Motiv Emot (2013) 37:245–260
DOI 10.1007/s11031-012-9312-7

ORIGINAL PAPER

Beauty is in the eye of the psychologically fulfilled: How need satisfying experiences shape aesthetic perceptions of spaces

Netta Weinstein · Nicole Legate · Andrew K. Przybylski

Published online: 25 July 2012

Abstract Individuals perceive beauty as a function of physical attributes paired with the subjective experience of an object or a space. Yet, little or no research has investigated how either relational or emotional experiences shape perceptions of the physical world. Four studies were conducted to address this question using self-determination theory (Ryan and Deci in Psychol Inq 11:319–338, 2000) as a guiding framework. Studies 1 and 2 indicated that satisfaction of the needs for competence, relatedness, and autonomy in one's childhood home was linked to perceptions of beauty directly and indirectly through emotions of the past (recollections of happiness) and present (nostalgia). Two additional studies focused on present-day spaces. In Study 3, we found that need satisfaction impacted perceptions of the university campus as beautiful. In a final study, we manipulated needs in the lab to identify a causal model of aesthetic perceptions. Findings are contextualized within the self-determination theory and perceived beauty literatures.

Keywords Beauty · Self-determination theory · Needs · Happiness · Nostalgia

Introduction

Beauty comes from the lines, forms, colors, and harmony of a physical space (Daniel 2001), but perceived beauty is a function of material form interacting with subjective experience (Bachelard 1958). Though architects, developers, and environmental scientists have suggested that there is a role for subjective experience and constructed meaning to play in how physical spaces are seen as beautiful or not (Reber et al. 2004), little empirical work has linked relational and personal experience with perceptions of beauty. We propose that these experiences can be linked in a lasting way to the objective properties of physical spaces to shape perception of those spaces as beautiful. In this paper, we test whether spaces are perceived as beautiful to the extent people feel supported in their basic psychological needs for relatedness, competence, and autonomy when in them. We also examine whether having basic needs met leads to feelings of happiness when in spaces and a sense of nostalgia when recalling important spaces of the past; both of these processes may in turn shape perceptions that spaces are beautiful.

Basic psychological needs

Research grounded in self-determination theory (SDT; Deci and Ryan 1985) has identified three basic needs as being essential to people's sense of well-being. These are the needs for competence (Deci and Ryan 1985; Harter 1978; Ryan and Deci 2000; White 1959), relatedness (Baumeister and Leary 1995; Deci and Ryan 1985; Reis 1994), and autonomy (deCharms 1968; Deci 1975). Satisfaction of the need for *competence* comes from the perception that one is able to influence his or her environment in intended and desirable ways. Social contexts support individuals' sense of competence by providing constructive and useful feedback and by presenting individuals with achievable challenges. The need for *relatedness* involves feeling close and connected to others, and the sense that

N. Weinstein (✉) · A. K. Przybylski
University of Essex, Colchester CO4 3SQ, UK
e-mail: netta@essex.ac.uk

N. Legate
University of Rochester, Rochester, NY, USA

one is cared about by, and cares for, others. Finally, *autonomy* is the perception that one's behavior is self-endorsed and choiceful. Social environments can support individuals' sense of autonomy by encouraging behaviors that are consistent with desires and values, and by avoiding the use of pressuring or coercive relational behavior (Ryan and Deci 2000).

Satisfaction of each of the three basic psychological needs is important for well-being across the lifespan. Individuals who experience a sense of competence, relatedness, and autonomy report more life meaning and feelings of energy and aliveness (Ryan and Frederick 1997). On the other hand, when they are deprived of their needs for competence, relatedness, and autonomy, people report poor stress regulation and more anxiety, depression, and burnout (e.g., Gagné et al. 2003; Lynch et al. 2005; Reis et al. 2000; Weinstein and Ryan 2010). These costs and benefits are incurred from day-to-day and over longer periods of time (Reis et al. 2000; Sheldon et al. 1996).

Relationships that promote psychological needs are also more rewarding. Close relationships that fulfill needs are more satisfying to partners and produce more relational and individual well-being (Patrick et al. 2007), and the same is true for relationships in the workplace (Van den Broeck et al. 2010; Vansteenkiste et al. 2007). Importantly, the relevance of basic psychological needs for mental health is not a culturally specific one. Research has shown that satisfaction of the basic psychological needs is important universally, across both individualistic and collectivist nations (Chirkov et al. 2003; Deci et al. 2001; Jang et al. 2009; Ryan et al. 2005).

In the present paper we explore the idea that need satisfying experiences concerning feeling competent, related to others, and autonomous may not only shape emotional experiences, as has been previously shown, but may also influence perceptions of the physical world. Specifically, we expect that basic psychological need satisfaction promotes perceptions of spaces as beautiful, both when thinking back to important physical spaces from the past and when perceiving physical spaces in the present.

What makes a space beautiful?

Understanding what makes something beautiful has been the subject of substantial inquiry across history and disciplines. Philosophers of the Middle East, India, China, and the West have focused their attention on defining and understanding aesthetics (Ali 1999; Danto 2003; Korsmeyer 1998; Siegel 1955; Stewart 2008). Plato, for example, defined beauty in terms of the proportion, harmony, and unity of spaces and physical objects (see Cooper 1997). Much of the research concerned with aesthetics examines biophysical features of spaces from an objectivist perspective (Birkhoff 1933; Gombrich 1995), placing emphasis on formal design parameters such as form, line, variety, or unity of a space (Daniel 2001).

Modern perspectives, on the other hand, have adopted a subjectivist approach that offers that perceptions of beauty emerge from individual qualities of the object and viewer (Gepshtein and Kubovy 2000). According to this approach, biophysical features of spaces and psychological processes—perceptions, cognitions, and emotions—interact to shape experiences of beauty (Brown and Daniel 1987, 1990; Craik and Zube 1977; Daniel 1976, 1977, 1990, 2001; Daniel and Boster 1976; Parsons 1991; Ulrich 1983, 1993; Zube 1974). Cognitive-perception research, for example, explores how objective physical properties of a subject combine with factors that facilitate fluid processing, such as the ease of identifying an object's identity, clarification, duration of exposure, repetition, and figure-ground contrast, to influence whether or not people perceive something as beautiful (for extensive review see: Reber et al. 2004; also Winkleman et al. 2006).

Evolutionary perspectives also emphasize that the psychological characteristics of a space shape perceptions of its beauty (Appleton 1975, 1984; Balling and Falk 1982; Kaplan 1987; Orians and Heerwagon 1992; Ulrich 1983, 1993). One finding, in particular, concerns perceptions of safety by indicating that feeling safe is important for evaluating the beauty of a place (Shaffer and Anderson 1985). Supporting research adopting a similar approach shows men and women have different perspectives on what makes a scene beautiful, with women preferring enclosed observation points and men preferring open ones, presumably for evolutionarily adaptive reasons (Nasar 1983).

From a design perspective, space can transition from just being characterized by its geometric and physical features to a context or situation imbued with psychological meaning (Jones 1992); 'Spaces' can transform into 'places' when they take on meanings that are associated with the settings (Canter 1977). Similar perspectives offer that physical spaces have significance for people, based not only on physical properties but also on a series of psychological associations (Russell and Ward 1981). Illustratively, Bachelard (1958) said, "A house that has been experienced is not an inert box. Inhabited space transcends geometrical space" (p. 47). In other words, meaningful experiences shape perceptions of a space's beauty.

Previous research has investigated the roles of two subjective contributors that shape perceptions of beauty: cognitive processing and utility of spaces. We propose social experience may also be an important factor for people imbuing meaning into physical spaces. With little or no research to support this notion, we set out to test the role that social experiences, in the form of psychological need provisions, play in shaping perceptions of beauty.

Important places of the past and present

In the first two studies, we examine perceptions of physical spaces with a focus on the childhood home. Over time, spaces are thought to take on additional meaning that transcends that of contemporary physical spaces (Seamon 1982; Tuan 1974), and as such relational experiences may influence whether important past spaces are perceived as beautiful. Childhood homes may hold the most significance in this regard, in part because they link people to important developmental events and relationships, for example those with close family members (Boschetti 1987). In fact, childhood homes can hold even greater significance after the period of growth is over (Watkins 2001).

We also explore the extent to which need satisfaction relates to *nostalgia*—or feelings of longing or affection for the past—when people think back to their childhood home, a feeling that in turn may influence perceptions of beauty. A growing literature gives reason to believe that as events of the past are imbued with psychological needs they elicit feelings of nostalgia. In qualitative work, close relationships often emerge as a theme in nostalgic memories (Holak and Havlena 1992), and nostalgia often involves important emotional experiences from childhood. Quantitative findings, as well, show that nostalgia is deeply linked with meaningful past experiences and relationships (Wildschut et al. 2006), suggesting that satisfaction of psychological needs, especially the need for relatedness, might augment feelings of nostalgia. Nostalgia has also been shown in previous work to increase social bonds, self-regard, and positive emotions (Sedikides et al. 2008), but it has not yet been shown to impact perceptions of the physical environment. Well-known research on cognitive biases consistently shows that mood and psychological states can influence perceptions, memory, and judgments of attributes like physical attractiveness (e.g., Bower 1981; Nisbett and Wilson 1977), leading us to believe that nostalgia likely colors the way one remembers one's childhood home.

Related to bittersweet experiences of nostalgia, individuals may also recall feeling a sense of happiness when remembering need satisfying experiences from the past, which may in turn influence perceptions of beauty. Previous research shows that satisfying psychological needs encourages a sense of well-being, including experiences of positive affect and vitality (e.g., Gagné et al. 2003; Lynch et al. 2005; Reis et al. 2000; Sheldon et al. 1996), concepts that are closely related to happiness. Happiness relates to perceptions of one's own physical attractiveness (e.g., Stokes and Frederick-Recascino 2003), but research has yet to demonstrate a link between happiness and perceptions of objects or spaces as attractive, although some work suggests that emotions, in general, can shape perceptions of physical objects (Reber et al. 2004). In the same way that we expect fulfillment of psychological needs to color perceptions of important past spaces (e.g., childhood homes) as beautiful by promoting nostalgia, we expect need fulfillment to impact perceptions of beauty by increasing feelings of happiness when individuals are in those spaces.

The present studies

We propose that having needs satisfied makes spaces significant, based on previous work indicating the social significance of a space is important (Audirac 1999; Seamon 1982) and additional findings that suggest spaces gain more psychological meaning when they provide comfort, freedom, and togetherness (Lindberg et al. 1992)—many of the same dynamics at play in psychological needs satisfaction. Because much of the work in SDT has shown that psychological need satisfaction leads to feelings of happiness and well-being (e.g., Ryan and Deci 2000; see more above), we also explore the extent to which psychological needs satisfaction experienced in different spaces fosters feelings of happiness when in those physical spaces, which in turn shapes perceptions of physical beauty.

In the present studies we therefore examined how the experience of need satisfaction in a particular physical space (e.g., a room or a defined outdoor area) shapes an individual's perception of that space as beautiful. With this end in mind, we designed and conducted four studies. In the first two studies we focused on how experiences of the past shape perceptions of people's childhood homes; specifically, how need satisfaction promoted memories of happy times (both studies) and feelings of nostalgia (Study 2). We focused on childhood homes because these offer a physical context for important early social interactions and periods of development. In the latter two studies, we shifted focus to spaces experienced in the present as a way of understanding how psychological need satisfaction influences perceptions of beauty in one's current surroundings. In Study 3 we surveyed university students about specific areas around their college campus, and in a final study we experimentally manipulated relatedness need satisfaction to examine, causally, the relation between psychological needs and beauty. By keeping the spaces being perceived consistent, the latter two studies provided a robust test for the link between need satisfaction and perceptions of beauty. Across studies, we expected that the relation between need satisfaction and perceptions of beauty would be mediated by memories of happiness when in each space, and in Study 2 we believed nostalgia would provide an additional mediator for needs.

Study 1

Method

Participants and procedure

Participants were 120 university students (94 females), aged 18–26 ($M = 20.0$, SD = 1.2). Participants were asked to "Think back to your childhood home - where you spent the longest period growing up. When you close your eyes and imagine it …" Participants reported on a house where they spent 12.4 years (SD = 4.3) on average. Exploratory analyses showed the length of time did not relate to any of the observed variables included in the study, $ps > .05$.

Participants were then instructed to respond on a number of qualities regarding six distinct spaces inside and outside their home. Specifically, they reported on their living room, bedroom, kitchen, dining room, front yard, and back yard. These spaces were identified to be important areas in childhood homes in pilot research and are fairly characteristic of most homes. Participants reported on perceived needs (relatedness, competence, and autonomy), happiness, and beauty of each of the six spaces in their homes. Spaces were randomly presented within construct, and the order of constructs randomly varied.

Psychological characteristics of spaces Responding to each space, participants reported on their relatedness: "How much of a sense of closeness with others have you felt when you were in [each space (e.g., the kitchen)]," using a scale ranging from 1 (*not at all close to others*) to 5 (*very close to others*), $M = 3.50$, SD = .84; competence: "How much did you feel that you could effectively accomplish the things you set out to do when you were in the [each space]", with a scale from 1 (*not at all effective*) to 5 (*very effective*), $M = 3.20$, SD = .90; and autonomy: "How much did you feel that you could express yourself honestly and make your own choices freely when you were in [each space]", with a scale from 1 (*not at all freely*) to 5 (*very much freely*), $M = 3.80$, SD = .90. Using a similar scale, participants also reported how happy they felt in each space, from 1 (*not at all happy*) to 5 (*very happy*), $M = 3.59$, SD = .86.

Perceived beauty Finally, participants also reported on how 'physically attractive or beautiful' they considered each space on a scale ranging from 1 (*not at all beautiful*) to 5(*very beautiful*), $M = 3.33$, SD = .81.

Results

Preliminary results

Basic correlations (presented in Table 1) showed all psychological experiences we assessed (competence, autonomy, relatedness, and happiness) to be related to one another and to perceptions of beauty. Additional preliminary analyses using repeated measures analysis of variance compared spaces on study variables to gain descriptive information about the character of different spaces. On average, spaces did not differ from one another in terms of beauty, $F(5, 590) = 1.92$, $p = .12$; but they did differ on relatedness, $F(5, 590) = 12.88$, $p < .001$, competence, $F(5, 590) = 9.11$, $p < .001$, and autonomy, $F(5, 590) = 15.09$, $p < .001$. The *kitchen, dining room,* and *living room* elicited more feelings of relatedness ($Ms = 3.6$, 3.8, and 3.8, respectively) than the front yard and bedroom ($M = 3.10$ and 3.30), $ps < .05$. Interestingly, the *bedroom* was the most competence ($M = 3.60$) and autonomy ($M = 4.28$) supportive space, satisfying these needs above all other spaces in the house (the average autonomy for other spaces = 3.70, competence average = 3.20; all $ps < .05$). Figure 1 presents a plot of the averages for each room.

Data analytic strategy

To gain a general idea of the links between psychological need satisfaction and perceptions of beauty across contexts a series of ordinary least squares (OLS) multiple regression analyses models were tested. Results derived by regressing aggregated perceptions of beauty onto experiences of relatedness, $\beta = .29$, $t(116) = 3.94$, $p < .001$, competence, $\beta = .20$, $t(116) = 2.47$, $p = .02$, and autonomy in a space, $\beta = .22$, $t(116) = 2.85$, $p = .005$. Results also revealed a relation between self-reported happiness and relatedness, $\beta = .64$, $t(116) = 9.55$, $p < .001$, competence, $\beta = .54$,

Table 1 Study 1 means, SD, and correlations between major study variables

	M	SD	1	2	3	4	5
1. Gender	–	–	–				
2. Relatedness	3.50	.84	.12	–			
3. Competence	3.20	.90	−.14	.54**	–		
4. Autonomy	3.80	.90	−.02	.67**	.66**	–	
5. Happiness	3.59	.86	.09	.70**	.51**	.70**	–
6. Beauty	3.33	.81	.10	.45**	.42**	.34**	.57**

** $p < .01$

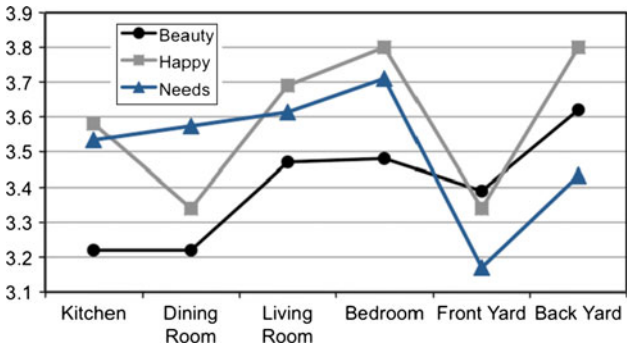

Fig. 1 Variation in needs (averaged across relatedness, competence, and autonomy), happiness, and beauty in each space, results reflecting both studies 1 and 2

$t(116) = 6.71$, $p < .001$, and autonomy, $\beta = .64$, $t(116) = 9.43$, $p < .001$.

Following initial support using regression, we conducted analyses using hierarchical linear modeling (HLM; Raudenbush and Bryk 2002) to account for the interdependence that arises when a single participant reports on perceptions of six different spaces. HLM is considered the best way to control for extraneous variance in repeated-measures designs (Shin et al. 2004). In addition, recognizing that spaces differ in how need supportive they are (see Fig. 1), HLM allows us to account for variability between these factors observed for both spaces (level 1) and people (level 2), whereas OLS regression only tests for the latter.

Primary model Averaged scores of need satisfaction and happiness were defined at level 2 to account for effects of individual differences on beauty, whereas space-specific scores were included at level 1 to examine how variation in needs and happiness in a space relates to experiences of beauty in that same space (our primary focus in this study). Unconditional models were first conducted to determine whether sufficient variance existed between- and within-participants. Intraclass correlation (ICC) derived from these models showed that, across outcomes, 67 % of the total variance occurred within persons across spaces. Given this substantial variance, full models were tested. Across analyses, the general level 1 equation for the primary model was as follows, where OV reflects the outcome variable used in the model (e.g., perceived beauty):

$$\begin{aligned}\mathrm{OV}_{ij} = {} & \beta_{0j} + \beta_{1j}(\text{estimated population slope of competence within rooms}) + \beta_{2j}(\text{estimated population slope of relatedness within rooms}) + \beta_{3j}(\text{estimated population slope of autonomy within rooms}) + \beta_{4j}(\text{estimated population of slope of happiness within rooms}) + r_{ij}.\end{aligned}$$

The level 2 equation was:

$$\begin{aligned}\beta_{0j} = {} & G_{00}(\text{average report of OV for a person}) + G_{01}(\text{effect of competence, averaged across all spaces}) + G_{02}(\text{effect of relatedness, averaged}) + G_{03}(\text{effect of autonomy, averaged}) + u_{0j}\end{aligned}$$

As Bryk and Raudenbush (1992) recommended, level 1 variables were centered on individual rather than sample means, and level 2 variables were sample-mean centered.

Mediation model For mediation effects of happiness on the relation of need satisfaction and perceptions of beauty, we conducted analyses based on Kenny et al. (2003) for lower level mediations in HLM. We first assessed the effect of need satisfactions on perceptions of beauty (see equations above). We then tested the effect of happiness on perceptions of beauty (also at level 1). Finally, we tested the impact of the three needs on perceptions of beauty when including happiness in the model. The level 1 model for the fourth step was:

$$\begin{aligned}\text{Beauty}_{ij} = {} & \beta_{0j} + \beta_{1j}(\text{relatedness}) + \beta_{2j}(\text{competence}) + \beta_{3j}(\text{autonomy}) + \beta_{4j}(\text{happiness}) + r_{ij}.\end{aligned}$$

Beauty

Our primary model predicted perceptions of beauty from all need satisfactions experienced in each space (at level 1) and overall need satisfaction averaged across the spaces (level 2). Need satisfaction at level 2 was included to hold constant participants' overall impressions of their homes but was not central to our hypotheses (these results were not specific to spaces). As such we summarize them in Table 2 and do not present them in the text. At level 1,

Table 2 Need satisfaction at level 2 (at the house level, averaged across rooms) predicting beauty, happiness, and nostalgia in studies 1, 2, and 3

	Relatedness	Competence	Autonomy
Study 1, level 2			
1. Beauty	2.67**	2.05*	.38
2. Happiness	4.86**	2.41*	3.55**
Study 2, level 2			
1. Beauty	2.33*	1.49	.48
2. Nostalgia	3.25**	4.11**	1.80^
3. Happiness	3.05**	2.17*	.44
Study 3, level 2			
1. Beauty	2.87**	1.91^	−.49
2. Happiness	6.69**	2.17*	3.05**

** $p < .01$; * $p < .05$; ^ $p < .06$

individuals perceived a space to be more beautiful when they felt more relatedness, $t(707) = 3.13$, $p < .001$, competence, $t(707) = 2.96$, $p = .004$, and marginally, autonomy in that space, $t(707) = 1.88$, $p = .06$. Variance was left over in predicting beauty, $\sigma = .37$, $p < .001$, indicating additional factors may account for the perceived beauty of a childhood home.

Happiness

A second model used the same strategy to predict happiness from needs. At level 1, people remembered themselves as happier in spaces where they also remembered more satisfaction of their needs for relatedness, $t(707) = 8.11$, $p < .001$, autonomy, $t(707) = 4.64$, $p < .001$, and competence, $t(707) = 6.46$, $p < .001$.

Mediation by happiness

Finally, we conducted mediation analyses in HLM using recommendation by Kenny et al. (2003) described above. From the full model, happiness in spaces related to perceptions of those spaces as more beautiful, $t(706) = 4.17$, $p < .001$. Controlling for happiness resulted in weaker effects for relatedness, $t(276) = 1.69$, $p = .09$, competence, $t(276) = 2.16$, $p = .03$, and autonomy, $t(276) = .77$, $p = .44$, at level 1. Indirect effects of happiness were significant for relatedness, $z = 3.71$, $p < .001$, and competence, $z = 2.41$, $p = .02$. Despite autonomy only marginally predicting beauty, happiness significantly accounted for the indirect effect on beauty, $z = 3.10$, $p < .001$.

Brief discussion

Results of Study 1 demonstrated that perceptions of spaces in childhood homes as beautiful related to remembering basic psychological need satisfaction when in those spaces. Further analyses suggested that need satisfaction elicited a sense of happiness when thinking back to one's home, which in turn shaped perceptions that spaces were beautiful.

Study 2

Study 2 expanded on Study 1 by examining how need satisfying experiences of spaces related to a present feeling of nostalgia, an emotion that arises when thinking back to meaningful, and presumably positive, experiences of the past (Sedikides et al. 2008). In the second study we also controlled for size of spaces as a proxy of their grandeur. We did so to control for the possibility that large, grand spaces are more beautiful and also offer more opportunities for psychological need satisfaction.

Method

Participants and procedure

Forty-eight undergraduate students (37 women), ranging in age from 18 to 36 ($M = 20.5$, SD = 3.7), took part in this study. The procedure and measures were similar to those used in Study 1. Participants were asked to think back to their childhood home and report on their experiences of relatedness (overall $M = 3.3$, SD = .9), competence ($M = 3.2$, SD = .9), and autonomy ($M = 3.4$, SD = .8) in the spaces of their homes, feelings of happiness in those spaces ($M = 3.6$, SD = 1.0), and perceptions of those spaces as beautiful ($M = 3.1$, SD = 1.0).

New materials

Psychological characteristics of spaces Participants reported how nostalgic they feel when thinking about each space using a scale that ranged from 1(*not at all nostalgic*) to 5(*very nostalgic*) ($M = 3.1$, SD = 1.0).

Physical characteristics of spaces Also new to this study, participants reported on the size of each space in their childhood homes using a scale that ranged from 1(*not at all large*) to 5(*very large*) ($M = 2.9$, SD = .9). These reports were averaged to derive an overall score for the size of the house.

Results

Preliminary results

As in Study 1, zero-order correlations (presented in Table 3) showed all psychological experiences (competence, autonomy, relatedness, happiness, and nostalgia) to be related to one another and to perceptions of beauty. Analyses indicated that women were more likely to recall feeling relatedness in their childhood homes, and remembered their homes to be larger and more beautiful. However, exploratory analyses showed controlling for gender did not change the direction or significance of results in our subsequent analyses. In this study, spaces differed in perceptions of their size, $F(5, 235) = 5.39$, $p < .001$, and in the nostalgia they elicited, $F(5, 235) = 10.82$, $p < .001$. Spaces also differed across measures of relatedness, autonomy and competence in a similar pattern to that detailed in Study 1.

Preliminary multiple regression analyses were conducted as in Study 1, this time controlling for size of house. Results from these analyses showed *perceived beauty* was linked with relatedness, $\beta = .54$, $t(45) = 4.65$, $p < .001$, competence, $\beta = .48$, $t(45) = 4.08$, $p < .001$, and autonomy, $\beta = .45$, $t(45) = 3.80$, $p < .001$. Results also showed a

Table 3 Study 2 means, SD, and correlations between major study variables

	M	SD	1	2	3	4	5	6	7
1. Gender	–	–	–						
2. Relatedness	3.28	.90	.32*	–					
3. Competence	3.19	.85	.14	.73**	–				
4. Autonomy	3.44	.83	.26	.79**	.73**	–			
5. Nostalgia	3.05	1.01	.13	.69**	.72**	.52**	–		
6. Happiness	3.56	.96	.25	.78**	.72**	.69**	.71**	–	
7. Beauty	3.05	.98	.35*	.71**	.66**	.65**	.71**	.76**	–
8. Large size	2.87	.93	.31*	.54**	.51**	.51**	.55**	.52**	.61**

* $p < .05$; ** $p < .01$

relation between self-reported *happiness* and relatedness, $\beta = .71$, $t(45) = 6.44$, $p < .001$, competence, $\beta = .62$, $t(45) = 5.37$, $p < .001$, and autonomy, $\beta = .57$, $t(45) = 4.69$, $p < .001$. Final analyses showed links between *nostalgia* and relatedness, $\beta = .55$, $t(45) = 4.49$, $p < .001$, competence, $\beta = .59$, $t(45) = 5.12$, $p < .001$, and autonomy, $\beta = .32$, $t(45) = 2.38$, $p < .001$. HLM analyses were conducted on these measures to account for within- and between-space variability.

Beauty

A model predicted perceptions of beauty from all need satisfactions experienced in spaces (at level 1), from overall need satisfaction averaged across the spaces (level 2, presented in Table 2 as in the previous study), and from overall size of the property averaged across the spaces (level 2). At level 2, individuals who remembered their homes to be larger also remembered them to be more beautiful, $t(43) = 2.33$, $p = .03$. Controlling for this, spaces that satisfied relatedness were perceived to be more beautiful at level 1, $t(277) = 2.32$, $p = .02$, as were spaces that supported autonomy, $t(277) = 4.11$, $p < .001$; the relation with competence was not significant, $t(277) = 1.54$, $p = .34$. The perceived size of the property did not interact with any of the psychological needs in predicting perceived beauty, $ts(277) = -.42$ to $.23$, $ps < .34$. Variance was left over in predicting beauty, $\sigma = .27$, $p < .001$, indicating more predictors may account for the perceived beauty of one's home.

Nostalgia

Spaces in which competence, $t(277) = 3.79$, $p < .001$, and autonomy, $t(277) = 5.88$, $p < .001$, needs were met were remembered with more nostalgia, but no relation was in evidence for relatedness, $t(277) = .82$, $p = .41$. Further, there were no interactions between psychological needs and perceived size of the house in predicting nostalgia, $ts(277) = -1.58$ to 1.83, $ps = .09$ to $.13$. At level 2, perceived size of the house predicted nostalgia, $t(43) = 2.13$, $p = .04$, with significant variance left over in the model, $\sigma = .33$, $p < .001$.

Happiness

Individuals felt happier in spaces where they experienced more support for relatedness, $t(275) = 4.89$, $p < .001$, competence, $t(275) = 2.25$, $p = .003$, and autonomy, $t(275) = 7.86$, $p < .001$. The only interaction by perceived size of the house was for competence. Though competence largely promoted happiness, larger houses dampened this effect, $t(275) = -1.93$, $p = .05$. At level 2, size of the house did not directly relate to happiness, $t(43) = .76$, $p = .45$. Variance remained in explaining happiness, $\sigma = .17$, $p = .009$.

Mediation by happiness and nostalgia

Results showed that need satisfaction related to feelings of happiness and nostalgia across physical spaces. We conducted mediation models building on the analyses of Study 1 to test whether happiness and nostalgia were responsible for the effects of need satisfaction. Since competence did not show a direct link with perceptions of beauty, we did not test mediation for this need. From the full model (see Fig. 2), nostalgia related to perceptions of beauty, $t(275) = 4.00$, $p < .001$, as did feelings of happiness, $t(275) = 2.03$, $p = .04$.

Controlling for these two constructs accounted for the link between need satisfaction and perceptions of beauty at level 1: relatedness $t(275) = .97$, $p = .33$, and autonomy, $t(275) = .72$, $p = .47$. The indirect effects for happiness were significant or marginal: autonomy, $z = 1.97$, $p = .05$, and relatedness, $z = 1.88$, $p = .06$; and for nostalgia: autonomy, $z = 3.07$, $p < .001$. Thus, in cases where need satisfaction related to perceptions of beauty, happiness and nostalgia tended to explain this effect.

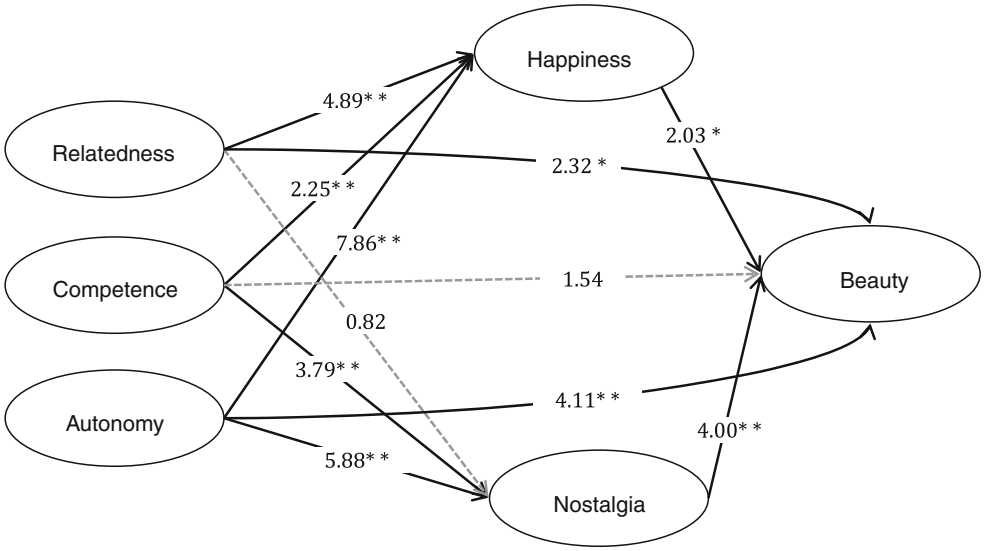

Fig. 2 Study 2 summary of relations of the three needs, beauty, happiness, and nostalgia

Brief discussion

Study 2 replicated and expanded on findings derived from the first study by exploring the extent to which psychological need satisfactions promote nostalgia, a feeling that also influences aesthetic perceptions of beauty. The results further clarified the way psychological experiences shape perceiving beauty: findings indicated that when individuals felt a sense of relatedness and autonomy in childhood home spaces, they perceived those spaces to be more beautiful. Furthermore, all three needs related to memories of feeling happy in one's childhood home, but only competence and autonomy seemed to evoke nostalgia when thinking back to one's home. In turn, recalling feelings of happiness in a space and feeling nostalgia when thinking back to the space independently predicted perceptions of beauty, and they mediated the effects of relatedness (only happiness) and autonomy (both happiness and nostalgia). Taken together, Studies 1 and 2 provide convergent evidence that people remembered spaces in which needs were satisfied to be beautiful, effects that were mediated by nostalgia and happiness. Both studies concerned spaces from the past; Study 3 sought to address error specific to thinking back to the past by examining perceptions of spaces in the present.

Study 3

In Study 3 we pivoted our focus from past to present psychological experiences to gauge their effect on perceptions of beauty. This approach allowed us to explore aesthetic evaluations while avoiding bias associated with the passing of time. The study focused on perceptions of beauty on a college campus. By testing a set of spaces that are familiar to all participants, we held constant the objective physical characteristics that might influence perceptions of beauty and focused more directly on subjective perceptions of space.

Method

Participants and procedure

Participants were 152 students (115 women) from a northeast US university, with ages ranging from 18 to 28 ($M = 20.0$, SD $= 1.4$).

Ninety-two percent of participants reported living on campus. Of these, 17 % were first-year, 28 % second-year, 29 % third-year, and 26 % fourth-year college students. Year in college did not relate or interact with any observed variables, $ps > .05$.

As in the previous studies, participants completed assessments of perceived relatedness, competence, autonomy, happiness, beauty, and size in relation to a number of physical spaces. In keeping with our focus on the present, these measures were completed for eight spaces on the university campus: the library, academic quadrangle, a popular space at a nearby river, two lecture halls in which participants took classes, the student union, dorm rooms, and the campus cafe (Fig. 3 presents some images from these areas as examples). As in the previous studies, participants provided ratings for each space across all measures, and measures were presented randomly.

Results

Preliminary analyses

As in the previous studies, reports of psychological and physical experiences were correlated (see Table 4). In this

Fig. 3 Images of the university spaces. *Top Left* Wilson Commons, *Top Right* academic quad, *Bottom Left* library reading room, *Bottom Right* river adjoining university

Table 4 Study 3 means, SD, and correlations between major study variables

	M	SD	1	2	3	4	5	6
1. Gender	–	–	–					
2. Relatedness	2.85	.66	.07	–				
3. Competence	2.91	.69	.08	.65**	–			
4. Autonomy	3.28	.78	.06	.54**	.62**	–		
5. Happiness	3.06	.67	.10	.73**	.68**	.58**	–	
6. Beauty	2.64	.63	.08	.53**	.48**	.32**	.56**	–
7. Large size	2.92	.56	−.01	.33**	.35**	.23**	.30**	.34**

** $p < .01$; correlations based on $n = 152$

study, gender did not relate to study variables. For descriptive purposes, exploratory analyses were also used to test which psychological needs are most satisfied on college campuses. Students tended to report differentially experiencing needs at college, $F(6, 7{,}290) = 70.23$, $p < .001$, such that the need for autonomy ($M = 3.3$) was experienced more than competence ($M = 2.7$) or relatedness ($M = 3.0$, $ps < .01$).

Additional analyses showed spaces differed in the extent that they were seen as beautiful, $F(7, 1{,}057) = 107.70$, $p < .001$. Students perceived the academic quadrangle, river, and library to be the most beautiful spaces on campus (*Ms* averaged 3.46), and classrooms to be the least beautiful (*Ms* averaged 1.69). See Fig. 4 for an illustration of

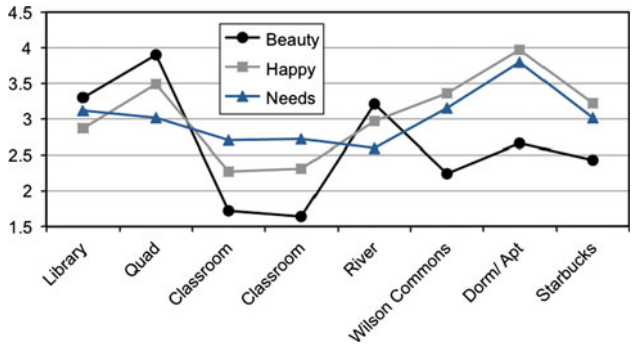

Fig. 4 Study 3 variation in needs (averaged across relatedness, competence, and autonomy), happiness, and beauty in each space on a college campus

beauty perceptions, happiness, and need satisfactions in each location.

Preliminary multiple regression analyses tested basic relations, averaged across spaces and controlling for size of spaces. Results from these analyses were consistent with regressions conducted in previous studies and showed *perceived beauty* was linked with relatedness need satisfaction, $\beta = .47$, $t(149) = 6.52$, $p < .001$, competence, $\beta = .41$, $t(149) = 5.40$, $p < .001$, and autonomy, $\beta = .25$, $t(149) = 3.29$, $p < .001$. Results also showed a significant relation between reported *happiness* and relatedness, $\beta = .71$, $t(149) = 12.10$, $p < .001$, competence, $\beta = .66$, $t(149) = 10.28$, $p < .001$, and autonomy, $\beta = .54$, $t(149) = 7.97$, $p < .001$.

Beauty

Hierarchical linear models predicting perceived beauty showed findings similar to those of Study 2. At level 1, spaces in which participants reported experiencing more relatedness were perceived to be more beautiful, $t(1,204) = 2.87$, $p < .001$, as were spaces where autonomy was experienced, $t(1,204) = 5.63$, $p < .001$. There was no relation with competence, $t(1,204) = -.75$, $p = .40$. The perceived size of the property did not interact with any of the psychological needs in predicting perceived beauty, $ts(277) = .19–1.39$, $ps = .34–.82$. Variance was left over in predicting beauty, $\sigma = .12$, $p < .001$, indicating more predictors may account for the perceived beauty of the campus.

Happiness

People reported feeling happier in spaces where they experienced more support for relatedness, $t(1,204) = 15.95$, $p < .001$, competence, $t(1,204) = 2.89$, $p < .001$, and autonomy needs, $t(1,204) = 12.38$, $p < .001$. At level 2, perceived campus size did not relate to happiness, $t(147) = .32$, $p = .75$. Variance was left to be explained in happiness, $\sigma = .10$, $p < .001$.

Mediation by happiness

Need satisfaction in specific spaces on a college campus increased happiness when in those spaces. As in Study 2, competence need satisfaction did not directly relate to beauty and so we did not test for its mediation by happiness. From the full model (including both psychological needs and happiness), happiness related to perceptions of beauty on campus, $t(1,203) = 8.04$, $p < .001$. Happiness in turn fully mediated the effects of relatedness $t(1,203) = -1.04$, $p = .29$, and partially mediated autonomy, $t(1,203) = 2.56$, $p = .01$, both at level 1. The indirect effects for happiness were significant: autonomy, $z = 7.17$, $p < .001$, and relatedness, $z = 6.74$, $p < .001$.

Brief discussion

Results from Study 3 indicated psychological experiences shape perceptions of beauty for present spaces as they do for important ones of the past. In this study, university students were asked to assess their need satisfaction, feelings of happiness, and perceptions of physical beauty across a number of indoor and outdoor areas on campus. Consistent with relations observed with childhood homes, results showed that satisfaction of one's basic psychological needs in certain physical places related to perceptions of those spaces as beautiful. Mediation analyses further suggested that feelings of happiness experienced in each space are at least partly responsible for shaping these perceptions.

Study 4

Study 4 aimed to gain causal insight into the correlational links uncovered in the previous studies. In place of comparing perceptions of a number of physical spaces already important to participants, we created new climates in a laboratory context with no personal significance to participants. Specifically, we manipulated the psychological experience of relatedness. Across our previous studies we found the relatedness need was most robustly linked to perceptions of physical beauty, and therefore in this study we evaluated its influence on assessments of the lab's attractiveness overall, the aesthetic appeal of its architecture, and the beauty of objects in it. Because our manipulation of relatedness depended on delivering feedback about one's likability, we measured and subsequently controlled for state self-esteem, a potential confound that has been previously linked to negative social feedback (e.g., Leary and Baumeister 2004).

Method

Participants and procedure

Seventy-three students (44 women) took part in the study. Participants ranged in age from 19 to 45 years ($M = 25.74$, $SD = 6.25$). Funneled debriefing indicated none of the students had experiences in the lab before taking part in this study. Before arriving to the lab, participants were randomly assigned to either a 'high relatedness' or 'neutral' condition (detailed below). Participants were then asked to report on the physical characteristics of the lab (also described below). Before leaving the lab, participants were fully debriefed about the nature of the experiment.

Materials

Relatedness need satisfaction manipulation All participants underwent a relational experience adapted from Mendes et al. (2008). Participants were provided with a bag containing a number of folded pieces of paper and were told that the papers identify one of two roles, 'speaker' or 'partner'. They were also told that if they picked 'speaker' out of the bag, they would be asked to give a 2-min speech that would be recorded and heard by the second participant in the study. If, on the other hand, they selected the 'partner' role from the bag, the other participant would be asked to give a speech, which they would evaluate. In actuality, all participants were identified as the 'speaker' and were provided with instructions regarding the audiotaped task. Namely, they were given 2 min of preparation time to develop a speech entitled 'all about me.' After participants prepared and audiotaped their speeches, the experimenter took the audiotape to the next room, returning 3 min later with a sealed envelope form (the envelope presumably prevented the experimenter from seeing the feedback). Participants were then asked to open the form and take a few minutes to think about the answers. Forms included five Likert-type items ranging from; 0(*not at all*) to 5(*very much*) supposedly filled out by the second participant. Items were: "I would like to be in a small class with the other subject," "I would like to work closely with the other subject," "I would like to get to know the other subject better," "I would enjoy being roommates with the other subject," and "I would like to be close friends with the other subject." Participants in the high relatedness condition received feedback that their partner felt close to them: All items were circled '5'—the top score. The final item was circled '4', crossed out, and then circled '5'. In the neutral condition, items were circled with '2' to '4' ratings (reflecting moderate liking), and the final item was completed as '4' then crossed out and replaced with a '3' rating.

Assessments of psychological experiences Participants reported on their experiences of psychological need satisfaction (relatedness, competence, autonomy), and perceived happiness after the manipulation using measures from the previous studies.

Assessments of physical spaces In this study, we tested beauty in more diverse ways by asking participants to respond to five items, using a scale of 1(*not at all*) to 7(*very much*): "This room is physically attractive" ($M = 3.0$, $SD = 1.3$), "This space appears beautiful, overall" ($M = 3.6$, $SD = 1.7$), "The architecture in this room seems attractive" ($M = 2.6$, $SD = 1.89$), "The physical characteristics of this room appeal to me" ($M = 3.6$, $SD = 1.9$), and "I find the furniture in this room attractive" ($M = 3.0$, $SD = 1.7$). Each item was treated separately.

Self-esteem To include this as a potential covariate responsible for the effect of the manipulation on our major outcomes, participants completed a state measure of the Rosenberg Self-Esteem Scale (Rosenberg 1965). These items included: "Right now, I feel satisfied with myself" and "Right now, I feel I am a person of worth" ($\alpha = .79$).

Results

Preliminary analyses

Correlations are presented in Table 5, and showed the relatedness manipulation was effective in shaping need satisfaction, and reports of need satisfaction were related to higher perceptions of the lab as physically attractive. Correlations with self-esteem, a potentially confounding variable, were noteworthy. We expected that self-esteem might be highly collinear with the effects of condition on perceived beauty. We found, unexpectedly, that self-esteem was not affected by condition, nor was it related to perceptions of the space as beautiful. This may have been because neither manipulation directly thwarted relatedness (that is, gave participants feedback that they were unlikable), an experience that would likely lead to depletions in self-esteem. As such, self-esteem was dropped from consideration in the primary analyses.

Primary analyses

We evaluated a full model in AMOS (Arbuckle 2006), including all predictors (condition, satisfaction of each of the three needs, happiness, and a latent variable reflecting beauty). We used parameters based on maximum-likelihood estimations. Paths for a first, experimental model were specified as in Fig. 5. An exploratory model revealed the item "I find the furniture in this room attractive" loaded poorly onto the latent factor of beauty, $\beta = .12$, $t(65) = .95$, $p = .35$. Condition did not relate to competence need satisfaction, $\beta = .08$, $t(65) = .82$, $p = .41$, and happiness failed to predict perceived beauty in this study, $\beta = -.02$, $t(65) = .20$, $p = .84$. We removed these paths from our full model.

Full model

Beauty was entered as a latent construct that includes the observed variables: "This room is physically beautiful" (loaded $\beta = .55$, $p < .001$), "This space appears beautiful, overall" (loaded $\beta = .63$, $p < .001$), "The architecture in

Table 5 Study 4 means, SD, and correlations between major study variables

	M	SD	1	2	3	4	5	6	7	8	9	10
1. Condition	–	–	–									
2. Relatedness	4.33	1.20	.48**	–								
3. Competence	4.11	1.13	.18	.51**	–							
4. Autonomy	4.20	1.17	.28*	.69**	.60**	–						
5. Happiness	3.97	1.22	.34**	.70**	.51**	.62**	–					
6. Beauty	3.03	1.34	.39**	.51**	.33**	.51**	.36**	–				
7. Space	4.60	1.74	.33**	.59**	.45**	.56**	.50**	.48**				
8. Architecture	3.10	1.08	.33**	.59**	.49**	.69**	.52**	.42**	.57**			
9. Appeal	5.05	1.72	.29*	.73**	.50**	.74**	.54**	.43**	.72**	.63**		
10. Furniture	2.85	1.19	.17	.17	.07	.02	−.06	.07	.27*	.04	.19	
11. Self-esteem	2.30	.29	−.10	.25*	.08	.16	.20	.20	−.08	.04	−.14	.05

* $p < .05$; ** $p < .01$; correlations based on $n = 73$

Variables Beauty = "This room is physically beautiful", Space = "This space appears beautiful, overall", Architecture = "The architecture in this room seems attractive", Appeal = "The physical characteristics of this room appeal to me", and Furniture = "I find the furniture in this room attractive"

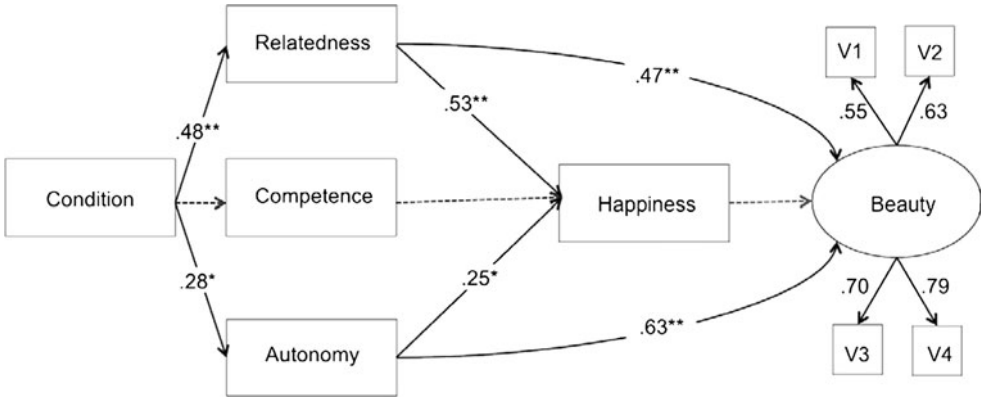

Fig. 5 Study 4 results of SEM model, with both significant and non-significant links between major study variables. *Notes* "Beauty" is a latent construct that includes the observed variables: *V1* "This room is physically beautiful", *V2* "This space appears beautiful, overall", *V3* "The architecture in this room seems attractive", *V4* "The physical characteristics of this room appeal to me". *$p < .05$, **$p < .01$

this room seems attractive" (loaded $\beta = .70$, $p < .001$), and "The physical characteristics of this room appeal to me" (loaded $\beta = .79$, $p < .001$). Before including paths specifying need satisfaction as a mediator, condition directly related to perceptions of beauty, $\beta = .35$, $t(69) = 3.15$, $p = .002$.

Participants who were assigned to the 'high relatedness' condition indeed reported higher levels of relatedness satisfaction, $\beta = .48$, $t(69) = 4.66$, $p < .001$, and autonomy satisfaction, $\beta = .28$, $t(69) = 2.48$, $p = .01$, compared to those who were assigned to receive 'neutral' feedback. In turn, both relatedness satisfaction, $\beta = .46$, $t(69) = 4.19$, $p < .001$, and autonomy satisfaction, $\beta = .63$, $t(69) = 5.09$, $p < .001$, related to perceptions of the lab as beautiful.

We examined fit of the final model paying attention to CMIN/DF (Wheaton et al. 1977), comparative fit index (CFI; Bentler 1990), and RMSEA (Chen et al. 2008). These indicators showed good fit of the data, $X^2(15, n = 73) = 15.87$, $p = .39$, CMIN/DF = 1.06, CFI = 1.00, RMSEA = .03.

General discussion

Previous formulations of beauty hold physical characteristics—the lines, forms, colors, and complements specific to a space—as most important, yet modern perspectives and findings from cognitive psychology suggest that physical objects are evaluated based, in part, on the subjective experience of the perceiver (e.g., Gepshtein and Kubovy 2000; Reber et al. 2004). Consistent with this perspective, we expected that subjective relational and personal experiences that take place in a particular physical space (e.g., a room or a defined outdoor area) would link to those physical spaces and shape perceptions of those spaces as beautiful.

Across four studies, we found overall support for our hypothesis that satisfaction of the psychological needs of relatedness, competence, and autonomy can shape perceptions of physical beauty. Correlation analyses indicated that perceived satisfaction of all three psychological needs

related to perceptions of physical beauty for recalled and presently occupied spaces. Using more conservative models we tested all need satisfactions as concurrent predictors, thus setting them to compete with one another in predicting perceived beauty. We found that autonomy and relatedness were particularly robust predictors that determined perceptions of beauty in important spaces of the past (i.e., one's childhood home), and spaces in the present that can be considered important (college campus) or novel (an unfamiliar laboratory). When individuals recalled (Studies 1–3) or experienced (Study 4) closeness and connectedness with others, or when they felt themselves to be volitional agents in a space, they in turn saw the space where these experiences transpired as being more beautiful. Our findings that individuals who have psychological need satisfaction perceived their world to be more beautiful complements previous research showing that those high in need satisfaction experience their world as more psychologically rewarding (Reis et al. 2000).

Interestingly, with the exception of Study 1 results, our findings indicated that competence need satisfaction appeared less important in shaping perceptions of the physical world compared to other needs. Although we found one robust effect of competence predicting memories of one's childhood home as beautiful in the first study, competence did not predict perceived beauty in Study 3, a university setting where performance and achievement are salient aspects of the setting (e.g., Levesque et al. 2004). This unexpected result suggests that positive psychological experiences may relate to, but do not equate, evaluations of beauty in the physical world.

Another pattern of relations explored in these studies concerned the idea that psychological need satisfactions would foster feelings of happiness that in turn shape perceptions of beauty. In line with our predictions, we found that when individuals recalled feeling effective, close to others, and choiceful, they also remembered feeling happier in a specific space, a result that is consistent with research showing that satisfying psychological needs promotes a sense of well-being (e.g., Gagné et al. 2003; Lynch et al. 2005; Reis et al. 2000; Sheldon et al. 1996). New to these studies, we found that happiness may be linked to need satisfactions within certain physical spaces. Broadly speaking, we also found that happiness generally impacted perceptions of beauty, the latter finding consistent with a literature that links affect and perception of physical objects (Reber et al. 2004). Yet we found inconsistent support for happiness as a mediating construct responsible for the effects of needs on perceiving beauty. In many cases, psychological need satisfactions were still predictive of perceptions of beauty when variability in happiness was taken into account. It may be, then, that relational and emotional experiences play a distinct role in shaping aesthetic perceptions.

The first two studies focused on the childhood home as an especially meaningful and important place (Boschetti 1987) that contained some of the most important and influential early relational experiences (Bachelard 1958; Watkins 2001). Spaces in one's childhood home provided different psychological experiences. In these studies, the living room and dining room, places where people may have connected most with their families, were important rooms for relatedness. On the other hand, the bedroom, a more personal and private space, was remembered as being most autonomy and competence supportive.

In Study 2, we also explored whether remembering need satisfaction during childhood would foster a feeling of nostalgia when thinking of one's childhood home. Comparing spaces showed that thinking back to one's childhood bedroom and living room were linked most strongly with nostalgia. Furthermore, in the full analytic models autonomy and competence impacted feelings of nostalgia toward one's home. In turn, nostalgia was a robust correlate of perceived beauty, and it fully mediated the effects of these needs. The finding that people only felt nostalgic for contexts that supported competence and autonomy but not relatedness seems at first blush inconsistent with previous work showing that nostalgia is often felt when people think back to important relationships of the past (Holak and Havlena 1992; Wildschut et al. 2006). But it is important to note basic relations showed a link between nostalgia and relatedness, which was subsumed by the more robust relations with competence and autonomy. Importantly, in this study we also found that nostalgia links with aesthetic perceptions of the physical world, and may be responsible for the relation between basic psychological needs and perceptions of beauty. Philosophers have proposed that childhood homes stand for the values absent in contemporary experiences (e.g., de Botton 2006), and future research may pursue this question directly by assessing how current experiences of need satisfaction and nostalgia both shape the meaning given to, and aesthetic perceptions of, childhood homes.

By using a relatedness manipulation, Study 4 provided causal evidence that experiencing need satisfactions shapes perceptions of beauty. This experimental finding is an important addition to this set of studies in light of previous research that suggests the reverse—that beauty may impact the psychological experiences in a given space (Reber et al. 2004). Another strength of this final study was that it explored a broader spectrum of aesthetic qualities of a space by asking participants to evaluate the lab as attractive and beautiful, overall, as well as to appraise specific aspects of the space such as the architecture, physical characteristics, and aesthetic appeal of the furniture, the latter of which had little to no relation with psychological experiences. The absence of a relation between perceived psychological needs

and assessment of furniture aesthetics in Study 4 is noteworthy because this item was the only one focusing on evaluations of particular objects rather than ambient factors. Possibly, people evaluate the beauty of objects in a different way than they do when viewing physical spaces. It may be that perceptions of objects are only changed when need satisfying events are directly linked to those objects (for example when an object is given as a gift).

To date, much of the research that has examined perceptions of beauty has used rankings or ratings of physical spaces represented by images (e.g. Arthur 1977; Peterson and Neumann 1969; Zube 1974). In this set of studies, we evaluated the qualities of space differently by guiding individuals to think back and report on the beauty of important places, as a way of personalizing the experience and increasing the fusion of spaces and the psychological needs experienced in them. By using recently experienced locations we minimized retrospective bias in Studies 3 and 4, but future research may use images of important spaces to more carefully evaluate the contrast between actual and perceived beauty.

Research on beauty tends to look at how pleasing physical characteristics benefit those who come in contact with them (Michell 1995), or how built and natural environments create a sense of identity that in turn drives personal experiences (Guest and Lee 1983; Lynch 1960). Some have suggested that physical spaces provide opportunities for social interaction, both good and bad, which may be determined in part by the physical characteristics of the space (Altman 1993). We took a different approach by testing how psychological experiences shape aesthetic perceptions. Yet, the present findings in light of this previous research may inform design. When attempting to create an optimally beautiful place, designers may focus on the relational and need potential of a space as well as its physical characteristics, because contexts that achieve both physical and social appeal may be most physically attractive.

Limitations

This set of studies presented several limitations. First, results were primarily based on retrospective reports. Using within-person reports on multiple spaces from a single place (e.g., home, campus), we minimized the likelihood that a positive halo affected responding on both needs and beauty. That is, if individuals were in a positive mood when coming to the lab they would remember their homes as more beautiful and satisfying overall (person-level effects), but in our studies they remembered certain rooms as being more or less need satisfying and beautiful (within-person effects). Yet this methodology does not exclude the possibility that a halo effect drove the present effects, and as such future research may focus more on present experiences and pursue strategies to make spaces more clearly envisaged (as discussed above), as well as measuring perceptions of physical attractiveness in more concrete ways, for example using the measures from our Study 4. Second, we relied on self-report in all studies, and conclusions would benefit from behavioral or physiological indicators that individuals find spaces satisfying and beautiful (Winkleman et al. 2006).

Closing remarks

The present research provided a novel look at how relational and personal psychological experiences shape perceptions of physical spaces. Past work in this area suggests that aesthetic perceptions are important because they influence satisfaction with, and likelihood of seeking out, spaces (Daniel and Vining 1983; Rossman and Ulehla 1977). The present series of studies examined the need satisfying experiences that shape aesthetic perceptions, and showed that feeling related and autonomous, in particular, makes meaningful spaces appear especially beautiful.

References

Ali, W. (1999). *The Arab contribution to Islamic art: From the seventh to the fifteenth centuries*. Cairo: American University in Cairo Press.

Altman, I. (1993). Dialectics, physical environments, and personal relationships. *Communication Monographs, 60*, 26–34.

Appleton, J. H. (1975). *The experience of landscape*. New York: Wiley.

Appleton, J. H. (1984). Prospects and refuges revisited. *Landscapes Journal, 3*, 91–103.

Arbuckle, J. L. (2006). *Amos* (Version 7.0) [Computer Program]. Chicago: SPSS.

Arthur, L. M. (1977). Predicting scenic beauty of forest environment: Some empirical tests. *Forest Science, 23*, 151–160.

Audirac, I. (1999). Unsettled views about the fringe: Rural-urban or urban-rural frontiers. In J. F. Owen & M. B. Lapping (Eds.), *Contested countryside: The rural urban fringe in North America* (pp. 7–32). Brookfield: Ashgate.

Bachelard, G. (1958). *The poetics of space*. Paris: Beacon Press.

Balling, J. D., & Falk, J. H. (1982). Development of visual preference for natural environments. *Environment and Behavior, 14*, 5–28.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*, 497–529.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin*, *107*, 238–246.

Birkhoff, G. D. (1933). *Aesthetic measure*. Cambridge, MA: Harvard University Press.

Boschetti, M. A. (1987). Memories of childhood homes: Some contributions of environmental autobiography to interior design education and research. *Journal of Interior Design, 13*, 27–36.

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36*, 129–148.

Brown, T. C., & Daniel, T. C. (1987). Context effects in perceived environmental quality assessments: Scene selection and

landscape quality ratings. *Journal of Environmental Psychology, 7*, 233–250.

Brown, T. C., & Daniel, T. C. (1990). *Scaling of ratings: Concepts and methods*. USDA Forest Service Research Paper RM-293. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models in social and behavioral research: Applications and data analysis methods* (1st ed.). Newbury Park, CA: Sage Publications.

Canter, D. (1977). *The psychology of place*. London: Architectural Press.

Chen, F., Curran, P. J., Bollen, K. A., Kirby, J., & Paxton, P. (2008). An empirical evaluation of the use of fixed cutoff points in RMSEA test statistic in structural equation models. *Sociological Methods and Research, 36*, 462–494.

Chirkov, V. I., Ryan, R. M., Kim, Y., & Kaplan, U. (2003). Differentiating autonomy from individualism and independence: A self-determination theory perspective on internalization of cultural orientations and well-being. *Journal of Personality and Social Psychology, 84*, 97–110.

Cooper, J. (1997). *Plato: Complete works*. Indianapolis: Hackett.

Craik, K., & Zube, E. (1977). *Perceived environmental quality indices*. New York: Plenum Press.

Daniel, T. C. (1976). Measuring public aesthetic preference. In J. Thames (Ed.), *Disturbed land reclamation and use in the southwest*. Tucson: University of Arizona Press.

Daniel, T. C. (1977). Criteria for the development of perceived environmental quality indices. In E. Zube & K. Craik (Eds.), *Perceived environmental quality indices*. New York: Plenum Press.

Daniel, T. C. (1990). Measuring the quality of the human environment: A psychophysical approach. *American Psychologist, 45*, 633–637.

Daniel, T. C. (2001). Whither scenic beauty? Visual landscape quality assessment in the 21st century. *Landscape and Urban Planning, 54*, 267–281.

Daniel, T. C., & Boster, R. S. (1976). *Measuring landscape aesthetics: The scenic beauty estimation method*. USDA Forest Service Research Paper RM-167. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Daniel, T. C., & Vining, J. (1983). Methodological issues in the assessment of landscape quality. In I. Altman & J. Wohlwill (Eds.), *Human behavior and environment* (Vol. 6, pp. 39–84). New York: Plenum Press.

Danto, A. (2003). *The abuse of beauty: Aesthetics and the concept of art*. Chicago: Open Court.

De Botton, A. (2006). *The architecture of happiness*. New York: Pantheon Books.

deCharms, R. (1968). *Personal causation: The internal affective determinants of behavior*. New York: Academic Press.

Deci, E. L. (1975). *Intrinsic motivation*. New York: Plenum Publishing Co.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behaviour*. New York: Plenum.

Deci, E. L., Ryan, R. M., Gagné, M., Leone, D. R., Usunov, J., & Kornazheva, B. P. (2001). Need satisfaction, motivation, and well-being in the work organizations of a former eastern bloc country. *Personality and Social Psychology Bulletin, 27*, 930–942.

Gagné, M., Ryan, R. M., & Bargmann, K. (2003). Autonomy support and need satisfaction in the motivation and well-being of gymnasts. *Journal of Applied Sport Psychology, 15*, 372–390.

Gepshtein, S., & Kubovy, M. (2000). The emergence of visual objects in space-time. *Proceedings of the National Academy of Sciences, 97*, 8186–8191.

Gombrich, E. H. (1995). *The story of art*. London: Phaidon Press Ltd.

Guest, A. M., & Lee, B. (1983). Sentiment and evaluation as ecological variables. *Sociological Perspectives, 26*, 159–184.

Harter, S. (1978). Effectance motivation reconsidered: Toward a developmental model. *Human Development, 1*, 34–64.

Holak, S. L., & Havlena, W. J. (1992). Nostalgia: An exploratory study of themes and emotions in the nostalgic experience. In J. F. Sherry Jr & B. Sternthal (Eds.), *Advances in consumer research, 19* (pp. 380–387). Provo, UT: Association for Consumer Research.

Jang, H., Reeve, J., Ryan, R. M., & Kim, A. (2009). Can self-determination theory explain what underlies the productive, satisfying learning experiences of collectivistically-oriented Korean students? *Journal of Educational Psychology, 101*, 644–661.

Jones, J. C. (1992). *Design methods* (2nd ed.). New York: van Nostrand Reinhold.

Kaplan, S. (1987). Aesthetics, affect, and cognition: Environmental preference from an evolutionary perspective. *Environment and Behavior, 19*, 3–32.

Kenny, D. A., Korchmaros, J. D., & Bolger, N. (2003). Lower level mediation in multilevel models. *Psychological Methods, 8*, 115–128.

Korsmeyer, C. (1998). *Aesthetics: The big questions*. Oxford: Basil Blackwell Publishers.

Leary, M. R., & Baumeister, R. F. (2004). The nature and function of self-esteem: Sociometer theory. *Advances in Experimental Psychology, 32*, 1–62.

Levesque, C., Zuehike, N. A., Stanek, L. R., & Layla, R. M. (2004). Autonomy and competence in German and American university students: A comparative study based on self-determination theory. *Journal of Education Psychology, 96*, 68–84.

Lindberg, E., Hartig, T., Garvill, J., & Gärling, T. (1992). Residential-location preferences across the life span. *Journal of Environmental Psychology, 12*, 187–198.

Lynch, K. (1960). *The image of the city*. Cambridge, MA: MIT Press.

Lynch, M. F., Plant, R. W., & Ryan, R. M. (2005). Psychological needs and threat to safety: Implications for staff and patients in a psychiatric hospital for youth. *Professional Psychology, 36*, 415–425.

Mendes, W. B., Major, B., McCoy, S., & Blascovich, J. (2008). How attributional ambiguity shapes physiological and emotional responses to social rejection and acceptance. *Journal of Personality and Social Psychology, 94*, 278–291.

Michell, C. T. (1995). Action, perception, and the realization of design. *Design Studies, 16*, 4–28.

Nasar, J. L. (1983). Adult viewers' preferences in residential scenes: A study of the relationship of environmental attributes to preference. *Environment and Behavior, 15*, 589–614.

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology, 35*, 250–256.

Orians, G. H., & Heerwagon, J. H. (1992). Evolved response to landscapes. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture*. New York: Oxford University Press.

Parsons, R. (1991). The potential influences of environmental perception on human health. *Journal of Environmental Psychology, 11*, 1–23.

Patrick, H., Knee, C. R., Canevello, A., & Lonsbary, C. (2007). The role of need fulfillment in relationship functioning and well-being: A self-determination theory perspective. *Journal of Personality and Social Psychology, 92*, 434–457.

Peterson, G. L., & Neumann, E. S. (1969). Modeling and predicting human response to the visual recreation environment. *Journal of Leisure Research, 1*, 219–237.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Newbury Park, CA: Sage.

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? *Personality and Social Psychology Review, 8*, 364–382.

Reis, H. T. (1994). Domains of experience: Investigating relationship processes from three perspectives. In R. Erber & R. Gilmour (Eds.), *Theoretical frameworks for personal relationships* (pp. 87–110). Hillsdale, NJ: Lawrence Erlbaum.

Reis, H. T., Sheldon, K. M., Gable, S. L., Roscoe, J., & Ryan, R. M. (2000). Daily well-being: The role of autonomy, competence, and relatedness. *Personality and Social Psychology Bulletin, 26*, 419–435.

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.

Rossman, B., & Ulehla, Z. J. (1977). Psychological reward values associated with wilderness use: A bifunctional-reinforcement approach. *Environment and Behavior, 9*, 41–65.

Russell, J. A., & Ward, L. M. (1981). On the psychological reality of environmental meaning: A reply to Daniel and Ittelson. *Journal of Experimental Psychology: General, 110*, 163–168.

Ryan, R. M., & Deci, E. L. (2000). The darker and brighter sides of human existence: Basic psychological needs as a unifying concept. *Psychological Inquiry, 11*, 319–338.

Ryan, R. M., & Frederick, C. M. (1997). On energy, personality and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality, 65*, 529–565.

Ryan, R. M., La Guardia, J. G., Solky-Butzel, J., Chirkov, V. I., & Kim, Y. (2005). On the interpersonal regulation of emotions: Emotional reliance across gender, relationships, and culture. *Personal Relationships, 12*, 146–163.

Seamon, D. (1982). The phenomenological contribution to environmental psychology. *Journal of Environmental Psychology, 2*, 119–140.

Sedikides, C., Wildschut, T., Arndt, J., & Routledge, C. (2008). Nostalgia: Past, present, and future. *Current Directions in Psychological Science, 17*, 304–307.

Shaffer, G. S., & Anderson, L. M. (1985). Perceptions of the security and attractiveness of urban parking lots. *Journal of Environmental Psychology, 5*, 311–323.

Sheldon, K. M., Ryan, R. M., & Reis, H. (1996). What makes for a good day? Competence and autonomy in the day and in the person. *Personality and Social Psychology Bulletin, 22*, 1270–1279.

Shin, J., Espin, C. A., Deno, S., & McConnell, S. (2004). Use of hierarchical linear modeling and curriculum-based measurement for assessing academic growth and instructional factors for students with learning difficulties. *Asia Pacific Education Review, 5*, 136–148.

Siegel, E. (1955). Is beauty the making one of opposites? *Journal of Aesthetics & Art Criticism, 14*, 282–283.

Stewart, I. (2008). *Why beauty is truth: The history of symmetry*. New York: Basic Books.

Stokes, R., & Frederick-Recascino, C. (2003). Woman's perceived body image: Relations with personal happiness. *Journal of Women & Aging, 15*, 17–29.

Tuan, Y.-F. (1974). *Topophilia: A study of environmental perception, attitudes and values*. Prentice Hall, New Jersey: Englewood Cliffs.

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman & J. Wohlwill (Eds.), *Behavior and the natural environment* (pp. 85–125). New York: Plenum Press.

Ulrich, R. S. (1993). Biophilia, biophobia, and natural landscapes. In S. R. Kellert & E. O. Wilson (Eds.), *The biophilia hypothesis*. Washington, DC: Island Press.

Van den Broeck, A., Vansteenkiste, M., De Witte, H., Soenens, B., & Lens, W. (2010). Capturing autonomy, competence, and relatedness at work: Construction and initial validation of the work-related basic need satisfaction scale. *Journal of Occupational and Organizational Psychology, 83*, 981–1002.

Vansteenkiste, M., Neyrinck, B., Niemiec, C. P., Soenens, B., De Witte, H., & Van Den Broeck, A. (2007). On the relations among work value orientations, psychological need satisfaction, and job outcomes: A self-determination theory approach. *Journal of Occupational and Organizational Psychology, 80*, 251–277.

Watkins, R. (2001). *Lived space is poetic space. A study of the home as an aesthetic enterprise*. Unpublished manuscript.

Weinstein, N., & Ryan, R. M. (2010). When helping helps: An examination of motivational constructs underlying prosocial behavior and their influence on well-being for the helper and recipient. *Journal of Personality and Social Psychology, 98*, 222–224.

Wheaton, B., Muthén, B., Alwin, D. F., & Summers, G. F. (1977). Assessing reliability and stability in panel models. In D. R. Heise (Ed.), *Sociological methodology, 1977* (pp. 84–136). San Francisco: Jossey-Bass.

White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review, 66*, 297–333.

Wildschut, T., Sedikides, C., Arndt, J., & Routledge, C. (2006). Nostalgia: Content, triggers, functions. *Journal of Personality and Social Psychology, 91*, 975–993.

Winkleman, P., Halberstadt, J., Fazendeiro, T., & Catty, S. (2006). Prototypes are attractive because they are easy on the mind. *Psychological Science, 17*, 799–806.

Zube, E. H. (1974). Cross-disciplinary and intermode agreement on the description and evaluation of landscape resources. *Environment and Behavior, 6*, 69–89.