Perceived well-being by visiting urban green areas: an exploratory analysis using Partial-Least Squares models

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ABSTRACT

Literature on human experience in green environments has widely demonstrated how the direct and indirect experience with nature has positive impact on individuals' well-being. Experience with nature reduces psychophysical stress, induces positive emotions and facilitates the renewal of cognitive sources providing both physical and psychological benefits. In addition, many studies on psychological restoration have shown that green spaces have a greater capacity of promoting human health and well-being than built-up areas.

With the increasing interest in the use of urban green space for promoting human health, it is interesting to gain knowledge and development on this important topic, focusing also on the related methodological issues. Indeed, perceived well-being is generally assessed indirectly and a set of proxy variables (i.e. indicators) are used to measure it, thus leading to the definition of well-being as a latent composite construct. As a novelty in the analysis concerning the relationships between perceived well-being and green environment, this study aims at investigating this issue by referring to the Partial-Least Squares Structural Equation Modelling (PLS-SEM) within the framework of Attention Restoration Theory (ART).

We selected three typologies of urban and peri-urban green spaces in Central Italy, characterized by different physical features (e.g. presence of natural and built up elements). A questionnaire including measures of length and frequency of visits, perceived restorativeness - introduced according to the ART - and self-reported benefits of the visit to the green spaces was administered *in situ* within five sites. By adopting the PLS-SEM approach, we explored the relationships between restorative components and psychological and physical self-reported well-being. PLS approach allowed us to verify also the existence of mediator effects in order to better understand these interactions.

Keywords: PLS-SEM, Well-being, Restorativeness, Urban forest

1. Introduction

Environment and environmental conditions have a significant effect on human health and quality of life (EEA 2013). Indeed, direct and indirect experience with nature have positive impacts on individuals' well-being since natural environment helps to recover psychological and physiological resources (Hartig 2004). There is a wide body of literature dealing with the effect of natural elements such as trees, woodland and green spaces on physical, psychological and social well-being (e.g. Ulrich et al. 1991, O'Brien 2005, Carrus et al. 2015; Scopelliti et al. 2016; Tomao et al., 2016). They provide empirical evidence of attention restoration and stress reduction from the experience of nature. Furthermore, some of these studies (e.g. Carrus et al. 2015) report how green spaces promote a higher level of well-being if compared to built-up areas.

The restorative effects of green areas can be assessed based on different theories, including the stress reduction theory (Ulrich et al. 1991) and the Attention Restoration Theory (ART) (Kaplan 1995). In particular, the ART proposes that regenerative environments are characterized by four components: (i) *being-away*, (ii) *extent*, (iii) *fascination*, and (iv) *compatibility* (Kaplan 1995). *Being-away* is linked to the experience of being in an environment physically different from the one of daily routine, where cognitive efforts are requested. The *extent* relates to the physical characteristics of an environment that has to be wide enough to promote exploration without cognitive effort. *Fascination* refers to regenerative aesthetic stimuli of environments. *Compatibility* is the property of places able to support individual expectations.

With the increasing interest in the use of urban green space for promoting human health, our study aims at investigating the relationships between perceived well-being and green environment by proposing a Partial-Least Squares Structural Equation Model (PLS-SEM) and distinguishing between direct and indirect effects related to physical and psychological benefits deriving from urban green space. To the best of our knowledge, this is the first study that combines these two aspects of well-being, the PLS-SEM methodological framework and the ART restorative components.

2. Research hypothesis

Bearing in mind the complexity of ART theory and by considering that the components of restorativeness can be considered as predictors of perceived well-being (Carrus et al. 2015; Tomao et al. 2016), we formulated the following Research Hypotheses (RHs):

RH1: Restorative (ART) components as well as well-being[1] (WB) can be considered as latent variables and can be measured by using manifest variables within the PLS approach.

RH2: Restorative (ART) components have a direct effect on psychological and physical WB.

RH3: Restorative (ART) components have an indirect effect on well-being deriving from visiting green areas and woodlands in urban context.

[1] In this study we refer to well-being as the overall benefits obtained while visiting urban green areas.

3. Method and model specification

3.1 Data

The exploratory study refers to a sample of 200 individuals (50% women; mean age = 41.6 years; Standard Deviation - SD = 15.4). In order to increase the range of knowledge on urban and peri-urban green areas as well as their relationships with human well-being, we selected five sites in accordance with three typologies of green spaces characterized by different physical features: a botanic garden (Rome), two urban parks in Rome (Villa Borghese and Villa Pamphili) and two peri-urban forests (the pinewood of Castelfusano - Ostia, RM - and a high forest beech stand located in Soriano nel Cimino -VT-). A total of 28 visitors in the botanical garden, 66 in the urban parks, 69 in the pinewood of Castelfusano and 37 in the beech forest in Soriano nel Cimino have been involved, requesting them to fill a questionnaire during the visit of the green area. Specific items derived from the Italian version of the Perceived Restorativeness Scale (PRS; Pasini et al. 2009) were included in the questionnaire as manifest variables for measuring restorative components. Specific questions aimed at measuring psychological and physical benefits while visiting study sites were included according to Carrus et al. (2015). All variables were measured through a 5-point scale ranging from 1 to 5.

3.2. Modelling FW within the PLS-SEM approach

According to the ART framework, we modelled perceived subjective well-being and restorative components of green areas by referring to the PLS–SEM approach.

The PLS path modelling is a variance-based technique recommended during the first stages of research in order to test and validate exploratory models, especially when variables cannot be easily determined or measured directly. These types of models well fit human (subjective) well-being whose measurement is generally obtained indirectly by means of data gathered using questionnaires.

A PLS path model consists in two components (Hair et al. 2014). The first is a structural model (the inner model) which illustrates the specified constructs and focuses on the relationships (paths) between them. The second is the measurement models (the outer models), that shows the relationships between the constructs and the indicators also known as manifest variables. Furthermore, while structural and measurement models are present in all types of SEMs with latent constructs, the weighting scheme represents the third specific component of the PLS approach (Monecke and Leisch 2012) and is used for estimating the inner weights linking latent constructs. Table 1 illustrates the Latent Variables (LVs) of the specified structural model (first column) and the related indicators used in the measurement model (second column).

Table 1: *Latent variables and manifest variables*

LATENT VARIABLE	MANIFEST VARIABLES
COMPATIBILITY	Q1. Being in this place is in accordance with my personal interests Q2. In this place it is easy to do what I want
BEING AWAY	Q3. Spending the time here allows me to distance myself from my daily routine Q4. In this place I can run away from the things that usually require my attention
FASCINATION	Q5 This place is fascinating Q6 There is much to explore and discover in this place
EXTENT	Q7 It's like this place had no boundaries Q8 There is a clear order in the physical layout of this place
PSYCHOLOGIAL WELL-BEING	Q9 Do you feel psychological benefits during the visit to this place? Q10 Do you think you will feel psychological benefits during the visit to this place?
PSYSYCAL WELL-BEING	Q11 Do you feel physical benefits during the visit to this place? Q12 Do you think you will feel physical benefits during the visit to this place?
WELL-BEING	Q13 How much do visiting this place make you feel better than before? Q14 After visiting this place, how much do you believe you will feel better if compared to how you usually feel?

In our model *Compatibility*, *Being away*, *Fascination* and *Extent* are exogenous LVs since they do not have any predecessor in the structural models while the other three LVs (psychological, physical WB and well-being) are specified as endogenous LVs. Figure 1 illustrates the structural model specified in our analysis and the relationships between the latent variables.
Figure 2 reports the complete (inner and outer components) specified model, which reflects the RHs. In order to test this model we used SmartPLS 3 software and applied the path-weighting scheme.

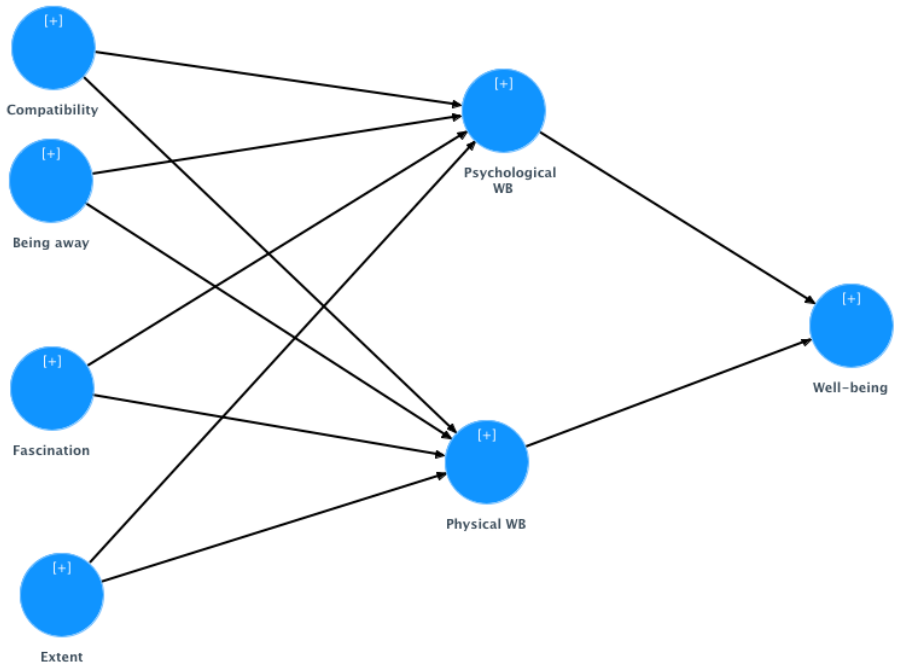

Figure 1: *The specified structural (inner) model*

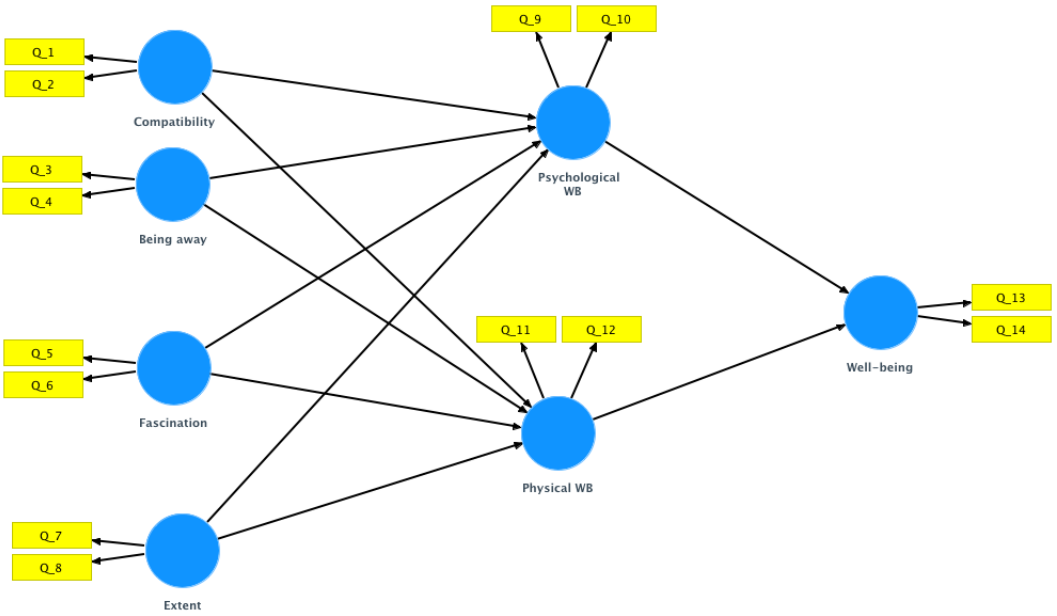

Figure 2: *The specified inner and outer models*

3. Results

The analysis of results was carried out by following recent guidelines for PLS-SEM by Hair et al. (2014). Firstly, we examined the measurement models by evaluating item and construct reliability as well as convergent and discriminant validity of the constructs. Secondly, we evaluated the structural model by verifying its ability to predict the endogenous constructs in terms of goodness of fit, cross-validated redundancy and path coefficients. Once the validity of the models was assessed, we analyzed estimated direct and indirect effects.

The reflective measurement models were evaluated for reliability and validity. Item reliability of our model is higher than 0.7 in almost all of the cases. Only two items (Q2, Q8) have outer loadings between 0.55 and 0.7. However, the Average Variance Extracted (AVE) values, defined as the grand mean of the squared loadings of the indicators associated with the construct, are higher than 0.5 for all the LVs, indicating convergent validity for all the constructs. Composite reliabilities for the 7 constructs range between 0.72 to 0.95, satisfying the requirements suggested by Hair et al. (2014). The values of Variance Inflation Factors (VIFs) are lower than 10 for all the constructs, demonstrating that our structural model results are not affected by collinearity.

Table 2 shows the results concerning the coefficients describing the relationships between latent variables (standard errors were obtained from bootstrap).

The results of direct structural relationships reveal that four out of the ten relationships hypothesized are statistically significant at 1% level (p-value<0.01) and two of them are statistically significant at 5% level (p-value<0.05). In particular, restoration components - except for *extent* - have a direct and positive effect on psychological WB. On the other hand, only *compatibility* has a direct effect on Physical WB. Both psychological and physical WB show a positive and highly significant effect on well-being.

Besides, direct effects on both physical and psychological WB, restorative components – and specifically compatibility, fascination and being away – proved to have indirect significant effects on well-being via both psychological and physical WB.

Table 2: *Estimated direct, indirect and total effects*

	Direct effects		Indirect effects		Total effects	
	Estimate	Sign	Estimate	Sign	Estimate	Sign
Being away -> Psychological WB	0.227	***			0.227	***
Being away -> Physical WB	0.024				0.024	
Being away -> Well-being			0.122	*	0.122	*
Fascination -> Psychological WB	0.191	**			0.191	**
Fascination -> Physical WB	0.085				0.085	
Fascination -> Well-being			0.125	**	0.125	**
Compatibility -> Psychological WB	0.178	**			0.178	**
Compatibility -> Physical WB	0.347	***			0.347	***
Compatibility -> Well-being			0.210	***	0.210	***
Extent -> Psychological WB	0.080				0.080	
Extent -> Physical WB	0.027				0.027	
Extent -> Well-being			0.049		0.049	
Psychological WB -> Well-being	0.500	***			0.500	***
Physical WB -> Well-being	0.348	***			0.348	***

Notes: Significance level: *** p-value<0.01; ** p-value<0.05; * p-value<0.10

4. Discussion and concluding remarks

Findings of this study support the evidence emerged from other studies that mental and physical benefits can be obtained by visiting urban and peri-urban green areas (Hartig 2004; Carrus et al. 2015; Tomao et al. 2016).

We applied PLS-SEM models to self-reported well-being considering it as a latent variable (RH1). Results on item reliability showed how subjective well-being as well as restorative components can be estimated by the selected proxy variables as well path-modelling can be considered as an appropriate framework for linking well-being and ART components. This evidence also confirms that the manifest variables identified by the Italian version of the PRS (Pasini et al. 2009) can be successfully used to evaluate restorativeness, even using PLS procedures.

Our results show that all the intrinsic restoration properties of the green areas have a positive and direct effect on both psychological and physical WB (RH2), even if *extent* is not statistically significant. This evidence highlights how components of restorativeness can be considered as important predictors of well-being, confirming the findings of other previous studies (e.g. Carrus et al., 2015; Marselle et al. 2016; Tomao et al., 2016). On the other hand, the dimensions of green areas, wide enough to capture the individuals' attention, seem to have a more marginal role in well-being perception. This is probably due to the perception, in many cases, of the so called "grey infrastructure" elements (buildings, roads, etc.), that can be seen outside, but also from inside the boundaries of the green areas.

Compatibility has been the only one component having a significant influence on both psychological and physical WB. It also showed a highly significant indirect effect on overall well-being (RH3), suggesting that the characteristics of places able to support individual expectations are very good predictors of well-being and for this reason should be considered in managing and designing public green areas.

Our preliminary and explorative results represent a good starting point for deeper analysis, required to better understand the complex issue of well-being evaluation. In particular, an interesting improvement can be the evaluation of the effect of the "site quality" on well-being perception, for

example by comparing scores of latent variables obtained for each green area. Moreover, variables related to the demographic and economic characteristics of the users of green areas could be also introduced in the model in order to verify if and to what extent context variables may affect directly or indirectly perceived well-being.

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