend, educational programs have developed teaching strategies that encourage greater interaction and learning about plants (Çil, 2015; Kissi & Dreesmann, 2018; Amprazis *et al*., 2019; Borsos *et al*., 2023). Although children generally demonstrate a greater interest in animals, studies suggest that they are better able to recognize plants when they are stimulated through images, videos, and drawings, especially if they have had direct contact and significant experiences with these plants, which often occur in the family environment (Bartoszeck *et al*., 2015).

The literature discusses several promising strategies to address this phenomenon (see Chart 2). One is adopting immersive practices and activities that provide direct contact with plants and nature. These practices have proven effective in promoting botany as a relevant subject for students (Krosnick *et al*., 2018; Colon *et al*., 2020). Furthermore, including plants of direct interest to students, such as those with nutritional properties, can increase engagement with the subject (Pany *et al*., 2019). Different studies have observed that many children's botanical knowledge is mostly derived from their relatives or guardians (Beasley *et al*., 2021; Bruschi *et al*., 2019; Jiménez-Balam *et al*., 2019), which suggests that integrating the family nucleus into formal education can generate more persistent interest in botany. For example, this integration could be achieved with the active participation of relatives during practical activities involving interactions with biodiversity (*e.g.*, walking in botanical gardens) (Laffitte *et al*., 2024). In Brazil, Neves *et al*. (2019) argued that teachers' inclusion of plants familiar to students (*e.g.*, species from the region and food) in the school curriculum could increase students' interest and promote a greater appreciation of plant diversity.

In a study conducted in secondary schools in Vienna and surrounding areas, Pany *et al*. (2019) found that by focusing on botany teaching on useful plants, educators can create more relevant and meaningful expectations for students, integrating content into everyday life. This resulted in an increase in student engagement and performance regarding botany. The study covered students aged 10 to 18, from the 5th to 12th grades, and highlighted the importance of making plant teaching more tangible and connected to students' experiences.

Evidence indicates that early contact with nature is fundamental as children are more likely to develop interest and learning at this stage (Hughes *et al*., 2019; Keith *et al*., 2021). In addition to promoting the perception of plant diversity, this contact also improves children's health and well-being and strengthens their connection with nature (Barrable, 2019; Harvey *et al*., 2020; Robinson & Barrable, 2023; Roslund *et al*., 2020). Both direct exposure to nature and indirect contact through books or games have been shown to promote positive attitudes towards the environment (Soga *et al*., 2016). Brownlee *et al*. (2023) found that animal figures are often selected to exemplify biological concepts, whereas plants receive less emphasis.

To maximize benefits, contact with plants must be continually encouraged throughout the child's development, integrating botany into multiple disciplines (Çil, 2015) and developing practical activities, such as gardening or visits to natural environments, which encourages children's active involvement with these organisms (Kong & Chen, 2024) (Fig. 3).

Final Argument

To deconstruct the concepts of botanical blindness, botanical imperception, and PAD, we rely on the central argument that the evolutionary history of the hominid lineage was shaped by selective pressures present in the ancestral environment. Throughout evolution, these pressures have influenced the construction of the human naturalistic mind, marked by a natural hierarchization of experiences with the natural world, prioritizing, in particular, attention to animals.

Therefore, human-differentiated attention to plants should not be interpreted as a cognitive failure, lack of perception, or limited recognition of their importance. Instead, it represents one among several evolved perceptual mechanisms that can vary in intensity according to sociocultural, environmental, and educational contexts.

Chart 2. Educational approaches applied to plant diversity.

Case #1: The study by Chozas *et al.* (2023) focuses on integrating citizen science with formal education to increase interest and knowledge about plant biodiversity. They explored the potential of this approach to engage students and the public in scientific research and environmental conservation actions. The key points covered include the following.

1. Activities: This includes several initiatives, such as plant identification, leaf characteristics, and plant-animal interactions (pollination). Tools such as iNaturalist (https://www.inaturalist.org/) and BioDiversity4All (https://www.biodiversity4all.org/) have been used as citizen science platforms. This process mobilizes the public to collect scientific information on a large scale, covering different spatial and temporal dimensions while promoting the scientific education of citizens. In this activity, participants were encouraged to observe the environment in search of plants and to identify the species.

2. Educational impact: The impact on education is wide-ranging from (a) the perception that botany teaching is not restricted to the formal environment, (b) a greater emotional connection with the natural environment, which normally goes unnoticed, and (c) increased interest and motivation about nature, especially regarding plants, among others.

3. Challenges: Using citizen science as a tool to aid education faces resistance to changes in the school environment, such as integrating technologies into formal education, among other challenges, such as digital training or economic and security restrictions.

Case #2: Corbacho-Cuello *et al.* (2024) examined the implementation and impact of a Botanical Research Track as an innovative practical and experimental learning activity in botany teaching to improve future teachers' learning. This study sought to demonstrate the effectiveness of this approach in encouraging active learning and engagement in teaching. The study approach was as follows:

1. Activities: The botanical investigation track consisted of interactive activities, such as identifying plants, collecting information about their characteristics, and exploring their practical applications. To assess the impact of this approach, the authors administered questionnaires before and after the activities, measuring changes in participants' botanical knowledge, teaching preferences, and perceptions about the educational value of the trail.

2. Educational impact: The results demonstrated that the botanical research track's impact was quite significant on three axes of investigation: knowledge, teaching preferences, and perception of the activity's value. After the trial, the students reported increased knowledge about botany and greater motivation and engagement related to plant biodiversity. This approach demonstrates that collaborative learning and practical activities in the natural environment can encourage future teachers to integrate active and interactive teaching practices, contributing to teaching training that is connected to reality.

3. Challenges: Implementing activities such as botanical investigation trials faces significant challenges, such as educators' resistance to adopting innovative and playful methodologies. In addition, more institutional support and resources for ongoing training must be needed. However, these challenges provide valuable opportunities for the development of teaching practices. For example, promoting partnerships between educational institutions and environmental organizations can enable access to teaching resources and encourage a natural learning culture. Finally, these practices can enrich the educational experience and expand the knowledge and perception of students and teachers about biodiversity, contributing not only to the teaching-learning process but also to nature conservation and the formation of environmentally friendly citizens.

Case #3: Robles-Piñeros *et al.* (2019) addressed the use of school gardens as educational and cultural recovery tools, emphasizing the importance of these gardens in preserving traditional knowledge and strengthening the connection between people and nature. The approaches are:

1. Activities: The activities consisted of planting and garden management practices, as well as learning about plant growth cycles, pest control, and harvesting. Approaches have been made to assist in identifying plants, especially those for medicinal and food use, thus promoting the appreciation of local biodiversity. Simple experiments involved observing plants under different conditions (such as soil, light, and water), providing a practical understanding of the concepts of biology and ecology.

2. Educational impact: The results demonstrated that practical activities in school gardens helped integrate local and cultural knowledge into formal education. Garden cultivation and management activities aroused interest in environmental sustainability and the preservation of biodiversity, which can reflect pro-environmental behaviors. This approach demonstrated greater student engagement in classes, corroborating the importance of school gardens as interdisciplinary spaces in teaching biology and other areas.

3. Challenges: Implementing and maintaining school gardens can incur financial and material costs, making creation difficult or limiting practical activities. It is proposed that the activities carried out in the school garden be integrated into the student's curriculum in an interdisciplinary way. However, there is a real difficulty in this integration, as practical activities need to be aligned with the theoretical content taught in the classroom. Furthermore, it is necessary to train teachers because the lack of adequate training or practical experience in gardening affects the execution and quality of educational practices.

In modern environments, this experience may be reduced or impoverished, which does not reflect a cognitive limitation but rather the influence of sociocultural and structural factors that prioritize other stimuli over plants.

Human relationships with plants are a natural characteristic of the mind, shaped by evolution and influenced by cultural and contextual factors. Pathologizing this phenomenon risks (a) ignoring the plasticity and adaptability of the human cognitive system, which is dynamic and responds to environmental demands; (b) disregarding the complexity of interactions between humans and the environment, which involves not only perception but also memory, culture, sensory experience, and social learning; and (c) neglecting that perception can be better explained by structural and educational factors, and not by individual cognitive deficiencies. Therefore, there is no such thing as botanical blindness, botanical imperception, or PAD as distinct pathological entities—there is only differential attention.

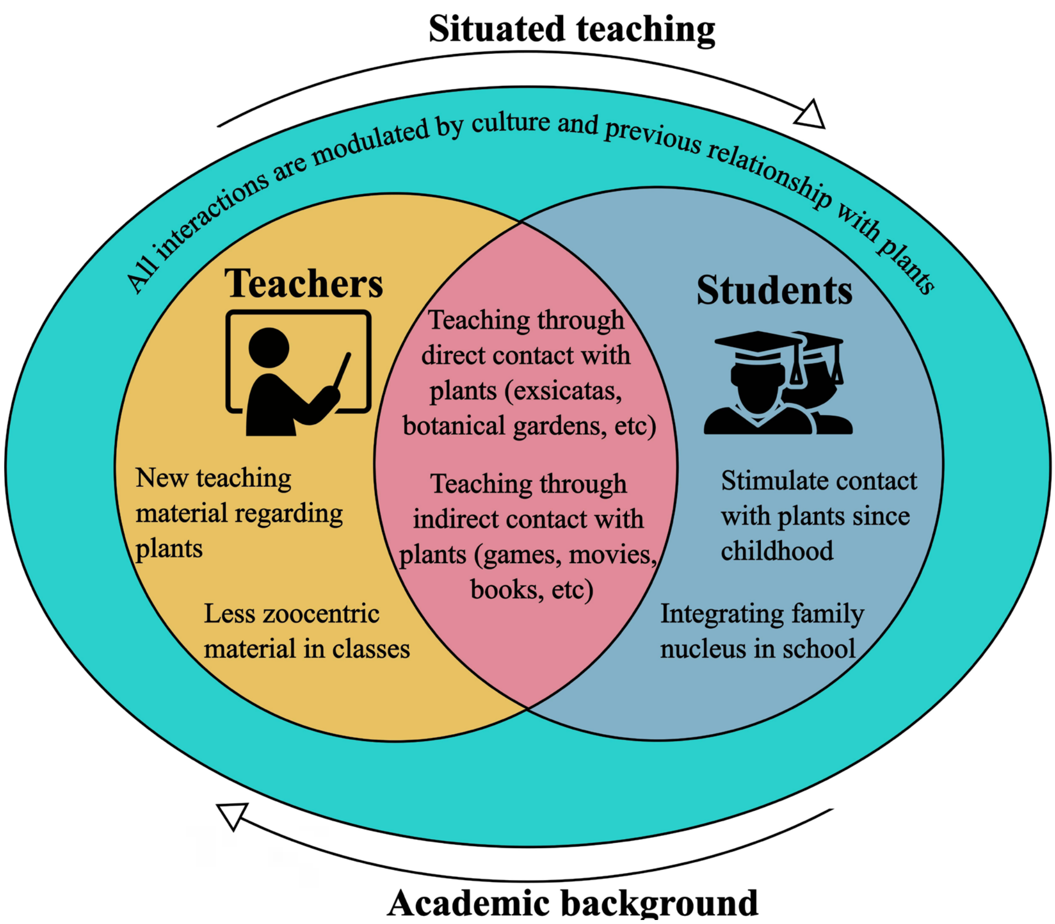

Figure 3. Educational model for addressing differential attention toward nature. This model is an original contribution informed by discussions from educational research, including science and botany education. It proposes specific and contextualized interventions for both students and teachers across different educational levels—including higher education—recognizing the plurality of sociocultural experiences that shape human perception of nature. By integrating insights from previous studies with novel perspectives, the model aims to foster more inclusive, affective, and critical approaches to teaching about the natural world.

Considering this, we advocate that future research and educational efforts prioritize the integration of evolutionary, sociocultural, and intersectional perspectives, moving beyond diagnostic metaphors and focusing on promoting meaningful human-plant connections in diverse contexts.

Acknowledgments

ASC, FIRS, HCS, ISL, LE, MMAS, MVAS, RKSS, VMBJ, and YACS sincerely appreciate the support from the Coordination for the Improvement of Higher Education Personnel (CAPES), code no. 001. ESO extends thanks to the Foundation for the Support of Science and Technology of the State of Pernambuco (FACEPE) for the financial support provided through grant no. BFP-0195-2.01/23. JVMS and PTM also express their gratitude to the National Council for Scientific and Technological Development (CNPq) for their financial support through Grant Nos. 116538/2024-4 and 350611/2024-6, respectively.

Authors' Contribution

Ulysses Albuquerque: Conceptualization, Writing Original draft, Writing- Reviewing and Editing; Aníbal Cantalice, Edwine Oliveira, Francisco Santos, Hermeson Santos, Ingrid Lima, João Silva, Letícia Elias, Marcela Albuquerque-Silva, Maria Santana, Paula Mata, Rayane Santos, Valdir Júnior, Yasmim Santos: Writing Original draft, Writing- Reviewing and Editing.

Conflicts of Interest

The authors have no conflicts of interest to declare.

References

Achurra A. 2022. Plant blindness: A focus on its biological basis. Frontiers in Education 7: 963448. doi: 10.3389/feduc.2022.963448

Aguiar-Dias ACA, Pinheiro SCV, Pinheiro JC. 2023. "My student hates studying Botany!" about university professors and teaching of Botany. Brazilian Journal of Botany 46: 499-503. doi: 10.1007/s40415-023-00898-5

Aigo J, Ladio AH. 2016. Traditional Mapuche ecological knowledge in Patagonia, Argentina: Fishes and other living beings inhabiting continental waters, as a reflection of processes of change. Journal of Ethnobiology and Ethnomedicine 12: 56. doi: 10.1186/s13002-016-0130-y

Albuquerque UP. 2006. Re-examining hypotheses concerning the use and knowledge of medicinal plants: A study in the Caatinga vegetation of NE Brazil. Journal of Ethnobiology and Ethnomedicine 2: 30. doi: 10.1186/1746-4269-2-30

Albuquerque UP. 2024. Etnobiologia evolutiva: livro texto completo do básico ao avançado. Bauru, Canal 6 Editora. doi: 10.52050/9788579176630

Albuquerque UP, Alves RRN. 2016. Introduction to ethnobiology. Switzerland, Springer International Publishing. doi: 10.1007/978-3-319-28155-1

Albuquerque UP, Ferreira Júnior WS. 2017. What do we study in evolutionary ethnobiology? Defining the theoretical basis for a research program. Evolutionary Biology 44: 206-215. doi: 10.1007/s11692-016-9398-z

Albuquerque UP, Ladio A, Almada E, Vandebroek I, Silva MTP, Fonseca-Kruel *VS*. 2024a. Exploring biocultural diversity in urban ecosystems: An ethnobiological perspective. Ethnobiology and Conservation 12: 10. doi: 10.15451/ec2023-06-12.10-1-12

Albuquerque UP, Maroyi A, Ladio AH *et al.* 2024b. Advancing ethnobiology for the ecological transition and a more inclusive and just world: A comprehensive framework for the next 20 years. Journal of Ethnobiology and Ethnomedicine 20: 18. doi: 10.1186/s13002-024-00661-4

Albuquerque UP, Medeiros PM, Casas A. 2015. Evolutionary ethnobiology. New York, Cham, Springer. doi: 10.1007/978-3-319-19917-7

Albuquerque UP, Nascimento ALB, Neto EMFL *et al.* 2022. Brief introduction to evolutionary ethnobiology. Recife, Nupeea.

Albuquerque UP, Ramos MA, Ferreira Júnior WS, Medeiros PM. 2017. Ethnobotany for beginners. London, Springer International Publishing. doi: 10.1007/978-3-319-52872-4

Albuquerque UP, Silva JVM. 2024. Why do we love pandas and hate cockroaches? Ethnobiology and Conservation 13: 22. doi: 10.15451/ec2024-07-13.22-1-7

Alencar NL, Araújo TAS, Amorim ELC, Albuquerque UP. 2010. The inclusion and selection of medicinal plants in traditional pharmacopeias – evidence in support of the diversification hypothesis. Economic Botany 64: 68-79. doi: 10.1007/s12231-009-9104-5

Allen W. 2003. Plant Blindness. BioScience 53: 926.doi: 10.1641/0006-3568(2003)053[0926:PB]2.0.CO;2

Amprazis A, Papadopoulou P, Malandrakis G. 2019. Plant blindness and children's recognition of plants as living things: A research in the primary schools context. Journal of Biological Education 55: 139-154. doi: 10.1080/00219266.2019.1667406

Balas B, Momsen JL. 2014. Attention "blinks" differently for plants and animals. CBE – Life Sciences Education 13: 437-443. doi: 10.1187/cbe.14-05-0080

Barrable A. 2019. Refocusing environmental education in the early years: A brief introduction to a pedagogy for connection. Education Sciences 9: 61. doi: 10.3390/educsci9010061

Barrett HC, Broesch J. 2012. Prepared social learning about dangerous animals in children. Evolution and Human Behavior 33: 499-508. doi: 10.1016/j.evolhumbehav.2012.01.003

Barrett HC. 2005. Adaptations to predators and prey. In: Buss DM (eds.). The Handbook of Evolutionary Psychology. Hoboken, John Wiley & Sons. p. 200-223. doi: 10.1002/9780470939376.ch7

Bartoszeck AB, Cosmo CR, Dasilva BR, Tunnicliffe SD. 2015. Concepts of plants held by young Brazilian children: An exploratory study. European Journal of Educational Research 4: 105-117. doi: 10.12973/eu-jer.4.3.105

Beasley K, Lee-Hammond L, Hesterman S. 2021. A framework for supporting the development of botanical literacies in early childhood education. International Journal of Early Childhood 53: 119-137. doi: 10.1007/s13158-021-00291-x

Bebbington A. 2005. The ability of A-level students to name plants. Journal of Biology Education 39: 63-67 doi: 10.1080/00219266.2005.9655963

Berkes F, Colding J, Folke C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 10: 1251-1262. doi: 10.1890/1051-0761(2000)010[1251]2.0.CO;2

Bertels J, Bourguignon M, Heering A *et al.* 2020. Snakes elicit specific neural responses in the human infant brain. Scientific Reports 10: 7443. doi: 10.1038/s41598-020-63619-y

Blue S, Hargiss CLM, Norland J, Dekeyser ES, Comeau P. 2023. Plant blindness represents the loss of generational knowledge and cultural identity. Natural Sciences Education 52: e20106. doi: 10.1002/nse2.20106

Boch M, Wagner IC, Karl S, Huber L, Lamm C. 2023. Functionally analogous body- and animacy-responsive areas are present in the dog (*Canis familiaris*) and human occipito-temporal lobe. Communications Biology 6: 645. doi: 10.1038/s42003-023-05014-7

Borsos É, Borić E, Patocskai M. 2023. What can be done to increase future teachers' plant knowledge? Journal of Biological Education 57: 252-262. doi: 10.1080/00219266.2021.1909632

Bowles S. 2009. Did Warfare Among Ancestral Hunter-Gatherers Affect the Evolution of Human Social Behaviors? Science 324: 1293-1298. doi: 10.1126/science.1168112

Brownlee K, Parsley KM, Sabel JL. 2023. An analysis of plant awareness disparity within introductory biology textbook images. Journal of Biological Education 57: 422-431. doi: 10.1080/00219266.2021.1920301

Bruschi P, Sugni M, Moretti A, Signorini MA, Fico G. 2019. Children's versus adult's knowledge of medicinal plants: An ethnobotanical study in Tremezzina (Como, Lombardy, Italy). Revista Brasileira de Farmacognosia 29: 644-655. doi: 10.1016/j.bjp.2019.04.009

Bugaiska A, Grégoire L, Camblats AM, Gelin M, Méot A, Bonin P. 2019. Animacy and attentional processes: Evidence from the Stroop task. Quarterly Journal of Experimental Psychology 72: 882-889. doi: 10.1177/1747021818771514

Caramazza A, Shelton JR. 1998. Domain-specific knowledge systems in the brain: The animate-inanimate distinction. Journal of Cognitive Neuroscience 10: 1-34. doi: 10.1162/089892998563752

Castillo-Huitrón NM, Naranjo EJ, Santos-Fita D, Estrada-Lugo E. 2020. The Importance of Human Emotions for Wildlife Conservation. Frontiers in Psychology 11: 1277. doi: 10.3389/fpsyg.2020.01277

Cho Y, Lee D, 2018. 'Love honey, hate honey bees': Reviving biophilia of elementary school students through environmental education program. Environmental Education Research 24: 445-460. doi: 10.1080/13504622.2017.1279277

Chozas S, Nunes A, Serrano HC *et al.* 2023. Rescuing Botany: Using citizen-science and mobile apps in the classroom and beyond. Npj Biodiversity 2: 6. doi: 10.1038/s44185-023-00011-9

Çil E. 2015. Integrating botany with chemistry & art to improve elementary school children's awareness of plants. The American Biology Teacher 77: 348-355. doi: 10.1525/abt.2015.77.5.5

Colon J, Tiernan N, Oliphant S *et al.* 2020. Bringing botany into focus: Addressing plant blindness in undergraduates through an immersive botanical experience. BioScience 70: 887-900. doi: 10.1093/biosci/biaa089

Corbacho-Cuello I, Hernández-Barco MA, Munoz-Losa A. 2024. Exploring the local vegetation: Botanical inquiry trail, an interactive journey of learning. Journal of Biological Education 58: 1-14. doi: 10.1080/00219266.2024.2320111

Demps K, Zorondo-Rodríguez F, García C, Reyes-García V. 2012. Social learning across the life cycle: Cultural knowledge acquisition for honey collection among the Jenu Kuruba, India. Evolution and Human Behavior 33: 460-470. doi: 10.1016/j.evolhumbehav.2011.12.008

Díez J, Meñika A, Sanz-Azkue I, Ortuzar A. 2018. Urban and rural children's knowledge on biodiversity in Bizkaia: Tree identification skills and animal and plant listing. International Journal of Humanities and Social Sciences 12: 427-431. doi: 10.5281/ZENODO.1316197

Fernández-Díaz M. 2022. Pre-service teachers' ideas and misconceptions about the nutrition, reproduction and importance of plants: A case study in Spain. Journal of Biomedical Research and Environmental Science 3: 930-933. doi: 10.37871/jbres1534

Gallois S, Duda R, Reyes-García V. 2017. Local ecological knowledge among Baka children: A case of "children's culture"? Journal of Ethnobiology 37: 60-80. doi: 10.2993/0278-0771-37.1.60

Harvey DJ, Montgomery LN, Harvey H, Hall F, Gange AC, Watling D. 2020. Psychological benefits of a biodiversity-focused outdoor learning program for primary school children. Journal of Environmental Psychology 67: 101381. doi: 10.1016/j.jenvp.2019.101381

Hershey DR. 1996. A historical perspective on problems in botany teaching. The American Biology Teacher 58: 340-347 doi: 10.2307/4450174

Hughes J, Rogerson M, Barton J, Bragg R. 2019. Age and connection to nature: When is engagement critical? Frontiers in Ecology and the Environment 17: 265-269. doi: 10.1002/fee.2035

Ianni E, Geneletti D, Ciolli M. 2015. Revitalizing traditional ecological knowledge: A study in an alpine rural community. Environmental Management 56: 144-156. doi: 10.1007/s00267-015-0479-z

Inta A, Trisonthi P, Trisonthi C. 2013. Analysis of traditional knowledge in medicinal plants used by Yuan in Thailand. Journal of Ethnopharmacology 149: 344-351. doi: 10.1016/j.jep.2013.06.047

Jager IT, Moraes AG. 2021. Mulheres, flores e suas prisões: Reflexões sobre botânica, gênero e ciência com alunas privadas de liberdade. Ensino & Multidisciplinaridade 7: 91-110. doi: 10.18764/2447-5777v7n1.2021.6

Jiménez-Balam D, Alcalá L, Salgado D. 2019. Maya children's medicinal plant knowledge: Initiative and agency in their learning process. Learning, Culture and Social Interaction 22: 100333. doi: 10.1016/j.lcsi.2019.100333

Jose SB, Wu CH, Kamoun S. 2019. Overcoming Plant Blindness in Science, Education, and Society. Plants, People, Planet 1: 169-172. doi: 10.1002/PPP3.51

Kaasinen A. 2019. Plant species recognition skills in Finnish students and teachers. Education Sciences 9: 85. doi: 10.3390/educsci9020085.

Kanske P, Schönfelder S, Wessa M. 2013. Emotional modulation of the attentional blink and the relation to interpersonal reactivity. Frontiers Human Neuroscience 7: 641. doi: 10.3389/fnhum.2013.00641

Keith RJ, Given LM, Martin JM, Hochuli DF. 2021. Urban children's connections to nature and environmental behaviors differ with age and gender. PloS One 16: e0255421. doi: 10.1371/journal.pone.0255421

Kinchin I. 1999. Investigating secondary-school girls' preferences for animals or plants: A Simple 'head-to-head' comparison using two unfamiliar organisms. Journal of Biological Education 33: 95-99.

Kissi L, Dreesmann D. 2018. Plant visibility through mobile learning? Implementation and evaluation of an interactive "Flower Hunt" in a botanic garden. Journal of Biological Education 52: 344-363. doi: 10.1080/00219266.2017.1385506

Kletečki N, Hruševar D, Mitić B, Šorgo A. 2023. Plants are not boring, school botany is. Education Sciences 13: 489. doi: 10.3390/educsci13050489

Knapp S. 2019. Are humans really blind to plants? Plants, People, Planet 1: 164-168. doi: 10.1002/ppp3.36

Komar GF, Mieth L, Buchner A, Bell R. 2024. Manipulations of richness of encoding do not modulate the animacy effect on memory. Journal of Experimental Psychology: Learning, Memory, and Cognition 50: 580-594. doi: 10.1037/xlm0001249

Kong C, Chen J. 2024. School gardens and instructional interventions foster children's interest in nature. People and Nature 6: 712-732. doi: 10.1002/pan3.10597

Kose EO. 2011. Number of Animal and Plant Species Identified by Biology Students. Energy Education Science and Technology Part B-Social and Educational Studies 3: 245-252.

Koster J, Bruno O, Burns JL. 2016. Wisdom of the elders? Ethnobiological knowledge across the lifespan. Current Anthropology 57: 113-121. doi: 10.1086/684645

Krosnick SE, Baker JC, Moore KR. 2018. The pet plant project: Treating plant blindness by making plants personal. The American Biology Teacher 80: 339-345. doi: 10.1525/abt.2018.80.5.339

Kubiatko M, Fanèovièová J, Prokop J. 2021. Factual knowledge of students about plants is associated with attitudes and interest in botany. International Journal of Science Education 43: 1426-1440 doi: 10.1080/09500693.2021.1917790

Laffitte B, Seyler BC, Tang Y. 2024. Environmental education to engage urban youth: Anecdotes from Southwest China. Journal of Biological Education 58: 997-1009. doi: 10.1080/00219266.2022.2118812

Leding JK. 2019. Adaptive memory: Animacy, threat, and attention in free recall. Memory & Cognition 47: 383-394. doi: 10.3758/s13421-018-0873-x

Linderwell S, Hargiss CL, Norland J. 2024. Do demographic factors impact plant knowledge and plant awareness disparity? Natural Sciences Education 53: e20146. doi: 10.1002/nse2.20146

LoBue V. 2012. Perceptual biases for threat. In: Mills GW, Stone SJ (eds.). Psychology of Bias. Nova Science Publishers, Inc. p. 37-52.

Lousley C. 2016. Charismatic life: Spectacular biodiversity and biophilic life writing. Environmental Communication 10: 704-718. doi: 10.1080/17524032.2016.1205644

Luczaj L, Nieroda Z. 2011. Collecting and learning to identify edible fungi in southeastern Poland: Age and gender differences. Ecology of Food and Nutrition 50: 319-336. doi: 10.1080/03670244.2011.586314

MacKenzie MDC, Kuebbing S, Barak RS *et al.* 2019. We do not want to "cure plant blindness" we want to grow plant love. Plants, People, Planet 1: 139-141. doi: 10.1002/ppp3.10062

Medeiros PM, Ferreira Júnior WS, Ramos MA, Silva TC, Ladio AH, Albuquerque UP. 2017. Why do people use exotic plants in their local medical systems? A systematic review based on Brazilian local communities. PLoS One 12: e0185358. doi: 10.1371/journal.pone.0185358

Moura JMB, Silva RH, Ferreira Júnior WS, Silva TC, Albuquerque UP. 2020. Theoretical insights of evolutionary psychology: New opportunities for studies in evolutionary ethnobiology. Evolutionary Biology 47: 6-17. doi: 10.1007/s11692-020-09491-0

Nairne JS, VanArsdall JE, Cogdill M. 2017. Remembering the living: Episodic memory is tuned to animacy. Current Directions in Psychological Science 26: 22-27. doi: 10.1177/0963721416667711

Nairne JS, VanArsdall JE, Pandeirada JNS, Cogdill M, LeBreton JM. 2013. Adaptive Memory: The Mnemonic Value of Animacy. Psychological Science 24: 2099-2105. doi: 10.1177/0956797613480803

Neves A, Bündchen M, Lisboa CP. 2019. Cegueira Botânica: É Possível Superá-la a Partir da Educação? Ciência & Educação 25: 745-762. doi: 10.1590/1516-731320190030009.

Neuhoff JG. 2018. Adaptive Biases in Visual and Auditory Looming Perception. In: Hubbard TL (ed.). Spatial Biases in Perception and Cognition. Cambridge, Cambridge University Press. p. 180-190.

New J, Cosmides L, Tooby J. 2007. Category-specific attention for animals reflects ancestral priorities, not expertise. Proceedings of the National Academy of Sciences 104: 16598-16603. doi: 10.1073/pnas.0703913104

Nyberg E, Brkovic I, Sanders D. 2021. Beauty, memories and symbolic meaning: Swedish student teachers views of their favourite plant and animal. Journal of Biological Education 55: 31-44. doi: 10.1080/00219266.2019.1643761

Opfer JE, Gelman SA. 2011. Development of the animate-inanimate distinction. In: Goswami U (eds.). The Wiley-Blackwell handbook of childhood cognitive development. Oxford, England, Wiley-Blackwell. p. 213-238.

Pany P, Lörnitzo A, Auleitner L, Heidinger C, Lampert P, Kiehn M. 2019. Using students' interest in useful plants to encourage plant vision in the classroom. Plants, People, Planet 1: 261-270. doi: 10.1002/ppp3.43

Parsley KM. 2020. Plant awareness disparity: A case for renaming plant blindness. Plants, People, Planet 2: 598-601 doi: 10.1002/ppp3.10153

Patrick P, Tunnicliffe SD. 2011. What Plants and Animals Do Early Childhood and Primary Students' Name? Where Do They See Them? Journal of Science Education and Technology 20: 630-642. doi: 10.1007/s10956-011-9290-7

Pedrera O, Ortega U, Ruiz-González A, Díez JR, Barrutia O. 2021. Branches of plant blindness and their relationship with biodiversity conceptualisation among secondary students. Journal of Biological Education 57: 566-591. doi: 10.1080/00219266.2021.1933133

Pratt J, Radulescu PV, Guo RM, Abrams RA. 2010. It's alive! Animate motion captures visual attention. Psychological Science 21: 1724-1730. doi: 10.1177/0956797610387440

Prokop P, Fančovičová J. 2014. Seeing coloured fruits: Utilisation of the theory of adaptive memory in teaching botany. Journal of Biological Education 48: 127-132. doi: 10.1080/00219266.2013.837407

Prokop P, Fančovičová J. 2019. The perception of toxic and non-toxic plants by children and adolescents with regard to gender: Implications for teaching botany. Journal of Biological Education 53: 463-473. doi: 10.1080/00219266.2018.1501405

Prokop P, Zvaríková M, Zvarík M, Pazda A, Fedor P. 2021. The Effect of Animal Bipedal Posture on Perceived Cuteness, Fear, and Willingness to Protect Them. Frontiers in Ecology and Evolution 9: 681241. doi: 10.3389/fevo.2021.681241

Quinlan MB, Quinlan RJ, Council SK, Roulette JW. 2016. Children's acquisition of ethnobotanical knowledge in a Caribbean horticultural village. Journal of Ethnobiology 36: 433-456. doi: 10.2993/0278-0771-36.2.433

Richerson PJ, Boyd R. 1999. The evolution of human ultra-sociality. In: Eibl-Eibisfeldt I, Salter F (eds.). In Indoctrinability, ideology, and warfare: Evolutionary perspectives. New York, Berghan Books. p.71-95.

Robles-Piñeros J, Ramírez-Olaya LCJ, Baptista GCS. 2019. Estrategias educativas e etnobiológicas: la huerta escolar como espacio para el rescate de saberes y el reencuentro con la natureza. Gaia Scientia 12: 60-74. doi: 10.22478/ufpb.1981-1268.2018v12n4.42381

Robinson JM, Barrable A. 2023. Optimising early childhood educational settings for health using nature-based solutions: The microbiome aspect. Education Sciences 13: 211. doi: 10.3390/educsci13020211

Roslund MI, Puhakka R, Grönroos M *et al.* 2020. Biodiversity intervention enhances immune regulation and health-associated commensal microbiota among daycare children. Science Advances 6: eaba2578. doi: 10.1126/sciadv.aba2578

Salatino A, Buckeridge M. 2016. Mas de que te serve saber botânica? Estudos avançados 30: 177-196 doi: 10.1590/S0103-40142016.30870011

Sanders DL, Jenkins D. 2018. Plant Biology. In: Kampourakis K, Reiss M (eds.). Teaching biology in schools: Global research, issues, and trends. New York, Routledge. p. 124-138.

Santos CR, Moreira LS, Lauriano MP, Silva LB, Corte, VB. 2021. O ensino de botânica na formação de professores de biologia: por que é urgente reformular teoria e prática? ACTIO: Docência em Ciências 6: 11490. doi: 10.3895/actio.v6n1.11490

Schalk S. 2013. Metaphorically speaking: Ableist metaphors in feminist writing. Disability Studies Quarterly 33: 3874. doi: 10.18061/dsq.v33i4.3874

Silva NA, Alves AGC, Albuquerque UP, Ramos MA. 2024. Dynamics of knowledge and use of natural resources in expressions of popular culture in Northeast Brazil: influence of urbanization on biocultural heritage. Environment, Development and Sustainability 26: 2385-2414. doi: 10.1007/s10668-022-02825-2

Silva RH, Medeiros PM, Ferreira Júnior WS, Albuquerque UP. 2017. Human mnesic performance in a survival scenario: The application of the adaptive memory concept in ethnobiology. Ethnobiology and Conservation 6: 9. doi: 10.15451/ec2017-07-6.9-1-6

Silva RH, Ferreira Junior WS, Moura JMB, Albuquerque UP. 2020. The link between adaptive memory and cultural attraction: New insights for evolutionary ethnobiology. Evolutionary Biology 47: 273-284. doi: 10.1007/s11692-020-09516-8

Silva RH, Ferreira Junior WS, Medeiros PM, Albuquerque UP. 2019. Adaptive memory and evolution of the human naturalistic mind: Insights from the use of medicinal plants. PLoS One 14: e0214300. doi: 10.1371/journal.pone.0214300

Silverstein M. 1976. Hierarchy of features and ergativity. In: Dixon R (eds.). Grammatical categories in Australian languages. Acton, Australia, Australian Institute of Aboriginal Studies. p. 163-232. doi: 10.5281/ZENODO.4688088

Skibins JC, Powell RB, Hallo JC. 2013. Charisma and conservation: Charismatic megafauna's influence on safari and zoo tourists' pro-conservation behaviors. Biodiversity and Conservation 22: 959-982. doi: 10.1007/s10531-013-0462-z

Soares JPR. 2020. A prática no ensino de botânica: o que dizem os principais congressos? Revista de Ensino de Ciências e Matemática 11: 73-93. doi: 10.26843/rencima.v11i6.2360

Soga M, Gaston KJ, Yamaura Y, Kurisu K. Hanaki K. 2016. Both direct and vicarious experiences of nature affect children's willingness to conserve biodiversity. International Journal of Environmental Research and Public Health 13: 529. doi: 10.3390/ijerph13060529

Sousa DCP, Ferreira Júnior WS, Albuquerque UP. 2022. Short-term temporal analysis and children's knowledge of the composition of important medicinal plants: The structural core hypothesis. Journal of Ethnobiology Ethnomedicine 18: 51. doi: 10.1186/s13002-022-00548-2

Stagg BC, Dillon J. 2022. Plant awareness is linked to plant relevance: A review of educational and ethnobiological literature (1998–2020). Plants, People, Planet 4: 579-592. doi: 10.1002/ppp3.10323

Stroud S, Fennell M, Mitchley J, Lydon S, Peacock J, Bacon KL. 2022. The botanical education extinction and the fall of plant awareness. Ecology and Evolution 12: e9019. doi: 10.1002/ece3.9019

Torres-Avilez WM, Nascimento ALB, Cantalice AS, Medeiros PM, Silva TC, Albuquerque UP. 2024. Do gendered social roles drive knowledge variation in local medical systems? Human Ecology 52: 813-822. doi: 10.1007/s10745-024-00537-x

Townsend C, Ferraro JV, Habecker H, Flinn MV. 2023. Human cooperation and evolutionary transitions in individuality. Philosophical Transactions of the Royal Society B: Biological Sciences 378: 20210414. doi: 10.1098/rstb.2021.0414

Tuan Y. 2012. Children and the natural environment. In: Altman IW, Wohlwill JF (eds.). Children and the environment. 3. ed. New York, Plenum Press. p. 9-12.

Uno G. 2018. Plant blindness, science illiteracy, and the future of botany. South African Journal of Botany 115: 227. doi: 10.1016/j.sajb.2018.02.011

Ursi S, Barbosa PP, Sano PT, Berchez FAS. 2018. Ensino de botânica: conhecimento e encantamento na educação científica. Estudos Avançados 32: 5-24. doi: 10.1590/s0103-40142018.3294.0002

Ursi S, Salatino A. 2022. É tempo de superar termos capacitistas no ensino de Biologia: impercepção botânica como alternativa para “cegueira botânica”. Boletim de Botânica 39: 1-4. doi: 10.11606/issn.2316-9052.v39ip1-4

Vandebroek I, Balick MJ. 2012. Globalization and loss of plant knowledge: Challenging the paradigm. PloS One 7: e37643. doi: 10.1371/journal.pone.0037643

Wandersee JH, Schussler EE. 1999. Preventing plant blindness. The American Biology Teacher 61: 284-286 doi: 10.2307/4450624

Wandersee JH, Schussler EE. 2001. Toward a theory of plant blindness. Plant Science Bulletin 47: 2-9.

Wertz AE, Wynn K. 2014. Selective social learning of plant edibility in 6- and 18-month-old infants. Psychological Science 25: 874-882.

Wilson EO. 1986. Biophilia. Cambridge, Harvard University Press.

Windzio M. 2023. The Evolution of Human Sociality. Categorizations, Emotions, and Friendship. KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie 76: 415-441. doi: 10.1007/s11577-023-00919-x

Yang G, Wang Y, Jiang Y. 2024. Social perception of animacy: Preferential attentional orienting to animals links with autistic traits. Cognition 251: 105900. doi: 10.1016/j.cognition.2024.105900

Yorzinski JL, Penkunas MJ, Platt ML, Coss RG. 2014. Dangerous animals capture and maintain attention in humans. Evolutionary Psychology 12: 534-548. doi: 10.1177/147470491401200304

Zani G, Low J. 2022. Botanical priming helps overcome plant blindness on a memory task. Journal of Environment Psychology 81: 101808 doi: 10.1016/j.jenvp.2022.101808

Zank S, Ferreira Júnior WS, Hanazaki N *et al*. 2022. Local ecological knowledge and resilience of ethnomedical systems in a changing world – South American perspectives. Environmental Science & Policy 135: 117-127. doi: 10.1016/j.envsci.2022.04.018

Zarger RK. 2002. Acquisition and transmission of subsistence knowledge by Q’eqchi’ Maya in Belize. In: Stepp JR, Wyndham FS, Zarger RK (eds.). Ethnobiology and biocultural diversity: Proceedings of the Seventh International Congress of Ethnobiology. Athens, International Society of Ethnobiology, University of Georgia Press. p. 593-603.

Zarger RK, Stepp JR. 2004. Persistence of botanical knowledge among Tzeltal Maya children. Current Anthropology 45: 413-418. doi: 10.1086/420908