Climate-adapted, traditional or cottage-garden planting? Public perceptions, values and socio-cultural drivers in a designed garden setting

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ARTICLE INFO

ABSTRACT

The global climate crisis precipitates a call to 'futureproof' cities by introducing resilient climate-adapted urban green infrastructure (UGI). Recent UK research has revealed public support for climate-adapted UGI, yet there is a lack of research focusing on the values underlying public perceptions, particularly in relation to climate change, and the socio-cultural factors driving these. This was addressed by asking 249 people to walk through one of three contrasting areas of planting: exotic (climate-adapted); traditional or cottage-garden, within a designed garden setting, whilst conducting a self-guided questionnaire assessing participants' perceptions of aesthetics, self-reported restorative effect, and plant and invertebrate biodiversity. Participants' held values in relation to climate change, non-native species, and nature-connectedness were also addressed. Findings indicated aesthetic preference for climate-adapted planting over the other two styles, providing further evidence of cultural acceptance for policymakers and land-managers seeking to 'futureproof' cities by introducing climate-adapted UGI. Planting of a cottage-garden style was perceived as the least attractive, but the most restorative. Socio-cultural characteristics including age, educational qualifications, and taking holidays overseas were drivers of perceptions. Professional involvement and interest in the environment, landscape, and horticulture were identified as drivers of perceptions and values. Values in relation to climate change were directly related to participants' educational qualifications. This identifies a need to consider novel approaches to climate change education to promote wider understanding of the implications of climate-change and the potential for climate-adapted UGI to deliver 'futureproofing' benefits for climate-change mitigation and human mental wellbeing.

1. Introduction

Arguably the most severe challenge facing our planet (Grundmann, 2016), climate change has exacerbated urban heating (Emmanuel and Loconsole, 2015), flood risk (Demuzere et al., 2014), and levels of human suffering throughout the world (Burke et al., 2018; Stanke et al., 2012). By 2050 almost 70 % of the global population will live in urban areas (United Nations, 2018) particularly vulnerable to the impacts of high temperatures and flooding. Climate change enhances the 'urban heat island effect' whereby cities experience higher temperatures than surrounding rural areas due to anthropogenically generated heat, built surfaces with low albedo (reflectivity), higher pollution levels, and a lack of cooling vegetation (Emmanuel and Loconsole, 2015). The Intergovernmental Panel on Climate Change (IPCC, 2019) has called for appropriately designed policies, institutions and governance systems to enable both climate change mitigation and adaptation measures to be realised.

At the same time mental illness accounts for a considerable proportion of global human suffering (Steel et al., 2014) with research by Vigo et al. (2016) estimating the proportion of global burden of disease attributable to mental illness comparable to that of cardiovascular and circulatory diseases (32 % of total years lived with disability (YLD), and 13 % disability-adjusted life years (DALYs)). In Europe, the economic cost of this mental ill-health has been estimated at €187.4 billion per year (Olesen et al., 2012). Urban areas specifically have been associated with mental health challenges such as depression and anxiety (Lederbogen et al., 2011). Although the causal link between urban living and these challenges is complex and not fully understood (Bratman et al., 2015), reduced nature contact, 'the extinction of experience' associated with urban living has been identified as a key contributor (Soga and Gaston, 2016; Cox et al., 2017).

The significant psychological benefits of spending time in nature have been highlighted repeatedly (for review see Frumkin et al., 2017) with recent UK research estimating the monetary value of human

wellbeing associated with frequent use of local parks and green spaces at £34.2bn/yr, with the NHS saving £111 m/yr based solely on reduction in GP visits (Fields in Trust, 2018). Positive effects of exposure to natural environments include reduced stress, depression, anxiety, and increased happiness, wellbeing, and life-satisfaction (Frumkin et al., 2017). Much of this research draws on Attention Restoration Theory (ART) (Kaplan and Kaplan, 1989) which proposes that spending time in nature provides an antidote to the intensity of urban living and working, where directed attention on a focused task is fatiguing. In the last ten years there has been a burgeoning of research addressing human reaction to varying natural environments at different scales (Carrus et al., 2015; Fischer et al., 2018; Hoyle et al., 2017a,b; Martens et al., 2011; Qiu et al., 2013; Southon et al., 2017; Van den Berg et al., 2014; Wheeler et al., 2015), whilst also considering the varying responses of people with different socio-cultural characteristics (Fischer et al., 2018; Hoyle et al., 2017a,b; Southon et al., 2017; Wheeler et al., 2015). A considerable body of this research specifically highlights the role of biodiversity and biodiversity perception in delivering human health and wellbeing benefits (Carrus et al., 2015; Fuller et al., 2007; Dallimer et al., 2012; Qiu et al., 2013; Fischer et al., 2018). Research by Hoyle et al., 2017a indicated that colourful planting with a flower cover of 27 % or above was exciting and stimulating for the visiting public, whereas green vegetation was most supportive of relaxation and mental restoration. Women found walking through woodlands, shrub and herbaceous planting more mentally restorative than men and the views of people in environmental professions diverged from those of other members of the public. There has for some time been an awareness of the role of held or underlying values in shaping these individual or group perceptions (Fishbein and Ajzen, 1975). The Cognitive Hierarchy (Fulton et al., 1996) explains that relatively stable and unchanging held values inform our behaviours, attitudes and perceptions, the latter being fleeting and fickle (Ives and Kendal, 2014). Nature-connectedness is a one such held value, shaping individual or group attitudes, behaviours and norms (Nassauer, 1995). Also referred to as 'nature-relatedness' (Nisbet et al., 2011), 'eco-centricity' (Southon et al., 2018) or holding 'biophilic' values (Ives and Kendal, 2014), this has been shown to promote wellbeing (Lumber et al., 2017; Zelenski and Nisbet, 2012).

Focusing specifically on garden environments, there is increasing evidence for the positive psychological benefits of spending time in community gardens, allotments, and domestic gardens, for people at different stages of the life course, or at a specific stage in the life course (see Suyin et al., 2019 for an overview). Gross and Lane (2007) identified shifting meanings associated with domestic gardens across the life course, highlighting as significant the three concepts of 'Escapism' (echoing 'being away', Kaplan and Kaplan (1989)), 'Identity' and 'Ownership'. Domestic gardens provided a setting for people's relationships or 'connectedness' with nature and a place associated with 'retreat'. This resonates particularly during the current coronavirus pandemic, when many people find themselves confined within their private spaces, unable to access the benefits of public greenspaces. The activity of gardening itself has been widely recognised for its therapeutic benefits (Robinson and Breed, 2019), resulting in increasing green prescribing of gardening for people experiencing psychological ill-health. Different garden aesthetics have elicited particular responses from people with contrasting socio-cultural characteristics. Comparison of individual preferences for manicured, romantic, and wild gardening styles revealed that participants with a high Personal Need for Structure (PNS) rated wild gardens less beautiful and manicured gardens more beautiful than those with a low PNS (Van den Berg and Winsum-Westra, 2010).

The need to prioritise urban green infrastructure has therefore never been so great. The introduction of resilient, climate-adapted, 'fit-for-place' urban green infrastructure (networks of multifunctional parks, green and blue spaces, and features such as green roofs and walls) (UGI) (Norton et al., 2015) provides an opportunity to futureproof cities, mitigating and adapting to the challenges of climate change whilst

simultaneously addressing the growing mental health issues amongst urban residents' enduring an 'extinction' of nature experience. Yet UGI itself must be adapted and resilient to climate change (McPherson et al., 2018) whilst at the same time socially and culturally acceptable to the public (Hoyle et al., 2017b; Miller, 1997). Urban woodlands, street trees, shrubs and herbaceous vegetation are themselves vulnerable to climate change stressors including extreme heat, drought, winds and pests (McPherson et al., 2018). Building resilience into urban planting necessitates identifying 'climate-ready' species compatible with future climates. Researchers in the USA (McPherson et al., 2018) and UK (Watkins et al., 2020) are currently doing this, modelling future climates to identify 'climate-ready' species. In terms of social and cultural acceptability, recent UK research (Hoyle et al., 2017b) indicated strong public support (75 %, n = 1411 participants) for the introduction of non-native, climate-adapted urban planting in public parks and gardens. Whilst resilience to climate change was identified as the main driver of public acceptance, participants importantly perceived non-native planting as significantly more attractive and interesting than native UK planting. Greater understanding is needed of public perceptions of contrasting planting styles including exotic climate-adapted, and the held values underlying these. I address this need within an institutional garden context, providing transferable insights informing policymakers and land managers prioritising climate resilience and human wellbeing within the wider urban context. I ask: (i) What is the key driver of people's perceptions in relation to aesthetics, self-reported restorative effect, and plant and invertebrate biodiversity: planting style or socio-cultural variability? (ii) What are the socio-cultural drivers of people's held values in relation to climate change, the introduction of non-native species, and nature-connectedness? (iii) Do the perceptions and values of people with a personal interest or professional involvement in landscape, horticulture or the environment diverge from those of other members of the public?

2. Methods

2.1. The garden context and study sites

On-site walks and questionnaires were conducted (after Hoyle et al., 2017a,b) with members of the visiting public within three aesthetically distinctive areas of planting: i) Exotic, (climate-adapted); ii) Cottage-garden and iii) Traditional Borders within the Royal Horticultural Society (RHS) Garden, Wisley, Surrey, UK (Fig. 1). The three contrasting garden styles were deliberately selected in order to compare public reaction to 'climate-ready' planting incorporating exotic planting to the UK (such as *Canna Phasion* with large vibrant orange flowers, and *Musa lasiocarpa*, (Chinese dwarf banana)), with an informal, English 'cottage-garden' style, with a wilder aesthetic and incorporating more familiar native species (such as *Digitalis*, *Geranium*, *Achillea* and *Rosa*), and a traditional, English formal style of planting in blocks, incorporating plant species both native and non-native to the UK (*Agapanthus, Dahlia, Rosa, Clematis*) (Fig. 2). The Exotic Garden was recently (2017) introduced at RHS Wisley as an innovative experiment to gauge the response of exotic planting to the changing UK climate. The three contrasting, visually distinctive gardens are located adjacent to each other within the institutional gardens at RHS Wisley, thereby facilitating a constant background context, allowing comparison of people's reactions to the specific garden aesthetics themselves ().

2.2. Questionnaires with the visiting public

A self-guided questionnaire (after Hoyle et al., 2017a,b) was conducted to assess participants' perceptions of the three contrasting gardens in terms of aesthetics, restorative effect, and plant and invertebrate biodiversity. Participants held values in relation to climate change, non-native biodiversity, and nature-connectedness were also assessed. Most items in the questionnaire took the form of attitudinal statements,

Fig. 1. The location of Royal Horticultural Society (RHS) Garden, Wisley, Surrey, UK.

using a five-point Likert scale from +2 (agree strongly) to -2 (disagree strongly), following established methodology (e.g. Balling and Falk, 1982) (Table 1). Ten items were used to address aesthetic perception. 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 and Kaplan, 1989). This followed Herzog et al. (2003) approach, adapted (Hoyle et al., 2017a,b) to address human reactions to a range of natural planted environments. Three questions focusing on perceived biodiversity involved participants answering within the categories: 'many', 'some' 'few' or 'none'. Three items were used to assess participants' values in relation to climate change (after Hoyle et al., 2017b) and four those in relation to the introduction of non-native biodiversity. Seven items were included to assess participants' nature-connectedness, with two deliberately crafted to address participants' appreciation of the aesthetics of nature ('I like colourful flowering plants' and 'I can distinguish between different plants'). One open question was also included, 'Give your overall impression of the planting along the walk'. This gave participants the opportunity to express key experiential observations in relation to walking through the planting (see Table 7). A section focusing on the respondents' socio-cultural characteristics was included.

The questionnaire was conducted on-site within the Royal Horticultural Society (RHS) Garden, Wisley, Surrey, UK (Fig. 1) on three consecutive days in August 2018. Potential participants were selected at random as a convenience sample, approached in one of the three areas of planting: i) Exotic, (climate-adapted) (20th August); ii) Cottage-garden

(21st August); and iii) Traditional Borders (22nd August) and invited to complete a self-guided questionnaire gauging their response to that particular garden-style alone (after Hoyle et al., 2017a,b). Although a degree of self-selection took place, i.e., participants had decided to walk through the planting before being approached, because the three areas of planting were adjacent to each other, most garden visitors toured the wider garden, walking from one garden to the next, experiencing all three during their visit. Over the three consecutive days of data collection temperatures were consistently between 20–23 degrees centigrade, with part sun, part cloud-cover. All three gardens displayed significant flower cover (above 27 %).

2.3. Questionnaire data analysis

With the exception of the open question focusing on participants' overall impression of the planting, all data were analysed statistically using IBM SPSS version 23.

An initial Principal Components Analysis (PCA) with a varimax rotation was applied to all questionnaire items relating to participants' perceptions (research themes a, b, and c in Table 1) to identify which varied consistently and loaded onto single components each measuring a specific dimension of perceptions (after Hoyle et al., 2017a,b; Hoyle et al., 2018; Kendal et al., 2012). Parallel analysis (Watkins, 2005) was used to extract meaningful components. To assess whether planting style or socio-cultural variability were drivers of participants' perceptions in relation to aesthetics, self-reported restorative effect, and plant and

Fig. 2. The three contrasting areas of planting style at RHS Wisley, Surrey UK.

Fig. 3. Planting non-native to the UK as featured in the questionnaire.

Table 1

On-site questionnaire: Individual attitudinal statements and questions used to address participants' perceptions of the (a) aesthetic qualities (b) restorative effect (c) biodiversity value of the planting and held values in relation to (d) climate-change, (e) non-native plant species, (f) nature-connectedness.

Research theme	Questionnaire Measures (Individual attitudinal statements & questions)
(a) 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 is colourful
	The combination of colours is attractive in this planting
	The planting on this walk looks familiar to me
	How structurally complex would you describe this planting?
	The planting on this walk looks cared for
	The planting on this walk looks designed
	The planting on this walk looks tidy
(b) Restorative effect	I feel comfortable on this walk (compatabilty)
	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)
(c) Perceived biodiversity value	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?
(d) Climate-change awareness	I believe global climate change is happening
	I believe that global climate change will have serious consequences
	I think global warming will change the plant species most suited to grow in UK parks and gardens over the next 50 years
(e) Non-native biodiversity	Planting in parks and gardens should be restricted to native species
	Native plants support more native butterflies, bees and other insects than non- native plants
	I would be happy to see more non-native species like those below (Fig. 3) growing in UK parks and gardens
	I would accept non-native species like those (Fig. 3) in UK parks and gardens if they were better suited to the climate than present day species
(f) Nature-connectedness	Outdoor green spaces lift my spirits
	I like being in outdoor green spaces
	I like looking at colourful flowering plants
	I can distinguish between different plants
	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
	The environment is important regardless of its value to people

invertebrate biodiversity, four multi-factor ANOVAs were conducted, one with each of the emergent perceptions components as the dependent variable and the planting style and socio-cultural variables (Table 2) as independent, to identify significant drivers of perceptions.

A second Principal Components Analysis (PCA) with a varimax rotation was applied to all questionnaire items relating to participants' values (research themes d, e, and f in Table 1) to identify which varied consistently and loaded onto single components each measuring a specific dimension of participants' held values. Parallel analysis (Watkins, 2005) was used to extract meaningful components. To identify the socio-cultural drivers of people's held values in relation to climate change, the introduction of non-native species, and nature-connectedness five multi-factor ANOVAs were conducted, one with each of the emergent values components as the dependent variable and socio-cultural variables (Table 2) as independent, to identify

Table 2

Questionnaire participants' (n=249) socio-cultural profile.

*(valid %)	
Gender (missing values = 5 respondents)	
M	79 (32.4 %)
F	165 (67.6 %)
Age (missing values = 3 respondents)	
18 – 24	12 (4.9 %)
25 – 34	12 (4.9 %)
35 – 44	15 (6.1 %)
45 – 54	37 (15.0%)
55 – 64	75 (30.5 %)
65 +	95 (38.6 %)
Ethnicity (missing values = 4 respondents)	
White British/Irish	217 (88.6 %)
White (other)	12 (4.9 %)
Mixed white/Asian	1 (0.4 %)
Asian Indian	4 (1.6 %)
Asian Pakistani	1 (0.4 %)
Asian Chinese	1 (0.4 %)
Asian other	7 (2.9 %)
Black other (than African/Caribbean)	2 (0.8 %)
Educational qualifications (missing values = 8 respondents)	
None	24 (10.0 %)
GCSE/O'levels/Scottish standard grades	50 (20.7 %)
A' levels/Scottish higher grades/International bacalauriat	49 (20.3 %)
Degree	77 (32.0 %)
Masters' degree	33 (13.7 %)
Doctorate	8 (3.3 %)
Economic status (missing values = 4 respondents)	
Paid employment/self-employed	91 (37.1 %)
Retired	127 (51.8 %)
Full-time student	11 (4.5 %)
Living with family	5 (2.0 %)
Unemployed/seeking work	1 (0.4 %)
Looking after family/home	8 (3.3 %)
Long term sick/disabled	1 (0.4 %)
Other	1 (0.4 %)
Have you spent most of your life until now in an urban area (town or city), a rural area (village or countryside) or in the rural/urban fringe? (missing values = 2 respondents)	
Urban	115 (46.6 %)
Rural	42 (17.0 %)
Rural/urban fringe	90 (36.4 %)
Do you or have you taken holidays overseas in warmer climates? (missing values = 3 respondents)	
Yes	224 (91.1 %)
No	22 (8.9 %)
Landscape/horticulture/environmental professional? (missing values = 6 respondents)	
Yes	23 (9.5 %)
No	220 (90.5 %)
Personal interest in landscape/horticulture/environment? (missing values = 7 respondents)	
Yes	147 (60.7 %)
No	95 (39.3 %)

*Valid percentages given due to missing values.

significant socio-cultural drivers of held values.

The perceptions and values of people with a personal interest or professional involvement in the environment, landscape or horticulture were identified through the analyses focusing on the role of socio-cultural variables, as described above.

Participants' overall impressions of the planting were transcribed and coded thematically to identify the recurrence of key terms (see Elliot, 2018).

3. Results

Questionnaires (n = 249) were completed with the visiting public in the Exotic, (climate-adapted) Garden (n = 89), Cottage-garden (n = 88), and Traditional Borders (n = 72). The socio-cultural profile of participants is shown in Table 2. Over two thirds of participants were women, with the sample skewed towards the older age groups and those

no longer in active employment. There was some ethnic diversity, although White British/Irish participants dominated. Over half the participants were educated to degree level or above, yet 10 % had no formal educational qualifications. A majority (61 %) of participants demonstrated an interest in landscape/horticulture or the environment.

3.1. Drivers of public perception

Four components were extracted from the PCA of questionnaire items relating to participants' perceptions of the planting (Table 3), together accounting for 59.38 % of total variability in responses. Components were clearly identifiable as: *aesthetic effect* (30.66 % variance), *restorative effect* (13.82 % variance), *native biodiversity* (8.43 % variance), and *plant diversity and complexity* (6.47 %).

3.1.1. Aesthetic effect

Eight individual questionnaire items relating to the aesthetic qualities of the planting loaded onto this component (Table 3), indicating that attractiveness in the planting was strongly correlated with colour, interest, and care. *Planting style* was identified as a significant driver of aesthetic effect, with participants perceiving the climate-adapted planting style significantly more attractive, colourful, interesting, and cared for than the other two styles (Table 4). The cottage-garden planting was rated significantly lower for aesthetic effect than the other two styles. Participants self-reporting as a *landscape, horticultural or environmental professional* perceived lower levels of aesthetic effect. Two further socio-cultural variables (*ethnicity* and *economic status*) were identified as significant drivers of aesthetic effect, yet the low numbers of participants in some ethnic and socio-economic groups limits the robustness of further interpretation. (Table 2).

3.1.2. Restorative effect

Four individual questionnaire items loaded onto this component; three relating to participants self-reported restorative response to the planting, and one their perceptions of the naturalness of the planting (Table 3). *Planting style* was also a driver of restorative effect, with participants perceiving the cottage-garden style as the most restorative to walk through, significantly more so than the traditional style (Table 4). Participants self-reporting as a *landscape, horticultural or environmental professional* perceived the planting as less restorative overall than other members of the public. The variable *Educational qualifications* was associated with restorative effect, although patterns are unclear. Participants with a doctorate and those with UK advanced level high school qualifications perceived the planting as significantly more restorative to walk through than those with no qualifications.

3.1.3. Perceived native biodiversity

Five individual questionnaire items loaded onto this component, three referring explicitly to biodiversity. Of these two referred specifically to native biodiversity (one plant, one invertebrate) (Table 3). The two further items referred to 'naturalness' and 'familiarity' to participants. *Planting style* was a driver of perceptions of native biodiversity, with participants accurately associating the climate-adapted planting dominated by exotic species such as *Canna Phasion* and *Musa lasiocarpa* with a significantly lower level of native biodiversity than the other two planting styles (cottage-garden and traditional) (Table 4). Participants self-reporting as a *landscape, horticultural or environmental professional* perceived lower levels of native biodiversity than did non-professionals. Participants *aged between 25−34* perceived significantly lower levels of native biodiversity than older participants, and *people who had taken holidays in warmer climates* perceived significantly higher levels of native biodiversity than those who had not (Table 4).

3.1.4. Perceived plant diversity and complexity

Three individual questionnaire items loaded onto this component, one referring to aesthetics and design, one to plant species diversity, and

Table 3

Sorted pattern matrix for the four key dimensions of participants' perceptions (n = 249) emerging from principal components analysis with a varimax rotation. Item loading values >0.3 are shown. Values >0.5 are in bold.

Questionnaire item (Individual attitudinal statements & questions)	Components			
	Perceived aesthetic effect	Perceived restorative effect	Perceived native biodiversity	Perceived plant diversity and complexity
The combination of colours is attractive in this planting	**0.81**			
The planting on this walk is colourful	**0.80**			
The planting along this walk is attractive	**0.79**			
The planting on this walk looks cared for	**0.78**			
The planting along this walk is interesting	**0.72**			
The planting on this walk looks tidy	**0.72**			
This walk reveals a special unique place	**0.60**			
The planting on this walk looks designed	0.48			0.45
I feel relaxed on this walk		**0.81**		
This walk allows me to escape from more mundane routines and work		**0.79**		
I feel comfortable along this walk		**0.70**		
The planting on this walk looks natural		**0.58**	0.44	
How many species of native UK insects (flies, butterflies, bees) do you think this planting will support?			**0.80**	
The planting along this walk appears good for butterflies, bees and other insects			**0.72**	
How many native UK plant species do you think are in this planting?			**0.68**	
The planting on this walk looks familiar to me			0.45	
How many different plant species do you think there are here?				**0.82**
How structurally complex would you describe this planting?				**0.66**
Variance explained %	30.66	13.82	8.43	6.47

the final one to complexity (Table 3). There was no association between *planting style* and perceived plant diversity and complexity, yet *educational qualifications* were significantly related. Participants with no qualifications and those with doctorates perceived significantly lower levels of diversity and complexity than did all other participants. (Table 4).

3.2. Drivers of held values

Five components were extracted from the PCA of questionnaire items relating to participants' held values (Table 5), together accounting for 60.42 % of total variability in participant responses. Components were clearly identifiable as: *Climate change awareness* (20.64 %), *Ecological awareness* (12.57 %), *Compatibility (of non-native planting and native invertebrates)* (9.89 %), *Acceptance of non-native planting* (9.16 %), and *the Connection to the aesthetics of nature* (8.16 %).

3.2.1. Climate change awareness

Educational qualifications were the dominant significant driver of Climate change awareness (Table 6), with results showing a direct correlation between participants' level of education and their awareness of the implications of climate change. Participants with no formal educational qualifications demonstrated significantly lower levels of Climate change awareness than all other participants. In contrast, participants with a *personal interest in landscape/horticulture and environment* had higher levels of Climate change awareness than other participants (Table 6).

3.2.2. Compatibility (of non-native planting and native invertebrates)

Findings indicated that participants who had *spent most of their lives in urban areas* perceived significantly higher levels of Compatibility between non-native planting and native invertebrates than those who had lived in rural or rural/urban fringe areas (Table 6).

3.2.3. Connection to the aesthetics of nature

Four individual questionnaire items loaded onto this component, indicating Connection to the aesthetics of nature (appreciation of colourful flowering plants, distinctions between plants) (Table 5). Participants with an *interest in landscape/horticulture and environment* demonstrated greater connection to the aesthetics of nature than did other participants.

No participants' socio-cultural variables were significantly related to their Ecological awareness or Acceptance of non-native planting (Table 6)

4. Discussion

4.1. Drivers of people's perceptions in relation to aesthetics, self-reported restorative effect, and plant and invertebrate biodiversity

4.1.1. Planting style

Planting style was the dominant driver of our participants' perceptions of aesthetic effect, restorative effect, and perceived native biodiversity, with participants rating the aesthetic qualities of the Exotic, (climate-adapted) Garden significantly more highly than those of the Traditional Borders or the Cottage-garden (Table 4). The Exotic Garden was designed to incorporate the dramatic, alien forms of plants such as *Canna Phasion* and *Musa lasiocarpa*. More participants volunteered the term 'Interesting' to describe it (15) than the Cottage-garden (9) or Traditional Borders (5). Participants volunteered comments including "Exotic, unusual, colourful, innovative", "beautiful, sensual, and stimulating", and "Colourful and unusually appealing" when giving their overall impressions of the Exotic Garden. This concurs with earlier findings that 'strongly non-native' planting was significantly more colourful, attractive, and interesting than 'intermediately native' or 'strongly native' planting Hoyle et al. (2017b), and research by Qiu et al.

Table 4

Results of ANOVA with perceptional principal components as dependent and planting style and socio-cultural factors as independent variables. Significant values are in bold. Marginal mean *(MM)* scores for significant variables are shown in bold. Those with different subscripts are significantly different from each other.

	Perceptional principal components															
	Perceived aesthetic effect				Perceived restorative effect				Perceived native biodiversity				Perceived plant diversity and complexity			
	F	P-value	Variance %	*MM*	F	P-value	Variance %	*MM*	F	P-value	Variance %	*MM*	F	P-value	Variance %	*MM*
Planting style	**56.23**	**<.001**	**39.4**	**Climate 3.24a** **Cottage** **1.84c** **Trad 2.92b**	**4.59**	**0.01**	**5.00**	**Climate 2.50ab** **Cottage** **2.70a** **Trad 2.17b**	**23.85**	**<0.001**	**21.60**	**Climate 2.13b** **Cottage 3.00a** **Trad 3.01a**	1.06	0.35	1.20	
Gender	3.22	0.08	1.80		0.32	0.57	0.20		1.95	0.17	1.10		2.59	0.11	1.50	
Age	1.52	0.19	4.20		0.69	0.63	2.0		**2.36**	**0.04**	**6.40**	**18−24 2.58ab** **25−34 1.88b** **35−44 2.73a** **45−54 3.10a** **55−64 2.97a** **65+2.97a**	0.22	0.96	0.60	
*Ethnicity	**2.64**	**0.02**	**8.40**		1.50	0.18	4.90		1.43	0.21	4.70		1.15	0.33	3.80	
Educational qualifications	0.86	0.51	2.40		**2.45**	**0.04**	**6.60**	**None 1.99b** **O'level 2.52ab** **A'level 2.74a** **Degree 2.22ab** **Masters 2.40ab** **Doctorate 2.87a**	1.67	0.16	4.60		**2.42**	**0.04**	**6.50**	**None 2.20b** **O'level 2.80a** **A'level 3.08a** **Degree 3.10a** **Mast ers 3.03a** **Doctorate 2.75b**
*Economic status	**2.82**	**0.01**	**8.90**		0.56	0.76	1.90		1.15	0.33	3.80		0.61	0.72	2.10	
Have you spent most of your life until now in an urban area (town or city), a rural area (village or countryside) or in the rural/ urban fringe?	2.11	0.12	2.40		2.61	0.08	2.90		1.42	0.25	1.60		1.02	0.36	1.20	

Table 4 (*continued*)

| | Perceptual principal components | | | | | | | | | | | | | | | |
| | Perceived aesthetic effect | | | | Perceived restorative effect | | | | Perceived native biodiversity | | | | Perceived plant diversity and complexity | | | |
	F	P-value	Variance %	MM	F	P-value	Variance %	MM	F	P-value	Variance %	MM	F	P-value	Variance %	MM
Do you or have you taken holidays overseas in warmer climates?	0.24	0.63	0.10		2.88	0.09	1.60		4.33	0.04	2.40	Yes 2.94 No 2.47	1.27	0.26	0.70	
Landscape/horticulture/environmental professional?	4.86	0.03	2.70	Yes 2.45 No 2.89	13.50	<0.001	7.20	Yes 2.01 No 2.90	8.37	0.004	4.60	Yes 2.38 No 3.03	3.58	0.06	2.00	
Personal interest in landscape/horticulture/environment?	0.65	0.42	0.40		1.14	0.29	0.70		0.01	0.91	0.00		0.66	0.42	0.40	

* Ethnicity and Economic status sample sizes are too small for further interpretation.

(2013) where participants expressed a higher recreational preference for an ornamental park with a higher percentage of exotic biodiversity than three contrasting habitat zones with lower percentages of exotic species. Individual items relating to colour and effective colour combinations loaded onto the component 'aesthetic effect' (Table 3), yet although perceptions of colour and flowering played some role in driving a positive aesthetic response, all three areas of planting demonstrated a flower cover over 27 %, the threshold identified to create 'the wow factor' associated with particularly attractive planting (Hoyle et al., 2017a) and participants' responses to the open question, 'give your overall impression of the planting along the walk' (Table 7) reveal a comparable number of participants volunteering the description 'Colourful' in response to the Exotic Garden (17) and Cottage-garden (16). The three individual items relating to 'care' ('cared for', 'designed', and 'tidy') loaded onto the component 'aesthetic effect', indicating that participants expressed an aesthetic preference for planting that appeared 'cared for', with one participant commenting, "It is a very beautiful and well cared-for planting. Looks designed, not natural" in response to the Exotic Garden. This concurs with earlier research by Nassauer (1995) proposing that people like to see 'human intention' or 'cues to care' in an urban environment, with 'cues' identified as mown edges and bright flowers in prominent positions.

The rating of cottage-garden planting as significantly lower than the other two planting styles for aesthetic effect (Table 4) was reinforced by comments generated by the open question (Table 7). Whereas sixteen participants volunteered the term 'beautiful' to describe the Exotic Garden and fifteen the Traditional Borders, only two individual participants volunteered it in response to the Cottage-garden. Yet in contrast, the Cottage-garden was rated the most restorative of the three gardens to walk through, and associated with a significantly higher restorative effect than the Traditional Borders (Table 4). Participants impressions included: "Restful, colourful, and pleasing", "Natural and a sense of calm" and "It's very soothing", concurring with findings (Hoyle et al., 2017a) that people find planting with a most or moderately natural structure more restorative to walk through than a highly designed 'least natural' structure. Reinforcing this, ten participants volunteered the term 'natural' to describe the Cottage-garden, whereas only one used the term in in reference to the Traditional Borders, with no participants describing the Exotic Garden as 'natural'. A small number of participants also used the terms 'untidy' (1), 'messy' (3) and 'wild' (1) to describe the Cottage-garden, with comments including "Higgledy piggledy", "Natural, haphazard" and "Mixed, messy, wild". Appreciation and support for planting with a wilder aesthetic was also revealed in an extensive (N = 3716) European study (Fischer et al., 2018) including diverse research participants from five European cities (Malmo, Berlin, Edinburgh, Bari, Ljubljana), where generally positive valuation ratings were recorded for wasteland scenes of three varying levels of biodiversity. Findings from these studies contrast with earlier studies revealing negative (Brun et al., 2017; Martens et al., 2011) or ambivalent attitudes to more naturalistic urban vegetation (Jorgensen et al., 2007), indicating a role for wilder urban planting in some contexts. That the Exotic Garden was rated highest for aesthetic effect, yet the Cottage-garden, rated the lowest for aesthetic effect was rated highest for restorative effect can be explained with reference to earlier research by Hoyle et al. (2017a) indicating that contrasting stimuli elicit reactions of aesthetic delight (the more colourful, highly designed) and relaxation (greens background with a wilder aesthetic).

Participants associated the Exotic, climate-adapted garden with significantly lower levels of native biodiversity than the other two garden styles (Table 4), indicating that participants were able to recognise the distinctive, visually exotic species such as *Canna Phasion* and *Musa lasiocarpa*. Clearly unfamiliar visual cues such as the spiky leaves of palms (Fig. 2) were on display. Participants' open responses included: "Escapism to the exotic", "Beautiful and tropical", with one commenting on "the most beautiful combination of plant shapes and colours". There was no significant difference in participants' perceptions of native

Table 5
Sorted pattern matrix for the five key dimensions of participants' values (n = 249) emerging from principal components analysis with a varimax rotation. Item loading values >0.3 are shown. Values >0.5 are in bold.

Questionnaire item (Individual attitudinal statements)	Components				
	Climate change awareness	Ecological awareness	Compatibility non-native planting & native and invertebrates	Acceptance Non-native planting	Connection to aesthetics of nature
I believe that global climate change will have serious consequences	**0.91**				
I believe global climate change is happening	**0.89**				
I think global warming will change the plant species most suited to grow in UK parks and gardens over the next 50 years	**0.85**				
Insects such as flies, butterflies and bees are an important part of ecosystems		**0.84**			
Plants, shrubs and trees provide valuable habitats for butterflies, bees and other insects		**0.79**			
Planting in parks and gardens should be restricted to native species			**−0.84**		
Native plants support more native butterflies, bees and other insects than non- native plants			**−0.70**		
Outdoor green spaces lift my spirits		0.31			
I would be happy to see more non-native species like those below (Fig x) growing in UK parks and gardens'				**0.86**	
I would accept non-native species like those (Fig. X) in UK parks and gardens if they were better suited to the climate than present day species				**0.80**	
I like looking at colourful flowering plants					**0.67**
I like being in outdoor green spaces					**0.66**
I can distinguish between different plants					**0.63**
The environment is important regardless of its value to people					0.34
Variance explained %	20.64	12.57	9.89	9.16	8.16

biodiversity between the Cottage-garden and Traditional Borders. Previous research suggests that biodiversity recognition by the lay-person is better at the broad visual habitat scale (Hoyle et al., 2017b; Qiu et al., 2013), and less-honed at the species level. Research conducted in Sheffield, UK (Fuller et al., 2007) found that greenspace users could recognise species richness, yet recognition was best in the case of plants, moderate in the case of birds and poor in the case of butterflies. Southon et al. (2018) found that actual and perceived plant species richness were positively correlated, yet the accuracy of biodiversity estimates was greater for more nature-connected research participants.

4.1.2. Socio-cultural variability

Socio-cultural variability played some role in driving participants' perceptions. *Educational qualifications* were associated with Restorative effect, yet there is no clear pattern to the results. *Age* and *Whether people had taken holidays in warmer climates* were related to native biodiversity perception. That participants aged between 25−34 perceived lower levels of native biodiversity than older participants irrespective of the type of planting they were walking through could be explained with reference to lower levels of native biodiversity experience amongst this group (Soga and Gaston, 2016; Cox et al., 2017) and limited familiarity with any green or planted environments comparted with retired older participants, particularly if they spend a significant amount of time working within indoor environments (Klepeis et al., 2001). In contrast people who had taken holidays in warmer climates perceived higher levels of native biodiversity than those who had not probably due to a form of 'luxury effect' (Hope et al., 2003), whereby these participants had experience of a wider range of plant and invertebrate species, through overseas travel. This afforded them a wider frame of reference with which to compare the planting they were experiencing along the walk at RHS Wisley. One participant appreciated the Exotic Garden because of the memories it evoked, describing it as "Exotic- pleasing especially having lived with many of these plants in Uganda".

4.2. Socio-cultural drivers of held values in relation to climate change, the introduction of non-native species, and nature-connectedness

Two socio-cultural variables were associated with participants' held values: *Educational qualifications* and *Whether participants had spent most of their lives in an urban area* (as opposed to a rural or a rural/urban fringe area).

That participants lacking any formal educational qualifications demonstrated significantly lower levels of climate change awareness than others participants suggests that formal education is the route to gaining understanding and awareness of the issues and challenges for cities and populations associated with climate change discussed above (Burke et al., 2018; Demuzere et al., 2014; Emmanuel and Loconsole, 2015; Grundmann, 2016; Stanke et al., 2012). This is a possibility, indeed this research took place in August 2018, before the term 'Climate crisis' moved into popular currency. It may, however, be that people without any formal educational qualifications consume different media to those with higher levels of education, with contrasting messages about climate change. Nonetheless, this finding suggests that there is still a need to develop science communication strategies to raise climate change awareness at the population level.

That research participants who had spent most of their lives in an urban area (as opposed to a rural or a rural/urban fringe area) demonstrated a greater awareness of the compatability between non-native planting and native invertebrates is likely to be related to their personal experience of this compatability within urban domestic garden environments (Hoyle et al., 2017b). Urban domestic gardens in the UK tend to be dominated by non-native plant species. A study of 61 domestic gardens in Sheffield (Smith et al., 2006) revealed 70 % non-native plants mainly from Europe and Asia, deliberately selected and planted by residents, and 30 % native garden plants including mainly unchosen lawn and garden weeds. In contrast, rural or rural/-urban fringe areas in the UK are experiencing dramatic biodiversity loss (in terms of insects, vascular plants and vertebrates) mainly due to the intensive management of agricultural land under monocultural crops

Table 6

Results of ANOVA with values principal components as dependent and socio-cultural factors as independent variables. Significant values are in bold. Marginal mean *(MM)* scores for significant variables are shown in bold. Those with different subscripts are significantly different from each other.

	Values principal components																	
	Climate change awareness				Ecological awareness			Awareness compatibility non-native planting and native invertebrates				Acceptance non-native planting			Nature-connectedness			
	F	P-value	Variance %	*MM*	F	P-value	Variance %	F	P-value	Variance %	*MM*	F	P-value	Variance %	F	P-value	Variance %	*MM*
Gender	1.13	0.29	0.60		2.36	0.13	1.20	0.04	0.84	0.00		1.94	0.17	1.00	1.24	0.27	0.60	
Age	1.01	0.42	2.60		1.34	0.34	2.90	1.17	0.33	3.00		0.88	0.50	2.20	1.20	0.31	3.10	
Ethnicity	0.54	0.80	2.00		1.56	0.15	5.40	1.86	0.08	6.40		1.03	0.41	3.60	1.46	0.19	5.10	
Educational qualifications	**2.99**	**0.01**	**7.30**	**None 2.12**$_b$ **O'level 2.68**$_a$ **A'level 2.79**$_a$ **Degree 2.86**$_a$ **Masters 3.11**$_a$ **Doctorate 3.32**$_a$				0.77	0.57	2.00		2.14	0.06	5.30	1.02	0.41	0.03	
Economic status	0.16	0.99	0.50		0.52	0.79	1.60	1.43	0.21	4.30		0.80	0.57	2.40	0.88	0.51	2.70	
Have you spent most of your life until now in an urban area (town or city), a rural area (village or countryside) or in the rural/urban fringe?	0.08	0.93	0.10		0.61	0.54	0.60	**3.58**	**0.03**	**3.60**	**Urban 3.33**$_a$ **Rural 2.81**$_b$ **Rural/ Urban 2.81**$_b$	0.25	0.78	0.30	0.93	0.40	1.00	
Do you or have you taken holidays overseas in warmer climates?	1.40	0.24	0.70		2.24	0.14	1.20	0.44	0.51	0.20		1.00	0.32	0.50	0.32	0.57	0.20	
Landscape/horticulture/environmental professional?	0.61	0.44	0.30		1.38	0.24	0.70	3.52	0.06	1.80		2.06	0.15	1.10	0.02	0.88	0.00	
Personal interest in landscape/ horticulture/environment?	**7.59**	**0.01**	**3.80**	**Yes 3.01 No 2.62**	0.26	0.61	0.10	0.73	0.40	0.40		2.32	0.13	1.20	**13.91**	**<0.001**	**6.8**	**Yes 2.72 No 2.21**

Table 7
Participants' overall impressions of planting along the walk.

Participants' self-generated responses	Exotic climate-adapted	Cottage-garden	Traditional borders
Attractive	5	5	6
Beautiful	16	2	15
Colourful	17	16	12
Interesting	15	9	5
Dramatic	4	0	0
Exotic	9	1 (species level)	0
Natural	0	10	1
Untidy	0	1	0
Messy	0	3	0
Wild	0	1	0
Calming	1	4	2
Relaxing	3	8	3
Restful	2	1	1
Scented	0	1	1

(Burns et al., 2016).

4.3. Perceptions and values of people with a personal interest or professional involvement in landscape, horticulture or the environment

Our findings indicated that having professional involvement in landscape, horticulture or the environment had a bearing on perceptions, whereas having an interest in these same areas was a driver of held values.

4.3.1. Professional involvement and perceptions

Consistent with findings from earlier studies, (Fischer et al., 2018; Hoyle et al., 2018; Ozguner et al., 2007), we found that participants who were *Professionally involved* in landscape, horticultural or the environment demonstrated perceptions and preferences significantly divergent from other participants with no such professional involvement. Regardless of the planting style they walked through (exotic, cottage-garden or traditional) professionals rated the planting lower for aesthetic effect, restorative effect and perceived native biodiversity than other members of the public. Lower ratings for aesthetic effect may be related to the situation of the planting within an institutional garden context which meant that professionals were acutely aware that the planting was all designed, even the more naturalistic Cottage-garden. All three areas of planting displayed significant flower cover (over 27 %), which may also have been a cue. Previous research has shown that professionals preferred more naturalistic, spontaneous planting, with subtle flowers, to tidier, ordered planting with bright flowers. In an extensive Europe-wide study (Fischer et al., 2018) environmental experts rated wild wasteland sites more highly than did non-experts, and in a UK study of public reaction to annual (predominantly non-native) meadows, environmental experts rated colourful flowering meadows as less colourful, attractive, and biodiverse than did non-experts (Hoyle et al., 2018). Lower scores for restorative effect may be related to participants finding themselves in an environment which was their usual work environment, so the planting did not offer them an opportunity of 'being away' (Kaplan and Kaplan, 1989). The significantly lower ratings for perceived native biodiversity amongst professionals compared with other members of the public may be related to professionals' enhanced eco-centricity and ability to recognise and accurately assess biodiversity (Southon et al., 2018).

4.3.2. Personal interest and held values

That 61 % of our participants reported a *Personal interest* in the environment, landscape or horticulture is not surprising, because an institutional garden like RHS Wisley attracts people who have in interest in viewing gardens. Many of these participants are enthusiastic gardeners with their own domestic gardens. These participants demonstrated significantly higher levels of climate change awareness than other members of the visiting public, possibly due to personal experience of the impacts of climate change in their own domestic gardens (Hoyle et al., 2017b). That these participants also demonstrated significantly stronger connection to nature, (Lumber et al., 2017; Nisbet et al., 2011) and the aesthetics of nature is also unsurprising. These participants had made the decision to travel to RHS Wisley, which is advertised as an institutional garden where colourful flowering plants are on display. Other participants who expressed no interest in landscape, horticulture or the environment were often visiting as accompanying friends, partners or family members making social visits to the gardens.

5. Key conclusions and implications for policy and practice

Our findings inform policy and practice towards the realisation of environmentally and socially sustainable UGI. That participants expressed a significantly higher aesthetic preference for the Exotic, (climate-adapted) Garden over the other two garden styles provides evidence of public support for non-native planting, a positive transferable finding informing policymakers and land-managers seeking to 'futureproof' cities by introducing climate-adapted UGI in parks and gardens. Nevertheless, the Cottage-garden, perceived as the least attractive, was considered the most restorative of the three areas of planting. This provides further evidence that different stimuli elicit contrasting responses in the public. Landscape planners and designers should draw from these findings to inform practice on the ground, also providing opportunities for restoration amongst familiar, naturalistic planting in public parks. When planning and designing culturally acceptable UGI, professionals should also be mindful of the divergence of their own perceptions and preferences from those of the wider public. Caution should be exercised in the wide generalisation of findings from this relatively homogenous sample of dominantly female, older, White British/Irish participants, most of whom expressed landscape, horticultural or environmental interests. Our participants were, however, heterogenous in educational background. We identified a direct relationship between *Educational qualifications* and Climate change awareness, with significantly lower levels of awareness amongst people with no formal qualifications. This is a striking finding and identifies a need to consider novel science-communication strategies to transcend formal educational channels if the public is to be better informed about the challenges of climate change and their implications for urban green infrastructure. This will also broaden understanding of the positive potential for climate-adapted UGI to deliver 'futureproofing' benefits for climate-change mitigation and human mental wellbeing.

Author statement

Helen Hoyle: Conceptualization, Methodology, Data collection and analysis, Writing-original draft preparation, reviewing and editing.

Declaration of Competing Interest

The authors report no declarations of interest.

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Further reading

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