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Talking Trees:

Can anthropomorphising trees promote urban tree advocacy by increasing our cognitive understanding of their functions and our emotional connection to them?

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This thesis is dedicated to my family—Samuele, Donatella, and Franco—the steadfast roots from which this scholarly endeavor has flourished.

Abstract

Anthropomorphism, the attribution of human-like characteristics to non-human entities, has been explored as a communication strategy to enhance environmental engagement. This study examined the effects of anthropomorphism on urban tree advocacy intentions and behaviour, considering both cognitive understanding and emotional connection as potential mediators. Using an experimental design, participants (N = 242) were randomly assigned to one of three conditions: a control group, a moderate anthropomorphism condition, or a strong anthropomorphism condition. Data was collected via an online survey and analysed using descriptive statistics, reliability analyses, MANOVA, logistic regression. The analyses revealed that both the moderate and strong experimental manipulation of anthropomorphism (ANT) had no significant effect on emotional or cognitive responses, nor on tree advocacy intention or behavior. Consequently, no support was found that anthropomorphised messages (compared to a neutral message) can promote tree advocacy behaviour. Due to the lack of a main effect, the planned mediation analyses were not conducted. However, the effects of cognitive and emotional effects on tree advocacy behaviour and intentions were significant. These findings contribute to the body of literature exploring the effects of anthropomorphism within environmental communication, with implications for conservation campaigns and public engagement strategies.

keywords: Anthropomorphism, environmental communication, urban tree advocacy, mediation analysis, conservation psychology

Talking Trees:

Can anthropomorphising trees promote urban tree advocacy by increasing our cognitive understanding of their functions and our emotional connection to them?

Demographic projections indicate that by 2050, 68% of the world's population will reside in urban areas (UN, 2019). Simultaneously, urban greenery per capita is declining. A study focusing on the Netherlands' largest municipalities revealed a 24% decrease in public green space per household over the past five years (Natuur en Milieu & Sweco Nederland, 2024). Considering that green spaces have a multitude of beneficial impacts on a city and its inhabitants, including the aid of psychological well being, cleaning the air from pollutants, and reducing heat island effects (Mullaney et al, 2015; Wolch et al, 2014), their decline should be addressed quickly to ensure the health and safety of urban dwellers.

While urban green spaces are widely recognised for their environmental benefits, there remains a notable gap between this recognition and active advocacy for their preservation. Too little action is currently being taken to increase urban greenery. One explanation for this inaction lies in the way urban trees are perceived—not as valuable components of the city ecosystem, but as nuisances that damage infrastructure and require costly maintenance (Moffat, 2016; Mullaney et al., 2015). These prevailing attitudes obscure the substantial benefits trees provide, reinforcing the notion that they are liabilities rather than assets. This disconnect is particularly pronounced in urban populations, who often have limited access to nature and therefore fewer opportunities to develop positive associations with it (Gifford, 2011; Mullaney et al., 2015). Despite valuing cities for their cultural diversity, economic opportunities, and educational prospects, many residents experience a psychological distancing from nature. This transformation extends beyond the physical reduction of green spaces, affecting human psychology and behaviour in profound ways. Pyle (1978) conceptualised this shift as the "extinction of experience"—a progressive

disconnection from nature marked by reduced emotional connection to and weakened understanding of ecological processes (Soga & Gaston, 2016).

This phenomenon creates a self-reinforcing cycle wherein urban dwellers, having limited interaction with nature, become less aware of and appreciative of its benefits. Consequently, they not only engage with nature less frequently, but also come to accept the absence of green space as the norm, rather than recognising what is being lost. This leads to passive acceptance rather than active advocacy for the preservation or expansion of urban green spaces (Restall & Conrad, 2015; Martin et al., 2020). The critical question then becomes: how can we effectively motivate people to break this cycle and actively engage in protecting urban nature?

One promising approach to reinforce understanding and emotional connection when communicating about nature is anthropomorphism (ANT), the attribution of human qualities to non-human entities. Previous studies have shown how ANT can foster a sense of connection towards nature, which ultimately leads people to behave more environmentally friendly (Yang et al., 2023; Tam et al., 2013; Tam, 2014; Tam et al., 2019; Williams et al., 2021). ANT operates through two complementary pathways. First, by aiding cognitive understanding of the functioning processes of the anthropomorphised subject. This process allows us to dissolve the psychological barriers that make us feel like we are not competent enough to address the situation at hand i.e. self efficacy beliefs (Morewedge et al, 2007; Gučas & Dahlbäck, 2019; Waytz et al, 2013). Secondly, by enhancing emotional connection toward the anthropomorphised subject (Epley et al, 2007). Through these dual mechanisms, ANT can potentially overcome both the knowledge deficit and emotional disconnection that characterise the extinction of experience phenomenon. However, the effectiveness of anthropomorphising specifically trees has yet to be fully explored. The current study will investigate whether communicating the role of trees within urban environments in human

terms will enhance participants' understanding and emotional connection towards them, potentially activating both cognitive and affective pathways to pro-environmental behaviour.

Anthropomorphism: Definition, Psychological Dimensions, and Communicative Potential

Anthropomorphism (ANT) refers to the tendency to attribute human characteristics, emotions, or intentions to nonhuman agents (Epley, Waytz, & Cacioppo, 2007). This psychological process is common and often intuitive. For example, someone might interpret their computer as “refusing to cooperate” when it crashes unexpectedly, or feel as if a pet is “guilty” after chewing a shoe. These interpretations reflect a broader cognitive habit: people tend to rely on their own internal experiences to make sense of the world around them, including nonhuman subjects.

The activation of anthropomorphism is influenced by both internal and external factors. Internally, characteristics such as age, personality traits, or psychological states like loneliness and uncertainty can increase the likelihood of anthropomorphising. Externally, the features of the subject itself—such as its ability to move, express emotion-like behavior, or appear life-like—can make it easier for observers to project human traits onto it. These factors do not mean that anthropomorphism is always deliberate or effective; rather, they reflect the underlying tendency shared by most people, which is activated more readily under certain conditions (Epley et al., 2007).

Two key psychological motivations help explain why people anthropomorphise: cognitive and emotional. Cognitively, anthropomorphism can serve the function of increasing understanding. When individuals are faced with something unfamiliar or complex, attributing human-like features to it can make it more relatable and predictable. This process, often referred to as effectance motivation, reflects a basic human desire to comprehend and control one’s environment (Waytz, Cacioppo, & Epley, 2010). By interpreting the behavior of a

nonhuman agent in human terms, individuals apply familiar mental frameworks to unfamiliar stimuli. For instance, most people would find it easier to describe a group of monkeys as "playing" than they would a group of chairs arranged in a circle, as the concept of play is deeply rooted in human experience and more applicable to living beings.

In addition to enhancing comprehension, anthropomorphism also fulfills emotional needs. Specifically, it can satisfy the motivation for social connection—commonly referred to as sociality motivation (Epley et al, 2007). This has been particularly evident in studies examining loneliness. Individuals experiencing social disconnection are more likely to anthropomorphise objects, animals, or technologies in an attempt to meet their unmet affiliative needs (Caruana, De Vries, & De Dreu, 2021; Tanrikulu & Dortyol, 2024). In such cases, anthropomorphism allows for the simulation of companionship by engaging emotionally with a nonhuman entity. Epley et al. (2007) argue that this dynamic reflects a broader pattern in human behavior: when social needs are not being met through interpersonal relationships, individuals turn to alternative agents that are easier to humanise.

Moreover, anthropomorphising nonhuman agents not only fulfills social needs but also elicits emotional responses typically reserved for human relationships. When people ascribe thoughts, feelings, or intentions to a nonhuman subject, they are more likely to develop empathy, connection, or care toward it. For example, Cooremans and Geuens (2019) found that participants responded more positively to misshapen fruits and vegetables when these items were given smiling faces and described using human-like traits. The anthropomorphised produce elicited emotional reactions that, in turn, increased participants' willingness to purchase them. Similarly, Jesse and Schwarz (2010) demonstrated that individuals who anthropomorphised their cars were less likely to replace them, as they developed a stronger emotional connection and perceived doing so as a form of abandonment.

These examples illustrate how anthropomorphism operates not only as a cognitive shortcut but also as an emotional amplifier. When a subject is anthropomorphised, it becomes more comprehensible and more emotionally salient, increasing both understanding and connection. These effects are not mutually exclusive; in fact, they often reinforce one another. The easier it is to understand a subject, the more likely we are to care about it—and vice versa.

Given these dual functions, anthropomorphism has gained attention as a potentially powerful communicative strategy. Although anthropomorphism itself is a psychological tendency, it can be deliberately activated in communication by emphasising features that encourage human-like interpretation. This distinction is important: while people vary in their dispositional tendency to anthropomorphise, communication can make anthropomorphic interpretations more likely by highlighting familiar traits or emotional cues. For instance, Midden and Ham (2009) found that when a robot delivered feedback about its energy use in an anthropomorphic manner, participants were better able to understand the information. Although this example reflects a communication strategy, it relies on the same underlying mechanism—making the unfamiliar more familiar by drawing parallels to human behavior.

In environmental communication, this approach may offer particular value. Many ecological issues are abstract, complex, or emotionally distant from people's everyday lives. Anthropomorphising nonhuman elements of the environment—such as trees, rivers, or animals—can help bridge this gap by fostering understanding and emotional connection. In the context of the present study, anthropomorphism may therefore function as an effective means of conveying the benefits of urban trees, by creating the opportunity for emotional connection and aid understanding. This in turn, might increase conservation behaviour in the form of urban tree advocacy.

The Present Study: Talking Trees

Studies within sustainability science have shown that anthropomorphic messages can indeed increase conservation behavior. For instance, anthropomorphising nature has been found to enhance feelings of connectedness to the natural world (Tam et al., 2013; Yang et al., 2023), increase environmental guilt when harm is inflicted (Tam, 2019), and heighten perceived efficacy in engaging in protective behaviors (Tam, 2014). These effects appear to operate through both emotional and cognitive pathways, suggesting that anthropomorphism may trigger not only affective concern but also a deeper understanding of environmental systems. However, the majority of this research has focused on broad, often personified abstractions such as "Mother Nature" or "the planet" (Williams et al., 2021), or on animals whose similarities to humans make them easy targets for empathy (Apostol et al., 2013; Díaz, 2016). In contrast, plants—and trees in particular—have received limited attention in this domain, despite their ecological importance and visibility in urban environments.

The relative neglect of trees in anthropomorphism research may be due to inherent challenges in anthropomorphising them. From a cognitive standpoint, the lack of shared behaviors or facial features between humans and trees limits the ease with which people can apply human-like schemas (Epley et al., 2007). Moreover, the phylogenetic distance between humans and plants, which is considerably greater than that between humans and animals, has been shown to correlate negatively with empathy (Miralles et al., 2019). As a result, trees are often perceived as passive or even inanimate, undermining emotional connection.

Despite these challenges, trees offer a compelling subject for anthropomorphic messaging, particularly within urban settings. As the most common form of nature in cities, trees are visible, familiar, and functionally important: they mitigate air pollution, cool city streets, and provide crucial ecosystem services (Mullaney et al., 2015). Yet, these roles are often overlooked or misunderstood by the public. By framing trees in human terms—such as

referring to the chemical reactions between roots as “talking to each other” or their leaves as "lungs" that clean our air—we may be able to bridge the gap between human cognition and plant biology. This study seeks to test this possibility.

Specifically, we examine whether anthropomorphic descriptions of trees can enhance advocacy for urban tree protection and maintenance. Advocacy is defined here as a set of civic behaviors including signing petitions, opposing tree removal in development projects, sharing educational content, and volunteering for tree maintenance initiatives. We propose that anthropomorphic messages may increase both emotional connection (e.g., by evoking gratitude or protectiveness) and cognitive understanding (e.g., clarifying ecological functions), which in turn could enhance support for such actions. Based on this rationale, the present study proposes the following hypotheses:

H1: *Anthropomorphic descriptions of trees, compared to non-anthropomorphic descriptions, increase urban tree advocacy.*

H2: *Anthropomorphic descriptions of trees increase cognitive understanding of trees' ecological roles.*

H3: *Anthropomorphic descriptions of trees increase emotional connection to trees.*

H4: *The positive effect of anthropomorphic messaging on tree advocacy is mediated by both (a) enhanced cognitive understanding and (b) increased emotional connection.*

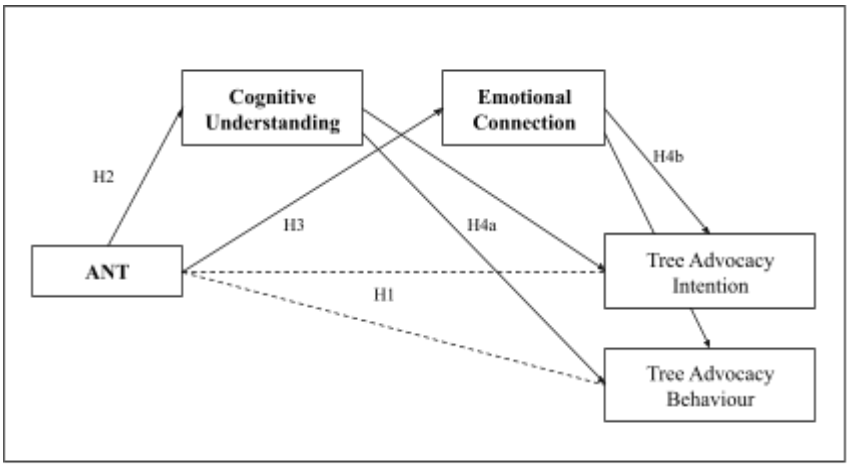

Figure 1. Model of the theorised relationships between the variables as relating to hypotheses 1- 4

Moreover, considering the phylogenetic and perceptual distance between humans and trees, we explore whether varying the degree of anthropomorphism affects audience responses. Prior research suggests that overly anthropomorphic messages may be perceived as childish or untrustworthy, particularly among adults (Tam, 2014; Yang et al., 2023). Accordingly, we designed two levels of anthropomorphism: a strong anthropomorphism condition using first-person narrative (e.g., "I'm a tree, and I work hard to clean your air") and a moderate anthropomorphism condition that anthropomorphises function but retains a third-person perspective (e.g., "A tree breathes and works hard to clean the city air"). This exploratory component leads to additional hypotheses:

H5: *Different styles of anthropomorphic messaging (strong vs. moderate) yield differential effects on urban tree advocacy.*

H6: *Different styles of anthropomorphic messaging yield differential effects on cognitive understanding of tree functions.*

H7: *Different styles of anthropomorphic messaging yield differential effects on emotional connection to trees.*

H8: *Cognitive understanding and Emotional connection have differential effects on participants' likelihood of engaging in tree advocacy.*

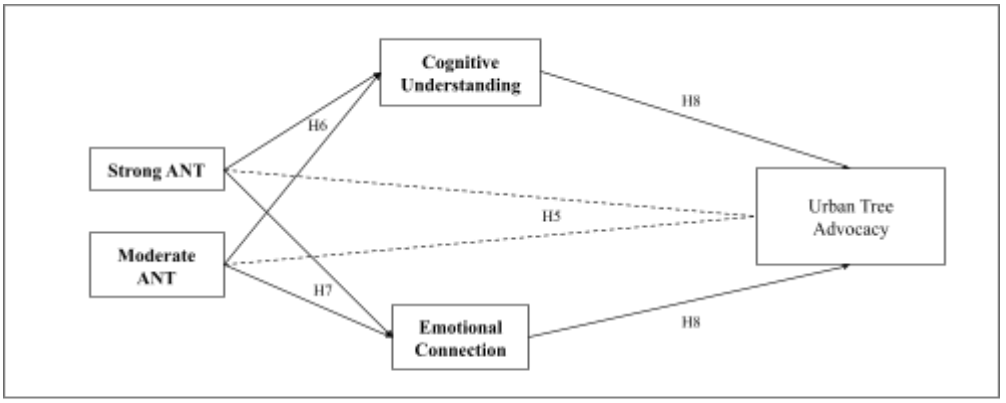

Figure 2. Model of the theorised relationships between different levels of Anthropomorphism and the variables as relating to hypotheses 5 - 8

In summary, this study seeks to expand the literature on environmental anthropomorphism by focusing on an often-overlooked subject: trees. Through a comparative

design that manipulates the level of anthropomorphic framing, the study aims to investigate whether and how these messages can effectively engage urban populations in tree advocacy through emotional and cognitive pathways. This work contributes to our understanding of environmental communication and offers practical insights for urban sustainability initiatives.

Method

Research Design and Sampling

The study employed a between-subjects experimental design with three conditions (strong anthropomorphism, moderate anthropomorphism, and control). Tree advocacy behaviour served as the outcome variable, with two parallel mediators: cognitive understanding of trees and emotional connection to trees.

The study was conducted entirely online using convenience sampling. A survey link was distributed via email to a list of available contacts, who were encouraged to share it further. The study anticipated recruitment primarily from a European population, aged 18–50 years. Demographic information, including age (month and year of birth), and gender (female, male, other/third gender), was collected.

To determine the required sample size, an a priori power analysis was conducted based on effect sizes from a study that also followed a double mediation model within an experimental online survey design (Yang et al., 2023). To adopt a conservative approach and ensure caution, the estimates were rounded down.. The primary relationship between anthropomorphism and tree advocacy behaviour was adjusted from 0.33 to 0.30, while the mediating relationships through cognitive understanding and emotional connection were maintained at 0.18. The relationships between the mediators and the outcome variable were adjusted from 0.40 to 0.30.

Based on these parameters, the power analysis indicated that 131 participants were required to achieve a power of 0.80. To account for potential missing data, the sample size

was adjusted using the formula: Adjusted Sample Size = Required Sample Size / (1 − Expected Missing Data Rate). Using the attrition rate of 15.59% from Yang et al. (2023), the final target sample size was calculated as 155 participants.

Quality Assurance Measures

Preventive measures were implemented to maximise data quality and retention. Experimental stimuli were kept concise, with anthropomorphised messages under 150 words (*see Appendix*). The scales were constructed to avoid unnecessary or repetitive items, maintaining reliability while ensuring survey completion. Additionally, the survey was organised in sections to appear shorter to participants, with attention checks and a progress bar to encourage completion (*see Table 1*).

Data Cleaning Protocol

Data cleaning procedures were established prior to data collection. The data from participants who did not provide informed consent will be immediately removed from the sample. Individuals who fail to answer the attention checks correctly (*see Table 1*), who failed to complete all items in the Cognitive Understanding and Emotional Connection towards trees scale (*see Table 1*) or the Tree Advocacy Attitude and Behaviour scales (*see Table 1*), and who failed to disclose the demographic information will be excluded from analyses. The duration for which the survey will be active was also established prior to data collection, and it was set at two weeks time. If the required sample population was not met within this time frame, an additional day will be added until the necessary number of participants is reached.

Design and Procedure

The research was conducted online via Qualtrics. After providing informed consent, participants were randomly assigned to one of the three experimental conditions. The control condition establishes baseline scientific information, while the two experimental conditions

represent varying degrees of anthropomorphisation (*see Appendix*). Immediately after the experimental condition, cognitive understanding and emotional connection towards trees were measured with respectively, 4 and 5 items, which were presented in randomised order (*see Table 1*). Thereafter, tree advocacy intention and behaviour, were measured with 13 items measuring attitudes and 1 item measuring behaviour. All items measuring attitudes were measured using a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree) whilst the single behavioural item was measured using a simple YES or NO.

Upon completing the survey, participants were thanked, debriefed on the study's purpose, and provided with the principal investigator's contact information for further inquiries.

Table 1

Summary of all Items

Emotional Response Items (α = .823)		
Final Item	Adapted From	Original Item
I feel refreshed when I spend time around trees	Clayton et al, 2021	I feel refreshed when I spend time in nature
I enjoy encountering trees in my city environment	Clayton et al, 2021	I enjoy encountering elements of nature, like trees or grass, even in a city setting
I feel emotionally connected to the trees in my surroundings	Nisbet et al., 2008	I feel very connected to all living things and the earth
I feel a sense of connection with trees around me	Mayer & Frantz, 2004	I often feel a sense of oneness with the natural world around me
I feel a kinship with trees in my environment	Mayer & Frantz, 2004	I often feel a kinship with animals and plants
Cognitive Understanding Items (α = .605)		
Final Item	Adapted From	Original Item
I understand how my actions affect the health and survival of urban trees	Mayer & Frantz, 2004	I have a deep understanding of how my actions affect the natural world
I have knowledge about the processes that trees perform	Mayer & Frantz, 2004	I recognize and appreciate the intelligence of other living organisms
I am aware of the challenges urban trees face	Nisbet et al., 2008	I am very aware of environmental issues
I think of trees as valuable members of our urban community	Clayton et al, 2021	I think of myself as a part of nature, not separate from it

Tree Advocacy Attitudes Items (α = .887)		
Final Item	Adapted From	Original Item
I would sign a petition supporting the protection of trees in my city	New, New, policy-focused. Moffat, 2016; Mullaney et al, 2015	N/A
I would share information about the importance of urban trees on social media	New, social-influence action, based on Moffat, 2016; Mullaney et al, 2015	N/A
I would support a local effort for planting more trees in my area	New, urban-specific action. Moffat, 2016; Mullaney et al, 2015	N/A
I would attend community meetings about urban tree planning	New, participation-focused. Moffat, 2016; Mullaney et al, 2015	N/A
I would volunteer to help maintain trees in my neighbourhood	Based on Clayton et al, 2021 stewardship concept	I consider myself a steward of our natural resources
The presence of trees would significantly influence my housing decisions	Modified from Clayton et al, 2021. Moffat, 2016; Mullaney et al, 2015	If I could choose, I would prefer to live where I can have a view of the natural environment, such as trees or fields
I would actively participate in local tree planting initiatives	New, action-oriented. Moffat, 2016; Mullaney et al, 2015	N/A
I would donate money to organisations that protect and plant urban trees	Modified from Clayton et al, 2021	If I had enough resources such as time or money, I would spend some of them to protect the natural environment
I would advocate for tree protection policies at city council meetings	New, policy-focused. Moffat, 2016; Mullaney et al, 2015	N/A
I would prioritise planting trees in my personal garden or space	New, action-oriented. Moffat, 2016; Mullaney et al, 2015	N/A
I intend to learn more about how to care for trees in urban environments	New, learning-focused. Moffat, 2016; Mullaney et al, 2015	N/A
I would encourage others to support tree conservation in our city	New, social influence focused. Moffat, 2016; Mullaney et al, 2015	N/A
I would object to the unnecessary removal of trees in my neighbourhood	New, protection focused. Moffat, 2016; Mullaney et al, 2015	N/A
Tree Advocacy Behavioural Item		
Final Item	Adapted from	Original item

I would like to learn more about how trees benefit urban environments, and possibly donate to an NGO that supports this cause.	New, behavioural action. Moffat, 2016; Mullaney et al, 2015	N/A

Attention Checks	
Final Item	Location within the study
Please select "Somewhat Agree" to show you are paying attention to this study.	Randomised within the Emotional and Cognitive evaluation section
Please select "Neutral" to show you are paying attention to this study.	Randomised within the Tree Advocacy Attitudes evaluation section

Experimental Manipulation: Anthropomorphism

The independent variable manipulated in this study was the style of anthropomorphism. All conditions are similar in length to ensure comprehensive engagement (*see Appendix*). In the strong anthropomorphism condition, trees were personified using first-person language, personal pronouns, and human-like behaviours (e.g., “I’m a tree, and every day, I’m here ‘breathing’ and ‘cleaning’ to make your city better”). The moderate anthropomorphism condition conveyed the same information but omitted first-person pronouns, using third-person phrasing to humanise trees without directly embodying them (e.g., “A tree breathes and cleans the city air, working hard to improve urban life”). The control condition presented the same factual content in a neutral, textbook-style manner without anthropomorphic language (e.g., “Trees in urban spaces play a critical role in maintaining air quality and moderating temperatures”).

Mediating Variables: Emotional Connection and Cognitive Understanding

The mediating variables in this study were the Emotional Connection and Cognitive Understanding towards trees. Both constructs were measured using a 9-item Likert scale adapted from established scales assessing connectedness to nature and environmental identity (Clayton et al, 2021; Mayer & Frantz, 2004; Nisbet et al., 2008). Items were selected and categorised based on their relevance to either emotional or cognitive constructs (see *Table 1*).

A factor analysis was conducted to determine the dimensionality of the scale. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.848, and Bartlett's test of sphericity was significant ($p < .001$), indicating that the data were suitable for factor analysis. The analysis extracted two factors based on Eigenvalues greater than 1, explaining a cumulative 55.74% of the variance (Factor 1 = 41.65%, Factor 2 = 14.09%). The scree plot confirmed this two-factor structure, with a clear "elbow" at the second component. The rotated component matrix showed that all five emotional items loaded onto the first factor (ranging from .583 to .811), while three of the four cognitive items loaded onto the second factor (ranging from .425 to .840). One cognitive item cross-loaded onto the emotional factor (.632), but overall, the structure supported treating the two constructs separately.

The **Emotional Connection** towards trees was assessed using five items that emphasised feelings and emotional connections (e.g., "feel," "love"), demonstrating strong internal consistency ($\alpha = .823$). (*see Table 1*)

The **Cognitive Understanding** of tree functioning was measured using four items focused on understanding and awareness (e.g., "think," "recognise"), though this subscale exhibited lower reliability ($\alpha = .605$). (*see Table 1*)

All items were minimally modified to ensure construct validity while aligning with the study's urban tree focus (*see Table 1*). For instance, the item "I enjoy encountering elements of nature, like trees or grass, even in a city setting" was revised to "I enjoy encountering trees in my city environment." The final scale retained the original conceptual distinctions between emotional and cognitive components while adapting to the study's specific context.

The Outcome Variables: Tree Advocacy Attitudes and Intention

Tree advocacy attitude was measured using a 13 item Likert scale (*see Table 1*) with a reliability index of $\alpha = .887$. The items were inspired from previous literature regarding the

benefits of trees in urban environments and how to effectively communicate them (Moffat, 2016 ; Mullaney et al, 2015) and on previously validated scales of connectedness to nature (Clayton et al, 2021). The items focused on participants' attitudes towards specific actions.

Tree advocacy behaviour. To capture an actual behavioural component, participants were given the option to be redirected to an external website (sugiproject.com) to learn more about urban trees and potentially donate to an NGO supporting the cause (*see Table 1*). behaviour was coded as 1 (participant selected “YES” and was redirected to the website to learn more about urban trees) or 0 (participant selected “NO” and continued the study), serving as a tangible indicator of tree advocacy behaviour. The two measures were kept separate during the final data analysis, and were both tested as independent outcome variables

Results

Descriptive Statistics

Within the predetermined period of two weeks (January 8-22, 2025) in which the survey was active, a total of 360 participants responded. Following the pre established data cleaning protocol, the participants who did not provide informed consent ($N = 2$); who failed to answer the attention checks correctly ($N = 28$); who failed to complete all items in the scales ($N = 82$); as well as those who did not complete the demographics ($N = 6$) were excluded from analyses. The final sample consisted of 242 participants, exceeding the predetermined sample size of 155 based on power analysis. The demographics of the sample population are presented in Table 2.

Table 2
Descriptive Statistics of Sample Population

Variable	Categories	Frequency (%)	Number (n)
Age Group	18-20 years	3.7%	9
	20-30 years	49.2%	119

	31-40 years	16.1%	39
	41+ years	31%	75
Childhood Context	Urban	45.9%	111
	Suburban	33.5%	81
	Rural	20.7%	50
Gender	Female	57%	138
	Male	40.5%	98
	Other/Third Gender	0.8%	2
	Prefer not to say	1.7%	4

Analysis of the Effects of Anthropomorphism on All Variables

A **one-way multivariate analysis of variance (MANOVA)** was conducted to examine the effect of condition type (Strong ANT, Moderate ANT, Control) on the emotional connection towards trees, the cognitive understanding of their functioning, and tree advocacy intention. Box's test of equality of covariance matrices was significant, Box's M = 22.92, F(12, 274510.82) = 1.88, p = .032, indicating a violation of the homogeneity of covariance assumption. While Wilks' Lambda is more sensitive to such violations, it was retained for consistency and interpretability across analyses. However, given the relatively large and balanced sample size across groups, the analysis is considered robust enough to tolerate minor deviations from this assumption (Field, 2018). Moreover, the non-significant result of Wilks' Lambda, $\Lambda = .98$, $F(6, 474) = 0.96$, $p = .452$, supports the conclusion that condition type had no significant multivariate effect on the dependent variables.

Consistent with this finding, follow-up univariate **ANOVA**s showed no significant effects of condition type on emotional connection, $F(2, 474) = 1.03$, $p = .375$, cognitive understanding, $F(2, 474) = 0.98$, $p = .379$, or tree advocacy intention, $F(2, 474) = 0.57$, $p = .564$. Effect sizes were small, with R^2 values of .009, .008, and .005, respectively.

A **logistic regression analysis** was conducted to assess the effect of condition type on tree advocacy behaviour. The model was not statistically significant, $\chi^2(2) = 1.92$, $p = .383$. It

explained between 0.8% (R^2 = .008, Cox & Snell) and 1.1% (R^2= .011, Nagelkerke) of the variance in tree advocacy behaviour and correctly classified 55% of cases. The Hosmer and Lemeshow test indicated good model fit, $\chi^2(1) = 0.00$, $p = 1.000$. Neither condition type significantly predicted tree advocacy behaviour: Moderate ANT (vs. Strong ANT), $B = -0.34$, $SE = 0.31$, $Wald = 1.20$, $p = .273$, Exp(B) = 0.71; Control (vs. Strong ANT), $B = 0.06$, $SE = 0.32$, $Wald = 0.03$, $p = .858$, Exp(B) = 1.06.

Since neither the MANOVA nor the logistic regression analysis yielded statistically significant results, conducting a mediation analysis would not be meaningful. Mediation models require a significant relationship between the independent variable and the mediator, as well as between the mediator and the dependent variable. Given the absence of such relationships, we opted for exploratory analyses focusing on the mediators and outcome variables.

Predicting Tree Advocacy Intention with Emotional Connection and Cognitive Understanding

A **multiple regression analysis** was conducted to examine whether emotional connection and cognitive understanding predicted tree advocacy intention. The overall model was significant, $F(2, 474) = 148.99$, $p < .001$, explaining 55.5% of the variance (R^2 = .555, adjusted R^2 = .551). Both predictors were significant, with emotional connection ($B = 1.46$, $\beta = .56$, $p < .001$) and cognitive understanding ($B = 1.03$, $\beta = .28$, $p < .001$) contributing to the model. Collinearity statistics indicated no issues ($VIF = 1.34$ for both predictors).

Predicting Tree Advocacy behaviour with Emotional Connection and Cognitive Understanding

A **logistic regression analysis** was conducted to examine the effects of emotional connection and cognitive unnderstanding on tree advocacy behaviour. The model was statistically significant, $\chi^2(2) = 21.26$, $p < .001$, explaining between 8.4% (R^2 = .084, Cox &

Snell) and 11.2% (R^2 = .112, Nagelkerke) of the variance. The model correctly classified 62% of cases. The Hosmer and Lemeshow test suggested an adequate model fit, $\chi^2(8) = 6.48$, p = .594.

Emotional connection to trees significantly predicted tree advocacy behaviour, $B = 0.14$, SE = 0.04, $Wald = 12.12$, $p < .001$, Exp(B) = 1.15, while cognitive understanding of tree functioning was not significant, $B = 0.03$, $SE = 0.05$, $Wald = 0.39$, $p = .531$, Exp(B) = 1.03.

Demographic Effects on Emotional Connection, Cognitive Understanding, and Tree Advocacy Intention

Given the absence of significant main effects in the initial analyses, a set of exploratory ANCOVA tests was conducted to examine whether participant demographics (age, gender, and childhood context) influenced the emotional connection and cognitive understanding of anthropomorphism and tree advocacy intention. Although these analyses were not hypothesised a priori, they were included to provide additional insight into potential individual differences in how participants responded to the experimental conditions. As such, these results should be interpreted with caution.

A series of **ANCOVA** tests were conducted to examine the effects of demographic variables (age, gender, and childhood context) on emotional connection and cognitive understanding and tree advocacy intention. Levene's test indicated that the assumption of homogeneity of variances was met for all ANCOVA analyses (all p > .05).

For **Tree Advocacy Intention**, the analysis revealed a significant effect of **age**, $F(1, 216) = 8.162$, $p = .005$, $\eta^2 = .037$, indicating that older participants reported significantly higher tree advocacy intention. **Childhood context** also had a significant effect, $F(2, 216) = 4.517$, $p = .012$, $\eta^2 = .040$, with post-hoc comparisons suggesting that those from rural and suburban backgrounds exhibited greater advocacy intention compared to those from urban

backgrounds. **Gender** did not reach statistical significance, $F(2, 216) = 2.643$, $p = .073$, $\eta^2 = .024$. The model explained 14.5% of the variance ($R^2 = .145$, adjusted $R^2 = .065$).

For **Cognitive Understanding**, **age** showed a strong significant effect, $F(1, 216) = 26.889$, $p < .001$, $\eta^2 = .111$, with older participants demonstrating higher cognitive understanding of the anthropomorphised trees. **Childhood context** was also significant, $F(2, 216) = 5.239$, $p = .006$, $\eta^2 = .046$, indicating that individuals from rural and suburban backgrounds reported greater cognitive understanding compared to urban participants. **Gender** did not have a significant effect, $F(2, 216) = 1.820$, $p = .165$, $\eta^2 = .017$. The model accounted for 20.3% of the variance ($R^2 = .203$, adjusted $R^2 = .129$).

For **Emotional Connection**, **age** was a strong predictor, $F(1, 216) = 39.659$, $p < .001$, $\eta^2 = .156$, with older participants experiencing stronger emotional responses. **Gender** had a significant effect, $F(2, 216) = 3.183$, $p = .043$, $\eta^2 = .029$, suggesting some differences between groups, although post-hoc tests should be examined for clarification. **Childhood context** was also significant, $F(2, 216) = 3.919$, $p = .021$, $\eta^2 = .035$, with suburban and rural participants reporting stronger emotional reactions than urban participants. The model explained 23.3% of the variance ($R^2 = .233$, adjusted $R^2 = .162$).

Demographic Effects on Tree Advocacy Behaviour

A logistic regression analysis was conducted to determine whether demographic factors predicted whether participants had engaged in a tree advocacy behaviour. The model was significant, $\chi^2(7) = 15.234$, $p = .033$, and accounted for 6.3% (Cox & Snell $R^2 = .063$) to 8.3% (Nagelkerke $R^2 = .083$) of the variance in behaviour. The Hosmer and Lemeshow test indicated good model fit, $\chi^2(8) = 5.834$, $p = .666$. While the model was significant, the explained variance was relatively low, suggesting that additional factors beyond demographics likely play a role in tree advocacy behaviour.

Age was a significant predictor, $B = 0.027$, $SE = 0.011$, $Wald = 6.487$, $p = .011$, $Exp(B) = 1.027$, suggesting that as age increased, the likelihood of performing tree advocacy behaviour also increased.

Childhood context showed a trend but did not reach significance. Participants from **suburban** backgrounds were somewhat more likely to engage in advocacy behaviour than **urban** participants, $B = 0.582$, $SE = 0.312$, $Wald = 3.477$, $p = .062$, $Exp(B) = 1.789$, though this effect did not reach conventional significance levels. The comparison between **rural and urban participants** was non-significant, $B = 0.140$, $SE = 0.356$, $Wald = 0.155$, $p = .694$, $Exp(B) = 1.151$.

Gender did not significantly predict tree advocacy behaviour. **Male** participants were slightly less likely than females to engage in tree advocacy, though the effect was not significant, $B = -0.246$, $SE = 0.275$, $Wald = 0.799$, $p = .371$, $Exp(B) = 0.782$. For the **"Other Gender/Prefer Not to Say"** category, the analysis produced an unreliable estimate ($B = -21.103$, $SE = 28403.234$, $Wald = 0.000$, $p = .999$, $Exp(B) = 0.000$), indicating an issue due to the small sample size. Given this, results for this category should be interpreted with caution, and future studies should aim for a larger, more balanced sample.

Discussion

Summary of Findings

This study investigated the effect of anthropomorphic messaging on urban tree advocacy, examining whether anthropomorphism influenced cognitive understanding of trees' ecological roles, emotional connection toward trees, and subsequent advocacy intentions and behaviors. The study also explored whether different styles of anthropomorphism (strong vs. moderate) produced differential effects on these variables.

The analyses revealed that the experimental manipulation of anthropomorphism had no significant effect on emotional or cognitive responses, nor on tree advocacy intention or behavior. Consequently, none of the proposed hypotheses were supported by the data, and the null hypotheses could not be rejected. As a result, the planned mediation analyses were not conducted.

However, exploratory analyses yielded notable findings. Both emotional connection and cognitive understanding were significantly related to tree advocacy intention, with emotional connection exhibiting a stronger influence. Additionally, emotional connection to trees—but not cognitive understanding of their functioning—significantly predicted actual tree advocacy behavior.

Further exploratory analysis of demographic variables revealed varying degrees of influence on the dependent variables. Age significantly influenced all three dependent variables, with older participants showing higher levels of tree advocacy intention and stronger cognitive and emotional responses to anthropomorphism. Childhood context also played a role, with individuals from non-urban backgrounds reporting stronger cognitive and emotional connection. Gender effects were less consistent, with a significant effect only on emotional responses. The logistic regression analysis further highlighted age as a predictor of tree advocacy behavior, though the overall model explained only a modest proportion of the variance.

Theoretical Implications

The findings of this study have several important theoretical implications for understanding environmental communication and advocacy behaviors. The relationship between emotion and cognition in environmental advocacy suggests the important role that emotional connection has in this context. Findings indicate that both cognitive and emotional responses predicted advocacy intention, but only emotional responses predicted actual

behavior. This aligns with research suggesting that emotions play a more direct role in motivating environmental actions, while cognitive understanding may influence intentions but not necessarily translate to behavior change (Brosch, & Steg, 2021; Wang et al, 2018; Brosch, 2021).

Regarding anthropomorphism, the lack of significant effects challenges the present research's assumption that anthropomorphism expressed through text alone enhances environmental engagement. This raises questions about the contexts in which anthropomorphism is most effective and suggests that its impact may depend on additional factors such as the subject of the anthropomorphisation, message framing, visual cues, or audience characteristics.

Demographic influences emerged as important factors shaping urban tree advocacy intention and behaviours. Age, gender, and childhood background influenced advocacy responses, supporting theories that demographic factors significantly shape environmental attitudes (Yang et al, 2023; Smith & Kingston, 2021; Sargisson et al, 2020). This suggests that conservation interventions should be designed with demographic variations in mind.

Practical Implications

Despite the ineffectiveness of the anthropomorphism manipulation, emotional connection emerged as a strong predictor of tree advocacy intention and behavior. This suggests that conservation communication could focus on emotional engagement of the audience rather than relying solely on information provision.

Age significantly predicted all dependent variables, suggesting that conservation messaging may be more effective when tailored to different age groups. Older participants exhibited stronger advocacy intentions and behaviors, indicating that age-related experiences may shape engagement with environmental issues.

Participants' childhood environments (urban vs. suburban) approached significance in predicting advocacy behavior. This suggests that early-life exposure to nature may influence long-term environmental attitudes and behaviors, highlighting the importance of fostering nature connections in childhood. This supports already existing research on the positive effects of human nature interaction on nature conservation, especially during early developmental stages of life (Summers et al, 2019; Evans et al, 2018).

Limitations and Future Considerations

The primary limitation was the ineffectiveness of the anthropomorphism manipulation. The experimental conditions did not produce significant differences in cognitive, emotional, or advocacy outcomes. The text-based intervention, limited to less than 150 words, may not have provided sufficient depth to establish an emotional connection or enhance cognitive understanding. Previous studies have successfully used anthropomorphism to enhance both cognitive understanding and emotional affectance, by incorporating images of the anthropomorphised subject with facial features (e.g., eyes, mouth) (Tong et al, 2020; Kaifeng & Pengbo, 2024). Therefore, simply adding the image of a tree with a happy face might have strengthened emotional engagement and cognitive receptiveness.

Additionally, the online format of the study limited opportunities to create a strong manipulation. Unfortunately, the advantages of online surveys are coupled with the uncertainty over study conditions. Although participants spent an average of over 10 minutes reading the manipulation, it cannot be determined whether this time was spent actively engaging with the content or if participants were distracted. Future research should explore alternative study formats that allow for more potent anthropomorphism manipulations. This could include more interactive manipulations through storytelling, animated content, or visual representations of anthropomorphised trees. Small focus groups could provide insight through participant discussions, helping to develop more holistic hypotheses. Longitudinal

studies, perhaps using mobile applications that facilitate prolonged "interaction" with trees, could provide insight into how cognitive understanding and emotional connection evolve over time and influence sustained advocacy behavior. For example, an initiative led by an elementary school teacher had children learn about tree functioning to then record themselves explaining what they had learned in class as if they were the tree themselves. These recordings were then played through speakers which were placed on the tree in question, so that anyone who walked by could learn about that specific tree through the children's voice. Parents were invited to see this exposition, which was a great opportunity both for interactive learning and community building. (Flynn, 2017)

From a statistical perspective, Box's test indicated a violation of covariance homogeneity, potentially affecting the reliability of MANOVA results. This suggests future research should consider alternative statistical approaches, such as robust regression techniques. Additionally, the study's sample size of 242 participants, while adequate for general analyses, may not have provided sufficient power to detect small effects. Given the observed small effect sizes (R^2 = .009, .008, and .005), future studies should conduct a priori power analyses to determine necessary sample sizes for such small effects.

The study's sample, obtained through convenience and snowball sampling, may have influenced results. Since initial participants were drawn from the researcher's social network, many respondents likely already had strong awareness of trees and environmental issues, potentially limiting the manipulation's impact. Future studies should ensure more diverse samples, including individuals with varying degrees of environmental engagement.

The scales used demonstrated adequate reliability, though emotional items showed better reliability than cognitive ones. This may be because the measures were adapted from scales primarily focused on connectedness to nature, which is primarily an emotional variable. Future studies should validate more targeted measures for anthropomorphism's

cognitive understanding and emotional connection in conservation contexts. Perhaps a simple comprehension quiz at the end of the survey could have served as a better cognitive understanding scale.

Conclusion

This study examined the impact of anthropomorphic messaging on tree advocacy but found no significant effects of anthropomorphism on advocacy, cognitive understanding, or emotional connection. However, emotional connection emerged as a key predictor of advocacy, highlighting its central role in conservation communication. Additionally, demographic variables such as age and gender influenced advocacy outcomes, suggesting that tailored messaging strategies are necessary. While these findings challenge some assumptions about anthropomorphism in environmental communication, they contribute to a broader understanding of factors that drive advocacy behavior. Future research should refine anthropomorphism manipulations and explore additional pathways to fostering environmental engagement.

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Appendix

Experimental Manipulation: the three different anthropomorphised texts

Control Condition (no ANT): *Trees in urban spaces play a critical role in maintaining air quality and moderating temperatures. Through photosynthesis, trees absorb carbon dioxide and release oxygen, improving the air that city residents breathe. Trees also reduce air pollution by filtering out particulates and other pollutants. By providing shade, trees help to lower surface and air temperatures, which reduces the urban heat island effect. Overall, trees are essential for creating healthier, more sustainable urban environments. Although trees communicate underground through their roots, they cannot speak up for themselves in ways humans can understand. Residents can help by planting more trees, protecting existing ones from physical damage, and advocating for policies that preserve urban green spaces. Planting and protecting trees ensures they can continue providing cleaner air, cooler environments, and healthier communities.*

Strong Anthropomorphism Condition: *I'm a tree, and every day, I'm here "breathing" and "cleaning" to make your city better. I take in the air around me, removing pollutants and refreshing it with oxygen. I cool the spaces nearby by giving you shade and moisture, like a caring neighbor. With each breath, I make the air cleaner and healthier for you to enjoy. By being here, I make your city a healthier, more welcoming place. I can communicate underground with other trees through my roots, but I can't speak like you can. That's why I need your voice. When you plant more of us and care for our roots and branches, you help us thrive. Speaking up for us by supporting city policies that protect trees means we can keep giving you cleaner air, cooler neighborhoods, and healthier communities.*

Moderate Anthropomorphism Condition: *A tree "breathes" and "cleans" the city air, working hard to improve urban life. Each day, it removes pollution from the surrounding air, refreshing it with clean oxygen. The tree cools nearby spaces by providing shade and*

releasing moisture, which makes the city more comfortable. With every "breath," the tree helps make urban environments healthier and more sustainable. Trees communicate underground through their roots but cannot speak out like humans do. Acting as their voice, residents can plant more trees, care for their roots and branches, and advocate for urban policies that protect green spaces. These efforts ensure trees continue to provide cleaner air, cooler environments, and healthier communities.