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People's Attitudes and Emotions towards Different Urban Forest Types in the Berlin Region, Germany

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Abstract: In an era of urbanization, forests are a key component of the urban green infrastructure, providing multiple benefits to urban residents. While emerging forests on urban wasteland could increase the urban forest area, it is unclear how residents view such novel forest types. In a comparative self-administered online survey, we assessed attitudes and emotions of residents (n = 299) from the Berlin region, Germany, towards forest types that represent transformation stages from natural to novel forests: (1) natural remnants, (2) silvicultural plantings, (3) park forests and (4) novel wild forests in wastelands. Respondents expressed positive attitudes and emotions towards all forest types, including the novel wild forest. Ratings were most positive towards natural remnants and least positive towards the novel wild forest. The indicated prevalence of non-native trees (*Ailanthus altissima*, *Robinia pseudoacacia*) did not evoke negative responses. Women and younger people were more positive towards the novel wild forest compared to other respondents, and men were most positive towards natural remnants. Place attachment was positively related to the park forest. Results indicate support for a wide range of forest types, including novel wild forests and non-native tree species, which can be used to expand urban forest areas and enhance opportunities for nature experience in cities.

Keywords: landscape preference; cognitive constructs; human cognition; four natures approach; non-native plant species; shifting baseline syndrome; urban wilderness; urban greenspaces; urban forestry; wild urban woodland

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1. Introduction

In a rapidly urbanizing world, urban forests are becoming increasingly important because they benefit urban residents by supporting a wide range of ecosystem services related to human health and well-being [1–5]. Promoting urban forests and optimizing their management is therefore important for developing urban green infrastructure [6–10] and thus is also a key component of nature-based solutions in cities [11–13]. A better understanding of landscape preferences and emotions of people towards different facets of forests is essential for assisting stakeholders in decisions about how to develop or manage urban forests [14–17]. Consequently, forests are most prominent in studies on the perception or valuation of urban greenspaces [18]. A large body of research has investigated attitudes (e.g., [19–22]) and emotions (e.g., [17,20,23–25]) towards forests in cities. Previous studies have addressed people's views in relation to manifold features of urban forests, including vegetation structure [26,27], naturalness [28,29], wilderness [30,31], management [32,33], biodiversity [21,34] and nativeness [35]. Findings revealed, for example, a high preference for semi-open forests [21,36], while dense shrubbery can lead to the experience of fear [25]. Deciduous forests have been found to evoke positive emotions [20], but adding evergreen trees is appreciated in another study [34]. Biodiversity matters as well, with demonstrated preferences for medium to high species richness [20,21]. A

study in the UK suggests that urban forests dominated by non-native trees are appreciated despite known risks of strongly non-native planting [35]. Invasive Acacia stands in South African cities are perceived as ugly or weedy [37], while wild grown stands of the invasive tree *Ailanthus altissima* are positively rated in some but not all urban settings in Berlin, Germany [38]. The context thus strongly matters in regard to attitudes or emotions towards urban forests.

People's views on forests differ also in relation to their personal background. Previous studies identified a range of socio-demographic variables related to forest preferences, including age, gender, place of growing up and place attachment [17,39,40]. In five European cities (Bari, Berlin, Edinburgh, Malmö, Ljubljana), for example, nature orientation, frequency of use or the personal migration background were significant predictors of residents' preferences for forests, yet with valuation patterns strongly differing among cities [21]—as they did on a continental scale in a study from the Americas [41].

Previous studies have highlighted manifold relationships of attitudes and emotions of urban residents towards an array of forest features, often differing with respondents' background. Expanding on these studies, we here address the question of how attitudes and emotions of urban residents vary in relation to forest types that represent different transformation stages from natural to novel forests. We selected these forest types according to the "four natures approach". This concept was developed in 1991 to highlight categorical differences between nature expressions that exist within the boundaries of Berlin and many other cities [42–44]. The concept highlights the differences between the main types of nature in an understandable way for a broad discourse among different stakeholders about urban development, but without making an a priori value assignment. In our study, we presented the following forest types to the participants of the survey:

- Natural forest remnant often occurring in the urban fringe and related to the pristine landscape (nature 1);
- Silvicultural forest planting existing as well in the fringe of many cities, representing components of the rural cultural landscape (nature 2);
- Forest in an urban park as omnipresent component of designed greenspaces (nature 3);
- Wild grown forest resulting from the recolonization of vacant land and representing novel ecosystems in many cities (nature 4).

These four forest types relate to a range of gradients as illustrated in Table 1. These gradients involve manifold implications for conserving, developing and managing urban forests. Conserving natural forest remnants in urban areas, for example, is a well-established conservation target (e.g., [34]), while promoting wilderness in cities increasingly gains importance [45–47], including opportunities associated with novel woodland emerging on vacant land [9,48]. Reconciling economically motivated forest management with the provisioning of cultural ecosystems is a common challenge [49] as is the consideration of aesthetic values [32]. Finally, how to include or manage non-native species in urban forests is a controversial issue [50,51]. Beyond this background, a better understanding of people's attitudes and emotions towards forest types with different development histories can support policies in urban forestry and environmental policies.

Table 1. Urban forest types, illustrating the four nature types according to Kowarik [42,43], characterized in relation to gradients of naturalness, wilderness, ecological novelty, management, design and dominance of native trees (see Section 2.1 for further explanation).

Type of forest/ Nature	Naturalness	Wilderness	Ecological Novelty	Management	Design	Native Dominance
Natural remnant (Nature 1)	High	High	Low	Low	Low	High
Silvicultural planting (Nature 2)	Medium	Medium	Low	Medium	Low	High
Designed park forest (Nature 3)	Low to medium	Low to medium	Medium	High	High	Medium
Novel wild forest (Nature 4)	Low	High	High	Low	Low	Low to medium

Forest types that can be assigned to the four natures exist in many cities globally [2] and have been previously subject to preference studies. Different from natural remnants and forest patches in parks, however, novel wild forests on vacant land are clearly understudied. Few previous studies have revealed the importance of vegetation structure on vacant land, which becomes denser as succession progresses toward forest. Participants in studies from French [52] and German cities [53] preferred dense woody vegetation less than previous, more open succession stages. However, comparisons of forests representing different nature types are scarce. For example, Hofmann et al. 30] compared different vegetation structures of vacant land and designed parks and showed that laypeople and professionals have different preferences for manicured or wild vegetation structures. Comparative studies on forests related to all of the four nature types are missing thus far.

We performed an online survey in the Berlin region, Germany, with photo stimuli depicting urban forests related to each of the four natures, i.e., to natural remnants, managed silvicultural plantings, designed park forests and novel forests on vacant land (Figure 1). In particular, we aimed to understand

1. how respondents' (a) attitudes and (b) emotions towards urban forests differ among the four nature types and
2. how respondents' sociocultural and demographic background (gender, age, growing up in the city vs. countryside and place attachment) relate to these attitudes and emotions.

We expected that emotions and attitudes would differ among the four nature types and that socio-demographic variables as underlying mediators have an impact on emotions and attitudes towards the four nature types. We anticipate that a better understanding of attitudes and emotions towards different forest types helps develop more effective conservation and management measures and ultimately supports connectedness with urban forests in everyday places.

Figure 1. Photographic stimuli depicting four forest types (**a**–**d**) typical of the Berlin region and differentiated according to the four natures concept [42,53] (Table 1): (**a**) nature 1 represented by a beech forest as natural remnant, dominated by the native *Fagus sylvatica*, (**b**) nature 2 represented by a silvicultural plantation, dominated by the native *Pinus sylvestris*, (**c**) nature 3 represented by a designed tree-dominated urban park with the non-native *Robinia pseudoacacia*, (**d**) nature 4 represented by a novel wild woodland dominated by the non-native *Ailanthus altissima*. A small branch with leaves of characteristic tree species is shown as inserts on the top left. Information about the prevailing management of the shown forest types and the origin (native/non-native) of the dominant tree species was provided in a text above each photograph.

2. Theoretical Background

2.1. Four Natures Concept

The four natures concept was developed in 1991 to highlight categorical differences between nature expressions in cities [42,44]. The *four natures* reflect different stages of transformation from natural remnants (nature 1), to ecosystems shaped by agricultural or silvicultural land use (nature 2), to designed urban greenspaces (nature 3), and finally to novel ecosystems emerging on specific urban-industrial sites (nature 4). The aim of the concept was to illustrate essential differences between these nature types in a comprehensible way without generally assigning different values to the respective nature types. This way, the concept also allowed the otherness of the novel nature 4, in relation to other nature types, to be understood. This supported controversial discussions on considering this type of novel urban nature in the development of Berlin's green infrastructure. The concept anticipated the later established novel ecosystem concept of Hobbs et al. [54,55] in important parts in an urban context [56]. The novel ecosystem concept illustrates the transformation of pristine "historical ecosystems" due to anthropogenic changes in the abiotic and/or biotic characteristics of an ecosystem. This change is assumed to be reversible in the case of "hybrid ecosystems" and irreversible in the case of "novel ecosystems" [54,55]. The four natures can be partly paralleled with the classifications of the novel ecosystem concept: nature 1 corresponds to the "historical ecosystems" and nature 4 to the "novel ecosystems", while natures 2 and 3 can largely be related to the "hybrid ecosystems" of Hobbs et al. [54,55].

As shown in Table 1, the four nature types are related to a range of gradients relevant for urban design, conservation and planning. The contrasting assignments of nature 4 to a low level of naturalness and a high level of wilderness result from different reference points. In traditional naturalness concepts, pristine nature is the historical reference (e.g., [57,58]), while wilderness can be defined without historical benchmark, based on the self-regulation of ecosystems [46]. Ecological novelty refers to the concept of Hobbs et al. [54,55], and particularly to its application for ecosystems [59], with a range of implications for urban green planning and management [60]. A high abundance of non-native species is typical of many urban settings, with the highest levels in the designed nature *3*, as in many urban parks, and in the novel wild nature 4, as in ecosystems on vacant land [51].

2.2. Attitudes

Attitudes towards landscapes and ecosystems are sometimes referred to as valuation or perception of landscapes [18] as well as preference [61] for landscapes. The concept of attitudes can be defined as "deeply held mental stance" [62] (p. 63) or as evaluative expressions (partially negative or positive reaction) to a certain object or to situations that underlie individual assessments of the environment [63,64]. This latter description of attitudes is followed in this study and is also reflected in the terminology of preference [64]. People's preference can thus express whether one landscape pleases more than another [62] and shows that it meets individual needs [61].

2.3. Emotions

While often investigated in relation to wildlife [65,66] or on environmentally friendly behavior in general [67], emotions can also be relevant for the examination of forest patches [17]. Emotions manifest themselves in different aspects, such as reactions of the physical body, expressions, patterns of behavior or experiences [66,68]. The diversity of emotions can be summarized in the dimensional and discrete perspective [69]. The dimensional perspective pursues the idea that emotions can be positioned according to different dimensions such as valence [69] which measure the opposite emotional states pleasure and displeasure [65,69], e.g., when thinking about an object. In contrast, the discrete perspective focuses purely qualitatively on differences in individual emotions such as fear or joy [65,69]. When differentiating emotions, the dimensional perspective is particularly present in classification approaches, especially the dimension of valence [70] and a useful self-report measure of emotions [71]. Hence, to measure emotions of respondents in relation to each nature type, we used the concept of valence [65] in this study.

3. Materials and Methods

3.1. Study Area

Berlin is the largest city in Germany, with 3.8 million inhabitants in 2021, within a total area of 891 km^2. About 60% of the city is developed with built-up areas and streets, while the remaining 40% is covered by green or blue spaces in 2020, including forests (18%) and parks (7%) [72]. Natural forest remnants are dominated by broadleaf trees, but many of these stands have been replaced by silvicultural pine plantations [73]. While native tree species prevail in natural or managed forest sites at the outskirts, a combination of non-native and native trees is typical of both designed urban greenspaces and in the wasteland vegetation that emerged on sites destroyed during World War II [74]. Some of these areas remained wild urban woodland while others were integrated as parks into Berlin's green infrastructure [46,75].

3.2. Survey Design

An online questionnaire created using the online tool "LamaPoll" (Lamano GmbH & Co. KG™, Berlin, Germany) was distributed in May 2020. To cover respondents from varying socio-demographic backgrounds, we approached 955 randomly selected institutions

in Berlin and the surrounding federal state of Brandenburg through internet research. The addressed institutions covered largely in equal parts sports, elderly people homes, urban gardening initiatives and cultural associations, adapting the approach from Fischer et al. [21]. We asked the institutions (n = 955) to distribute the survey through their email distribution lists or their social media channels. Following a snowball sampling method [76], we further asked the contacted institutions and persons from our own environment to forward the survey link to other people in their professional or personal environment. The survey was accessible for two months from May to July 2020, and we sent a reminder email to the institutions after two weeks. Respondents were invited to join a raffle as an incentive (5 × 2 tickets for the Museum für Naturkunde Berlin, Germany).

3.3. Questionnaire

The questionnaire included photo stimuli showing scenarios of forests representing the four nature types (Figure 1). It also included items to measure (a) attitudes and (b) emotions (measured as valence) towards these nature types as well as (c) socio-demographic variables, adapted from Fischer et al. [21], and included items measuring place attachment, i.e., whether respondents felt 'like a Berliner' [77] (Table 2, Table A1).We also asked for the zip code of current residence to ensure that only responses from respondents currently living in Berlin and Brandenburg were included in the analysis. We limited the study to Berlin and its wider surroundings (i.e., Brandenburg) to ensure a high familiarity of the participants with the four nature types shown.

Table 2. Tabular summary of the response variables used in the questionnaire to query the attitudes and emotions towards the four nature types, as well as the related predictor variables, corresponding questions, items and scales used. The complete questionnaire in its original wording is listed in Appendix A (Table A1).

Response variable	Question Items	Answer options			
Attitudes	To what extent do you agree with the following statements? Please tick on a scale from −2 to 2.				
	(1) I find [nature type] beautiful	−2	=	do not agree at all	
	(2) I find [nature type] worthy of protection	−1	=	do not agree	
		0	=	neutral	
	(3) I find [nature type] interesting	1	=	agree	
		2	=	agree completely	
Emotions (Valence)	On a scale of −2 to 2, what are your feelings when you see the photo stimuli with [nature type]?	Negative	−2, −1, 0, 1, 2	positive	
		Dislike	−2, −1, 0, 1, 2	like	
		uncomfortable	−2, −1, 0, 1, 2	comfortable	
		Unpleasant	−2, −1, 0, 1, 2	pleasant	
Predictor variable					
Place attachment	How strongly do you agree with the following statements about Berlin?				
	(1) No other city is comparable to Berlin.	−2	=	do not agree at all	
	(2) Berlin is the best city for what I like to do.	−1	=	do not agree	
	(3) I get more pleasure from living in Berlin than in any other city.	0	=	neutral	
		1	=	agree	
		2	=	agree completely	
Age	Respondents' age	____ years NA—no answer			
Gender	Respondents' gender	Female			

		Male Diverse NA—no answer
Place of growing up	Where did you grow up?	in the countryside in the city

3.3.1. Photo Stimuli

Including photo stimuli in surveys is a well-established approach to investigate attitudes or preferences towards forests, other landscapes and their biodiversity [21,30,40,78–80]. In our survey, each of the photo stimuli showed one tree-dominated scenario related to one of the four nature types according to the four natures approach (Figure 1). A picture of a remnant beech forest, dominated by the native tree *Fagus sylvatica*, represents nature 1, and a picture of a sylvicultural pine plantation, dominated by native *Pinus sylvestris* stands for nature 2. A tree-dominated park scene, with the non-native *Robinia pseudoacacia* as the major tree, represents nature 3. Nature 4, finally, was depicted by a scene of a wild woodland on a vacant urban site, dominated by the non-native *Ailanthus altissima*. The choice of dominant tree species reflects the prevalence of native trees in natures 1 and 2 in Berlin, while non-native trees often dominate settings of the other nature types [74]. The native or non-native status of the trees was mentioned in the description of the photo stimuli, and typical leaves of the respective tree species were shown in an insert in the upper left edge (Figure 1). Moreover, we mentioned the prevailing management of the forest types.

We considered the following aspects in editing the photo stimuli to reduce other potentially influencing factors: All photos showed the respective nature type from a similar angle, with a similar amount of visible sky and structural density. A partially sealed path was inserted in a similar place in each photo to indicate accessibility of the nature scenes to visitors and as a cue to care [14,46]. While the dimension of the paths was kept, the shape of the path was adapted to the character of common paths existing in each forest type. All potentially distracting natural or anthropogenic elements were deleted from the photos. To compensate for differences in vegetation density in the original photos and to ensure comparability, typical vegetation elements from the original photos were copied and subsequently added to the herb and shrub layers in the stimuli. The original photos were taken by one of the authors (I.K.) from specific places in Berlin and edited in Adobe Photoshop™.

3.3.2. Attitudes

Attitudes, as defined by Ajzen [63], were examined in relation to each of the photo stimuli with three items: 'I find [nature type] beautiful' (1), 'I find [nature type] worthy of protection' (2), 'I find [nature type] interesting' (3). Respondents could rate on a 5-point scale ranging from 'do not agree at all' (=−2) to 'agree completely' (=2) (Table 2). We adapted these attitude items from a general attitude approach [81] and decided on a negative to positive scale similar to that in previous studies to counteract the social desirability bias (i.e., people lean towards positive and agreeable ends of the scale) [65]. High values reflected positive and low values negative attitudes towards the corresponding nature type.

Internal scale reliability (Cronbach's alpha) was acceptable for attitudes (Table 3). The scale reliability of the examined attitude towards nature 1 (α = 0.66) would have increased to a value of 0.73 if item (3) had been removed. However, while a value of 0.7 is assumed as the tolerated threshold value of Cronbach's alpha [82], it is also discussed whether a generally valid threshold value exists [83]. The items used were retained for nature 1 due to the comparability between the different nature types. For nature 2, the removal of items would result in a lower Cronbach's alpha value, as for natures 3 and 4.

Hence, average scores were calculated as composite indices to reflect the attitudes towards the specific nature type.

Table 3. Respondents' attitudes and emotions towards urban forests representing four nature types (Table 1, Figure 1). Shown are mean values, standard deviation and reliability (Cronbach´s alpha) for each nature type.

Nature Type	Response Variable	Mean	SD	Cronbach's Alpha
Nature 1	Attitude	1.64	0.47	0.66
	Emotion	1.89	0.32	0.78
Nature 2	Attitude	0.59	0.93	0.86
	Emotion	1.05	0.90	0.96
Nature 3	Attitude	0.78	0.82	0.81
	Emotion	1.23	0.78	0.94
Nature 4	Attitude	0.38	1.05	0.87
	Emotion	0.69	1.16	0.97

3.3.3. Emotions

To measure emotions of respondents in relation to each nature type, we used the concept of valence [65]. Respondents were asked to express how they felt when seeing each photo stimulus by rating on four pairs of items, expressed in a bipolar scale ('negative—positive', 'dislike—like', 'uncomfortable—comfortable' and 'unpleasant—pleasant'). These item pairs were presented directly after the items in relation to attitudes. Scale reliability was acceptable (Cronbach's alpha value > 0.7 as the tolerated threshold [82]) (Table 3), so mean scores of the emotional disposition valence were used in further analyses.

3.3.4. Socio-Demographic Variables

Sociodemographic variables were addressed in the questionnaire (Table A1) to gain a better understanding about the background of the study sample. A subset of socio-demographic variables was used as predictor variables and included questions about respondents' age, gender, whether they grew up in urban or rural areas and items measuring place attachment adapted from Williams and Vaske [77] (Table 2). The three items on the construct place attachment were rated on a 5-point scale ranging from 'do not agree at all' (=−2) to 'agree completely' (=2). Scale reliability was acceptable (Cronbach's alpha value of 0.78), so mean scores of the three items were used in further analyses.

3.3.5. Pre-Test

The questionnaire was pre-tested with n = 12 respondents from different socio-demographic backgrounds, i.e., with people different in age (from 21–82 years; average age: 55 years), gender (5 males and 7 females) and occupation (students, employees and pensioners). The pre-tests were carried out in April 2020 as cognitive interviews, each with a length of up to 1.5 h following Fischer et al. [21]. The pre-test led to slight adaptations of the questionnaire for the final version (Table A1). We ensured that the questionnaire could be completed within approx. 15 min.

3.4. Statistical Analysis

We included only questionnaires in the analyses that were completely filled out by people living in Berlin or Brandenburg. Respondents that did not indicate their postal code correctly were considered as living in Berlin or Brandenburg (n = 48) since the survey was distributed only to institutions in Berlin and Brandenburg. We explicitly requested at the beginning of the survey that only people from Berlin and Brandenburg participate. As a control, we performed a separate analysis without the 48 individuals (Table A3). The

results are predominantly the same, and consequently, we included the $n = 48$ participants in the analyses. All analyses were performed in R, version 4.0.2 [84]. We used the package "psych" [85] for calculating Cronbach´s alpha and the package "stats" [84] for performing Kruskal–Wallis tests, for post-hoc pairwise Wilcoxon rank sum tests and for generalized linear models (GLMs). To adjust the *p*-value for multiple comparisons, the strict conservative Bonferroni method [84] was implemented in the pairwise Wilcoxon rank sum test. In order to test for significant differences in the ordinal scaled attitudes and emotion samples towards the four types of nature (H1), the parameter-free Kruskal–Wallis test was performed. As a post-hoc test, a pairwise Wilcoxon rank sum test was subsequently conducted to enable pairwise comparisons of the respondents' attitudes and emotions towards the four nature types. To test for relationships between respondents' socio-demographic backgrounds and their emotions and attitudes in relation to the four nature types (H2), we applied GLMs with age, gender, place of growing up and place attachment as fixed explanatory variables and attitudes and emotions towards the different nature types as response variables.

4. Results

4.1. Sample

From a total of 434 respondents, we used 299 responses (69%) for further analyses; 135 responses were not included because the questionnaires were incomplete or because postal codes from outside Berlin or Brandenburg were explicitly mentioned. Women (66.6%) were overrepresented in relation to other respondents (28.4% men, 0.3% divers, 4.7% NA). Respondents' age varied between 19 and 83 years (mean = 43 years). Most respondents (62.9%) stated that they grew up in a city, were born in Germany (94.3%) and used German as the preferred language at home (96.7%). Few respondents indicated that their parents (mother: 3%; father: 6.7%) or grandparents (parents of mother: 10%; parents of father: 10.4%) were born in a country other than Germany. A majority of the respondents (82.9%) had high school graduation as the highest general educational qualification and a university degree (58.5%) as the highest vocational training qualification. Slightly less than half of the respondents indicated that they own a garden (43.5%) (Appendix A, Table A2).

4.2. Attitudes and Emotions towards the Four Nature Types

Respondents expressed significantly different attitudes and emotions towards the four forest scenarios that represented the four nature types in our survey (Table 1, Figure 1), ranging from a natural forest remnant (nature 1), to a silvicultural planting (nature 2), to a designed forest in an urban park (nature 3), to a novel wild forest on an urban wasteland (nature 4).

While respondents' attitudes towards the four nature types differed significantly (chi-squared = 324.65, df = 3, $p < 0.0001$), all average score values for each nature type were positive, decreasing from nature 1 (natural remnant), to nature 3 (designed park), to nature 2 (sylvicultural plantation) to nature 4 (novel wild forest) (Table 3, Figure 2).

Similarly, respondents expressed overall positive but significantly (chi-squared = 296.11, df = 3, $p < 0.0001$) different emotions towards the four types of nature. The mean average scores for emotions decreased in the same order as did the scores for attitudes towards nature 1 to nature 4 (Table 3, Figure 2).

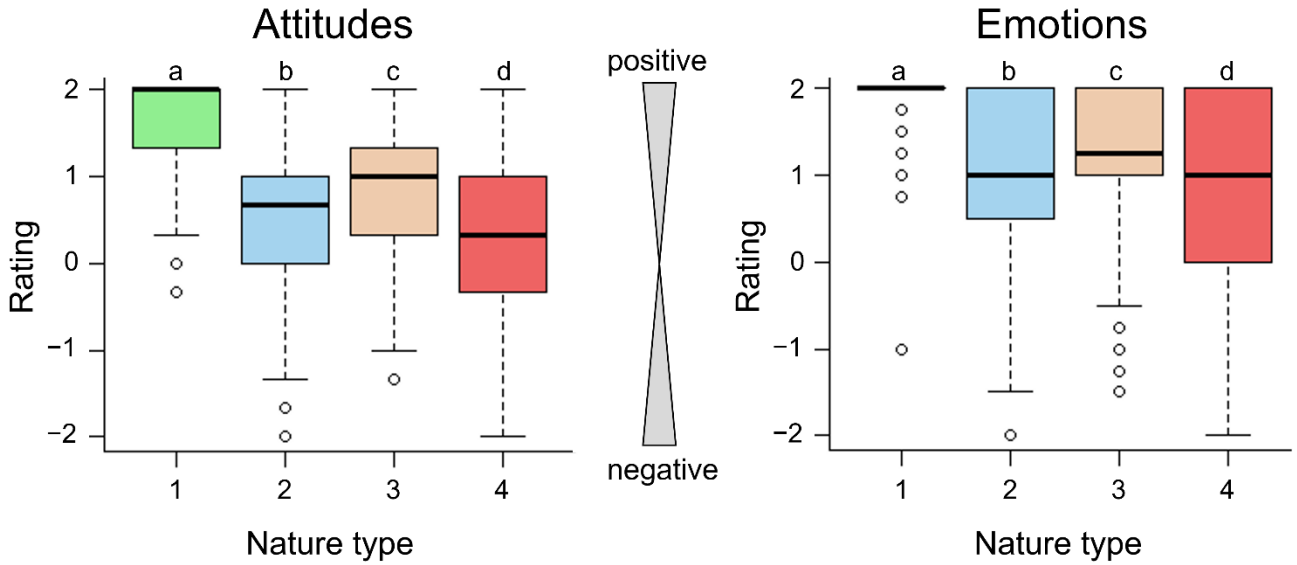

Figure 2. Respondents' (n = 299) attitudes and emotions towards four forest types shown in Figure 1 and representing four nature types according to the four natures concept [42,43]; see Table 3 for parameters related to attitudes and emotions. The letters a to d indicate significant differences (post-hoc pairwise Wilcoxon rank sum tests: for attitudes $p < 0.001$ for a to b, a to c, a to d and c to d; $p < 0.01$ for b to c and b to d and for emotions $p < 0.001$ for a to b, a to c, a to d, b to d and c to d; $p < 0.01$ for b to c). The left boxplot shows the respondents' attitudes towards the four types of nature plotted on the x-axis. Correspondingly, the emotions of the participants towards the four natures are shown in the right boxplot. The values −2 to +2 plotted on the y-axis correspond to a negative attitude or emotion (−2) to a positive attitude or emotion (+2).

4.3. Predictive Potential of Respondents' Socio-Demographic Background

Gender, age, place of growing up and place attachment showed predictive potential for attitudes and emotions towards the four nature types (Table 4).

For nature 1, the natural remnant, age and gender had a predictive potential on attitudes and emotions. Respondents older than 61 years showed more positive attitudes. Men generally expressed lower emotions towards this nature type than other respondents.

Table 4. Predictive potential of respondents' socio-demographic background for attitudes and emotions towards the four nature types. Results of the generalized linear models with estimate, standard error (S.E.) and p-value (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Significant results shown in bold and highlighted in shaded grey.

	Nature 1			**Nature 2**			**Nature 3**			**Nature 4**		
	Estimate	**S.E.**	***p*-Value**	**Estimate**	**S.E.**	***p*-Value**	**Estimate**	**S.E.**	***p*-Value**	**Estimate**	**S.E.**	***p*-Value**
						(1) Attitudes						
Age (reference 19-30)												
31–45	0.05	0.08	0.55	−0.04	0.15	0.79	0.01	0.13	0.96	−0.12	0.16	0.48
46–60	0.13	0.07	0.06	−0.12	0.14	0.38	−0.19	0.13	0.13	**−0.71**	**0.15**	**<0.001 *** **
>61	**0.18**	**0.09**	**<0.05 ***	0.10	0.18	0.57	0.19	0.16	0.23	**−0.57**	**0.20**	**<0.01 ** **
Gender (reference women)												
Men	−0.08	0.06	0.21	**−0.33**	**0.12**	**<0.01 ** **	−0.17	0.11	0.12	**−0.38**	**0.13**	**<0.01 ** **
Divers	−0.27	0.46	0.55	0.10	0.91	0.92	0.16	0.81	0.85	0.56	0.99	0.57

Place of growing up (reference rural)												
Urban	−0.04	0.06	0.54	**0.28**	**0.12**	**<0.05 ***	0.12	0.10	0.23	**0.28**	**0.13**	**<0.05 ***
Place attachment	0.04	0.03	0.17	0.06	0.06	0.34	**0.14**	**0.05**	**<0.01 ****	0.11	0.06	0.08
						(2) Emotions						
Age (reference 19-30)												
31–45	−0.08	0.05	0.10	0.05	0.14	0.74	0.03	0.13	0.80	−0.11	0.18	0.55
46–60	0.06	0.05	0.20	−0.11	0.14	0.42	**−0.26**	**0.12**	**<0.05 ***	**−0.76**	**0.17**	**<0.001 *****
>61	0.06	0.06	0.38	−0.04	0.17	0.82	0.11	0.15	0.48	**−0.45**	**0.22**	**<0.05***
Gender (reference women)												
Men	**−0.11**	**0.04**	**<0.05 ***	**−0.34**	**0.12**	**<0.01 ****	**−0.28**	**0.10**	**<0.01 ****	**−0.37**	**0.15**	**<0.05***
Divers	−0.58	0.31	0.07	−0.01	0.88	0.99	−0.39	0.77	0.61	0.13	1.09	0.91
Place of growing up (reference rural)												
Urban	−0.02	0.04	0.61	**0.25**	**0.11**	**<0.05 ***	0.16	0.10	0.11	**0.34**	**0.14**	**<0.5***
Place attachment	0.01	0.02	0.72	**0.12**	**0.06**	**<0.05 ***	**0.15**	**0.05**	**<0.01 ****	0.10	0.07	0.15

Men also reported significantly lower attitudes and emotions towards nature 2, while growing up in the city had a positive predictive potential for attitudes and emotions towards this nature type, as did place attachment for emotions.

Place attachment was a significantly positive predictor for emotions and attitudes towards nature 3, represented by the tree-dominated urban park. In contrast, men and older respondents (46–60 years) expressed significantly less positive emotions towards nature 3 than other respondents.

Older (>46 years) and male respondents showed significantly less positive attitudes and emotions towards nature 4, the novel wild woodland, compared to women and younger respondents. In contrast, growing up in the city had a positive predictive potential on attitudes and emotions towards nature 4.

The analyses excluding the participants that did not indicate their postal code were similar (Table A3 in brackets). Slight differences in significance were found for the age group > 61 and attitudes toward nature type 1, place attachment and emotions toward nature type 2 (no significant correlations) and place of growing up and emotions toward nature type 3 (new significant correlation).

5. Discussion

While people usually perceive forests in cities positively, urban forest patches can be very different in terms of history and anthropogenic imprint [2,3,43]. People's views of natural forests and forest patches in parks have often been studied—but less that of silvicultural plantings and of novel forests that often emerge on urban wasteland sites. We conducted, to our knowledge, the first comparative study of people's attitudes and emotions towards a wide range of natural to novel anthropogenic forests in a large city, representing all types of nature according to the four natures approach [42,43] (Table 1).

- A first major insight was that the ratings of attitudes and emotions towards all forest types were positive overall, including the novel wild forest dominated by non-native tree species.

- A second major result was that attitudes and emotions significantly differed between forest types, thus confirming our initial expectation.
- A third major result: Respondents' background mattered since a range of demographic or sociocultural variables, such as gender, age, place attachment and where they grew up, showed a predictive potential for response patterns.

5.1. Attitudes and Emotions

Both for attitudes and emotions, respondents assigned the highest scores to nature 1, the natural forest remnant. Here, our results add evidence to previous studies that have already demonstrated positive views of natural forests and pristine landscapes in general in relation to other forest and greenspace types (e.g., [14,21,86,87]). Although silvicultural pine plantings are often spatially linked with natural forest remnants in the Berlin region, respondents' ratings were less favorable for the former. Different from our study, pine forests were most favored by respondents in Finland [32]; yet, there, pine forests belong to the natural vegetation. While the presence of evergreen trees related positively to ratings in other studies [20,34], the lower ratings for evergreen pine plantings in our study, compared to broadleaf natural remnants, indicate that the apparently higher intensity of forest management was less appreciated by respondents. Since highly managed park forests received more positive ratings than silvicultural planting, it was likely not a high intensity of management per se that evoked less positive attitudes and emotions but the structural outcome of the human interference, resulting in a dense and rather homogeneous stand structure in silvicultural plantings, while the park forest showed semi-open, heterogeneous structures. This is in line with previous studies that demonstrated a decreasing attractiveness of forests with increasing narrowness, density of undergrowth and leaf canopy [36,88]. Dense shrubbery and coniferous forests can also convey feelings of fear or confinement [25,89].

Since "cues to care" are important for landscape preferences [14,90], we inserted clearly recognizable paths in each photo to control for differences in the accessibility of forest types. We decided on this approach since wild urban forests can be linked with anxieties resulting, for example, from the feeling of being on one's own [91]. It has to be pointed out the photo representing the wild nature 4 also received positive ratings of attitudes and emotions, albeit to a lesser extent than the other nature types.

Respondents' preference of the natural remnant forest over the novel wild forest was expected since a range of studies demonstrate a high appreciation of natural or pristine landscapes [14,80,86,92], especially near-natural deciduous forests [89]. Correspondingly, wasteland vegetation received less positive ratings than a natural forest remnant in a European study [21].

That respondents' attitudes and emotions towards nature 4 were still positive, was a surprising result since previous studies demonstrated ambivalent or negative associations with urban wastelands (e.g., [52,53,93,94]). Signs of neglect that are often associated with urban wasteland could have modulated respondents' view on wasteland sites in these studies. Given the importance of cleanliness to perceptions of urban greenspaces [95], we removed signs of neglect such as trash from the photos. This allowed us to control for effects of neglect and, finally, to detect positive attitudes and emotions towards the novel wild forest. Our results add evidence to other studies in which respondents react positively to urban wilderness [31,46].

Non-native (tree) species are important components of novel urban ecosystems [96,97], and their perception is at least ambiguous in urban societies [98,99]. We thus clearly indicated the presence of dominant native or non-native species in the photos related to the four nature types. Since respondents expressed their second most positive responses for the park forest, dominated by the non-native *Robinia pseudoacacia*, we suggest that the presence of another non-native tree, the Chinese *Ailanthus altissima*, in the novel wild forest did not decrease attitudes and emotions towards this nature 4 setting.

This idea is supported by a recent study from Berlin that revealed a largely positive perception of *Ailanthus altissima* when included in designed greenspaces, different from less positive responses to weedy populations in urban transport corridors [38]. These results indicate that people tend to accept non-native tree species (indicated in the description of the photo stimuli) as components of urban ecosystems, at least within what Nassauer [14] called "orderly frames".

5.2. Predictive Potential of Socio-Demographic Variables

Respondents' background was related to differences in the expressed attitudes and emotions towards the four nature types (Table 4). Women showed more positive attitudes and emotions to all nature types compared to men. This positive view of novel wild forests was particularly surprising, as previous studies have shown that women are less likely to use forests and other natural landscapes in urban areas due to safety concerns, feelings of fear and perceptions that they are not suitable for their own use needs in terms of visiting with children [22,100]. Our results thus suggest that offering access to novel wild forests as indicated in the photo stimuli might help counteract safety concerns. Other settings such as the isolation of a place, however, are also important with regard to gender and safety concerns [101] but were not included in our study.

Respondents' age also had a predictive potential for attitudes and emotions. Older respondents (>46 years) preferred nature 4 less and nature 1 more than younger respondents. Both forest types are related to wilderness, yet in a contrasting way since nature 1 represents the "ancient wilderness", linked to pristine landscapes, while nature 4 represents the "novel wilderness" emerging on urban-industrial sites [46]. Negative associations with wilderness could be linked to uncertainties or safety concerns, e.g., due to falling branches, and have been shown to increase with age [17]. Because such risks also exist in natural remnant forests, our results suggest that the otherness of nature 4 leads to divergent assessments by older people. They may be still aware that the emergence of novel wild forests on vacant land in Berlin is linked to the decline of the city in the decades after World War II until 1989 (the German reunification), while younger people might mostly see "wild nature" in these novel forests without a negative historical connotation. This could indicate a tendency according to the theory of 'shifting baseline' syndromes [102]. According to this theory, environmental changes are more noticed and consequently questioned by the older generations whereas they are less so by younger people, who have experiences about a different state of nature [102]. Place attachment, i.e., whether respondents felt 'like a Berliner', was not positively related to nature 4—but to *Nature 3*—, thus highlighting the importance of traditional parks for the identification of urban residents with their city.

This interpretation is supported by the predictive potential of the variable 'place of growing up' in our study. People who grew up in rural areas expressed less positive attitudes and emotions towards nature 4 than people who spent their childhood in urban areas and thus had more opportunity to become familiar with novel wild forests.

Although possible sample bias cannot be ruled out (e.g., access to internet, a slight bias towards women in this study), our online survey achieved a well-distributed group of participants (Table A2). Further, while we cannot draw generalizations from our study to Berlin residents in general (given the sample size of $n = 299$), we can show the relationship between socio-demographic factors and attitudes and emotions towards the four nature types. Since the analyses with and without the $n = 48$ participants without a postal code led to the same discussed major effects, we consider these effects as robust in our study.

6. Conclusions

This study is a first comparative survey on people's attitudes and emotions towards forest types in a big city, covering natural remnants, silvicultural plantings, designed park forests as well as novel wild forests on vacant land. The consistently positive ratings towards all forest types confirm the previously known high valuation of urban forests. Unexpectedly, the novel wild forest type evoked positive attitudes and emotions as well, however, more among younger participants. This supports approaches in planning and designing urban greenspaces that aim to make use of the manifold opportunities associated with wild urban forests [46,48,103,104] and indicates opportunities to better inform different groups of stakeholders about the benefits of urban forests in general, and of novel wild forests in particular. Such forests are often informal greenspaces that can allow nature experiences where people live and due to that help counteract the "extinction of experience" in interacting with nature [102].

While the high presence of non-native species is a controversial issue in cities, these species can support ecosystem services as well (e.g., [105]). In our study, the indicated presence of major non-native tree species did not result in a shift towards negative ratings of designed park forests or novel wild forests. The still positive ratings thus support the inclusion of non-native species in urban greenspaces—although both benefits and invasion risks must be considered [106,107].

The link between cognitive, affective and socio-demographic aspects and urban forests provides scope for further cross-disciplinary research in order to identify possible predictive factors for attitudes and emotions and create a deeper understanding of the reasons for human decisions and behavior in relation to urban forests and urban wilderness. As it turns out, not only cognitive processes and thus what urban residents like but also affective effects, in particular, what urban residents feel, need to be considered in developing urban forests.

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Institutional Review Board Statement: There were no institutional requirements for ethical clearance. However, the survey was undertaken in accordance with the General Data Protection Regulation (GDPR) of the European Union. A consent form was provided to participants ensuring their anonymity, information about the general aim of the study, data that will be collected, contact and that there would be no disadvantages for participants if they resign from the study at any stage of of their participation. Participants had to agree to this consent form before they could start the survey.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are available at Harvard Dataverse, https://doi.org/10.7910/DVN/EOKUVF (accessed on 29 April 2022).

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Appendix A

Table A1. Items measured in the questionnaire that are part of this manuscript. While other items were measured in addition, they are not part of the analyses in this manuscript. The questionnaire was conducted in German and has been translated for this overview.

Question Items	Answer options
In this section we present you successive pictures of areas densely overgrown with trees and shrubs, which occur, for example, in Berlin. We are interested to know how you like different types of woodlands in Berlin.	
Nature type 1	Here you can see a stand of native beech trees that has existed in Berlin for a very long time. This woodland can develop largely undisturbed.
Nature type 2	Here you can see a stand of lesser native trees and shrubs in Berlin, planted and maintained by foresters.
Nature type 3	Here you can see a stand of woody plants with many introduced trees and shrubs in Berlin. Introduced means that these plants do not normally occur naturally in this environment and have been brought here by humans, for example. This stand of trees is planted, shaped and much cared for by gardeners, for example.
Nature type 4	Here you can see a stand of trees with the introduced tree of heaven, which has only existed in Berlin for a short time and which is newly emerging on many abandoned areas in the city. This woodland can develop largely undisturbed.
On a scale of −2 to 2, what are your feelings when you see photo stimuli [1;2;3;4] with the [stand of native beech trees; woodland planted and maintained by foresters; tree stand planted, landscaped and maintained extensively by gardeners; woodland with the introduced tree of heaven]?	negative −2, −1, 0, 1, 2 positive I don´t like −2, −1, 0, 1, 2 I like uncomfortable −2, −1, 0, 1, 2 comfortable unpleasant −2, −1, 0, 1, 2 pleasant
To what extent do you agree with the following statements? Please tick on a scale from −2 to 2.	
I find [...] beautiful. I find [...] worthy of protection. I find [...] interesting.	2 = do not agree at all 1 = do not agree 0 = neutral 1 = agree 2 = agree completely
Please provide information about yourself on this page.	
Your age	____ years No answer
Your gender	Female Male Divers No answer
Where did you grow up?	In the countryside In the city
Your country of birth *Country of birth of your mother* *Country of birth of your father*	Germany Other country, namely:_____ No answer
Country of birth of your mother's parents *Country of birth of your father's parents*	Both are born in Germany Grandmother was born in ____ Grandfather was born in _____ No answer
Your highest general education high school graduation	Student

	Vocational student School leaver without graduation Hauptschulabschluss Realschulabschluss Abschluss Oberschule Fachhochschulreife Abitur Other high school graduation, namely:_____ No answer
Your highest vocational education	Student/trainee No graduation Traineeship Berufsfach-/Handelsschule Ausbildung an einer Fachschule o. Berufsakademie Fachhochschulabschlus Hochschulabschluss Other professional degree, namely____ No answer
Which language do you speak most at home?	German Other language _____ No answer
Do you own a garden?	Yes No No answer
What is your current place of residence?	Postal code_____ No answer

Table A2. Overview of socio-demographic information of study participants (*n* = 299) by number and percent (rounded to two decimal places).

Variable	Answer Option	*n*	%
Gender	Female	199	66.56
	Male	85	28.43
	Diverse	1	0.33
	NA	14	4.68
		299	100.00
Age	19–30	83	27.76
	31–45	74	24.75
	46–60	88	29.43
	>61	36	12.04
	NA	18	6.02
		299	100.00
place of growing up	in the countryside	105	35.12
	in the city	188	62.88
	NA	6	2.01
		299	100.00
Country of birth	Germany	282	94.31
	other country	10	3.34
	NA	7	2.34

		299	100.00
Country of birth (mother)	Germany	277	92.64
	other country	9	3.01
	NA	13	4.35
		299	100.00
Country of birth (father)	Germany	264	88.29
	other country	20	6.69
	NA	15	5.02
		299	100.00
Country of birth (mother's parents)	Germany	247	82.61
	other country	30	10.03
	NA	22	7.36
		299	100.00
Country of birth (father's parents)	Germany	242	80.94
	other country	31	10.37
	NA	26	8.70
		299	100.00
Last educational institution graduated	Student	1	0.33
	Vocational students	1	0.33
	School leaver without graduation	0	0.00
	Hauptschulabschluss	1	0.33
	Realschulabschluss	15	5.02
	Abschluss Oberschule	6	2.01
	Fachhochschulreife	21	7.02
	Abitur	248	82.94
	Others	3	1.00
	NA	3	1.00
		299	100.00
Highest vocational education	Student/trainee	32	10.70
	no graduation	2	0.67
	Traineeship	22	7.36
	Berufsschule	4	1.34
	Ausbildung an einer Fachhochschule, Berufsakademie	14	4.68
	Fachhochschulabschluss	35	11.71
	Hochschulabschluss	175	58.53
	Others	7	2.34
	NA	8	2.68
		299	100.00
Language most spoken at home	German	289	96.66
	others	6	2.01
	NA	4	1.34
		299	100.00
Garden ownership	yes	130	43.48
	no	164	54.85
	NA	5	1.67
		299	100.00

Table A3. Predictive potential of respondents' socio-demographic background for attitudes and emotions towards the four nature types. Results of the generalized linear models with estimate,

standard error (S.E.) and *p*-value (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Significant results shown in bold and highlighted in shaded grey. Analysis without $n = 48$ (participants that did not indicate their postal code) in brackets.

	Nature 1			Nature 2			Nature 3			Nature 4		
	Estimate	**S.E.**	***p*-Value**	**Estimate**	**S.E.**	***p*-Value**	**Estimate**	**S.E.**	***p*-Value**	**Estimate**	**S.E.**	***p*-Value**
(1) Attitudes												
Age												
19–30												
31–45	0.05 (−0.00)	0.08 (0.08)	0.55 (0.98)	−0.04 (−0.10)	0.15 (0.16)	0.79 (0.52)	0.01 (−0.04)	0.13 (0.14)	0.96 (0.77)	−0.12 (−0.14)	0.16 (0.17)	0.48 (0.41)
46–60	0.13 (0.14)	0.07 (0.07)	0.06 (0.06)	−0.12 (−0.04)	0.14 (0.15)	0.38 (0.77)	−0.19 (−0.15)	0.13 (0.13)	0.13 (0.26)	**−0.71** (−0.75)	**0.15** (0.16)	**<0.001 ***** (<0.001 ***)
>61	**0.18** (0.16)	**0.09** (0.10)	**<0.05 *** (0.11)	0.10 (0.09)	0.18 (0.19)	0.57 (0.66)	0.19 (0.16)	0.16 (0.17)	0.23 (0.37)	**−0.57** (−0.66)	**0.20** (0.21)	**<0.01 **** (<0.01 **)
Gender												
Women												
Men	−0.08 (−0.11)	0.06 (0.07)	0.21 (0.09)	**−0.33** (−0.28)	**0.12** (0.13)	**<0.01 **** (<0.05 *)	−0.17 (−0.15)	0.11 (0.12)	0.12 (0.19)	**−0.38** (−0.40)	**0.13** (0.14)	**<0.01 **** (<0.01 **)
Divers	−0.27	0.46	0.55	0.10	0.91	0.92	0.16	0.81	0.85	0.56	0.99	0.57
Place of growing up												
Rural												
Urban	−0.04 (−0.01)	0.06 (0.06)	0.54 (0.91)	**0.28** (0.29)	**0.12** (0.12)	**<0.05 *** (<0.05 *)	0.12 (0.15)	0.10 (0.11)	0.23 (0.18)	**0.28** (0.27)	**0.13** (0.13)	**<0.05 *** (<0.05 *)
Place attachment	0.04 (0.03)	0.03 (0.03)	0.17 (0.29)	0.06 (0.00)	0.06 (0.06)	0.34 (1.0)	**0.14** (0.13)	**0.05** (0.06)	**<0.01 **** (<0.05 *)	0.11 (0.10)	0.06 (0.07)	0.08 (0.14)
(2) Emotions												
Age												
19–30												
31–45	−0.08 (−0.10)	0.05 (0.06)	0.10 (0.07)	0.05 (0.03)	0.14 (0.16)	0.74 (0.83)	0.03 (−0.06)	0.13 (0.13)	0.80 (0.63)	−0.11 (−0.07)	0.18 (0.19)	0.55 (0.72)
46–60	0.06 (0.07)	0.05 (0.05)	0.20 (0.16)	−0.11 (−0.03)	0.14 (0.15)	0.42 (0.83)	**−0.26** (−0.27)	**0.12** (0.13)	**<0.05 *** (<0.05 *)	**−0.76** (−0.83)	**0.17** (0.18)	**<0.001 ***** (<0.001 ***)
>61	0.06 (0.05)	0.06 (0.07)	0.38 (0.42)	−0.04 (−0.07)	0.17 (0.20)	0.82 (0.72)	0.11 (0.02)	0.15 (0.16)	0.48 (0.91)	**−0.45** (−0.48)	**0.22** (0.23)	**<0.05 *** (<0.05*)
Gender												
Women												
Men	**−0.11** (−0.12)	**0.04** (0.05)	**<0.05 *** (<0.01 **)	**−0.34** (−0.33)	**0.12** (0.13)	**<0.01 **** (<0.05 *)	**−0.28** (−0.27)	**0.10** (0.11)	**<0.01 **** (<0.05 *)	**−0.37** (−0.39)	**0.15** (0.16)	**<0.05 *** (<0.05 *)
Divers	−0.58	0.31	0.07	−0.01	0.88	0.99	−0.39	0.77	0.61	0.13	1.09	0.91
Place of growing up												
Rural												
Urban	−0.02 (−0.02)	0.04 (0.04)	0.61 (0.68)	**0.25** (0.27)	**0.11** (0.12)	**<0.05 *** (<0.05 *)	0.16 (0.26)	0.10 (0.10)	0.11 (<0.05 *)	**0.34** (0.31)	**0.14** (0.15)	**<0.05 *** (<0.05 *)
Place attachment	0.01 (0.00)	0.02 (0.02)	0.72 (0.97)	**0.12** (0.09)	**0.06** (0.06)	**<0.05 *** (0.15)	**0.15** (0.13)	**0.05** (0.05)	**<0.01 **** (<0.05 *)	0.10 (0.11)	0.07 (0.07)	0.15 (0.13)

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