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RESEARCH ARTICLE

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What determines how we see nature? Perceptions of naturalness in designed urban green spaces

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Abstract

1. The multiple benefits of 'nature' for human health and well-being have been documented at an increasing rate over the past 30 years. A growing body of research also demonstrates the positive well-being benefits of nature-connectedness. There is, however, a lack of evidence about how people's subjective nature experience relates to deliberately designed and managed urban green infrastructure (GI) with definable 'objective' characteristics such as vegetation type, structure and density. Our study addresses this gap.
2. Site users (n = 1411) were invited to walk through woodland, shrub and herbaceous planting at three distinctive levels of planting structure at 31 sites throughout England, whilst participating in a self-guided questionnaire survey assessing reactions to aesthetics, perceived plant and invertebrate biodiversity, restorative effect, nature-connectedness and socio-demographic characteristics.
3. There was a significant positive relationship between perceived naturalness and planting structure. Perceived naturalness was also positively related to the perceived plant and invertebrate biodiversity value, participants' aesthetic appreciation and the self-reported restorative effect of the planting. A negative relationship was recorded between perceived naturalness and perceived tidiness and care. Our findings showed that participants perceived 'naturalness' as biodiverse, attractive and restorative, but not necessarily tidy. Perceived naturalness was also related to participants' educational qualifications, gender and nature-connectedness, with women and more nature-connected participants perceiving significantly greater levels of naturalness in the planting.
4. These findings are highly significant for policymakers and built environment professionals throughout the world aiming to design, manage and fund urban GI to achieve positive human health and biodiversity outcomes. This applies particularly under austerity approaches to managing urban green spaces where local authorities have experienced cuts in funding and must prioritise and justify GI maintenance practices and regimes.

KEYWORDS

aesthetics, green infrastructure, nature-connectedness, parks, perceived biodiversity, planting structure, restorative effect, socio-demographics

1 | INTRODUCTION

The multiple benefits of 'nature' for human health and well-being have been documented at an increasing rate over the past 30 years (for reviews see Clark et al., 2014; Hartig, Mitchell, de Vries, & Frumkin, 2014), with a growing body of research (Lumber, Richardson, & Sheffield, 2017; Richardson, Hallam, & Lumber, 2015) evidencing the positive well-being benefits of nature-connectedness. This is rooted in the concept of Biophilia (Wilson, 1984), which emphasises the fundamental evolutionary bond between humans and nature. Evidence for the psychological (e.g. White, Pahla, Wheeler, Depledge, & Fleming, 2017) and physical (e.g. White et al., 2016) benefits of contact with nature is particularly important because almost 70% of the world's population is expected to live in urban areas by 2050 (United Nations, 2018), where health challenges are concentrated (Dye, 2008). In urban areas direct experience of nature and its associated benefits are usually afforded by access to urban green infrastructure (GI), networks of interconnected, often multifunctional green spaces including parks, gardens and incidental green spaces. Increasing evidence for the benefits of contact with nature provokes policymakers (For example, Greater London Authority, 2015) to plan, design and manage high-quality GI to prioritise human physical and psychological well-being, whilst strengthening the resilience of ecosystem services and halting biodiversity loss (For example Goal 15 of UN Sustainability Goals, 2015). Yet local authorities managing urban GI and delivering public health services have also experienced major funding cuts. In the UK austerity approaches to local services have dominated since the formation of the Conservative-Liberal Democrat government in 2010 (Mell, 2018) with GI management severely impacted: 92% of urban park managers experienced cuts to their budgets during 2013–2016 (National Lottery Heritage Fund, 2016). Strategies to create liveable and biodiverse cities would benefit from greater insight into the people-biodiversity interface (Botzat, Fischer, & Kowarik, 2016). There is, however limited evidence available to planners and policymakers. If urban GI is to be designed, managed and funded optimally to achieve positive human health and biodiversity outcomes, we need to understand how the subjective nature experience of people with different socio-demographic characteristics relates to the deliberately planned, designed and managed urban GI with its clearly definable 'objective' characteristics such as vegetation type, structure, density and aesthetics. This relationship is the focus of our study.

Defining 'nature' and naturalness in the context of the planning, design and management of urban GI is itself a major challenge. Many researchers focusing on links between nature and health and well-being do not attempt this (e.g. Cox, Hudson, & , 2017; Soga & Gaston, 2016). Nassauer (1995) describes 'nature' as a 'cultural concept'. Others (e.g. Newman & Dale, 2013) discuss the apparent paradox of 'urban nature' where pockets of vegetation and associated wildlife provide stark contrasts to the built environment. Urban nature is 'mundane', either 'remnant or spontaneous nature', such as vegetation along railway lines, 'cultivated nature' such as within rooftop gardens or 'nature as display' as in formal gardens. Hartig et al. (2014) make the clear distinction between 'objective nature', the physical features and processes including 'living nature' (plants and animals), hydrological features (lakes, rivers and oceans), atmospheric processes (weather and climate) and landscape features, and 'subjective nature', nature as perceived by people.

Much existing research highlighting links between nature and human well-being has focused specifically on the role of human response to biodiversity at the broad habitat or ecosystem scale. There is much less focus on diversity at the species or community scale, where arguably the greatest scope for policy and practice intervention exists (Botzat et al., 2016). Studies which have considered biodiversity at the species scale have yielded conflicting results in different contexts. Positive relationships between species diversity and human well-being were recorded in urban and peri-urban areas in Italy (Carrus et al., 2013, 2015) and in urban parks in the UK (Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007). In contrast, research in Swedish green spaces revealed that recreational preferences were negatively related to high biodiversity values (Qiu, Lindberg, & Nielsen, 2013). A recent comprehensive study involving socio-demographically diverse participants (N = 3716) across five European cities considered reactions to three levels of plant species richness. Findings indicated that people generally preferred higher plant species richness in urban green spaces (parks, wastelands, streetscapes), providing convincing cross-cultural evidence for the benefits of enhanced species richness. Yet these positive reactions may be unconscious ones. There is evidence suggesting that most people are not aware of biodiversity levels at the species scale. The public is poor at recognising biodiversity at the species level, and stronger positive links exist between perceived biodiversity and well-being than between actual biodiversity and well-being (Dallimer et al., 2012). Visual cues such as vegetation height, evenness and colourfulness are used to estimate species richness and to make decisions about preference (Hoyle et al., 2018; Southon, Jorgensen, Dunnett, Hoyle, & Evans, 2018), hence the need for an integrated approach considering human reactions to aesthetics in addition to perceived biodiversity.

Other studies have focused specifically on the aesthetic qualities of 'natural' landscapes and human preference and restorative effect. Some earlier studies (Kaplan, Kaplan, & Wendt, 1972; Lamb & Purcell, 1990; Purcell & Lamb, 1984) identified 'naturalness' as a strong factor influencing human aesthetic preference. This was shown to have cross-cultural significance (Balling & Falk, 1982; Chokor & Mene, 1992; Tips & Savasdidara, 1986; Williamson & Chalmers, 1982). Findings (Kaplan, 1979; Kenner & McCool, 1985; Sheets & Manzer, 1991; Ulrich, 1986; Williamson & Chalmers, 1982) indicated that naturalness was associated with vegetation and how and to what extent humans had manipulated a scene, yet varying types or degrees of manipulation were not addressed in detail. Purcell and Lamb (1998) later identified that subtle degrees of difference in preference arose from variability

in 'naturalness' relating to the structural integrity of the vegetation. Martens, Gutscher, and Bauer (2011), assessed reactions to walking in wild or tended woodland conditions, finding stronger changes in 'positive affect' and 'negative affect' in the tended condition. Recent research focusing on nature-connectedness has also acknowledged the role of the aesthetics of nature (Lumber et al., 2017; Richardson et al., 2015). Lumber et al. (2017) provide evidence that contact (with nature), emotion, compassion, meaning and beauty are better pathways to nature connection than via activities based around increasing individuals' knowledge about nature. Richardson et al. (2015) identified aesthetic beauty as one of the key aspects of nearby nature associated with nature-connectedness.

This existing literature has tended to focus on human reaction to nature or GI in relation to a limited number of variables. Innovatively we adopt an integrative approach, assessing perceived naturalness in relation to planting structure (Purcell & Lamb, 1998), perceived biodiversity (Dallimer et al., 2012; Fuller et al., 2007), aesthetics (Martens et al., 2011; Tenngart Ivarsson & Hagerhall, 2008) and participants' nature-connectedness (Lumber et al., 2017; Richardson et al., 2015). To better inform policymakers and GI practitioners, we address perceived naturalness of a comprehensive typology of different woodland, shrub and herbaceous planting within designed and managed green spaces, considering the relationship between perceived naturalness and the definable 'objective' structure of the planting. To better understand the reactions of different socio-demographic subgroups of the population, we place our research at the interface between cultural and biological diversity (after Fischer et al., 2018) considering the perceptions and reactions of people from different socio-demographic backgrounds, with different values. Specifically we ask, for people walking through woodland, shrub and herbaceous planting of varying planting structure, *is perceived naturalness related to:* (a) planting structure? (b) the perceived biodiversity value, aesthetic perception and self-reported restorative effect of the planting? (c) participants' socio-demographic factors and nature-connectedness?

2 | MATERIALS AND METHODS

Site users (sample size = 1411) were invited to walk through woodland, shrub and herbaceous planting of one of three distinctive levels of planting structure at 31 sites throughout England (Figure 1) whilst participating in a self-guided questionnaire survey. Each participant took part in one walk only.

2.1 | Selection of case study sites

The planting was characterised as having one of three distinctive planting structures: *strongly natural*, *intermediate* or *strongly unnatural* in relation to natural ecosystems, that is, vegetation growing with a minimal degree of human intervention or design (see Hoyle, Hitchmough, & Jorgensen, 2017a). In the UK 'natural' woodland, shrub and herbaceous planting structure is exemplified by multilayered woodland, shrubby woodland edge and herbaceous communities of mixed tall grasses and forb species, respectively. Specific case study sites (Figures 2–4) were selected to represent these three structural levels across the three ecosystems, for example, in the case of woodland (Figure 2) multilayered woodlands are *strongly natural*, whereas a single layer of arboretum-style trees is highly designed and *strongly unnatural* in structure. In the case of herbaceous planting (Figure 4), *strongly natural* structure demonstrates a horizontal mixing of individual plants of a specific species with those of other species, whereas strongly unnatural structure is typified by blocks of plants of the same species distinct from those of

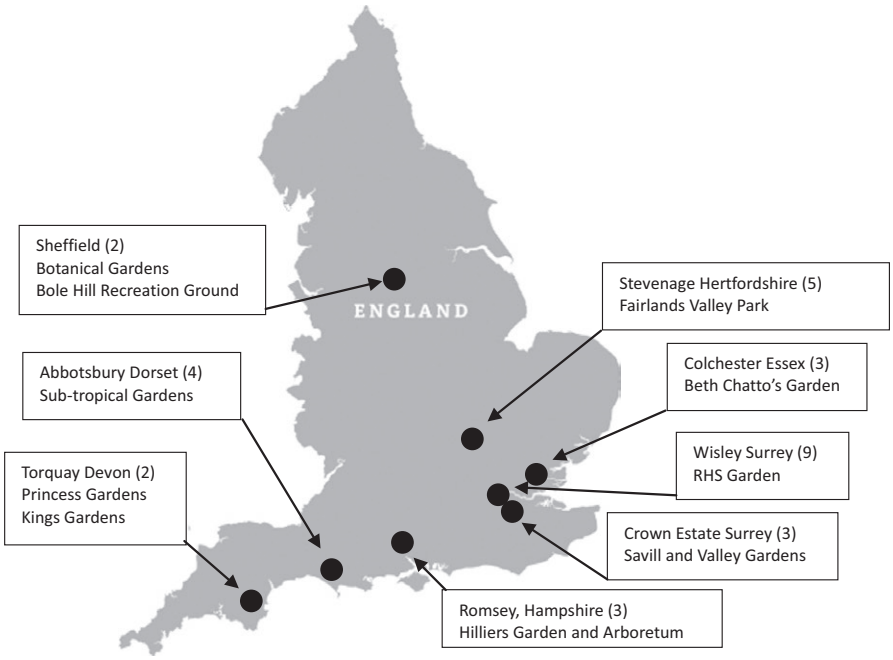

FIGURE 1 The walk and questionnaire survey sites (n = 31), England UK

FIGURE 2 Images of the woodland sites used in the study, showing the gradient of planting structure from strongly unnatural to strongly natural

FIGURE 3 Images of the shrub sites used in the study, showing the two levels of planting structure: strongly unnatural and strongly natural

other species, resulting from deliberate planting or placement. In the case of woodland (Figure 2) and herbaceous (Figure 4) planting all three structures were represented. In the case of shrub planting (Figure 3), where diversity of form in designed green spaces is less varied, two were represented, with the 'intermediate' structural level omitted. An additional planting variable 'percentage flower cover' was calculated to provide a measure of the effects of seasonality and colour on respondents' perceptions. This was done using panoramic photographs of the planting taken by the researcher during the on-site walks/

FIGURE 4 Images of the herbaceous sites used in the study, showing the gradient of planting structure from strongly unnatural to strongly natural

questionnaires. The percentage vegetated surface covered by flower was recorded.

Nine sites were in public parks or gardens: The Botanical Gardens and Bole Hills, Sheffield (2), Fairlands Valley Park, Stevenage (5), Princess Gardens and Kings Gardens, Torquay (2); twenty-two were in large institutional gardens where in most cases an entry fee was charged for public access: Beth Chatto's Garden, Colchester, Essex (3), RHS Wisley, Surrey (9), Savill and Valley Gardens, Crown Estate, Surrey (3), Harold Hilliers Garden and Arboretum, Hampshire (3), and Abbotsbury Subtropical Gardens, Dorset (4). *Strongly natural* planting was more common in public park settings, whereas *strongly unnatural* planting was more common in semi-public institutional gardens. A variable considering participants' reactions to the public vs. institutional garden context was also included in the analysis.

2.2 | On-site questionnaire survey

2.2.1 | Questionnaire design and procedure

An on-site self-guided questionnaire (Hoyle et al., 2017a; Hoyle, Hitchmough, & Jorgensen, 2017b) was used to assess participants' perceptions of the naturalness, the plant and invertebrate biodiversity, aesthetic qualities and restorative effect of the planting. Most items in the questionnaire took the form of attitudinal statements, using a 5-point Likert scale from +2 (agree strongly) to −2 (disagree strongly), following established methodology (e.g. Ives & Kendal, 2013; Table 1). Three questions focusing on perceived plant and invertebrate biodiversity value of the meadows involved participants answering within the categories: 'many', 'some' 'few' or 'none'. A direct rating approach was used to assess restorative effect, with single items applied to measure each of the four components of attention restoration theory (ART, Kaplan, 1995), (see Table 1). This followed Herzog, Maguire, and Nebel's (2003) approach, adapted by Hoyle et al. (2017a, 2017b), Hoyle et al. (2018) to address human reactions to a range of natural planted environments. Four belief statements were used to assess nature-connectedness. A section focusing on the respondents' socio-demographic characteristics was included (Table 2). After ethical clearance, the questionnaire was piloted at RHS Wisley, Surrey and at Fairlands Valley Park Stevenage. Walks (approximately 30 m) were established through sections of planting at the case study sites (Figures 2–4) and site users were invited to walk through the planting as detailed in Hoyle et al. (2017a, 2017b). Our rationale for this approach was that the environment is experienced rather than simply looked at (Ittleson, 1973).

All on-site walks and questionnaires were completed during spring, summer and autumn 2012 and 2013 (n = 1411, comprising 595 questionnaires at 13 different woodland sites, 348 at 8 different shrub sites and 486 at 10 different herbaceous sites).

2.2.2 | Statistical analyses

All questionnaire data were analysed using SPSS version 20. Multifactor ANOVA was conducted with the questionnaire item relating to 'perceived naturalness' as dependent and all planting variables including *planting structure* and *socio-demographic variables* as

TABLE 1 On-site questionnaire: Individual attitudinal and belief statements and questions used to address participants' perceptions of the (a) naturalness, (b) biodiversity value (c) aesthetic qualities, (d) restorative effect of the planting and (e) participants' nature-connectedness

Research theme	Questionnaire measures (Individual attitudinal statements & questions)
Naturalness	The planting along this walk looks natural
Perceived plant and invertebrate biodiversity	How many different plant species do you think there are here?
	How many native UK plant species do you think are in this planting?
	The planting along this walk appears good for butterflies, bees and other insects
	How many species of native UK insects (flies, butterflies, bees) do you think this planting will support?
Aesthetic qualities	The planting along this walk is interesting
	The planting on this walk is attractive
	The planting on this walk looks natural
	The planting on this walk looks cared for
	The planting on this walk looks designed
	The planting on this walk looks tidy
	The planting on this walk looks familiar to me
	The planting on this walk is colourful
	The combination of colours is attractive in this planting How structurally complex would you describe this planting?
Restorative effect	I feel comfortable on this walk (compatability)
	This walk allows me to escape more mundane routines and work (being away)
	I feel relaxed on this walk (extent)
	This walk reveals a special unique place (fascination)
Nature-connectedness	Outdoor green spaces lift my spirits
	I like being in outdoor green spaces
	Insects such as flies, butterflies and bees are an important part of ecosystems
	Plants, shrubs and trees provide valuable habitats for butterflies, bees and other insects

independent. This ascertained the residual independent main effect of *planting structure* on perceived naturalness, adjusting for *socio-demographic variables* and other planting variables, and secondly for individual *socio-demographic variables*, adjusting for other *socio-demographic variables*, *planting structure* and other planting variables. Post hoc multiple comparisons using the Sidak correction distinguished significant differences between groups or categories.

Principal components analysis (PCA) with a varimax rotation was applied to questionnaire items relating to participants' reaction to direct experience of the planting and perception of biodiversity, aesthetics, restorative effect (Table 1). The PCA identified items which varied in a consistent pattern and loaded onto single components, each measuring a specific perceptional dimension. A second PCA was conducted with items relating to participants' beliefs and values, to identify if 'nature-connectedness' was a meaningful dimension of our participants' response.

Pearson correlation coefficients were then calculated between perceived naturalness and the emergent PCA components relating to participants' perceptions of the planting and nature-connectedness, to identify significant associations. Pearson correlation analyses were also carried out between perceived naturalness and the four separate indicators of perceived plant and invertebrate biodiversity to better interpret any relationship between perceived naturalness and perceived biodiversity value.

3 | RESULTS AND DISCUSSION

3.1 | Is perceived naturalness related to planting structure?

Perceived naturalness was positively associated with planting structure (Table 3) yet planting with an *intermediate* structure was associated with the highest level of perceived naturalness, higher than that with a *strongly natural* structure. There was no significant difference in perceived naturalness between *intermediate* and *strongly natural* categories of planting structure. These two categories were associated with a significantly higher level of perceived naturalness than planting *strongly unnatural* in structure.

Our findings suggest that people can distinguish between strongly unnatural planting which shows the most visible signs of human intervention and 'the rest' but are unable to tease out more subtle differences between intermediate and strongly natural structure. This mirrors findings from Carrus et al. (2015) where participants recognised broad levels of visual biodiversity. In contrast, Fischer et al. (2018) found that significant differences in preference ratings were found between the most biodiverse park, wasteland and streetscape green space types and those of medium biodiversity, but that differences in preference between medium and low biodiversity scenes did not reach significance. In the case of 'forest' green spaces, significant differences in rating were recorded between all three levels of biodiversity, with medium diversity scenes most preferred and low diversity the least so. In our study, the intermediate structural category was considered more 'natural' than the strongly natural, maybe because our participants were culturally attuned to a certain degree of management, visual

TABLE 2 Questionnaire participants' (n = 1411) socio-demographic profile [a](valid %)

	Woodland walks (%)	Shrub walks (%)	Herbaceous walks (%)	Overall (%)
Gender (Overall missing values = 29 respondents)				
M	232 (39.9)	114 (33.4)	178 (37.4)	524 (37.5)
F	349 (60.1)	227 (66.6)	298 (62.6)	874 (62.5)
Age (Overall missing values = 34 respondents)				
18–24	38 (6.5)	19 (5.6)	33 (6.9)	90 (6.5)
25–34	35 (6.0)	28 (8.3)	43 (9.1)	106 (7.6)
35–44	54 (9.3)	29 (8.6)	53 (11.2)	136 (9.8)
45–54	95 (16.4)	48 (14.2)	95 (20.0)	238 (17.1)
55–64	172 (29.6)	82 (24.3)	114 (24.0)	368 (26.4)
65+	187 (32.2)	131 (38.9)	137 (28.8)	455 (32.7)
Ethnicity (Overall missing values = 187 respondents)				
White British/ Irish	413 (90.8)	285 (88.0)	405 (87.9)	1103 (89)
Educational qualifications (Overall missing values = 123 respondents)				
None	87 (16.3)	39 (12.3)	66 (14.6)	192 (14.7)
GCSE/O' level (or equiv)	183 (34.3	76 (23.9)	115 (25.4)	374 (28.7)
A level (or equiv)	86 (16.1)	61 (19.2)	83 (18.3)	230 (17.6)
Degree	127 (23.8)	104 (32.7)	128 (28.3)	359 (27.5)
Masters' degree	36 (6.8)	28 (8.8)	49 (10.8)	113 (8.7)
Doctorate	14 (2.6)	10 (3.1)	12 (2.6)	36 (2.8)
Landscape professional? (Overall missing values = 482 respondents)				
Yes	11 (3)	10 (3.9)	11 (3.4)	32 (3.4)
No	353 (97)	246 (96.1)	314 (96.6)	913 (96.6)

[a]Valid percentages given due to missing values.

'cues to care' such as mown paths and trimmed edges, deliberately designed into urban GI to communicate human intention to care (Nassauer, 1995). Due to lack of exposure to wilder less managed landscapes, urban residents may conceptualise nature in a relatively tamed, managed and sanitised way.

Percentage flower cover also had a significant effect on perceptions of naturalness (Table 3) with the extremes of flower cover (46% and above, and 0%–1%) considered the least natural and moderate flower cover as the most natural. Colourful flowers have also been described as 'cues to care' in some cultures and contexts (Nassauer, 1988, 1995, 2011). Our findings suggest that an absence of flower cover or a flower cover of over a threshold of 46% appeared more artificial to participants, perhaps suggesting an overt form of human intervention or design. The pattern is not consistent, however, with flower covers of 27%–46% and 2%–9% perceived as most natural, but that of 10%–26% less so.

There was also a significant relationship between perceived naturalness and the public/institutional gardens context (Table 3) with institutional gardens scoring significantly lower for perceived naturalness than public sites after adjustment for the characteristics of the planting itself and participants' socio-demographic characteristics. This indicates that people were responding to contextual cues, considering gardens less 'natural' than local green spaces regardless of the nature of the planting itself. This suggests that perceived 'naturalness' has a definite cultural component and is not just a proxy for biodiversity per se. This may be because participants visiting institutional gardens expected to see planting tended, managed and designed by human agency in a garden context, and therefore considered it less natural.

3.2 | Is perceived naturalness related to perceived biodiversity, aesthetic appreciation and self-reported restorative effect?

Five meaningful components emerged from the PCA of perceptional questionnaire items. One component measured *Perceived native plant and invertebrate diversity*, three measured dimensions of participants' aesthetic appreciation: (a) *Aesthetic effect (Colour, attractiveness, interest & invertebrate value)*, (b) *Neatness* and (c) *Unfamiliarity and complexity*, and another measured participants' self-reported *Restorative effect* (Table 4).

3.2.1 | Perceived biodiversity

There was a strongly significant moderate correlation between perceived naturalness and perceived plant and invertebrate

TABLE 3 Multi-factor ANOVA with perceived naturalness as dependent and actual structural naturalness, other planting variables and socio-demographic variables as independent. Significant values are in bold. Mean scores for significant variables are shown. Means of the same variable with different superscripts (a,b,c) are significantly different from each other. The highest scoring category of a variable is in bold

	Perceived naturalness				
	F	*p*-value	*df*	Mean	
Structural naturalness	**17.09**	**<0.001**	**2, 779**	Strongly unnatural	3.407[b]
				Intermediate	**3.961[a]**
				Strongly natural	**3.888[a]**
Species character-native-ness	2.04	0.130	2, 779		
Percentage flower cover	**9.29**	**<0.001**	**4, 779**	46+	3.516[b]
				27-45	**4.111[a]**
				10-26	3.656[b]
				2-9	**3.957[a]**
				0-1	3.521[b]
Public vs. Institutional garden context	**4.85**	**0.033**	**1, 779**	**Public**	**3.873**
				Institutional garden	3.631
Gender	**3.76**	**0.053**	**1, 779**	Male	3.675
				Female	**3.829**
Age	0.48	0.794	5, 779		
Ethnicity	0.83	0.611	11, 779		
Educational qualifications	**6.21**	**<0.001**	**5, 779**	None	4.041[ab]
				GCSE/O' level (or equiv)	**4.109[a]**
				A level (or equiv)	3.779[b]
				Degree	3.827[b]
				Masters' degree	3.716[b]
				Doctorate	3.019[c]
Horticultural professional?	2.98	0.085	1, 779		
Landscape professional?	2.50	0.114	1, 779		
Environmental professional?	0.69	0.407	1, 779		

biodiversity (Table 5). Respondents associated naturalness with what they perceived to be biodiverse, yet it is unclear whether they were using perceived biodiversity as a cue to perceived naturalness or vice versa. All correlations between perceived naturalness and individual perceived plant and invertebrate diversity indicators were strongly significant, though the correlations were of varying strength (Table 5). The strongest correlation was between perceived naturalness and the perceived invertebrate value of the planting. This may reflect the growing public awareness of the value of pollinators in the UK since the London 2012 Olympics, where meadow-style plantings received significant media coverage (Hoyle et al., 2017a) and prompted an increasing awareness of the body of academic research in this field (for example Baldock et al., 2015; Blackmore & Goulson, 2014; Hoyle et al., 2018; Salisbury et al., 2015). It is also possible that our respondents based their perceptions of naturalness on their sighting of visible pollinators and other invertebrates during their walk through the plantings.

3.2.2 | Aesthetic perception

There were three individual dimensions of participants' aesthetic perception: i) *Aesthetic effect (Colour, attractiveness, interest & invertebrate value), ii) Neatness* and iii) *Unfamiliarity and complexity.*

There was a strongly significant although weak correlation between perceived naturalness and *aesthetic effect* (Table 5). This

TABLE 4 Sorted pattern matrix for the three key dimensions of participants' perceptions (n = 1411) emerging from principal components analysis with a varimax rotation. Item loading values > 0.5 are shown

	Components				
Questionnaire item (Individual attitudinal statements and questions)	**Aesthetic effect (Colour, attractiveness, interest & invertebrate value)**	**Restorative effect**	**Neatness**	**Perceived plant and invertebrate biodiversity**	**Unfamiliarity and complexity**
The planting on this walk is colourful	0.85				
The combination of colours is attractive in this planting	0.85				
The planting along this walk is attractive	0.72				
The planting along this walk is interesting	0.72				
The planting along this walk appears good for butterflies, bees and other insects	0.59				
I feel relaxed on this walk		0.84			
I feel comfortable along this walk		0.79			
This walk allows me to escape from more mundane routines and work		0.76			
The planting on this walk looks tidy			0.84		
The planting on this walk looks cared for			0.78		
The planting on this walk looks designed			0.78		
How many native UK plant species do you think there are in this planting?				0.80	
How many species of native UK insects (flies, butterflies, bees) do you think this planting will support?				0.72	
The planting on this walk looks familiar to me					-0.69
How structurally complex would you describe this planting?					0.58
How many different plant species do you think there are here?					0.56
Variance explained %	30.56	12.40	9.75	6.39	6.27

TABLE 5 Correlations between (a) Perceived naturalness and perceptional PCA components: Aesthetic effect (Colour, attractiveness, interest & invertebrate benefit), Neatness, Unfamiliarity and complexity, Perceived native plant and invertebrate biodiversity and Restorative effect (b) Perceived naturalness and the belief PCA component 'Nature connectedness' and (c) Perceived naturalness and individual perceived biodiversity measures $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

(a) Perceived naturalness and perceptional PCA components				
	Aesthetic effect	Neatness	Unfamiliarity and complexity	Perceived plant and invertebrate biodiversity	Restorative effect
	0.119**	−0.315**	NS	0.442**	0.423**
(b) Perceived naturalness and Nature-connectedness					
	0.059*				
(c) Perceived naturalness and individual perceived biodiversity measures					
	Perceived no. different plant species		Perceived no. native UK plant species	Perceived value of planting for insects	Perceived no. native UK insects
	0.168**		0.260**	0.327**	0.278**

is interesting because earlier research (Hoyle et al., 2017a) found no significant relationship between actual planting structure and *aesthetic effect*. The loading of the individual items 'colour' 'attractiveness' 'interest' and 'perceived invertebrate value' onto this component indicates strong correlations between these individual indicators and that our respondents associated 'naturalness' with all these attributes of the planting. In the past preferences of urban people for tidy, manicured public landscapes have been reported widely (Gobster, Nassauer, & Daniel, 2007; Jorgensen, Hitchmough, & Dunnett, 2007; Jorgensen et al. 2002; Nassauer, 2011), with reference to the 'deep pervasive cultural norm' of 'care' (Nassauer, 2011). We found a strongly significant moderate negative correlation between *perceived naturalness* and *perceived neatness* (Table 5), that is, although naturalness was perceived as attractive and interesting, it was associated with a perceived lack of design and care. This suggests that although our participants may have contextualised subtle 'cues to care' (Nassauer, 1995) such as mown paths as 'natural', they still recognised more overt forms of human intervention and design, such as arboretum-style trees and blocks of herbaceous planting as 'unnatural'. Recent research focusing on the introduction of urban meadows has suggested that the UK public may be increasingly accepting of a less tended urban aesthetic (Hoyle, Jorgensen, Warren, Dunnett & Evans, 2017). This has been linked to a growing awareness of the biodiversity and pollinator benefits of such planting (Hoyle et al., 2017a) and the increasing economic pressures on local authorities maintaining urban GI (Hoyle, Jorgensen, et al. 2017). Other findings (Fischer et al., 2018) suggest this acceptance of wilder, informal green spaces could be Europe-wide. Here, positive valuation ratings were recorded for high, medium and low biodiversity levels in wasteland scenes, and streetscapes with wild vegetation in treepits were rated more highly than scenes with no vegetation around trees. At the individual level, in the Netherlands aesthetic preference for garden planting of a specific structure: manicured; romantic or wild (Van den Berg & Winsum-Westra, 2010) has been related to an individual's 'personal need for structure' (PNS; Neuberg & Newsom, 1993). Respondents with a high PNS rated wild gardens as less beautiful and manicured ones as more beautiful compared to respondents with a low PNS. In our study, we found no significant correlation between *perceived naturalness* and *unfamiliarity & complexity*.

3.2.3 | Restorative effect

Martens et al. (2011) found that a 'tended' forest environment offered greater restorative potential than 'wild' conditions, yet we identified a strongly significant moderate correlation between *perceived naturalness* and *restorative effect* (Table 5). This is in line with our findings in relation to actual structural naturalness and restorative effect (Hoyle et al., 2017a), where an intermediate level of structural naturalness was most restorative. It also concurs with findings from studies employing contrasting video and photo-elicitation techniques in cultural contexts such as the USA (Jiang, Li, Larsen, & Sullivan, 2016), Italy (Carrus et al., 2013) and Taiwan (Chiang, Li, & Jane, 2017), where vegetation density was used as a proxy for 'naturalness'. Van den Berg, Jorgensen, and Wilson (2014) found no significant difference in recovery between three different natural conditions, yet they did find significant associations between perceived naturalness and recovery of vitality in the natural conditions.

3.3 | Is perceived naturalness related to socio-demographic factors and nature-connectedness?

3.3.1 | Socio-demographic factors

There were more female (60.1%) than male (39.9%) questionnaire participants (n = 1411). They were drawn from the older age groups (Table 2). Most were White British/Irish from a wide range of educational backgrounds. Many participants showed some interest in the environment, landscape or horticulture.

There was a significant relationship between perceived naturalness and educational qualifications (Table 3). Generally, participants with higher educational qualifications recorded lower scores for perceived naturalness. Participants with a doctorate recorded

significantly lower levels of naturalness than all other participants, and the highest levels of perceived naturalness were recorded by people with O' level/GCSE qualifications or equivalent. There was a lack of consistency in the moderately qualified groups, with people of degree level recording slightly higher (although not significantly so) levels of naturalness than those with A' level qualifications or equivalent. This was the independent effect of educational qualifications after adjustment for other factors (public/institutional site context and actual planting characteristics). It is possible that people with higher educational levels were able to distinguish more accurately levels of naturalness by recognising human intervention, possibly resulting from higher levels of family income and exposure to a greater diversity of planting in private garden contexts (Hope et al., 2003). They may also have thought more critically about the meaning of 'natural' when completing the questionnaire. Previous research has shown that a higher education level was related to a lower aesthetic appreciation of gardens showing clear signs of human intervention (Kirkpatrick, Daniels, & Zagorski, 2007; Van den Berg & Koole, 2006; Van den Berg & Winsum-Westra, 2010) and a further Australian study (Kendal, Williams, & Williams, 2012) demonstrated that more educated participants chose native xerophytic planting with narrow grey-green foliage over more colourful flowering non-native species for their own gardens.

We also found a significant relationship between perceived naturalness and gender (Table 3) with female participants perceiving higher levels of naturalness than males. This might be interpreted with reference to evolutionary theory suggesting that women are predisposed to a superior perception and memory of vegetation complexity than men (Silverman & Eals, 1992). yet an alternative interpretation focuses on the stronger pro-environmental beliefs and values held by women (Xiao & McCright, 2015) possibly related to gender socialisation theory (Chodorow, 1978; Gilligan, 1982). There are interesting parallels between our findings and the previously cited Europe-wide study (Fischer et al., 2018) where females valued all park scenes and medium and high levels of species richness in forests more highly than males. Other research (Van den Berg & Winsum-Westra, 2010) found that men were less appreciative of gardens in general than women, particularly wild or romantic ones, and that they were more likely to own a manicured garden than a wild one. This could reflect findings that males have a greater desire than females to control nature (Gross & Lane, 2007). It is interesting that in the case of our research, markedly more female respondents (60.1%) took part in our study than males (39.9%), suggesting a greater interest/willingness to participate in the research amongst women, yet this may have reflected a greater number of women walking through the public spaces/institutional gardens than men on the days of the surveys.

3.3.2 | Nature-connectedness

'Nature-connectedness' was identified as a meaningful dimension of our participants' beliefs. This component accounted for 23.41% variability in our participants 'beliefs'. The loadings of individual questionnaire items were: *Outdoor green spaces lift my spirits* (0.78), *I like being in outdoor green spaces* (0.76), *Plants, shrubs and trees provide valuable habitats for butterflies bees and other insects* (0.71) and *Insects such as flies, butterflies and bees are an important part of ecosystems* (0.70).

The correlation between *perceived naturalness* and nature-connectedness reached significance (Table 5). This indicated that people who demonstrated higher levels of nature-connectedness perceived slightly higher levels of naturalness in the planting. There are again parallels with the previously cited Europe-wide study (Fischer et al., 2018) where perceived biodiversity was related to participants' nature orientation and frequency of green space visits. Nature-connectedness is concerned with a heightened sense of self awareness and an inclusion of the self in nature (Schultz, 1999). More nature-connected individuals are attuned to noticing nature (Frantz & Mayer, 2014) and in our study may have been more receptive to being asked to walk through the planting, complete a survey and to being asked about 'naturalness' in the questionnaire. Nature-connectedness also has an experiential, emotional dimension (Mayer & Frantz, 2004), so more nature-connected individuals may have been more responsive to the physical and psychological experience of walking through an area of planting. People with greater nature-connectedness are more likely to spend time in green spaces, (Lin, Fuller, Bush, Gaston, & Shanahan, 2014). Our study was conducted in gardens and green spaces, and it is therefore likely that all our participants were more nature-connected than the average UK citizen who might not visit such sites. This is borne out with reference to the socio-demographic data (Table 2) which shows good representation from people who work within the landscape professions. Particularly in the institutional garden sites, many of our participants showed a semi-professional interest in gardening. This has been shown to reinforce positive appreciation of nature (Clayton, 2007) and these participants expressed strongly biocentric (nature-centred, after Ives & Kendal, 2014) beliefs. Our respondents, particularly the most nature-connected, would be more exposed than the 'average' UK citizen to the much reported physical and psychological benefits (Clark et al.,2014; Hartig et al., 2014) of spending time in nature, meaning generalisation to the wider UK population must be addressed with some caution. Paid entry to most of the institutional gardens meant that the 'luxury effect,' might apply to these participants, that is, enhanced knowledge and appreciation of plant diversity resulting from higher exposure levels at home due to greater affluence and more extensive private gardens (Hope et al., 2003).

4 | CONCLUSIONS AND IMPLICATIONS FOR PRACTICE AND FURTHER RESEARCH

We addressed a gap in existing knowledge by addressing the perceived naturalness of a comprehensive typology of different woodland, shrub and herbaceous planting in designed and managed contexts. We found an association between people's subjective nature experience and definable 'objective' vegetation structure.

Perceived naturalness was also related to its perceived biodiversity value. Planting associated with 'naturalness' was considered attractive and restorative to walk through, yet not particularly tidy or designed. Our participants may have been more nature-centred than the average UK citizen, yet these findings are still highly significant for planners and policymakers aiming to design, manage and fund urban GI optimally to achieve positive human health and biodiversity outcomes. Planting with a moderately natural structure and some colourful flower cover which supports pollinators and other invertebrates should be prioritised, resulting in a win-win for both people and wildlife. Our findings support other Europe-wide research (Fischer et al., 2018) in suggesting that subtle maintenance interventions are welcomed by the public, but more extreme forms of control, design and maintenance are not desirable or necessary. The acceptance of a less than manicured visual aesthetic is a positive outcome in times of austerity when local authorities throughout the world have limited resources for the maintenance of urban GI and must make difficult choices. Indeed, our findings indicate a positive opportunity to promote and reconcile both human aesthetic and biodiversity conservation objectives. More research is needed to focus on perceptions of naturalness in relation to locational context and thresholds of acceptability.

The multiple benefits of exposure to nature in urban areas are experienced by people who spend time in public green spaces and gardens, many of whom are already nature-connected and aware of these advantages. Further research needs to focus on understanding the role of gender and the values and behaviour of people who do not demonstrate nature-connectedness and do not visit or use these spaces, particularly in the global south, where few studies have been conducted. This should facilitate understanding of the perceived and actual barriers to use, potentially engaging current non-users to make the physical and psychological benefits of nature more universally accessible.

CONFLICT OF INTEREST

Nothing to declare.

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AUTHORS' CONTRIBUTIONS

H.H., J.H., & A.J. conceived the ideas and designed the methodology, H.H. collected and analysed the data and led on the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA ACCESSIBILITY

Complete questionnaire data are available from the Dryad Digital Repository: https://doi.org/10.5061/dryad.q635dh0 (Hoyle, Jorgensen, & Hitchmough, 2019).

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