MuseumsForward

The role of botanical gardens in fostering visitor-plant relationships

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Abstract

With plant diversity at risk primarily due to human impact, conservation organizations are looking to botanical gardens to educate, foster, and strengthen the imperative understanding of our mutual relationships with plants. The purpose of this study was to examine the role of botanical gardens in fostering visitor-plant relationships. Thirty-one participants visited a local botanical garden, taking a photo of a plant or a group of plants they felt a connection with and something in the plant's surrounding area that contributed to that feeling. Photographs were used as a reference for a follow up interview with the participant about their experience at the garden. Findings suggest that visitors' connection with plants at a botanical garden are more often emotional or sensory than they are cognitive. Participants were more likely to think about the role plants play in their life than the role they play in the life of plants and self-plant role reflections occurred more often than reflecting on the role of plants for the wider world. The design of the space that most often contributed to plant connections were paths while written interpretation and signage played a limited role. Findings in this study have implications for practitioners and researchers interested in designing gardens with conservation education in mind.

Keywords

connection to nature, plant blindness, botanical garden, visitor, relationship

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Introduction

According to the Botanic Garden Conservation International (BGCI), 25% of plant species are threatened with extinction primarily due to human related activities such as habitat destruction, unsustainable economic practices, climate change, and invasive species introduction. This threat is predicted to increase to 50% in the next hundred years if climate change is unchecked (Botanic Gardens Conservation International, n.d.). Plant diversity is a fundamental support to sustaining ecosystems, playing a key role in environmental stability and human life (Convention on Biological Diversity, n.d.-a). The loss of plant diversity would harm habitats, animal life, and risk essential resources humans rely on such as food, timber, and fiber, risking our livelihoods, cultures, wellbeing, and existence (Botanic Gardens Conservation International, n.d.; Convention on Biological Diversity, n.d.-a).

Botanical gardens have the ability to promote and strengthen people's understanding of plants and our essential relationships with them (Sanders et al., 2018; Sharrock, 2020). As botanical gardens strengthen their public educational missions and the role of connection to nature and "plant blindness" in conservation becomes more evident, it becomes important that we know what human-plant relationship reflections occur at botanical gardens and what causes them. This article describes a research study designed to examine the role of botanical gardens in fostering visitor-plant relationships.

Connection to Nature

Human behaviors and values are a part of the causes of and the solutions to environmental conservation issues such as environmental destruction and climate change (Gifford, 2014; Saunders, 2003). Environmental psychology investigates how humans relate to their environment (natural or built) and how that affects behavior (Gifford, 2014). Conversations in literature relating to this have considered connection to nature to be essential in promoting sustainable behavior (Mayer & Frantz, 2004; Schultz, 2002). A compilation of studies shows that there are multiple ways individuals connect with nature with many predicting pro-environmental behavior and attitudes (Cheng & Monroe, 2012; Davis et al., 2009; Kals et al., 1999; Mayer & Frantz, 2004; Mackay & Schmitt, 2019; Nisbet et al., 2009; Vining et al., 2008).

Kals et al.'s (1999) study found that connection to nature as an emotional affinity toward nature is as strong a predictor of nature-protective behavior as cognitive interest in nature ("gathering

knowledge to understand a phenomenon") or indignation (feeling responsibility toward nature). Several connection to nature measurement tools were also able to predict pro-environmental behavior or attitude in individuals. Nisbet et al.'s (2009) nature relatedness scale assessed emotional and cognitive orientation of self-identity with, perspectives of, and experiences in nature. Mayer and Frantz's (2004) connectedness to nature scale measures individuals' sense of mutual belonging and welfare with nature. Cheng & Monroe's (2012) children's connection to nature index included the dimensions of enjoyment of nature, empathy for its creatures, sense of oneness, and sense of responsibility. Schultz (2002) developed a visual tool called the inclusion of nature in self scale, a series of circle pairs representing "self" and "nature" that overlap in varying degrees to measure implicit connection to nature as including nature within one's representation of self which was also found to play a role in predicting pro-environmental behavior (Davis et al., 2009). Martin & Czellar (2016) extended this with additional visual metaphors including pairs of parallel lines representing "nature" and "self" at varying distances, and a series of circles labeled "nature" moving closer to the center of a cross.

Vining et al.'s (2008) study's participants frequently identified themselves as a part of nature while also often describing nature as being absent of humans and human interference. This challenges other connection to nature studies, implying that even though connection to nature is perceived, individuals may experience a cognitive dissonance which is thought to possibly lead to problematic environmental decision making (Vining et al., 2008). This study, along with other literature, acknowledges the potential impacts that Western ideologies and laws have on the way people see their place in nature. This includes the legacy of Aristotle's Scala Naturae elevating humans in a hierarchical species relationship (Balding & Williams, 2016; Knapp, 2019) and the Wilderness Act of 1964 (Vining et al., 2008) which recognizes wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

Literature has associated the ways in which individuals experience or perceive connection to nature with various influential factors like residential proximity to natural areas, family values, knowledge of the environment, perception of one's ability to help the environment (Cheng & Monroe, 2012), duration of time in nature (Kals et al., 1999; Nisbet et al., 2009;

Vining et al., 2008), experiences in nature, gender, culture, and conditions of one's surrounding environment (Sedawi et al., 2020). The

author of this study was not able to locate studies that explore how humans connect with plants specifically.

Plant Blindness

A named concern for human-plant relationships was defined by Wandersee and Schussler (1999) as "plant blindness." They define "plant blindness" as

> "a) the inability to recognize the importance of plants in the biosphere; b) the inability to see or notice the plants in one's environment; c) the inability to appreciate the aesthetic and unique biological features of the life forms that belong to the Plant Kingdom; and d) the misguided anthropocentric ranking of plants as inferior to animals and thus unworthy of consideration" (p. 82).

"Plant blindness" has been contemplated as causing bias in conservation, resulting in a disparity in labor, funding, public engagement, and policy attention toward animals more than plants (Balding & Williams, 2016; Havens et al.,2014; Sharrock, 2020).

Studies exploring "plant blindness" have found that plants are more difficult to visually detect than animals (Balas & Momsen, 2017), that children tend to prefer animals over plants and not immediately recall plants as living things (Amprazis et al. 2021), and that children tend to over-simplify drawings of observed plants (Comeau et al., 2019). Literature has discussed "plant blindness" as potentially being a biological function caused by evolutionary or cognitive factors or a result of environmental factors like culture, ideologies, and lack of flora representation in curriculum (Amprazis et al., 2021; Balding & Williams, 2016) and media (Comeau et al., 2019).

Multiple strategies have been suggested and explored in addressing "plant blindness." Informed by connection to nature literature, Balding & Williams (2016) recommended fostering connection to plants through empathy and exposing human-like plant traits. Sanders (2019) claimed educators should focus on overcoming perceptual limitations of having to see ourselves in organisms to be interested in them and instead embrace differences. MacKenzie et al. (2019) brought attention to this term as being ableist and limiting. They urged appreciation of plants through multiple senses and emotions and rather than "curing" or "preventing" this perceived deficit, attention should be focused on our pre-existing relationships to plants. Wandersee et al. (2006) recommended a constructivist approach of using student reflections of

plant related childhood memories while teaching botanical subjects. Their study found that this motivated learning and that positive emotional association with plants sparked new awareness and appreciation of plants. Krosnick et al.'s (2018) study found that providing students with a "plant pet" to care for within an educational context encouraged interest in and appreciation for plants and caused students to notice plants in their surroundings more.

Botanical Gardens as an Intervention

In response to human-induced plant diversity loss, the Convention on Biological Diversity (CBD) proposed the Global Strategy for Plant Conservation (GSPC) (Sharrock, 2012). The GSPC vision is "of a positive, sustainable future where human activities support the diversity of plant life… and where in turn the diversity of plants support and improve our livelihoods and wellbeing" (Convention on Biological Diversity, n.d.-c). Their strategy includes Target 14: incorporating plant diversity importance and need for its conservation in communication, education, and public awareness programs (Convention on Biological Diversity, n.d.-b). CBD has looked to botanical gardens as leaders in implementing Target 14 with their ability to reach 500 million visitors per year globally and resources to display and simulate ecosystems (Kneebone et al., 2007; Sellman & Bogner, 2013; Sharrock, 2020).

A report includes a summarized reflection from BGCI's Head of Education, Julia Willison on the position of botanical gardens in this effort:

> "Botanic gardens are ideally placed to demonstrate to the public the importance of the plant/ human relationship and the critical need to protect that relationship as it comes under threat from the long built-up effects of urbanization, industrialization and human-induced climate change." (Dodds & Jones, 2010, p. 26).

In recent years, botanical gardens have increased their focus on public education (Sellman & Bogner 2013) and have implemented programs that address "plant blindness" like citizen science projects and Fascination of Plant Day events (Sharrock, 2020). These widespread programs give attention to the importance of plants through public participation, (Fairchild Tropical Botanic Garden, n.d.; Henderson et al., 2012; Fascination of Plants Day, n.d.) making a productive step toward Target 14 (Sharrock, 2020). But it can be argued that they are not

targeted to general botanical garden visitors who more often have self-guided visits and rarely attend workshops or activities (Gaio-Oliveira et al., 2017).

To reach a wider audience, common visitor behavior and attitudes should be considered when designing for education. Studies show that most botanical garden visitors are motivated in relaxation, enjoyment, aesthetic admiration, and spending time with others and have limited motivation for learning and conservation issues (Ballantyne et al., 2008; Wassenberg et al., 2015). But Wassenberg et al.s' (2015) study suggests that despite this, general visitors find new experiences and learning to be a meaningful part of their visit. Williams et al.s' (2015) study found that a general visit does not tend to impact knowledge, but it can positively influence environmental attitudes.

Informal plant displays can "act as a metaphor for the complex relationships that humanity has with the environment" (Sanders, 2007, p. 1213). Villagra-Islas (2011) identified four trending design strategies botanical gardens are utilizing to interpret ecological processes and human-plant associated environmental issues. These designs include 1) anthropomorphic elements and associations that show how plants are used, 2) arranging plant species in symbolic forms to communicate sustainable landscape use, 3) simulating natural habitats at micro scale, and 4) displaying controlled management of native ecosystem conservation such as burning trees (Villagra-Islas, 2011).

Villagra-Islas raises concerns of these designs possibly not resonating with visitors and calls for further research in audience perceptions and emotional responses to various types of exhibits and their messages. As botanical gardens educate their visitors about conservation, Ballantyne et al. (2008) point out that informal learning at botanical gardens should "not only promote the importance of plants, habitats and conservation, but also influence the attitudes and actions of their visitors" (p. 440). Mayer and Frantz (2004) state that cognitive beliefs in how humans should treat the environment is not enough to shape behavior and that a sense of connection to nature is essential in this. This author was not able to locate studies that aim to explore how visitors reflect on their relationship and connection with plants during a general visit to a botanical garden and what specific elements of the garden contribute to that connection.

Although studies show that botanical garden spaces and programs can be effective in promoting environmental attitudes (Wassenberg et al., 2015; Williams et al., 2015) and knowledge (Sellman & Bogner, 2013), literature has critiqued their nature (Heyd, 2006; Sanders et al., 2018).

Heyd (2006) states that botanical gardens do not act like spaces found in the natural world and that their specimens are presented like artifacts rather than organic and living. He points out that particularly in the 20th century, botanical gardens have functioned as entertaining displays and from this point of view, the relationship between human and plant may be subject to possession/ object. Botanical gardens' role in ex-situ conservation is also thought to resemble "havens from the ravages of human enterprise and carelessness" (p. 201). In this role, they may communicate a relationship of stewardship (Heyd, 2006). As an alternative, Heyd (2006) proposed that botanical gardens model the "collaborative relations between human beings and the natural world" (p.200) and presents the question, "How should we conceive the space in botanic gardens so we do come to reflect on the possibility that we may be partners of plant life and not just its owners or protectors (p. 205)?"

Study Purpose

The purpose of this study was to examine the role of botanical gardens in fostering visitor-plant relationships. This study explored three questions; 1) In what ways do visitors connect with plants while visiting a botanical garden? 2) What aspects of the botanical garden do visitors attribute to these connections? and 3) In what ways do visitors reflect on the roles of plants while visiting a botanical garden?

Methodology

This study used a descriptive survey design (Creswell, 2014) in which data were collected from a sample of individuals to generalize findings to a wider population of botanical garden audiences. The data were collected by interviewing adults who were asked to visit a local botanical garden. This particular botanical garden holds themed gardens that include educational interpretive elements and artwork.

Sampling

Participant recruitment materials explaining the study's purpose and requirements were distributed to various groups known to the researcher via email and social media. Participants were asked to do the following: 1) visit the botanical garden sometime between February and March, 2) take photographs of a plant or group of plants they felt a connection with and something in the plant's surrounding area that

contributed to this feeling, and 3) email the photographs to the researcher so that they can be referenced in the follow up interview. This method was based on Hitchings and Jones' (2004) use of photographs to help study participants recall and talk about their relationships with plants.

Data Collection

Data were collected through interviews that lasted approximately 20 to 30 minutes (see Appendix A). The interview structure was organized in three parts. Part one explored visitors' reflection of their experience and relationship with the plant(s) they felt a connection with at the botanical garden. Part two investigated environmental and exhibit design factors that contributed to them feeling connected with plant(s). Part three collected visitor demographic data. Interviews occurred on Zoom or over the phone while the participant and interviewer looked at the pre-interview task photographs.

Participants

Data were collected from thirty-one participants. These participants ranged in age from twenty-two to seventy-six with a mean average of fifty-one years old. Ninety-four percent (n=29) identified their gender as female (with one individual using the term woman) and six percent (n=2) as male. Eighty-one percent (n=25) identified as white or Caucasian, six percent (n=2) Asian, three percent (n=1) mixed, three percent (n=1) Hispanic, three percent (n=1) white and Hispanic, and three percent (n=1) European American. When participants were asked if they had any disabilities, ninety percent (n=28) said no and ten percent (n=3) said yes.

When asked if they had worked in a professional field that involves plants or ecology, forty-eight percent (n=15) said no, thirty-nine percent (n=12) said yes, and thirteen percent (n=4) mentioned that they have as a volunteer or intern. When asked if they had studied plants or ecology, thirty-nine percent (n=12) said no, thirty-two percent (n=10) said yes, and twenty-nine (n=9) mentioned that they study the topics informally. When asked how many times they visited any botanical garden in the last two years, answers ranged from one to one hundred, with a mean average of eighteen times.

Data Analysis

Participants' responses relating to the three research questions were analyzed by identifying trends and patterns as emergent themes which were assigned a numerical code. These codes identified the qualitative data which was then analyzed for frequencies.

Interview excerpts in the results section were edited to omit conversational pauses and backtracks for readability.

Positionality

As the researcher and author of this study, I hold the perspective of a US born, University of Washington graduate student with a mixed background. Experiences and ways of knowing connection to nature and plants are diverse and it is worth acknowledging that the context this research is approached in holds a dominant Western perspective.

Results

1. In what ways do visitors connect with plants while visiting a botanical garden?

Participants were asked to take a photograph of a plant or a group of plants that they felt a connection with during their visit to the botanical garden, and then to describe that connection in the interview. Four themes emerged from their responses: 1) emotional, 2) sensory appreciation or observation, 3) association, and 4) learning or inspiration. Because some participants expressed more than one of these themes in their answers, the sum of frequency of themes mentioned exceeded 100%.

Thirty-five percent (n=11) described their connection as the plant(s) being a catalyst for experiencing an emotion. These emotions were generally positive: happy, grateful, hopeful, peaceful, anticipation, and emotional wellbeing. One participant described their connection saying, "...I felt kind of, like, grateful toward it because it was so pleasant and pleasing and transporting." Another participant said, "...to the particular plant it was more of a happy connection. It made me smile. It was almost like I wanted to be a fairy myself and small and childlike and be there in their presence in that whole environment." Feelings of hope and gratitude were expressed by a participant responding, "I think the connection again was kind of this feeling fortunate. And feeling, I don't know, sort of, very hopeful that, you know, there's this cold weather now and it's earlyish February, but this season is going to pass..."

Thirty-two percent (n=10) based their description in sensory appreciation or observation of the plant(s). One participant described this saying,

> "...I think again it's because, you know, when you would expect a garden to be least interesting is where you find some of the most interesting nuggets. And so, I think showy bark on trees is one of those things that allows you to appreciate it year-round."

Another participant said, "I guess just appreciative." When asked what it was about the plant that they appreciated they said, "I guess the amount, and the stages, and the beauty."

Twenty-three percent (n=7) described the connection as the plant being an association with a time, place, or person. These included associations with childhood, adolescence, a spouse, a community member, or a familiar place. One participant talked about their connection being an association with another time and place in their life:

> "Anytime I see a daphne I see the house I grew up in with this plant by the stairs that we had...you know how sometimes you hear a song that connects you to your past, but you're listening to it in the present. Well, this is sort of that I would say, is sort of like, this plant connects me between those two time periods."

Another participant said,

> "...it was definitely a connection to sort of my past self or my inner child in a way... and now I associate it, not just with me as a kid playing in the woods, but also like, why I kind of was drawn towards the Pacific Northwest in that it has these sort of beautiful whimsical forestscapes that really excited me."

Nineteen percent (n=6) described plants as being subjects for them to learn about and others described them as inspirations for learning. For example, one participant said, "...it felt like a learning moment where I acquired this new knowledge about something that I might see other times my life." Another participant said,

2. What aspects of the botanical garden do visitors attribute to these connections?

What contributes to connection?

Participants were asked if anything in the plant's surrounding area contributed to their feeling connected with them. Ninety-three percent (n=29) said that there was an aspect of their surroundings that contributed to their feeling of connection. From their descriptions six themes emerged: 1) other plants, 2) non-biological natural elements, 3) paths, 4) man-made structures, 5) other visitors, and 6) signs. Some participants expressed more than one of these themes in their answers.

Of the participants who said that something in the plant(s)' surrounding area contributed to their connection (n=29), thirty-seven percent (n=11) mentioned other plants in the area as being an element influential to their experience. They described other plants acting as elements that set a scene or made the plant(s) they connected with stand out with how they either complimented or contrasted each other. One participant talked about contrasting elements of two species influencing their connection:

> "...I was kind of surprised that bamboo can just grow there. Whereas, you know, ten steps away, it's a completely different type of plant, it's like a Northwest plant, right? ... And then here you turn ninety degrees and it's a tropical plant... I almost can do the pivot and then my memory will shift..."

Another participant said, "...I think that was part of what made me feel connected to this area was that it was just so green and so lush for being still winter... there were lots of ferns around and lots of other evergreens."

Thirty-one percent (n=9) of the twenty-nine participants said non-biological natural elements contributed to their connection. These included rocks, water features, wind, natural light, and shadow. One participant stated, "...I was really enjoying the shadow of the catkins on the ground..." Another participant responded, "Perhaps just surprised that it was in with the rocks and blooming. Because I always thought of it as a cactus kind of area."

Twenty-four percent (n=7) of the twenty-nine participants said that paths contributed to them feeling connected with the plant(s). Participants referred to paths controlling their gaze and allowing them to get close or view multiple perspectives. One participant said "Well, there was a trail nearby so I could access it." Another participant

responded, "...the path went all the way around the grove of cedars, so you could easily see them from all angles..."

Twenty-one percent (n=6) of the twenty-nine participants said that man-made structures were a contributing factor. These included architectural or artistic features that added extra interpretation to experience a connection with the plant(s). One participant referred to a structure resembling features of a plant saying, "...I feel like the cherry blossom and that structure really went together well... when you go into the structure you just like see all these specks of light everywhere, almost like the flowers."

Fourteen percent (n=4) of the twenty-nine participants referred to other visitors as being something that contributed to their experience connecting with a plant. This included the presence of visitors or the absence of visitors having a positive impact. One participant said, "...there was a lot fewer people. So that kind of encouraged sort of more engagement..." Another participant said

> "...another mom with two or three girls were there and they noticed a bird is on that tree, too...so again, that's the community together, but separately enjoying the tree. So that also makes us to have that connection, invisible connection with other observers, too."

Eleven percent (n=3) of the twenty-nine participants mentioned signs contributing to their experience. This included informational signs about the plants' species, thematic category, or a donor plaque that referred to a familiar person. One participant said,

> "...there was a sign just about the importance of native plants and some examples and so that had already gotten me thinking, I was kind of attuned to, okay, the plants around here are native plants, they are ancestral to this land, they have evolved here and are probably interacting with each other a lot as a result of that..."

Of the thirty-one total participants, six percent (n=2) said that nothing else in the surrounding area contributed to them feeling connected with a plant or a group of plants. These responses expressed the plant(s) themselves being the sole influence. One participant expressed this saying "No, it was totally the fragrance that hit me."

Participants were given another opportunity to answer this question by being asked if any other plants or objects around or nearby contributed

to them feeling connected with a plant or group of plants, but no new themes emerged in analysis of those responses.

Presence of information

The next question asked whether there was any information provided in the plant(s)' area and if it contributed to the participant feeling connected with them. Sixty-eight percent (n=21) said that there was either no information that they noticed or that whatever information that was provided did not play a role in their experience connecting with the plant(s). One participant said "I didn't notice any information in this area. I looked at a lot of information in the other areas, that was interesting. But this was just more of an emotional draw to these different plants." Another participant responded, "...what I'm most curious about when I'm looking at plants is identifying and learning more about the particular one I'm looking at and I don't remember seeing any signs, particularly about these plants."

Thirty-two percent (n=10) said that there was information near the plant(s) and that it contributed to feeling a connection. One participant responded,

> "I would say absolutely for the rose. That really solidified my interest in it is that I got to learn this like tiny little fact about it that expanded my understanding of it and give me this context...that sign was absolutely instrumental on that."

Design of the space

Participants were also asked if there was anything about the design of the space that they thought contributed to them feeling connected with the plant(s). Ninety percent (n=28) responded in the affirmative and analysis of their responses revealed five emergent themes: 1) paths, 2) the composition of surrounding physical elements, 3) empty or open space, 4) lack of formal design, and 5) lighting and atmosphere. Some participants expressed more than one of these themes in their answers. The other ten percent (n=3) of participants said that design did not play a role or did not refer specifically to their experience at the botanical garden.

Forty-two percent (n=13) said that the design of the paths and its control of their movement and perspective played a role in their experience connecting with the plant(s). This included statements

about path design allowing close proximity to the plant(s), being accessible, encouraging engagement, providing multiple perspectives, and controlling pace. One participant said,

> "Well, the fact that you can kind of wind around and get around things...you can get around other sides of plants and trees because it's a kind of a small space but you don't have to tromp on anything to do that..."

Another participant said,

> "...probably the way the path didn't go straight, that it curved, but yet it wasn't a wild feel to it, it was a very thoughtful, clean, but inviting... I didn't know what was around the next corner, I was enjoying it, I didn't feel rushed."

Twenty three percent (n=8) referred to the composition of surrounding physical elements. This included the arrangement of other plants, non-biological natural elements, and man-made structures creating contrast, a visually pleasing experience, a sense of scale, or an engaging scene. One participant referred to the contrast between the plant they felt a connection with and another plant nearby. They explained, "...the contrast sort of gives you a connection, because the brain likes to see things that are novel and different. And then, once it's gotten your attention, then you make the connection." Another participant discussed the arrangement and quantity of plants playing a key role in their experience saying, "They're all separate bunches...there's enough where all I see in front of me is all different heights and different thickness and different arrangement of the bamboo that created the sense of vastness which kind of triggers the memory..."

Nineteen percent (n=6) said that open or empty space contributed to their experience. This included empty space around the plant(s) which made it stand out or encourage interaction. "I think it helped that there was open area around it, so that really made it possible to see it really like in this kind of a dramatic way..."

Six percent (n=2) stated that lack of formal design made appealing spaces that gave it a natural look. For example, one participant responded,

> "It's an area that looks very much like a lot of the sort of forgotten bits throughout Seattle, the little ravines. I mean it's a design, you know somebody made the

> purpose of not over designing it, I guess, or not creating more formalized beds, so I think that was attractive…"

Lastly, another six percent (n=2) expressed that the lighting and atmosphere contributed to their experience. One participant responded,

> "I think the design of the space was nice because it was a lot brighter. A lot of the other parts of the garden went through like forested paths which are really nice but being in Seattle it's really nice to have that direct sun contact when it's out."

3. In what ways do visitors reflect on the roles of plants while visiting a botanic garden?

Role of plants in participants' lives

Participants were asked if and how they thought about their relationship with plants in terms of the roles they play in each other's lives in the experience of connecting with a plant. Forty-two percent (n=13) only mentioned thinking about the role plants played in their life, either as a source of wellbeing, enjoyment, inspiration, or influencing their surroundings. One participant said,

> "…I have a feeling that there's much more biodiversity here than when I was living in the Boston area and definitely a lot more flowers in the winter, so I kind of was thinking about how it shapes my surroundings."

Another talked about the effect of plants on behavior and wellbeing,

> "…I thought about it probably in the first way, which is, you know, how being outside and practicing observational skills, really focusing in on the details that nature provides us, can help you slow down, be more meditative, be more focused, be more calm."

Thirty-five percent (n=11) expressed a mutual sense of connectedness between plants and humans in which both human and plant roles were thought about. These answers referred to roles of larger society or provided a specific or generalized interpersonal connection. Stating a generalized connection, one participant said, "Well, I think I did, because I always do when I'm in nature. Just that it's very much a

reminder of the primacy of nature and that we're a part of nature…" After asking to clarify the directionality of the role they were thinking about they responded, "I think it's mutual for sure. Yeah. I do believe in many ways it's all interconnected…" Describing a specific mutual connection between plant and self, one participant said,

> "I think just how this plant has played into an early formative experience of my own, sort of getting interested in plants and also how I've used this plant in education and how I just love it. And so, then I hope my enthusiasm and the information that I can share with other people help them have more of a response to the natural world."

Nineteen percent (n=6) said they did not think about either the role plants play in their life or the role they play in the life of plants in this experience. An example of this was one participant saying, "Not based just on seeing that plant, no. I mean it is something I've thought about, but I wasn't inspired to think of it based on that plant."

Six percent (n=2) only mentioned thinking about the role they play in the life of plants. For example, one participant said, "…especially with the hellebores, because mine aren't doing as well as those are, so I was like, what could I do that they were doing for these plants?"

Role of plants in the world

To expand the reflection of plant roles beyond interpersonal relationships between visitor and plant, the next question asked if they thought about the importance of plants for the world around us or the environment, clarifying if needed, if the thoughts happened in this experience. Forty-five percent (n=14) said that they consciously thought about the importance of plants for the world around us or the environment. Responses reflected the importance of plants (with some mention of gardens in general) for both human life and the natural environment. One participant stated, "…I was quite taken aback with all the people who were enjoying the space…that's kind of a gift to the community for sure…" Another participant responded, "This one was on a slope, so I was kind of thinking about like the importance of roots to kind of hold things together…"

Forty-two percent (n=13) said they did not think about this in their experience. One participant said, "No. I just enjoyed walking around." Another expressed,

> "No, I wasn't thinking about that... I would have a very different reaction if I stumbled on a native plant I had been looking for I've never seen in nature... But in gardens to me, managed gardens like this are something else. There I care about the aesthetics."

Thirteen percent (n=4) said they thought about the importance of plants on a subconscious level. One participant said, "Well, I can't say I was actively thinking that. I mean, it's a part of my general consciousness, I guess I'd say, and it may have been there on some level, but not actively."

Discussion

1. In what ways do visitors connect with plants while visiting a botanical garden?

Findings from this study suggests that visitors' connection with plants at botanical gardens are more often emotional or sensory than they are cognitive. This finding relates to studies that describe and measure individuals' emotional connection to nature (Cheng & Monroe, 2012; Kals et al., 1999; Vining et al., 2008). It also suggests that connection to plants can be used to leverage learning strategies discussed in the literature like addressing "plant blindness" with empathy (Balding & Williams, 2016) or increasing awareness of plants through emotions (MacKenzie et al., 2019). The finding that participants experienced a sensory appreciation connection to plants speaks to conversations in the literature about concerns of "plant blindness" as a lack of appreciation or awareness of specificity of biological plant features (Comeau et al., 2019; Wandersee & Schussler, 1999).

This study also suggests that visitors connect with plants cognitively. These connections appear to be based in associations and learning or inspiration. Learning or inspiration as a connection to plants relates to literature that describe one form of connection to nature as being interested in nature (Kals et al., 1999). This was also the least commonly experienced connection in this study. This finding contributes to conversations in the literature around learning in botanical gardens where on one hand general visitors are unmotivated to learn (Ballantyne et al., 2008) and will often not gain knowledge from a visit, but learning is a meaningful outcome for visitors (Wassenberg et al., 2015) and will more likely be in the form of influencing attitude (Williams et al., 2015). Association diverges from how studies typically describe connection to nature like enjoyment in nature, interest in

nature, emotional affinity, sense of oneness, sense of responsibility, or empathy (Cheng & Monroe, 2012; Kals et al., 1999; Mackay & Schmitt, 2019; Vining et al. 2008). This may suggest something unique to experiences with plants or at botanical gardens. It also supports research that found associating plants with childhood memories can positively impact botanical learning (Wandersee et al., 2006).

Emotional, sensory appreciation or observation, association, and learning or inspiration connections with plants exclude other descriptions of connection to nature found in the literature like sense of oneness, sense of inclusion, or sense of responsibility (Cheng & Monroe, 2012; Vining et al., 2008; Davis et al., 2009; Mackay & Schmitt, 2019).

2. What aspects of the botanical garden do visitors attribute to these connections?

The two most common botanical garden elements that contributed to connection with plants were other plants and non-biological natural elements. This finding can be used to leverage the botanical garden exhibit design strategy of micro-scaled natural habitats to communicate human-plant-environment relationships (Villagra-Islas, 2011).

Man-made structures were a less common surrounding element that contributed to connection. This finding could suggest a potential barrier to the design strategy of using anthropomorphic elements and associations to illustrate human-plant relationships (Villagra-Islas 2011). This finding may also relate to the dissonance of connecting to nature while also claiming nature as being absent of human influence (Vining et al., 2008).

With over two-thirds of participants saying that the presence of information did not play a role in connecting with plants and the least common effective display element being signage suggests that written interpretation may not be the primary means of fostering visitor-plant connections for most general visitors. However, it is worth noting that for some, signage influenced awareness of the plant(s) they felt a connection with. These findings pose a consideration to the seventy-five percent of botanical gardens that use interpretation panels for educational communication (Gaio-Oliveira et al., 2017).

The most common spatial design element for contributing to connection with plants were paths controlling visitor movement and perspective. To inform future studies, landscape literature that speaks

to this may be worth reviewing. One example is a study by Jallouli & Moreau (2009) on wind turbine landscapes which found path proximity and progression through a landscape influenced how participants perceived wind turbines.

3. In what ways do visitors reflect on the roles of plants while visiting a botanical garden?

This study suggests that botanical garden visitors are more likely to think about the role plants play in their lives than how they might play a role in the life of plants. This relates to research that found participants describing themselves as being connected to nature while also perceiving the natural environment as absent of human involvement (Vining et al., 2008). It also relates to literature that found human related impacts like pollution as the least common theme addressed in botanical garden education (Gaio-Oliveira et al.'s, 2017). Thoughts about mutual roles between self and plants occurred in approximately one-third of participants, suggesting that it is not a frequent thought for general visitors. This finding provides a consideration for literature suggesting that botanical gardens should be aiming to communicate reciprocity and partnerships with plants to promote and educate sustainability (Villagra-Islas, 2011; Heyd, 2006; Sanders et al., 2018).

About half of the participants thought about the importance of plants for the wider world while occasionally describing their thoughts as being subconscious. This occurred less frequently than thoughts about self-plant roles. This finding contributes a consideration to literature that discusses implementing educational objectives that relate to awareness of the importance of plants for both human life and the wider biosphere. (Convention on Biological Diversity, n.d.-b; Wandersee & Schussler 1999). It may also reflect a critique found in the literature as botanical gardens appearing as separate and non-representative of the outside world (Heyd, 2006).

Limitations

COVID-19 guidelines at the botanical garden limited access to the site and therefore recruitment options. Participants were self-selected which may have skewed the sample and not reflect the general botanical garden audience. Participants were also asked to engage in a task during their visit, so the visit was not unmitigated and might not reflect typical general visitor behavior.

To fully participate in the study, subjects had to take digital photographs and share them via email. This study's reliance on technology posed a limit for potential subjects who may not be familiar or comfortable with these activities' digital applications.

The large majority of this study's audience are white or Caucasian women who do not identify as having a disability, meaning the findings provide a limited perspective and should not be used to determine what general audiences are experiencing. More representative diversity is needed in future studies.

Implications

Further research into the role of botanical gardens in fostering visitor-plant relationships may benefit from seeking a better understanding of emotional connections with plants by reflecting connection to nature descriptions such as emotional affinity, virtue of affect, and empathy. The research can also go further to investigate if connection with plants predicts or indicates plant conservation attitudes or behaviors. Since botanical gardens and conservation organizations are interested in promoting plant diversity specifically, future studies should explore visitor perceptions of their relationship and connection to plant diversity rather than just a single or limited group of plants.

Highlighting the role of humans in the lives of plants could create opportunities to learn about the role of self and human influence, addressing what seems to be missing in the human-plant mutualism reflection. Botanical garden practitioners could also further investigate educational communications that go beyond written interpretation and signage for general visitors and invest more consideration of the role of pathways and compositions of physical elements in relation to plants as informal learning opportunities. Botanical garden educators and exhibit designers could motivate learning by leveraging how visitors connect with plants through associations by using strategies similar to Wadnersee et al.'s (2006) constructivist method and encourage visitors to relate plants to personal memories. Practitioners can also create interpretations that incorporate emotional learning as a way to encourage the development of connection to plants or as an impactful supporting element to cognitive learning opportunities about sustainable human-plant relationships and the importance of plant diversity.

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Appendix A*

Post-Visit Zoom Interview:

Relationship reflection:

For your visit to the botanical garden, you were asked to take some photos of a plant or group of plants that you felt a connection with and some things in the plants surrounding area that contributed to that feeling and I'm going to ask you some specific questions about them. I am going to share my screen so we can look at these photos together.

1. When you were at the garden taking these photos was it a single plant or group of plants you felt that connection with?
2. Why did you take a photo of that plant?
3. What were you thinking about when you were looking at this plant?
4. How did you feel when looking at this plant?
5. How do you see this plant being of interest to you?
6. How would you describe your connection to this plant when you took this photo?
    a. Did you think at all about what role plants play in your life or what role you play in the life of plants? (Clarify, in this experience.)
    b. Did you think at all about the importance of plants for the world around us or the environment? (Clarify, in this experience.)
7. Did you talk to anyone about this plant during your visit? The effect of the exhibit/ display:

Thank you for sharing the experience you had with this plant(s). You were also asked to photograph something in the plant's surrounding area that may have contributed to you feeling connected to this plant. Now I am going to ask questions about how this aspect has, or may not have, played a role in your experience.

1. Do you remember which exhibit this plant was in? (Probe: or general area.)
2. Think back to where you were in the botanic garden when you took this picture. Can you think of anything in that area that might have contributed to your feeling connected with this plant?
3. Was there any information provided in this plant's area and did that contribute to you feeling connected with it?
4. Were there other plants or objects around or nearby that might have contributed to you feeling connected to this particular plant?

5. Was there anything about the design of the space that you think contributed to you feeling connected with it?

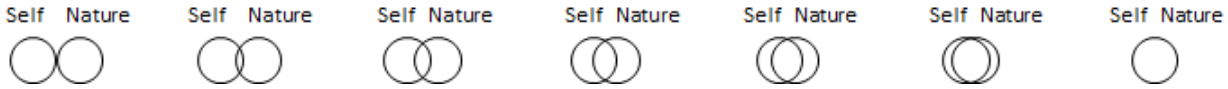
6. Think about how this plant was being presented to you. When the botanic garden designed the space that this plant was in, what do you think they wanted visitors to think about?

7. Did you have an opportunity to get close to this plant?

8. Can you recall any sensory experience you had with the plant? Like touch, taste, sight, sound, smell?

Demographic Questions:

1. In what year were you born?
2. What gender do you identify as?
3. What race or ethnicity do you identify as?
4. Do you have any disabilities?
5. Did you visit the garden with anyone else that day?
6. How many times have you visited any botanical garden in the last 2 years?
7. Have you or do you work in a professional field that involves plants or ecology?
8. Have you or do you study plants or ecology?
9. **Please choose the picture which best describes your relationship with the natural environment.



*Not all questions were used for analysis.

**This image was used from the Martin & Czellar (2016) Extended Inclusion of Self in Nature.