# Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas


**Abstract**

The literature on human experience in green environments had widely showed the positive outcomes of getting in contact with nature. This study addresses the issue of whether urban residents' evaluations of urban and peri-urban natural settings and the positive outcomes deriving from contact with such settings vary as a function of their biodiversity. A field study assessed benefits and subjective well-being reported by urban residents visiting four differenttypologies of green spaces, selected on the basis of urban forestry expert criteria according to a 2 × 2 factorial design. The biodiversity level (low vs. high) was crossed with the setting location (urban vs. peri-urban) as follows: urban squares with green elements, urban parks, pinewood forest plantations, and peri-urban natural protected areas. A questionnaire including measures of length and frequency of visits, perceived restorativeness, and self-reported benefits of the visit to the green spaces was administered in situ to 569 residents of four Italian medium-to-large size cities: Bari, Florence, Rome and Padua. Results showed the positive role of biodiversity upon perceived restorative properties and self-reported benefits for urban and peri-urban green spaces. Consistently with the hypotheses reported herein, a mediation role of perceived restorativeness in the relation between experience of natural settings (i.e., higher level of biodiversity) and self-reported benefits was found. The design and management implications of the findings are discussed.



**Keywords**: Biodiversity, Well-being, Psychological benefits, Perceived restorativeness, Urban green areas


## 1. Introduction

Research on restorative environments reveals that natural settings are, more consistently than others, capable of promoting psychological well-being by reducing psychophysical stress, inducing positive emotions, and facilitating the renewal of cognitive resources (Hartig, 2004). Many studies on psychological restoration in nature refer to evolutionary explanations, such as the Biophilia Hypothesis assuming thathumanbeings evolved in natural environments and developed an innate tendency to respond positively to natural settings (e.g., Wilson, 1984, 1999). This positive response also includes psychological restoration, as conceived by different authors in terms of stress reduction (Ulrich, 1983) and recovery of directed attention (Kaplan & Kaplan, 1989; see also Kaplan, 1995, for an integrative framework). Empirical evidence has frequently been provided in support of theories on stress reduction (e.g., Hartig, Mang, & Evans, 1991; Ulrich et al., 1991) and attention restoration derived from natural settings (e.g., Berman, Jonides, & Kaplan, 2008; Berto, 2005; Laumann, Gärling, & Stormark, 2003; Staats, Kievet, & Hartig, 2003; Tennessen & Cimprich, 1995). Yet, it is important to understand whether different kinds of natural settings can have different restorative effects. Furthermore, it is worth investigating the possible psychological mediators and moderators of the positive outcomes of contact with nature. Addressing relevant issues in this field of research can therefore help answer questions such as: Is the level of biodiversity (sensu ecological and landscape diversity) of a green setting related to its (actual or perceived) capacity to induce positive psychological states and benefits? Does this relation change across green spaces located in different parts of the urban system (e.g., urban vs. peri-urban settings)? Which modalities of interaction with nature can moderate the psychological benefits of an individual? What are the intervening mechanisms in this relation? The purpose of this study is threefold: (i) to assess the impact of biodiversity and location of green areas on the restorative effects perceived by its users. It is hypothesized that the biodiversity level and peri-urban location positively affect self-reported benefits, well-being and perceived restorativeness. A second hypothesis maintains that the location of green areas moderates the effects of biodiversity; i.e., the relation between biodiversity level and self-reported benefits, well-being and perceived restorativeness should be stronger for urban compared to peri-urban green areas: while peri-urban green experience is appreciated per-se, urban green experience is more positive when green spaces have a higher richness in biodiversity; (ii) to investigate the role of experience variables on restorative effects (by referring to the activities performed in the green areas and the duration of the visits). With reference to the types of activities performed, and in accordance with the studies on social interaction in restorative environments, it has been speculated that environment-oriented as opposed to socially oriented activities in restorative environments increase the perception of restorative properties and selfreported benefits. Concerning the amount of exposure to natural settings, and in accordance with previous studies on length and frequency of visits (e.g., Lafortezza, Carrus, Sanesi, & Davies, 2009) it is presumed that the longer the visit to green areas, the greater the self-reported benefits and well-being as well as the perceived sense of restorativeness; and (iii) to assess the role of perceived restorativeness as a psychological mechanism in the relation between contact with nature and psychological restoration. We expected the perceived restorativeness to mediate the relation between exposure to nature and self-reported benefits and well-being, as well as the relation between biodiversity level and self-reported benefits and well-being.

### 1.1. Biodiversity, preference and perceived restorativeness

In the study of restorative environments, nature has often been considered as an undifferentiated typology, in contrast to built environments. Yet, less attention has been devoted to analyzing the restorative potential of different types of natural environments. In the last decade, many have suggested the positive role of biodiversity in the promotion of human health in present day urbanized society (e.g., Brown & Grant, 2005). Fuller, Irvine, Devine-Wright, Warren, and Gaston (2007) have found that biodiversity increase the psychological benefits associated to the “green” experience. This result is still compatible with an evolutionary perspective, as biodiversity plays a fundamental role in life support and ecosystem continuity (e.g., Wilson, 1999). If we consider the implications of the Biophilia Hypothesis in the context of daily life situations, not only should we expect a systematic preference for natural compared to built settings, but we might also argue about the plausibility of a positive link between features such as biodiversity richness and human appreciation of green spaces. These positive evaluations should also be reflected in a greater capacity of settings with higher biodiversity levels (vs. settings with lower biodiversity levels) to induce positive outcomes. The empirical evidence accumulated to date does not allow to imply such a straightforward relation; in fact, the relation among factors such as biodiversity richness, preference and psychological restoration remains controversial. On one hand, evolutionary accounts such as the Biophilia Hypothesis and findings from studies on landscape preference and restorative environments converge in suggesting that the natural quality of a setting is positively linked to the preferences expressed by its users (or viewers). Indeed, recent evidence suggests that a linear, albeit low-to-moderate, relation exists between actual and perceived natural quality, perceived restorativeness, and preference for green spaces (e.g., Carrus et al., 2013; Scopelliti et al., 2012). Likewise, Kurz and Baudains (2012), found a very slight preference for high-habitat-providing private gardens. On the other hand, natural settings can induce negative feelings among their users (e.g., Bixler & Floyd, 1997; Burgess, Harrison, & Limb, 1988; Henwood & Pidgeon, 2001; Williams & Cary, 2002) and urban dwellers might express ambivalent attitudes towards urban green spaces (e.g., Bonnes, Passafaro, & Carrus, 2011; Carrus, Passafaro, & Bonnes, 2004). A study by Qiu, Lindberg, and Nielsen (2013), found for example no relation relation between biodiversity and preference, although people correctly perceive differences in biodiversity in urban green spaces. Another recent study by Johansson, Gyllin, Witzell, and Kuller, 2014 also shows that human appraisal of biodiversity richness is controversial. These authors combined physiological and psychological measures (e.g., qEEG, self-reported emotions, preferences, attitudes) to assess human response to different levels of biodiversity in forest settings. The findings revealed a pattern of positive appraisal for intermediate levels of biodiversity richness, compared to low or high levels. Studies directly investigating the relation of biodiversity with well-being also did not found compelling evidence. An empirical work by Dallimer et al. (2012) for example found no evidence for a consistent relationship between actual species richness of green areas and visitors' psychological well-being, while a positive relation emerged with perceived biodiversity richness.

These deviations from the general pattern linking positive reactions to wilderness may provide insights to understand conditions under which human preference for nature is moderated by other factors. For example, a work by Koole and van den Berg (2005) on wilderness and terror management shows that wilderness appreciation is hampered by the induction of mortality salience. These reactions may be explained, for example, by the automatic reactions of fear (and escape) after detection of animal predator cues, which have been described as a basic mechanism in mammalian evolution (Öhman & Mineka, 2000). In sum, this corpus of evidence suggests the need for investigating the mechanisms underlying the relation between biodiversity richness and positive psychological responses, as well as the possible moderators of this relation.

### 1.2. Mediators and moderators of the biodiversity-restoration relation

Previous research revealed that the amount of exposure to nature (e.g., frequency and length of visits to urban parks), promotes self-reported benefits and well-being (see Lafortezza et al., 2009). Also, epidemiological studies revealed that higher opportunities for contact with public green space in residential surroundings results in better population health indexes and reduce income-related health inequalities (e.g., Mitchell & Popham, 2008). As regards mediators, stress reduction and attention restoration theories suggest that the perceived restorative qualities are a possible mediator of the relation between contact with nature and psychological benefits. Urban settings with more natural elements are judged as more restorative (e.g., Hernández & Hidalgo, 2005). We argue here that going more frequently or for longer time to green spaces might lead the individual to a greater appreciation of its restorative qualities. These, in turn, might be reflected in more positive psychological outcomes and individual benefits of the actual “green” experience. Concerning moderators, our study focuses on the location of green spaces, aiming particularly at the distinction between urban and peri-urban green spaces. We hypothesize that this can be a moderator of the relation between the biodiversity of a green area and positive outcomes perceived by its user. On a general level, based on previous studies, we believe that peri-urban green areas should be perceived as more restorative and lead to more positive outcomes compared with urban green areas (e.g., Hauru, Lehvävirta, Korpela, & Kotze 2012). In fact, peri-urban green spaces are generally located in more calm and aesthetically attractive contexts. This is likely to make the visits to peri-urban green as an attractive and positive experience per-se, for urban residents. However, we expect biodiversity to bring about positive outcomes, in particular in the case of people visiting urban green areas. In fact, assuming that individuals experiencing urban green spaces are more nature-deprived and in higher restoration needs (a factor associated to stronger benefits of nature; see Hartig, Evans, Jamner, Davis, and Garling (2003)), we shall expect biodiversity to be a more crucial factor in this case, so that urban residents are more likely to get positive outcomes from more natural urban green spaces. A second moderator worth addressing concerns the different activities performed in a natural setting (Scopelliti & Giuliani, 2004). For example, the presence of other people may diminish the benefits of natural environments (Staats & Hartig, 2004). Scopelliti and Giuliani (2005) found that the perceived restorative potential of natural environments is higher when people are alone, and suggestthat socialinteractioninnatural environmentsmay represent a source of distraction from the relationship with restorative natural environments.

## 2. Materials and methods

### 2.1. Environment selection

Four different types of green areas were selected for the study varying in the level of biodiversity richness (low vs. high) and location (urban vs. peri-urban) according to a 2 × 2 factorial design: an urban square with trees (urban location, low biodiversity), an urban park (urban location, high biodiversity), a pinewood forest plantation (peri-urban location, low biodiversity), and a peri-urban protected reserve (peri-urban location, high biodiversity), a type of green area yet little studied with respect to the preferences of visitors (see López-Mosquera & Sánchez, 2014). The selected sites were located in (or in proximity to)four Italian cities located along a south-north geographic gradient: Bari, Rome, Florence, and Padua. The sizes of these cities range from medium to large, with Rome being the largest one (2,860,000 inhabitants) and Padua being the smallest one (about 210,000 inhabitants). The cities were selected by convenience, on the basis of previous empirical data available by the research team. Each of the four typologies of green space identified was covered in each of the four cities considered. These four typologies of green areas were selected according to parameters commonly used in the urban forestry science sector, such as species richness, degree of canopy closure, artificiality vs. natural quality, prospect, physical accessibility and beauty (e.g., Hofmann, Westermann, Kowarik, & van der Meer, 2012). The identification of the sites followed a two-step validation process, in order to cover different levels of biodiversity richness. First, the four typologies were classified in terms of their biodiversity richness, on the basis of previous empirical data, available for the city of Bari, showing differences in plant species and structural diversity, e.g., (Lorusso, Lafortezza, Tarasco, Sanesi, & Triggiani, 2007), as well as in other species such as insects and birds (e.g., Ferrara et al., 2008). In a second step validation the validity of the operationalization of this variable, and its suitability to all the cities considered, was ascertained through an expert-based assessment procedure. A panel of 15 independent experts from the urban forestry sector (7 women, 8 men; average age = 35) were asked to choose a sample picture ofthe different sites (urbanandper-urban) for eachcity, and to rank the pictures according to their biodiversity level. Experts were asked to perform the ranking having in mind specific criteria, suchas species diversity and complexity ofthe structure. Responses showed a unanimous consent across all the experts involved, and corroborated the operationalization based on the previous empirical data available. The aesthetic appeal of the man-made elements present in each of the typologies considered was also accounted for. A sample image for each of the four typologies is provided in Fig. 1. In terms of specific characteristics of the green spaces considered in this study, we might also refer to a recent work by Edwards et al. (2012). This study assessed public preferences for 12 key structural attributes of forests, using a Delphi survey procedure. Findings indicate that variations in tree spacing as well as naturalness of forest edges are relatively stable parameter associated with the recreational value expressed by expert panels. The characteristics of the high (vs. low) biodiversity settings, as identified in our study, are compatible with these findings. 2.2. Participants, procedure and measures A convenience sample of 569 respondents in total (295 females; mean age = 41.04 years; SD = 17.9) was contacted on site while spending their leisure time at the different locations. Subjects were invited to take part in the study by filling in a paper-and-pencil questionnaire, while spending time in the green areas.

[Here Fig. 1]

As the questionnaires where administered directly on the filed, response rate was not systematically recorded. However, qualitative debriefing sessions with the trained interviewers that administered the questionnaires revealed that the majority of the participants contacted in situ where keen to collaborate and fill in the survey, so that the likelihood of a self-selection biased sample is rather low. Data were collected at the beginning of spring 2009 (between March and early May), during daylight (from 11 am to 6 pm), only in sunny (or moderately cloudy) days, without any rain. Average temperatures in this period of the year in Italy are mild, and this period is typically considered in the Italian culture as the most comfortable to spend time outdoor in green spaces. Because our study did not involve any ethically relevant treatment, nor did we record any personal sensitive data, according to the Italian regulations there was not need of prior IRB approval from the University bodies. Participants were however informed of the anonymous character ofthe survey, and assured thatindividual responses were treated only as aggregate data for scientific research purposes, without any profit or marketing segmentation implications. The structure of the questionnaire was organized as follows: Section 1, consisting of open-ended, multiple-choice, and Likerttype scale questions on setting experience (length and frequency of visits, crowding), main activity performed (socialization, walking, contemplation, or physical activity) and socio-demographic data; Section 2, containing 8 items taken from the Italian version of the Perceived Restorativeness Scale (PRS; Pasini, Berto, Scopelliti, & Carrus, 2009) measuring the restorative properties of the settings on a 5-step Likert scale (scores range from 0 to 4; Cronbach’s alpha value is 0.79, indicating a good level of internal consistency and reliability), plus a single item measuring preference for settings i.e., “I like this place”; and Section 3, containing 6 items derived from Lafortezza et al. (2009), measuring the psychological and physical benefits experienced in the environment on a 5-step scale (example of items are: “Do you feel psychological benefits while visiting this place?”; “Do you feel physical benefits while visiting this place?”; “Overall, how much visiting this place makes you feel better than before?"; scores range from 0 to 4; Cronbach's alpha value is 0.92, indicating a good level of internal consistency and reliability).

## 3. Results

### 3.1. Effects of biodiversity level and green space location on perceived restorative qualities and self-reported positive outcomes

Aggregate scores were computed for the PRS and for the perceived physical and psychological benefits and well-being. A series of 2 × 2 ANOVA was conducted considering the biodiversity level (high vs. low) and location (urban vs. peri-urban) of the green areas as factors, and the aggregate benefits and well-being score and perceived restorativeness score as dependent variables. Descriptive statistics for all the dependent variables across the four cells ofthe factorial design are displayed in Table 1. Because missing values were deleted listwise when computing the aggregate measures, the participant's total number differs across the measures. In the case of the perceived restorativeness measure, the sample size in the "Low biodiversity–urban" cell is n = 169, and the total sample is N = 568. With reference to the benefits and well-being score, significant effects were detected for both "Location" [$F(1,569) = 33.62$; $p = .000$; partial eta squared = .056], with peri-urban green areas receiving higher scores, and "Biodiversity" [$F(1,569) = 24.87$; $p = .000$; partial eta squared = .042], with high biodiversity green areas receiving higher scores. The 2-way interaction was also significant [$F(1,569) = 4.95$; $p = .004$; partial eta squared = .015]. Concerning the perceived restorativeness score, significant effects were detected for both "Location" [$F(1,568) = 32.46$; $p = .000$; partial eta squared = .054], with peri-urban green areas receiving higher scores, and "Biodiversity" [$F(1,568) = 32.58$; $p = .000$; partial eta squared = .055], with high biodiversity green areas receiving higher scores. The 2-way interaction was also significant [$F(1,569) = 9.31$; $p = .002$; partial eta squared = .016]. Taken together, the effects discerned show that the level of biodiversity and the peri-urban (vs. urban) location of a green area are positively linked to selfreported benefits and perceived restorativeness. To disentangle the significant 2-way interactions detected, we examined the scores of the dependent variables within the single cells of the research design (as plotted in Figs. 2 and 3) and conducted simple post hoc comparisons. Results show that a high level of biodiversity was more strongly linked to benefits and well-being and to perceived restorativeness in the case of urban green areas, compared to periurban green areas: although significant in both cases, the effect sizes (Cohen's d, calculated from http://www.uccs.edu/~lbecker/) decreased from .64 to .19 for benefits and well-being, and from .74 to .22 for perceived restorativeness. 3.2. Effects of activities in the green area experience on positive outcomes To evaluate the effects of the different activities carried out during the "green" experience, we identified three different groups of respondents according to the main activity they reported while being in the setting. These activities were: (a) reading, talking, socializing (n = 163); (b) walking/exercising (n = 306); and (c) contemplating the setting (n = 84). Because of missing values (i.e., some of the respondents did not answered to this section of the questionnaire), the total sample size in this analysis is lower (N = 553). The activities range across an increasing level of personal involvement with the setting (or place dependency) from more socially to more environment-oriented activities. We assumed that restoration effects should be stronger for activities depending more on the restorative characteristics of the setting itself, such as contemplating, walking or exercising, as compared to activities that are relatively independent from the restorative characteristics of the setting, such as reading, talking, or meeting other people.

Consistently with our prediction, the results showed a significant effect of the main activity on the two criteria: self-reported benefits and well-being ($F(2,552) = 19.66$, $p = .000$) and perceived restorativeness ($F(2,551) = 18.6$, $p = .000$). Duncan post hoc comparisons were conducted to check whether the significant differences highlighted by the omnibus F-test are consistent with the general trend we predicted (i.e., well-being and perceived restorativeness are higher when shifting from activities that imply a lower level of involvement with the green setting, towards activities implying a higher level of involvement with the green setting). Indeed, the mean scores of well-being for “reading, talking, and socializing” ($M = 2.00$; $SD = .83$; $n = 163$) were significantly lower for alpha $< .05$ compared to “contemplating the setting” ($M = 2.40$; $SD = .88$, $n = 84$) and “walking, exercising” ($M = 2.48$; $SD = .75$, $n = 306$). These two scores did not differ from each other. Likewise, the mean scores of perceived restorativeness for “reading, talking, and socializing” ($M = 2.00$; $SD = .60$; $n = 163$) were significantly lower for alpha $< .05$ compared to “contemplating the setting” ($M = 2.29$; $SD = .60$, $n = 84$) and “walking, exercising” ($M = 2.35$; $SD = .59$, $n = 306$), which did not differ from each other. To assess the relations between length of visits to green areas, biodiversity level, perceived restorativeness, and self-reported benefits and well-being bivariate correlations were explored (see Table 2). The results show that self-reported benefits and wellbeing were significantly correlated with length of visit to green areas ($r = .15$; $p = .000$; $n = 566$), biodiversity level ($r = .22$; $p = .000$; $n = 569$), and perceived restorativeness ($r = .68$; $p = .000$; $n = 568$). Furthermore, our two main predictors (i.e., length of visit and level of biodiversity) were independent of each other ($r = .08$; $p = .06$; $n = 566$). Although very small, this marginally significant r value might suggest to test interactions between this predictors, but this is beyond the scope of the present paper. Both predictors correlated to perceived restorativeness ($r = .19$ and $.25$; $n = 565$ and $568$, respectively; $p = .000$). This pattern suggests a possible mediation process, where both length of visit and level of biodiversity influence benefits and well-being through perceived restorativeness. To test these mediation models, we used the INDIRECT procedure for SPSS, following the approach proposed by Preacher and Hayes (2008). A first model estimated the total, direct and indirect effects of length of visit to the green areas on self-reported benefits and well-being through perceived restorativeness (Fig. 4). The indirect effect of length of visit on benefits and well-being was quantified as the product ofthe ordinary least squares (OLS) regression coefficient estimating perceived restorativeness from length of visit (i.e., path “a”) and the OLS regression coefficient estimating self-reported benefits and well-being from perceived restorativeness, accounting for length of visit (i.e., path “b”). The INDIRECT procedure tested the significance of this product with 5000 bootstrap samples. The bias-corrected bootstrap-confidence interval (CI) for this parameter estimate that does not include zero indicated a significant mediation effect (Preacher & Hayes, 2008). As expected, results show that length of visit to green areas positively predicted self-reported benefits and well-being through perceived restorativeness (point estimate = 07; 95% CI = 0.03–0.11). Although significant and in the predicted direction, it is worth noting how the magnitude of this effect is rather small. A second model estimated the total, direct and indirect effects of biodiversity level on self-reported benefits and well-being through perceived restorativeness (Fig. 5). Again, the results support our mediation hypothesis showing that length of visit to green areas positively predicted self-reported benefits and well-being through perceived restorativeness (point estimate = 27; 95% CI = 0.18–0.36). Given the correlational nature of our data set, we also tested the significance for the reverse mediation path of the first model using the same procedure, i.e., from restorativeness to self-reported benefits and well-being through length of visit. Results indicate that the alternative mediation model was not significant, thus further corroborating our hypotheses. 4. Discussion This field study assessed the self-reported benefits and subjective well-being derived from visiting four diverse typologies of green spaces in different cities of Italy selected on the basis of urban forestry expert criteria. The green spaces differed in location (urban vs. peri-urban) and biodiversity level (high vs. low). Taken together, the findings confirm our hypotheses demonstrating that both the location and biological quality of green spaces are importantfactors affecting the positive outcomes of contact with nature on a daily basis. Peri-urban green areas and high biodiversity green areas are more likely to exert restorative effects on their visitors. Moreover, these two relevant factors (i.e., location and biodiversity) interact to determine the outcomes of contact with green spaces. In particular, biodiversity emerges as an important positive element for those green areas that are located within the urban system, while playing a somewhat minor role in peri-urban green areas. Looking at our findings from another point of view, we might also speculate that urban green areas are characterized by higher biodiversity, they seem to have a similar potential as peri-urban ones in exerting beneficial effects on visitors. Within this pattern it is important to take into account the activities and goals that drive individuals to visit green spaces. In agreement with our expectations, individuals that are engaged in more profound and direct interactions with green spaces are more capable of perceiving their restorative qualities and, consequently, of receiving greater benefits from the "green" experience. Consistently with these hypotheses, our study highlights a mediation role for perceived restorativeness in the relation between the natural setting experience (i.e., spending longer time periods in contact with nature, and contact with green space of a higher biodiversity level) and the benefits and well-being reported by individuals. Indeed, our findings show that spending more time within urban and peri-urban green areas leads to a greater appreciation of their restorative qualities, which results in more positive psychological outcomes. It should be noted, however, that our correlational dataset does not allow to draw definitive conclusion on the causality of this relation. Indeed, the opposite pattern is also plausible: i.e., higher perceived restorativeness may lead to longer visits. To partly rule out this alternative explanation, we tested the opposite mediation path, which was not statistically significant. Furthermore, the size of the effect we detected, albeit significant, is quite small. Therefore, in line with the recent trends in statistical testing in behavioural science, these results should be taken with caution (Cumming, 2014). A similar mediation pattern was detected linking biodiversity to perceived restorativeness and positive outcomes. The findings of our study are also relevant in terms of external validity, given the multiple areas from which the data were collected. As recently pointed out by many leading scholars in the field, a worthwhile topic for investigating psychological restoration in nature is represented by the factors that moderate the positive link between contact with nature and human well-being (e.g., Hartig, 2004; see also Hartig et al., 2011). In this regard, it is important to ascertain that not all green spaces are the same in terms of the positive outcomes they induce in their users. This consideration might hold important practical implications in the field of urban planning and management. It is important that public bodies and decision-making authorities ensure adequate functioning of large-scale protected areas and green spaces to tackle biodiversity loss globally and to protect fragile ecosystems. At the same time, guaranteeing the presence of green space with adequate biodiversity richness within the urban system is paramount to enhancing the well-being of urban dwellers (Brown & Grant, 2005). As recently noted, developing sustainable urban neighbourhoods is also a fundamental goal to promote sustainable lifestyles of urban inhabitants (e.g., Luederitz, Lang, & Von Wehrden, 2013). Our results indicate that providing high-quality green spaces within the dense urban context will likely promote individuals' appreciation of nature and foster more positive attitudes and behaviours towards nature itself, contributing to the overarching goal of creating more environmentally aware citizens. Recent investigations on how laypeople perceive and interpret the concept of biodiversity also point on the same direction, suggesting that concepts about biodiversity are related to laypeople attitudes towards biodiversity management, and how understanding this process might help to increase public support for biodiversity policies (Fischer & Young, 2007). Our study provides sound evidence that positive evaluations of urban and peri-urban natural settings and the positive outcomes deriving from contact with such settings vary as a function of their biodiversity. However, some specific limitations must be taken into consideration. First, we have to mention the use of self-reported well-being measures. Despite their good empirical reliability, these should be considered for future research along with more objective indicators. Second, it is important to take into account the origin of the selected sample, whose response to natural settings may be partially biased by daily experiences in a medium and large urban settings. In relation to this, because there were several spaces in each city that met our inclusion criteria, we shall be aware of the possibility contamination in exposure to green spaces: e.g., our respondents might have visited more than one of the parks where our survey took place. In this respect, it would be interesting to collect data on the effects of contact with nature from respondents living in small-sized urban (or completely rural) contexts. 5. Conclusions The major findings of the present study support our hypotheses that in individuals: (i) the level of biodiversity and peri-urban location positively affect self-reported benefits, well-being and perceived restorativeness;(ii) environment-oriented as opposed to socially oriented activities in restorative environments increase the perception of restorative properties and self-reported benefits; and (iii) perceived restorativeness plays a mediatory role in the relation between experience of natural settings (i.e., length of visits, activity performed, andhigher level of biodiversity) andself-reportedbenefits. An additional conclusion is the notion that various experiences in restorative environments may promote benefits to a different extent. The findings that emerge from our study on the positive role of biodiversity in promoting well-being among individuals within urban and peri-urban green spaces also suggest that the richness of species in natural environments deserve to be protected to benefit both nature as well as individuals. Our results might contribute in shedding light about the controversial relations between biodiversity of green space and human well-being (see Dallimer et al., 2012). These results can also be helpful for a healthier management of daily life settings; i.e., the arrangement and layout of urban and peri-urban forests should provide positive involvement through differentiation of areas, accessibility to and variety of activities. As a result, people would be drawn to spend longer periods of time in natural settings and be offered opportunities for deeper and more meaningful interactions with nature, thus leading to more positive outcomes. This, in the long run, might also contribute to promote sustainable urban lifestyles (Luederitz et al., 2013; Van den Berg, Hartig, & Staats, 2007). In summary, the results of this investigation support the planning management of green areas within and outside of urban contexts. Biodiversity appears to be a crucial element of urban landscape aimed at ensuring the well-being of humans and non-human living elements and, as such, should be employed to enhance the quality of urban life.

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Figures & captions

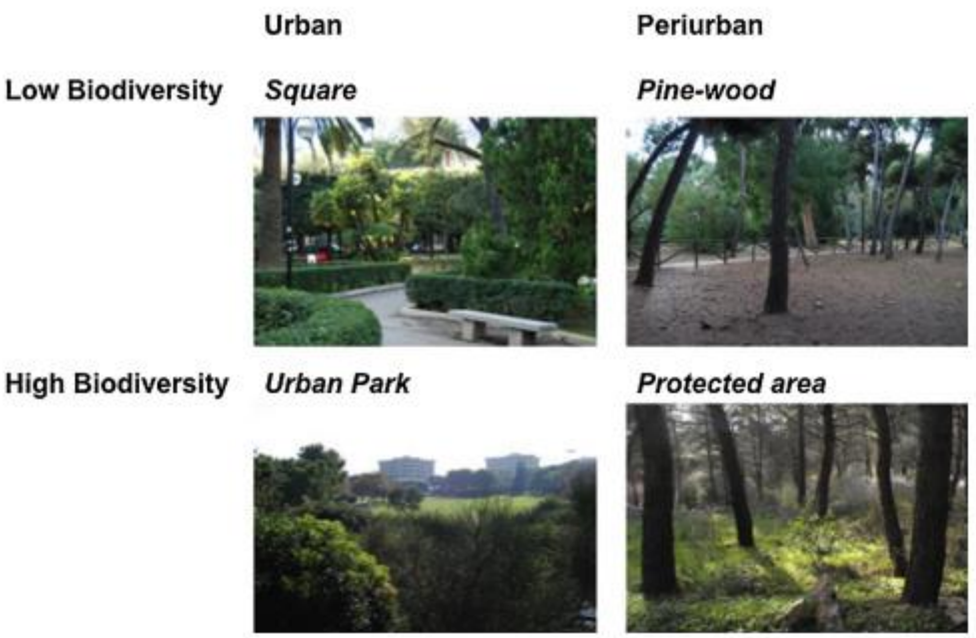


Fig. 1. Pictures of the four green area typologies selected as a function of urban vs. peri-urban location and high vs. low biodiversity (examples taken from the city of Bari).

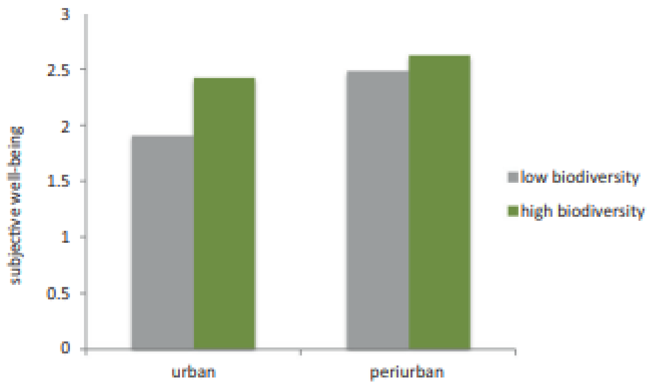


Fig. 2. Average scores in subjective well-being plotted as a function of location and biodiversity of green areas. A high biodiversity level is more strongly linked to wellbeing in urban green areas as compared to peri-urban green areas.

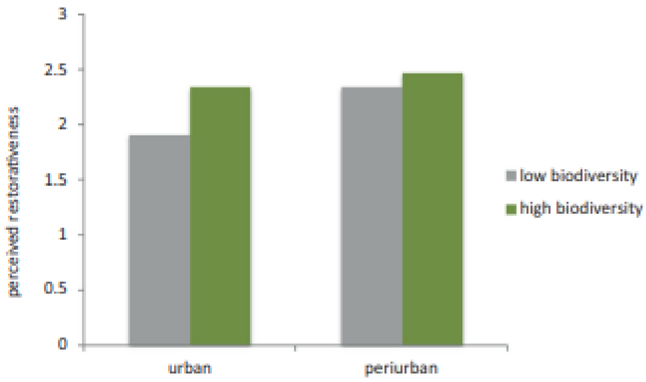


Fig. 3. Average scores in perceived restorativeness plotted as a function of location and biodiversity of green areas. A high biodiversity level is more strongly linked to perceived restorativeness in urban green areas as compared to peri-urban green areas.

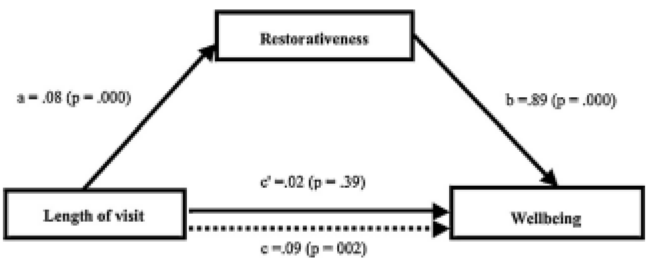


Fig. 4. Mediation analysis: length of visit to green area and perceived restorativeness predicting subjective well-being. The direct effect of length of visit to green area on well-being without accounting for restorativeness is represented by the dotted line. a, b, c and c' are unstandardized ordinary least squares regression coefficients.

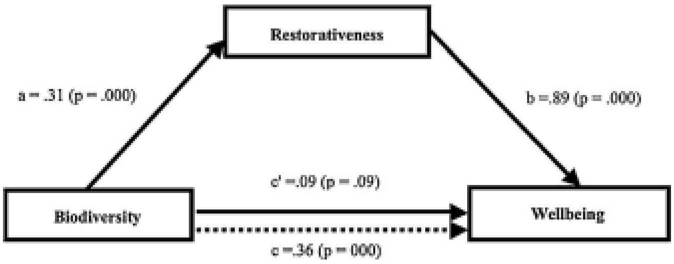


Fig. 5. Mediation analysis: biodiversity and perceived restorativeness predicting subjective well-being. The direct effect of biodiversity on well-being without accounting for restorativeness is represented by the dotted line. a, b, c and c' are unstandardized ordinary least squares regression coefficients.

Tables & captions

**Table 1**
Descriptive statistics for subjective well-being and perceived restorativeness.

| | Low biodiversity | | | High biodiversity | | |
|---|---|---|---|---|---|---|
| | Urban, *n* = 170 | Peri-urban, *n* = 120 | Total, *n* = 290 | Urban, *n* = 167 | Peri-urban, *n* = 112 | Total, *n* = 279 |
| Benefits and well-being | 1.91 (.79) | 2.48 (.73) | 2.15 (.81) | 2.42 (.83) | 2.62 (.71) | 2.50 (.78) |
| Restorativeness | 1.91 (.61) | 2.34 (.54) | 2.09 (.62) | 2.34 (.55) | 2.47 (.61) | 2.39 (.58) |

*Note*: Scale range, 0–4. For restorativeness, *n* = 169 in the "Low biodiversity–urban" cell and *N* = 568. Standard deviations are in parentheses.

**Table 2**
Descriptive statistics and bivariate correlations among length of visit to green areas, perceived restorativeness and self-reported benefits and well-being.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Length of visit | / | | | |
| Biodiversity | .08 | / | | |
| Restorativeness | .19$^*$ | .25$^*$ | / | |
| Well-being | .15$^*$ | .22$^*$ | .68$^*$ | / |
| *M* (SD) and *N* | 2.29 (1.1) 566 | 1.5 (.50) 569 | 2.24 (.62) 568 | 2.32 (.82) 569 |

*Note*: Length of visits was expressed in hours and minutes and recoded into a scale ranging from 1 to 4. Biodiversity ranges from 1 (low) to 2 (high). Perceived restorativeness and self-reported benefits and well-being, range 0–4.

$^*$ *p* = .000.