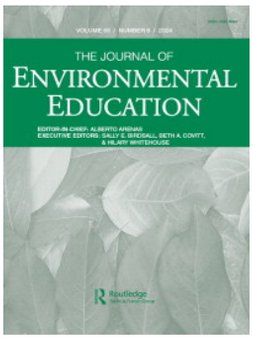

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RESEARCH ARTICLE

The importance of (not just visual) interaction with nature: A study with the Girl Scouts

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ABSTRACT

This study investigated whether children's nature interactions that are embodied (versus only visual) would be associated with a state of being highly aware without thought, including being in "the present moment," and/or feeling connected to something beyond the self. We refer to this state of being as Presence in nature. Using an interaction pattern approach, we coded written narratives from 127 Girl Scouts (8-11 years old) about a recent meaningful nature experience and, through a questionnaire designed for the study, assessed the degree to which participants experienced Presence in that nature experience. Exploratory analyses indicated that participants who enacted embodied interactions with nature (e.g., "making snowman,""wrapping arms around tree,""talking to chickens") reported a greater sense of Presence in nature than participants whose interactions relied solely on vision (e.g., "seeing snow," "seeing moss," "watching pileated woodpecker"). Discussion focuses on the implications of Girl Scouts' embodied nature interactions for environmental education.

KEYWORDS

nature interaction; interaction patterns; Girl Scouts; Presence; embodied cognition

Introduction

There is considerable agreement in the environmental educational community that children learn about nature, and learn to care about nature, through interaction with it (Beery & Jørgensen, 2018; Chawla, 2007; Kahn, 1999; Orr, 1992; Sobel, 2020; Williams, 2018). Book learning has its place. But environmental education is not only about didactic processes that occur in classrooms. That said, little attention has been paid to different broad forms of children's interaction with nature or to the different psychological outcomes arising from those interactions.

In our thinking, there are two forms of interaction with nature worth distinguishing. One we refer to as embodied interaction. Often multiple senses are engaged, and the whole body, or at least some part of it, is in motion. Digging in earth, harvesting vegetables, walking the land, hugging a dog, and building a snowman are all embodied interactions. This form of interaction has a history in the field of constructivist education (DeVries et al., 2002; Rogoff, 1990), with roots in Piaget's theory of cognitive development (1983), and in the field of embodied cognition (Lakoff, 1987; Shapiro, 2010). The other form of interaction relies almost exclusively on vision. We might look at a sunset, see flowers on a table, watch clouds in the sky, view trees outside the window, or gaze at birds at a feeder. In the United States there are many designated "scenic highways" which allow for connection with nature through looking at it from one's car or from a scenic viewpoint to the side of the highway. Of course, many forms of embodied interaction

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include vision. For example, it is difficult (but not impossible) to walk in nature without looking at where you are going but looking by itself does not get you where you want to go.

Throughout the evolutionary history of our species, daily life demanded more than just visual interaction with nature (Ehrlich & Ehrlich, 2008). Early humans relied on their bodies to forage for food, often walking over five miles a day, and returning to camp with tubers, nuts, and other starchy foods. We would hunt animals, often tracking them across long distances. Our embodied interactions supported our survival. Yet now, as the world becomes increasingly urbanized, and major aspects of nature are diminished and sometimes gone forever, there are fewer opportunities to interact with nature. Of that which remains, we often engage it visually. We may look at street-lined trees, at urban birds and plant life, or perhaps glance at green "living walls" on urban buildings. Or we may become immersed in some form of digital nature on our screens.

Much of the pioneering work in environmental psychology emphasized vision. For example, early studies on foundational theories such as Attention Restoration Theory, Stress Reduction Theory, and landscape preferences involved participants looking at nature imagery in photographs or on television screens (e.g., Balling & Falk, 1982; S. Kaplan & Kaplan, 1989; Ulrich et al., 1991). Even when the studies involved actual nature, it often relied on vision. For example, Kaplan (2001) conducted a study at six low-rise apartment communities and found a view of nature from the window (compared to views of the built environment) contributed substantially to residents' life satisfaction and well-being. Still today, visual nature interaction and nonspecific exposure to nature remain prevalent in the field. For instance, studies of nearby nature exposure, such as those investigating tree canopy cover, normalized difference vegetation index, land cover, or similar metrics lack specificity in their characterizations of nature exposure (see Dzhambov et al., 2020 for review). Though useful for broad public health claims and policy, a statement linking nearby greenspace to mental health disregards whether those living near greenspace simply viewed that greenspace through their kitchen window (a visual interaction), spent an afternoon laying in the grass constituting the greenspace, or met up with friends for a game of catch in the greenspace (both embodied interactions). Focusing on nature interaction—as opposed to a broader casting of nature exposure—we ask whether interactions with nature that are embodied, compared to just visual, are associated with a state of being we refer to as Presence. To investigate this question, we (1) drew on the theory of interaction patterns to characterize human-nature interactions, (2) developed a new questionnaire to assess Presence in nature, and (3) brought both together in a study of children who participated in an organization—the Girl Scouts of America—that has a long history of engaging children in interaction with nature.

The interaction pattern approach

Interaction patterns refer to abstract characterizations of essential features of human interactions with nature (Kahn et al., 2012, 2018, 2018a, 2018b; Kahn, Ruckert et al., 2010; Kahn & Weiss, 2017; Lev et al., 2020). Interaction patterns are each characterized such that they are both immediately recognizable and that countless specific enactments of the interaction pattern could be imagined given different people, nature, and purposes. For example, consider the interaction pattern *walking the edge of water and land*. This interaction pattern characterizes a person who walks along (a) the beach at the edge of the ocean's surf, (b) a path around an urban lake, (c) a path along a river, and (d) the edge of the water and concrete as part of an urban fountain. This example also highlights another feature of interaction patterns insofar as they usually can be enacted in relatively wild forms (e.g., at the ocean's edge) or domestic forms (e.g., at an urban fountain). Interaction patterns almost always have phylogenetic and/or ontogenetic significance; in other words, the interactions have been part of our evolution as a species and/or are important today for an individual's development and well-being. Establishing the validity of interaction patterns has been discussed elsewhere (Kahn et al., 2011; Kahn, Gill, et al., 2010). In brief, the approach is based on phenomenological modeling (Frigg & Hartmann, 2020) and draws initially on first person experience, in a sense face validity: not only whether any particular interaction pattern is within the realm of possibility (e.g., walking on a trail is; walking on a black hole is not), but whether it is meaningful to those involved in enacting it, or, in addition, does some of the "work" when researchers employ it to help model a phenomenon or test a hypothesis.

The idea of interaction patterns was inspired by (a) constructivist psychology, with its emphasis on interaction as the mechanism for the development of cognitive structures (Piaget, 1983), (b) the theory of affordances of landscapes (Gibson, 1977, 1979; Reed, 1996), and (c) a body of work in architecture that has developed design patterns for the built environment that engender meaningful human living (Alexander, 1979; Alexander et al., 1977). To date, around 500 human-nature interaction patterns have been identified, with photos and descriptions for many of them (e.g., Kahn et al., 2012, 2018; Kahn, Ruckert et al., 2010; Lam et al., 2023; Weiss et al., 2023). A few examples at differing levels of abstraction include *encountering wildlife, smelling a flower, hearing birdsong, foraging for berries, digging in earth, watching a sunset, recognizing and being recognized by a non-human other, walking to a desired nature location, running the land, hugging a dog, hugging a tree,* and *gazing onto large expanses of terrain.*

One study that employed an interaction pattern approach comes closest to the methods we employed in the current study. Namely, Lev et al. (2020) asked people who had recently visited a large, relatively wild 534-acre urban park (Discovery Park) in Seattle, Washington to write a brief narrative of what they found meaningful during their visit. From 325 narratives, the researchers coded 331 unique interaction patterns. They then synthesized these interaction patterns into what they referred to as keystone interaction patterns, which referred to those interaction patterns that (a) occur frequently, (b) appear phylogenetically meaningful for humankind and/or ontogenetically meaningful for the individual, (c) engender dozens or even hundreds of complementary, subsidiary, or overlapping interaction patterns, and/or, (d) similar to keystone species in an ecosystem (Paine, 1995), with their loss would likely lead to the subsequent loss of dozens or even hundreds of complementary, subsidiary, or overlapping interaction patterns. The six keystone interaction patterns that emerged from visitors' written narratives were *encountering wildlife*, *following established trail*, *walking to destination spot in nature*, *gazing out at Puget Sound or mountains*, *walking along edges*, and *walking with dog*. Through a thematic analysis, the authors then used this interaction pattern approach to establish that visitors' meaningful interactions with nature in Discovery Park depended on the park's size and wildness relative to the surrounding city of Seattle, Washington.

In our own approach for specifying keystone interaction patterns, we moved in a slightly different way. As with Lev et al. (2020), our emphasis was on providing higher order characterizations of interaction patterns so as to make them more meaningful to interpret. But unlike Lev et al., we did not use a cutoff based on frequency; for in our study, we anticipated that it would be instructive to know what interaction patterns were not only frequently used but seldom used.

Presence: A state of heightened awareness and connection

In addition to characterizing human-nature interaction patterns, we sought to conceptualize and assess a particular experience that we refer to as Presence. In our framing, Presence refers to a state of being highly if not optimally aware without thought, including being in "the present moment," and/or feeling connected to or merging with something beyond the self (Kahn et al., 2023; cf. Kahn, 2020). We drew on existing conceptualizations of Presence in other contexts to develop our use of the term. For instance, a common understanding of the term Presence in psychology is a subjective feeling of "being there" in a given environment (Zahorik & Jenison, 1998, p. 78). The term has been extended to specific contexts, such as virtual environments (Witmer & Singer, 1998; Zahorik & Jenison, 1998), therapeutic interactions (Geller & Greenberg, 2002), social interactions (Cuddy et al., 2015), and technologically mediated social interactions (Öztok & Kehrwald, 2017). Our understanding of Presence builds on the idea of "being there," but further specifies the psychological experience as one of optimal awareness and a sense of connection to something beyond the self.

Presence can be experienced simply and briefly. For example, one might be walking alongside a lake, and for a moment one stops, looks out on the expanse of water, and there you are, fully being yourself, which you experience as not so different from the water or the sky above. Or perhaps in a garden you simply bend over and smell a rose, and for a moment the sensory interaction provides a way for the mind to quiet. There is no thought. Just being. Presence can also be experienced as life-affirming. For example, in *The Tibetan Book of Living and Dying,* author Sogyal Rinpoche (2002) recounts an experience from his youth:

> My mind shattered. No words, no names, no thought remained—no mind, in fact, at all. What happened in that astounding moment? Past thoughts had died away, the future had not yet arisen; the stream of my thoughts was cut right through. In that pure shock a gap opened, and in that gap was laid bare a sheer, immediate awareness of the present, one that was free of any clinging. It was simple, naked, and fundamental. And yet that naked simplicity was also radiant with the warmth of an immense compassion. (p. 43)

This passage speaks to characteristics of Presence, such as awareness without thought ("No words no names, no thought remained—no mind, in fact, at all") and, simultaneously, an intense awareness of the present moment ("a gap opened, and in that gap was laid bare a sheer, immediate awareness of the present").

Presence also shares features with, yet is distinct from, constructs in the field of positive psychology, such as flow (Csikszentmihalyi, 1975; Csikszentmihalyi & Csikszentmihalyi, 1988), mindfulness (Kabat-Zinn, 2015), and nondual awareness (Josipovic, 2010). In our view, a construct such as Presence has the potential to unify similarities among these constructs by extracting from them a common experiential form of consciousness. While Presence can be experienced anywhere and anytime, it is Presence experienced in nature that we focused on in this study.

The current study

As we have laid out, given increasingly limited opportunities for interaction with nature, nature experiences may rely more and more on vision, rather than on embodied, multisensory interactions. In the broadest sense, this study asks whether embodied interaction with nature matters.

We take up our research question in partnership with the Girl Scouts of Western Washington, a regional council of Girl Scouts of America. We assessed Girl Scouts' meaningful interactions with nature using their written narratives of recent meaningful nature experiences. Using an interaction pattern approach, we sought to code the interaction patterns embedded in their written narratives and synthesize those interaction patterns to the keystone level so as to understand more of these children's experiences of nature. We then sought to characterize participants' interaction patterns as either embodied or visual. The Girl Scouts also completed a brief questionnaire constructed specifically for this study assessing Presence in nature. As we characterized interaction patterns, an exploratory hypothesis emerged that the Girl Scouts who enacted embodied interaction patterns with nature, compared to those who enacted solely visual interaction patterns, would experience a greater degree of Presence in nature.

Method

This study was approved by the Institutional Review Board at the University of Washington (IRB ID: STUDY00008426) and was conducted collaboratively with the Girl Scouts of Western Washington. Participation was voluntary and all child participants and most troop leader participants were compensated with a fitness-tracking watch used for data collection for the larger study, which they could retain after the study concluded. All participants were free to stop participating in the study at any time while retaining the fitness-tracking watch as compensation.

The Girl Scouts of America

We aimed to address our research question in the context of one of the oldest scouting organizations in the U.S., the Girl Scouts of America (GSA). Founded in 1912, GSA has nature at the forefront of their mission and activities. An early account of GSA's history indicates that offering opportunities to explore nature, go on hikes, and spend weekends camping was a central goal in serving "city girls" (The Girl Scouts of the United States of America, 2009). Outdoor camp was widely considered the pinnacle of the scouting experience, affording the opportunity to develop a relationship with nature that was fundamental to the Girl Scout identity (Miller, 2007). Embodied experiences were and remain central to the aim of developing girls' competence in a variety of outdoor activities: one cannot catch a fish or build a campfire through vision alone.

Today, GSA serves 1.7 million Girl Scouts ages 5-18 annually and engages over 750,000 adults in their mission of building "girls of courage, confidence, and character, who make the world a better place" (Girl Scouts of the United States of America, 2022b). Their programming is grounded in four pillars: the outdoors, life skills, STEM education, and entrepreneurship (Girl Scouts of the United States of America, 2022a). These pillars provide a foundation for the range of skills and experiences Girl Scouts build with GSA; indeed, 80% of Girl Scouts report participating in outdoor activities they would not have done otherwise through GSA (Girl Scouts Research Institute, 2019). Though they acknowledge their history, GSA has sought to stay relevant to the times that involve increasing urbanization, an increasing pervasiveness and sophistication of digital technologies (including social media), and less nature. Thus, Girl Scouts programming now includes skill-building badges for categories such as digital arts, computer coding, cyber security, and robotics (Girl Scouts of the United States of America, 2021).

Participants

Collaborating staff at the Girl Scouts of Western Washington provided the research team with contact information of English-speaking "Junior-level" troops in the greater Seattle metropolitan region, representing girls ages 8-11. A total of 47 troop leaders were contacted *via* email. The email sent to troop leaders invited the troop leaders, parents, and Girl Scouts in their troop to participate in a study investigating the impact of nature interaction on the Girl Scouts' health and well-being, which included an opportunity to attend a camping weekend (which was unable to take place due to COVID-19 restrictions). The results reported here were collected from December 2019-February 2020 as baseline data for this larger study, which ultimately assessed the relationship between time spent in nature and Girl Scouts' physical and mental well-being before and during the COVID-19 pandemic (Gray et al., 2023).

Interested parents were sent Qualtrics surveys *via* email with sections to be completed by their participating child. A total of 137 Girl Scouts and their parents responded to our survey. Additionally, 35 troop leaders responded to our survey, 26 of whom were also participating as parents of Junior Girl Scouts. Results presented here focus on Girl Scouts' responses. Of the 137 Girl Scout respondents, one child participant's responses were written from the parent's perspective and were therefore excluded from analyses. Nine other child participants did not complete the meaningful nature experience prompt and were therefore also excluded from analyses, resulting in a sample of 127 Girl Scouts. Participants were between eight and eleven years old ($M = 9.87$ years, $SD = 0.74$) and all but one (who identified as "bi-gender") indicated their gender as "female." Most participants identified as white ($n = 78$, 61.42%) or multiracial ($n = 27$, 21.26%). Median annual family income was 'more than $90,000' and median household size was four persons ($M = 4.08$, $SD = 1.07$).

Measures

Meaningful nature experience narratives

Participants were prompted to write about a recent meaningful nature experience of their choice with the following four-part prompt: "Please think of an experience you had in nature within the last month that was really important and wonderful for you. (a) Please describe the nature you saw. (b) What were you doing in nature? (c) Why was it meaningful to you? (d) Please tell us more about your experience. We'd love to know!" Each of the four sections of the prompt were followed by an open-ended space for the participant to write their narrative response. Participants' responses were then coded to identify interaction patterns.

Presence in nature

Immediately following the nature experience prompt, participants responded to an eight-item questionnaire designed for this study to assess participants' experience of Presence in nature during their meaningful nature experience (Table 1). Participants were prompted to respond to the items with the nature experience they had just recalled in mind. Other studies have used a similar paradigm in which

Table 1. Presence in nature questionnaire.

1. I felt more aware of what was going on around me.
2. I felt connected to the earth.
3. I felt connected to an energy inside me.
4. I was thinking about what other people might think of me.*
5. I was only thinking about what I was doing.
6. I was aware of about how much time had passed.*
7. I felt that nature made me pay extra attention because I didn't want to get hurt.
8. There were lots of noises and distractions.*

Note. * = Reverse scored.

participants complete a questionnaire in reference to a recent experience, as opposed to reporting on how they feel in the moment (e.g., Jackson & Marsh, 1996; Yaden et al., 2019).

The challenge in developing this questionnaire was threefold: first, to distill literature across diverse psychological, religious, and spiritual traditions that coalesced around our construct; second, to simplify the construct in ways that could tap into children's developing experience of Presence in nature; and third, to generate an initial set of questionnaire items that would show some reasonable measure of psychometric validity. Items were generated based upon existing scales measuring immersive experiences, including flow (Jackson & Marsh, 1996) and Presence in virtual environments (Witmer & Singer, 1998), as well as drawing on of accounts of Presence across time and cultures (e.g., James, 1902; Kahn, 2020; Kimmerer, 2013; Rinpoche, 2002; Tolle, 2004; Tzu, 2001). Face validity was assessed by members of the broader research team. All eight items were answered using a Likert-type scale, ranging from *Strongly disagree* (1) to *Strongly agree* (5). Three of the eight items were reverse scored. Presence in nature scores were calculated as the sum of participants' responses to the eight scale items.

Coding interaction patterns from meaningful nature experience narratives

Human-nature interaction patterns were coded from participants' meaningful nature experience narratives. Interaction patterns follow a standardized form composed of a verb (in the present progressive tense), preposition (when necessary), and a noun, where the noun is a "nature noun," defined as a feature of nature, generally excluding any humans or human artifacts. For example, the interaction patterns *walking on trail, petting dog, whistling birdsong,* and *making campfire* all follow this standardized form. More complex constructions of interaction patterns are also possible, such as *eating under shade of tree*, *walking along edge of water and land*, and *viewing valley from mountaintop*.

To identify and reliably code interaction patterns, a coding manual—a document that systematically explains the process used to formally code the qualitative data—was developed from a randomly selected half of the data, drawing when helpful from one developed by Kahn et al. (2019). Just like Kahn, Lev, and colleagues, we relied on participants' written language as much as possible to code interaction patterns while adhering to a standardized form. Following completion of the coding manual, all data were coded in Excel by the lead author according to the rules laid out in the coding manual. Afterward, a second coder was trained using the coding manual and 25% of the data were randomly selected for the second coder to conduct reliability coding. Because there is no upper limit to the number of interaction patterns that can be coded from one participant's narrative (our unit of analysis), the most appropriate assessment for interrater reliability of these data is Krippendorff's alpha for multi-valued data (Krippendorff & Craggs, 2016). However, this reliability metric runs into computational limits when the number of unique combination of codes is greater than ten, as was the case for our data (Krippendorff, 2018). Therefore, we used Krippendorff and Craggs (2016) software for calculating alpha for multi-valued data but relied on the less computationally demanding percent agreement statistic from the software to assess reliability. The second coder's percent agreement on exact interaction patterns was 78.68%, while their agreement on interaction pattern verbs was 92.12%. Where disagreements were present, the lead author's codes were used for analyses. Our coding manual is accessible online as a technical report (Gray & Kahn, 2022), thus providing detailed transparency to our coding approach.

To illustrate our coding process, we have italicized the phrases used to code interaction patterns in the following narrative from a 10-year-old participant:

> [Please describe the nature you saw]: The *rain* dripping from the cedar trees and the cold air on my face.
>
> [What were you doing in nature?]: *Exploring the forest* in the back yard. *Finding a bridge across the stream* and *sitting on a rock* on the shore of the water.
>
> [Why was it meaningful to you?]: I just find it relaxing. I like the cold and [I] love how everything is green and you can *see the rain* dripping on the water making ripples. The best time to go out is in the morning and if you *have breakfast under one of the trees* that's one of my favorite things to do. In the morning you can *hear all of the [forest]* waking up with all of the *birds singing*. The morning air is cold and fresh and it just feels like [you're] in another world.
>
> [Please tell us more about your experience. We'd love to know!]: [Usually I] go out with my best friend to the forest in the back yard first thing in the morning and we bring out fruit and cheese with [pretzels] and we would *eat the breakfast in the fort* we had built and packed a towel to sit down on. After we were done eating we would just take a walk [or] *add on to the fort* we had been making.

Interaction patterns coded from this participant's nature experience include *exploring forest, finding bridge across stream, sitting on rock, seeing rain, eating breakfast under tree, hearing forest, hearing birds, eating breakfast in fort*, and *adding on to fort*.

Interaction patterns coded from the first of the four prompts were sometimes coded as "inferred interaction patterns" when a nature noun was written without a preceding verb. The authors inferred that the participant saw the nature noun based on the verb "saw" in the prompt. For example, one participant wrote:

> [Please describe the nature you saw]: *Trees, moss* and *animals*
>
> [What were you doing in nature?]: *Hiking*
>
> [Why was it meaningful?]: It was pretty outside.
>
> [Please tell us more about your experience. We'd love to know!]: The big *tree* was so fun to *see*. I got to *find hidden holes* that I could fit in! My sisters and [I] could not *wrap our arms around the tree* it was so big. I *heard birds* too. It made me happy and tired at the same time.

The inferred interaction patterns *seeing trees*, *seeing moss*, and *seeing animals* are coded from the response to the first prompt, in addition to the interaction patterns *hiking in nature, seeing tree*, *finding holes*, *wrapping arms around tree*, and *hearing birds* from the rest of the written narrative. Analyses including inferred interaction patterns are identified as such in the Results.

Keystone interaction patterns were generated and coded by taking participants' specific interaction patterns and providing a more abstract characterization of the interaction pattern that would include other interaction patterns as well. For example, *sitting on rock* was recast as *interacting with inanimate natural features*, allowing us to group all examples of interaction patterns with this orientation (e.g., *jumping in puddles, finding rock*, *jumping in leaves, seeing dirt*). Similarly, *hearing birds* was recast as *listening to nature*, which allowed us to group this interaction pattern with similar interaction patterns (e.g., *hearing forest, listening to animals, hearing water in stream*). Table 2 presents an example of a meaningful nature experience narrative with its associated coded interaction patterns and keystone interaction patterns.

Coding embodied and visual interaction patterns

Our central hypothesis took shape as half of the narrative data were coded to develop our coding manual: we noticed many of the interaction patterns were visual interactions, such as *watching clouds*, *seeing birds, looking through window at nature*, or *staring at roses*. Our emergent hypothesis following from this research question was that participants who enacted embodied interactions in nature would report a greater degree of Presence in nature than those whose nature interactions relied solely on vision.

To operationalize embodied and visual interaction patterns, we considered all interaction patterns that relied on the verbs *looking*, *seeing*, *staring*, or *watching* to be visual interaction patterns. All other interaction patterns coded from participants' meaningful nature experience narratives were considered embodied

Table 2. Example of a coded meaningful nature experience narrative.

Prompt	Participant Response	Interaction Patterns	Keystone Interaction Patterns
Please describe the nature you saw	"Grass, trees, leaves on the ground, branches, puddles of water"	*Seeing grass*	*Viewing plant life*
		Seeing trees	*Viewing plant life*
		Seeing leaves	*Viewing plant life*
		Seeing branches	*Viewing plant life*
		Seeing puddles	*Seeing puddles*
What were you doing?	"Walking, looking at the scenery"	*Looking at scenery*	*Viewing nature*
Why was it meaningful?	"It was beautiful"	None	None
Please tell us more about your experience. We'd love to know!	"I saw animals around me. I heard birds singing. I also see hills."	*Seeing animals*	*Encountering wildlife*
		Hearing birds	*Listening to nature*
		Seeing hills	*Viewing landscape*

Note. The interaction *hearing birds* is considered an embodied (non-visual) interaction pattern. Therefore, this participant is considered to have enacted embodied interaction patterns.

interactions, with the exception of one interaction pattern in which nature acted on the participant (*rabbits pretending not to see me*) that was excluded from consideration in embodied versus visual analyses. These determinations were made using the interaction patterns coded directly from participants' written meaningful nature experience narratives, not the keystone interaction patterns we later abstracted. We then considered all participants who enacted at least one embodied interaction pattern, such as *jumping in leaves*, *playing with dog*, or *finding stream* to have had an embodied nature experience. Separately, we considered participants who enacted only visual interactions without any embodied interactions, such as *seeing birds*, *staring at roses*, or *looking at leaves*, to have had a solely visual nature experience. Participants who enacted both visual and embodied interactions were grouped with participants who enacted at least one embodied interaction. All statistical analyses were conducted using R version 4.3.1, including the *psych* and *effectsize* packages (Ben-Shachar et al., 2020; R Core Team, 2023; Revelle, 2023).

Results

Interaction patterns from meaningful nature experience narratives

Meaningful nature experience narratives from the 127 participants ranged from 6 to 263 words long ($M = 40.61$, $SD = 33.98$). Fourteen Girl Scouts did not express any nature interactions that could be coded using an interaction pattern approach, resulting in 113 narratives with coded interaction patterns. A total of 372 interaction patterns were coded from the 113 narratives, with between 1 and 14 interaction patterns coded per participant narrative ($M = 2.91$, $SD = 2.19$), including inferred interaction patterns. Of the 372 total interaction patterns, 259 (69.62%) were non-inferred interaction patterns. Between 0 and 10 non-inferred interaction patterns were coded per participant narrative ($M = 2.47$, $SD = 1.96$). Over one-third (38.00%) of non-inferred interaction patterns were visual interactions, those that relied on the visual verbs *looking*, *seeing*, *staring*, or *watching*. Over half (57.50%) of total interaction patterns, including inferred interaction patterns, were visual interactions.

Participants enacted 209 unique interaction patterns, including inferred interaction patterns. From the 209 unique interaction patterns, 36 keystone interaction patterns were synthesized. These keystone interaction patterns and the frequencies with which they were enacted are reported in Table 3.

Presence in nature and embodied nature interactions

The internal reliability of the Presence in nature questionnaire items was $\alpha = 0.50$, which is considered low. Three of the eight items were reverse scored, which can introduce noise to participant responses due to variability in item interpretation (Zhang et al., 2016). When reverse-scored items were excluded, internal reliability of the questionnaire improved ($\alpha = 0.61$), though would still be considered low. We proceeded with analyses using the full questionnaire, recognizing this research to be inherently exploratory.

Table 3. The 36 keystone interaction patterns and their frequencies.

Keystone Interaction Patterns	n (%) of participants enacting IP	n (%) of total IPs
Viewing plant life	48 (37.8%)	88 (23.66%)
Encountering wildlife	30 (23.62%)	40 (10.75%)
Experiencing snow	29 (22.83%)	61 (16.4%)
Interacting with domestic animal(s)	19 (14.96%)	29 (7.8%)
Traversing landscape on equipment	17 (13.39%)	18 (4.84%)
Traversing landscape	15 (11.81%)	17 (4.57%)
Viewing body of water	12 (9.45%)	12 (3.23%)
Viewing landscape	10 (7.87%)	11 (2.96%)
Interacting with inanimate natural features	9 (7.09%)	13 (3.49%)
Viewing nature	9 (7.09%)	9 (2.42%)
Listening to nature	6 (4.72%)	9 (2.42%)
Encountering aquatic life	5 (3.94%)	7 (1.88%)
Playing in human-curated natural area	5 (3.94%)	5 (1.34%)
Playing outside	5 (3.94%)	5 (1.34%)
Exploring nature	4 (3.15%)	4 (1.08%)
Interacting with plant life	4 (3.15%)	4 (1.08%)
Looking through window at nature	4 (3.15%)	4 (1.08%)
Being creative in nature	2 (1.57%)	2 (0.54%)
Building special place(s)	2 (1.57%)	2 (0.54%)
Experiencing rain	2 (1.57%)	2 (0.54%)
Gathering food	2 (1.57%)	2 (0.54%)
Non-human animals interacting with humans	2 (1.57%)	3 (0.81%)
Seeing puddles	2 (1.57%)	2 (0.54%)
Sensing air	2 (1.57%)	2 (0.54%)
Smelling nature	2 (1.57%)	2 (0.54%)
Viewing inanimate natural features	2 (1.57%)	2 (0.54%)
Viewing sky	2 (1.57%)	3 (0.81%)
Camping in nature	1 (0.79%)	1 (0.27%)
Discovering human artifacts in nature	1 (0.79%)	1 (0.27%)
Eating food in nature	1 (0.79%)	2 (0.54%)
Encountering invertebrate	1 (0.79%)	2 (0.54%)
Following established path	1 (0.79%)	2 (0.54%)
Immersing oneself in body of water	1 (0.79%)	3 (0.81%)
Seeing creations of non-human creatures	1 (0.79%)	1 (0.27%)
Seeing sun	1 (0.79%)	1 (0.27%)
Viewing storm	1 (0.79%)	1 (0.27%)

Note. Numbers and percentages include inferred interaction patterns. *N* participants = 127. *N* total IPs = 372.

After all data were collected, a split-half analysis approach was adopted to explore the hypothesis that emerged from the randomly selected half of the data used for developing the coding manual. The second half of the data not used for developing the coding manual were used to confirm the hypothesis, as is common for some exploratory and confirmatory factor analyses or computing reliability (Browne & Cudeck, 1989; Furr, 2010). Using the randomly selected half of the data used for developing the coding manual, we compared, using Welch's t-test for independent samples, scores on our Presence in nature questionnaire for participants who experienced at least one non-visual interaction pattern to those who enacted only visual interaction patterns. This analysis provided marginal, but nonsignificant, support for our hypothesis that participants who enacted at least one embodied interaction pattern experienced a greater degree of Presence in nature compared to participants who enacted solely visual interaction patterns, when including inferred interaction patterns, $t(12.89) = 1.71$, $p = 0.111$, Hedges' $g = .60$, 95% CI [-0.13, 1.31]. A statistically significant difference was observed with the second random half of the data, including inferred interaction patterns, $t(54.79) = 2.06$, $p = 0.044$, Hedges' $g = .52$, 95% CI [0.01, 1.03]. Data were then analyzed in the aggregate: among all participants, those who enacted at least one non-visual interaction pattern experienced a greater degree of Presence in nature compared to participants who enacted only visual interaction patterns, $t(64.58) = 2.52$, $p = 0.014$, Hedges' $g = 0.51$, 95% CI [0.10, 0.91], including inferred interaction patterns. When excluding inferred interaction patterns, the results were marginally significant, $t(27.40) = 1.93$, $p = 0.064$, Hedges' $g = 0.49$, 95% CI [-0.03, 1.00]. Thus, analyses provided some preliminary support for the emergent hypothesis that embodied nature experiences, compared to solely visual nature experiences, were associated with a greater degree of Presence in nature.

Discussion

The current study broached the question: Are embodied interactions, versus solely visual interactions, associated with a greater degree of Presence in nature among young girls? Quantitative results provided marginal support for our emergent hypothesis that the Girl Scouts who reported embodied interactions with nature (e.g., *making snowman*, *walking dog*, *wrapping arms around tree*, *talking to chickens*, *hearing birds*) experienced a greater sense of Presence in nature than participants whose interactions relied solely on vision (e.g., *seeing snow*, *seeing moss*, *watching pileated woodpecker*, *looking at birds*, *staring at roses*).

Vision has dominated the study of human-nature interactions and related effects on health and well-being for the past four decades. Looking out a hospital window, at photos of nature scenes, or at surrounding greenspace have all been linked to health benefits. However, experiences of nature are typically multisensory and embodied. Some have argued the "ocular-centric" approach of the past four decades positions nature as something to be admired from afar, rather than experienced directly (Myers, 2020, p. 75).

The current study elevates embodied nature interactions as potentially associated with Presence in nature. Presence in nature may be experienced simply or profoundly, momentarily or for a lasting period; yet we suggest these experiences engender meaning and personal fulfillment. In this sense, experiences of Presence in nature can be thought of as contributing to eudaimonic well-being. Past research has shown that nature connectedness is positively associated with eudaimonic well-being, in particular with personal growth (Pritchard et al., 2020). Simple moments in nature, such as smelling a flower or skipping a rock, have also been identified as positively related to living a worthwhile life (Richardson et al., 2021). Given that we asked participants to report on a recent meaningful experience in nature, the embodied interactions that emerged as associated with Presence align with the notion of simple moments in nature contributing to eudaimonic well-being.

Implications for environmental education

Educationally, the embodied keystone interaction patterns described here can help provide the "nature language" (Kahn et al., 2012, 2018; Kahn, Ruckert et al., 2010) and forms of interaction that teachers can use with their students, even in urban areas. For example, *interacting with plant life* can be fostered by asking young elementary-aged students to *walk to the largest tree you can find*, *wrap arms around tree,* and to *measure the circumference of the tree with your hands*; they can then bring that information (the number of hands around the tree) back to the classroom for descriptive statistics, and to integrate into a simple lesson on tree ecology. Of course, a large number of both embodied and visual interaction patterns may be enacted through the course of such a lesson, such as *touching tree bark*, *searching for largest tree*, *comparing tree trunks*, or *looking at tree bark patterns*. The important part, we suggest, is that the lesson involves direct, embodied interaction with nature, rather than relying on a didactic lesson in a classroom comparing predetermined measurements of trees and images of bark. Through these embodied interactions, our findings suggest the children may experience a greater degree of Presence in nature than if a lesson involved only visual interactions. This idea is pedagogically supported too: direct, sensorially rich interaction with nature is associated with greater understanding of ecological principles and is considered the most efficient teaching method for ecological learning (Beery & Jørgensen, 2018; Palmberg et al., 2019). As another example, the keystone interaction pattern *smelling nature* could be promoted by asking students to bring back into the classroom four nature items within their neighborhood that smell good to them (e.g., a pinecone, a flower, soil, cedar bark), and to integrate those items into, for instance, an art lesson or again an age-appropriate ecology lesson. Furthermore, the keystone interaction pattern of *listening to nature* can be fostered by asking students to go outside to listen to two nature sounds (e.g., bird song and rain fall), and jot down how they feel while listening. Students can then be instructed to listen to two city sounds (e.g., nearby car honking and more distant freeway noise) and also to jot down how they feel then. This activity builds on the empirical literature that shows that when people are instructed to intentionally notice nature, they more often experience positive emotions, compared to those instructed to intentionally notice the urban built environment (Passmore et al., 2022; Passmore & Holder, 2017). The reflections the students return with might support this scientific finding

and could be used to encourage students to intentionally listen more to nature, and to write about what they hear. Table 4 presents additional illustrative examples of embodied nature interactions in environmental education contexts and how we propose those might foster Presence in nature.

Some environmental educators stress that the most important thing teachers and parents can tell their children is to go outside and play (Sampson, 2015). This maxim complements the goals of the No Child Left Inside movement (Benbow & Camphire, 2008; "No Child Left inside (Movement)," 2022). But children can respond to such suggestions with some version of "there's nothing to do outside." This is where the interaction pattern approach can also be educationally useful: by helping adults and children alike generate what is possible to do in and with the specific nature at hand in daily life. One approach is to take the verbs of some interaction patterns and use them to encourage children to explore various nature features. For example, most children love climbing things. So, a parent or educator can ask them (or assist them) to go outside and find a couple of nature features they can climb, and have them climb them. Those interactions are interaction patterns, such as *climbing a tree*, or *climbing a boulder*. Perhaps if there is a little risk involved—part of the curriculum of "risky play" (Brussoni et al., 2012; Hanrahan & Duncan, 2019)—these specific interaction patterns will be more compelling for some children. Tree climbing, specifically, holds the ontogenetic and phylogenetic significance of a keystone interaction pattern. Climbing trees can afford access to honey, fruit, nuts, seeds, and other energy-rich resources, and can offer a vantage point for hunting or an escape from dangerous animals (Kraft et al., 2014). Ontogenetically, tree climbing emerges early in childhood through play and social learning with adult members of hunter-gatherer tribes (Demps et al., 2012). Though today most human beings no longer live in hunter-gatherer cultures, tree climbing persists as a common children's play activity, recognized to help children develop skills, negotiate risk, and connect with nature (Gull et al., 2018). Thus, enacting the interaction pattern of *climbing tree* holds rich evolutionary, cultural, and developmental meaning for children.

Alternatively, environmental educators, parents, and others can keep the nature feature the same in an interaction pattern and vary the verb. For example, using the interaction pattern just mentioned of *climbing a tree*, there is the possibility of enacting it for the sheer joy of climbing. But a child may have other goals, such as *finding secret spot in tree*, or *hiding from adults up high in tree*. Or for trees that cannot be climbed, there is, for example, *building fort against side of tree*, *keeping dry during rainstorm under canopy of tree*, *leaning against tree while reading*, and *having picnic under shade of tree*. Some such interaction patterns, like *building dens* and *constructing forts*, can be a way for children to carve out a "special place" in nature, which holds significance as a means of establishing a sense of place (Sobel, 2002). These nature interactions can be used to encourage children's independence, to create a safe place in nature, and to practice establishing orderly systems of the child's own imagination (Sobel, 2002). In these ways, all of the keystone interaction patterns reported in Table 2 can be used generatively by parents, children, and educators (see Table 4 for additional examples).

The interaction pattern approach also aligns well with Nicholson's (1972) theory of loose parts, where it is proposed that children's creativity and discovery in an environment are directly proportional to the number of variables within that environment. This focus on loose parts is especially amenable to outdoor environmental education (Flannigan & Dietze, 2018), as outside nature usually has immeasurably more loose parts than inside classrooms. For example, imagine a child playing in a stream, and *balancing on a natural feature in the water*: just this single interaction pattern is always unique in some way. Perhaps the child's foot is now on a different rock than before; or if it is the same rock, it is a different spot on the rock; or if it is the same spot on the rock, the foot is positioned a little differently; or even if the foot is positioned the same, the water each moment is always flowing a little differently. In this way, the loose parts in nature are seemingly endless, as are the ways children can interact with them. Said another way, the number of unique interactions patterns that can be enacted outside is immeasurably more because there are immeasurably more loose parts. Thus, we suggest that encouraging children to interact directly with nature, whether through formal environmental education programming or a nudge out the door after school, stands to afford countless opportunities for embodied interaction, and in turn, may help children experience Presence.

Following from the theory of loose parts, the design of schools, preschools, and other sites of environmental education can help support children's rich, diverse, and embodied interactions with nature.

Table 4. Illustrative keystone interaction patterns and educational activities (with an urban focus) to foster presence in nature.

Keystone interaction pattern	Illustrative examples	Suggested educational activities	Proposed connection to Presence in nature
Encountering wildlife	Observing or interacting with animals in their natural habitat, including urban wildlife.	Facilitate a project to observe and document urban wildlife such as birds, insects, and squirrels around the schoolyard. Students could create a wildlife journal to track observations.	Fosters a connection with living creatures and enhances observational skills, potentially allowing thoughts to quiet.
Interacting with domestic animals	Engaging with pets or farm animals through direct contact, which can also include city animals like small mammals.	A student could bring in a small pet, such as a hamster, for a day (if allowed). Or coordinate with local animal shelters for workshops on reading pets' body language or small animal care that can be held at school.	Can quiet the mind and anchor students in the present moment, fostering a deep emotional and sensory connection. This interaction can lead to a state of heightened awareness, potentially promoting a sense of unity and interconnectedness with another form of life.
Traversing landscape	Moving through various types of natural terrain available in urban environments, such as parks or greenways.	Plan urban nature walks through community parks or along green belts to study the landscape and human impact on urban ecosystems.	Can quiet the mind and sharpen awareness, allowing students to feel more deeply connected to their surroundings. Students may begin to feel a part of the larger ecosystem, which can subtly shift their awareness toward a broader understanding of their place within it.
Interacting with inanimate natural features	Engaging with non-living parts of nature such as rocks, sand, and natural water bodies accessible in urban environments.	Organize activities where students can physically interact with these features: such as building structures with rocks, walking barefoot on sand to feel its texture, or placing hands in a stream to feel the water's flow and temperature. Facilitate guided tactile explorations where students can describe the sensations they experience, such as the weight of rocks or the coolness of water.	Connects the body directly to nature through touch, grounding students in the tactile experience. This direct engagement can potentially lead to a sense of unity between their sensory experiences and the natural features they are interacting with.
Listening to nature	Focusing on the sounds within a natural setting, which can include urban parks or even quieter streets.	Host silent listening walks in nearby parks to identify different sounds, from wind rustling through trees to distant urban noises, and then discuss their feelings and thoughts about what they heard. Alternatively, have students create sound maps of their schoolyard or local park, noting where different sounds originate and what causes them.	Cultivates auditory awareness and mindfulness, thereby quieting the mind and connecting students to the present moment through their immediate sensory experience.
Interacting with plant life	Engaging directly with plants through urban gardening or exploration of city plant life.	Develop small container gardens on school property or visit city parks to study plant species adapted to urban environments. Incorporate activities like transplanting seedlings and maintaining garden plots.	Hands-on gardening promotes a stillness of mind and focus that cultivates present moment awareness. The nurturing of plants and observation of their growth can foster connection with processes of life and death.
Smelling nature	Using the sense of smell to explore and connect with the natural environment within an urban context.	Plan sensory exploration activities focusing on smelling different flowers and plants available in local parks or community gardens. Introduce guided sessions where students can blend their own natural fragrances using plant essences.	Engaging the sense of smell can ground students in the present moment.

(*Continued*)

Table 4. Continued.

Keystone interaction pattern	Illustrative examples	Suggested educational activities	Proposed connection to Presence in nature
Building special places	Creating personal or shared spaces within natural settings, adapted to smaller or designed urban areas.	Encourage students to design and build small natural retreats using available urban materials and plants in schoolyards or nearby parks. Facilitate projects to create "miniature worlds" or "secret gardens" that invite solitary reflection or small group collaboration.	Constructing special places in nature facilitates a physical engagement that can quiet the mind and expand students' sense of space and self.

Studies of schoolyards that have been "greened" (i.e., transformed to create or expand schoolyard green space) demonstrate the importance of natural landscapes for increasing prosocial behavior, play, and physical activity (Bates et al., 2018; van Dijk-Wesselius et al., 2022). Our findings suggest that such schoolyard greening interventions may benefit from designs that afford varied embodied interactions with nature, such by including many "loose parts." For instance, a playground that includes a mix of bark chips, movable tree stumps, varied trees and shrubs, rock gardens, and open green space affords many more loose parts, and thus potential for varied nature interaction patterns, than simply an open field.

While our study does not provide causal evidence for embodied nature interactions increasing Presence, the implications for environmental education seem to us important. Recall that Presence in nature is characterized in part by a heightened sense of connection to one's environment. In turn, previous research has demonstrated that connectedness to nature is bidirectionally related to pro-environmental behavior (Krettenauer et al., 2024). Thus, Presence in nature may promote or be facilitated by pro-environmental behavior or attitudes. This is an empirical question that should be tested with further research. Furthermore, as stated above, Presence in nature is considered an experience that engenders meaning and fulfillment. The experiences children wrote about were ones they considered personally important and/or meaningful. Ideally, schools and other educational contexts foster personal meaning for students, generating interest in the subjects at hand and a sense of identity (Mitchener & Schmidt, 1998). Therefore, affording children opportunities to experience Presence in nature through embodied nature interaction may be one way to realize this educational goal.

Finally, the results of this study bear on the environmental education efforts of the Girl Scouts of America as an organization. Traditionally, the organization had interacting with nature at the forefront of their many activities that sought to empower girls and promote a deep affinity for nature (Girl Scouts of the United States of America, 2022c). Activities such as hiking, camping, knot-tying, archery, and other outdoor activities have been commonplace in the Girl Scouts throughout its 110-year history. These activities not only seek to fulfill the Girl Scout mission of empowering future leaders through increasing their competence in the outdoors, but also to foster girls' relationship with nature. Yet increasing urbanization overlaid and embedded within technological systems have seen the Girl Scout organization now offering merit badges for indoor computational expertise, such as computer coding and robotics, and fewer opportunities for deep, embodied experiences in nature.

There is a tension here. On the one hand, we agree that the organization needs to stay relevant to the times. On the other hand, as discussed earlier, the need for embodied interaction with nature lies deep in the architecture of the human mind and body. If the Girl Scouts give ground on nature, and move away from girls' embodied interaction with it, in our view the organization will lose what is perhaps its most important educational and societal contribution: to empower all girls, and to help them to become future leaders, by leading with nature.

Limitations

Several limitations of the current study warrant discussion. First, we recognize that our measure of Presence in nature is the most exploratory part of this study and the study's largest limitation. Though

we drew on previously validated scales to assist us in constructing it, our questionnaire does not have the psychometric properties of a validated scale to call it one, such as strong internal consistency and convergent and discriminant validity with related constructs (Boateng et al., 2018; Carpenter, 2018; Kane, 2006). This limitation is best seen in the Cronbach's alpha value for our Presence in nature questionnaire items ($\alpha = .50$, and .61 when removing the reversed scored items), which is generally considered low. And while this value was likely dampened by our low number of items (Tavakol & Dennick, 2011), the measure needs to be understood as inherently exploratory. Given the encouraging results of this study, some members of our research group have (a) conceptualized the construct of Presence more fully, and (b) through a series of exploratory and confirmatory factor analyses, developed and provided evidence for the validity of what is now a multidimensional Presence scale (Kahn et al., 2023). This study's encouraging results can lead other researchers in related directions.

Furthermore, some of our comparisons of embodied and visual interactions approach, but do not meet, traditional significance levels for hypothesis testing. This study was an exploratory investigation of Girl Scouts' interactions with nature during recent meaningful nature experiences; our hypothesis about embodied and visual interactions emerged as the half of our data used to develop our coding manual were coded. One methodological strength is our split-half approach for our initial exploration of the relationship between embodied interactions and Presence in nature, which we then tested in the other half of our sample and then in the aggregated data set. Still, our findings should be interpreted as preliminary evidence for a relationship between Presence in nature and embodied interactions.

Another limitation of our findings is the unknown role of cognitive or linguistic differences manifesting in the participants' written narratives about their meaningful nature experiences. Given the range of ages represented in our sample, it is possible that the differences in Presence in nature reported by Girl Scouts are explained by a greater command of written language or a greater capacity for self-reflection within their nature experience narratives, rather than differences in the relative embodiment of their actual interactions with nature. Future research could address this limitation by conducting behavioral observations of children's nature interactions, rather than relying on written accounts, or perhaps by administering and statistically controlling for a measure of participants' language ability. This line of research could also be expanded to investigate differences within embodied interactions. For instance, do conservation-related nature interactions (e.g., planting trees, pulling weeds) impact children differently—in terms of their experience of Presence in nature or other outcomes related to psychological or physical well-being—compared to more recreational nature interactions?

Finally, our study looked at a relatively narrow sample: young girls in the Seattle metropolitan area, ages 8-12, involved in a scouting organization, the Girl Scouts of America. Previous research has uncovered gender differences in children's time spent outdoors (Larson et al., 2011; Larouche et al., 2023) and connection with nature (Keith et al., 2021), as well as gender differences in how exposure to or interaction with nature affords psychological benefits (e.g., Taylor et al., 2002). Further research is needed to examine links between embodied interactions and Presence in nature among other populations, such as young boys, adults, or rural populations.

Conclusion

For many people, experiencing Presence is a wonderful state to be in; but in daily life it is not so easy to experience because of the seemingly endless flow of information and of the nature of the mind that seems to repeatedly produce and engage with thought, even when it may be detrimental. Thus, our exploratory research is important in the following ways. It puts forward an initial conceptualization of Presence in nature, and how it may well deserve to be part of an account of human well-being. It suggests that Presence can be experienced by children; and that embodied—not solely visual—interaction with nature may be a powerful way for children to experience Presence. These experiences have the potential to promote children's connectedness to nature and, perhaps in turn, pro-environmental attitudes and behaviors. Finally, more broadly, this study is part of a growing literature that seeks to provide a counterpoint to earlier research paradigms that have relied foremost on vision to assess physical and psychological health outcomes of nature experiences.

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