



Nature-based solutions to promote human resilience and wellbeing in cities during increasingly hot summers



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ABSTRACT

Air temperatures are increasing because of global climate change. A warming phenomenon strongly related to global climate change is the urban heat island. It has been shown that the hotter temperatures occurring in cities during the summer negatively affect human wellbeing, but little is known about the potential mechanisms underlying the relationships between hotter temperatures, cognitive psychological resources and wellbeing. The aim of the present research is to understand whether, and how, spending time in urban green spaces, which can be considered as a specific kind of Nature-Based Solution (NBS), helps the recovery of cognitive resources and wellbeing. The main hypothesis is that contact with urban green is related to wellbeing through the depletion of cognitive resources (i.e., ego depletion). Moreover, we expected that individuals showing higher scores of ego depletion also report a higher estimate of the maximum temperature reached during the summer. The results of a survey (N = 115) conducted among visitors to Parco Nord Milano, a large urban park located in Milan (Italy), point out that people visiting the park during the summer show a higher level of wellbeing as well as a lower level of ego depletion. A mediation analysis shows that visiting urban green spaces is associated with greater wellbeing through less ego depletion. Our results also point out that, as expected, people showing a higher level of ego depletion tend to overestimate the maximum air temperature. Implications for future studies and applied interventions regarding the role of NBS to promote human wellbeing are discussed.

1. Introduction

The interaction of climatic factors and anthropic activities within cities can generate the so-called Urban Heat Island (UHI), a micro-meteorological phenomenon that consists in increasing temperatures of both the atmosphere and surfaces in cities compared to their surroundings as a consequence of changes in the surface energy balance (Geiger et al., 2009; Oke, 2002; Stewart and Oke, 2012).

Since the end of the Little Ice Age, conventionally established in 1850, global temperatures have been on the rise generating a macro-scale phenomenon referred to as Global Warming (GW) (IPCC, 2013). More specifically, during the 1901–2010 time-period the Northern and Southern hemispheres grew warmer by 1.12 °C and .84 °C, respectively (Jones et al., 2012), while the temperature in Europe increased by about 1 °C (European Environmental Agency, 2015). At the same time, both daily maximum and minimum temperatures have tended to increase as a consequence of increasing urbanization and the intensification of the UHI phenomenon in present-day societies (e.g.,

Oleson et al., 2015). If this phenomenon is positive in the cold period, reducing winter peak mortality (Gasparrini et al., 2015; Healy, 2003), it is quite negative in the summer with a significant increase in mortality due to heat waves. Should the increase in global temperatures continue as predicted by the IPCC (2013), the problem of containing the UHI during the summer months will become more relevant in the future. This should drive public authorities to adopt ad-hoc structural policies.

Currently, the UHI is one of the main threats to human health and wellbeing in European cities (Sanesi et al., 2011), and the associated hot temperatures in urbanized settlements are becoming a significant public health challenge (Dolney and Sheridan, 2006; Hajat and Kosatky, 2010; Xu et al., 2012). This challenge is particularly relevant considering that over 70% of Europe's population lives in cities and is expected to increase to more than 80% by the middle of the 21st century.

Cities around the world have attempted to mitigate the UHI by designing green areas and urban parks following an approach that has been labeled as Nature-Based Solutions (NBS, see European

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Commission (2015) for more details). The NBS approach offers sustainable solutions to cope with the challenge of climate change in urban areas. NBS can reduce greenhouse gas emissions and help to conserve and expand carbon sinks through the related ecosystem services. NBS can include several strategies, such as the conversion of abandoned land into urban farms and community gardens, or the regeneration of post-industrial sites through the bioremediation of toxic soils and subsequent transformation into green spaces (European Commission, 2015).

1.1. Heat exposure and wellbeing

Previous research suggests that heat exposure affects a wide range of physical and psychological health outcomes, such as respiratory and cardiovascular diseases, skin and eye damage due to high ultraviolet radiation exposure, decreased subjective and emotional wellbeing, increased interpersonal aggression and diminished satisfaction for the quality of life (e.g., Connolly, 2013; Lucas and Lawless, 2013; Noelke et al., 2016).

Heat exposure has also been extensively investigated as a major source of psychological distress both as a direct stressor and a cumulative factor compounding the effects of other environmental stressors such as noise, pollution and crowding (see Evans and Cohen (2004) for a review). For example, fatigue (i.e., a subjective sense of weakness that represents a relevant bioalarm for human health), passivity and low energy are commonly associated with thermal discomfort in hot summers and could represent a mechanism by which heat exposure affects people's subjective wellbeing (e.g., Fujii et al., 2015; Noelke et al., 2016). Exposure to heat and high temperatures can therefore have a series of negative consequences at the psychological level as well, exacerbating the effects of other stressors which, in turn, are associated with a series of negative consequences such as behavioral after-effects, negative spillover effects, learned helplessness, or diminished self-efficacy (Evans and Cohen, 2004).

Based on this integrated theoretical framework, we argue that urban heat exposure could also be linked to a specific aspect of self-regulation in human behavior such as ego depletion. Described as a general sense of mental fatigue, low cognitive energy and depleted self-control resources (Baumeister et al., 1998), ego depletion could play a relevant role in the relationship between summer visits to urban green spaces and residents' wellbeing.

1.2. Ego depletion and its consequences

Empirical evidence has shown that self-control provides an array of benefits across various domains, such as healthy lifestyles, longevity, occupational success, avoidance of crime and violence, satisfying close relationships, resistance to addictions, positive emotional outcomes and reduced social prejudice (Baumeister et al., 1994; Daly et al., 2014; Deary et al., 2010; Finkel et al., 2009; Gottfredson and Hirschi, 1990; Mischel et al., 1988; Moffitt et al., 2011; Muraven, 2008; Shoda et al., 1990; Tangney et al., 2004).

Baumeister and colleagues have proposed a model explaining the processes of regulation failure and active self-regulation, the so-called "Limited Strength Model of Self-Control" (e.g., Baumeister et al., 2007, 1998). This model conceives active self-control functioning as a muscle, which may deplete its energy after repeated use; thus, Baumeister and colleagues posited that self-control draws on a limited resource that after repeated use may result in a state of *ego depletion*. It refers to a state of diminished self-regulatory resources in which self-regulation is curtailed because of low mental energy. A state of depletion may compromise higher-order cognition such as decision making, reasoning or risk perception and may lead individuals to rely more on impulsive and automatic processes in response to environmental stimuli (Marcora et al., 2009; Vohs et al., 2016). These mechanisms underlying the relationship between ego depletion and higher-order cognition shed light on our understanding of human social behavior, since they show that

"depletion reduces top-down control, so that behavior is guided increasingly by external cues via automatic processes" (Baumeister and Vohs, 2016, p. 93). In other words, a reduced capacity for top-down control enhances automatic processes which, in turn, engender biased judgments and invalidate reasoning processes. As a consequence, depletion negatively influences human wellbeing with implications for the aggregate levels of psychological distress in society at large. These mechanisms might be exacerbated during the summer due to extreme heat exposure.

When a state of drained resources occurs, subsequent attempts at self-regulation typically fail. Thus, a state of depletion fosters unsustainable habits and impulsive and uninhibited behavior (Giacomantonio et al., 2014; Kahan et al., 2003; Vohs and Faber, 2007; Vohs and Heatherton, 2000). For example, Muraven and colleagues showed that in a state of ego depletion, people are prone to increase their consumption of alcohol (Muraven et al., 2002). Gailliot and Baumeister showed that depleted people respond to sexual urges to a greater degree (Gailliot and Baumeister, 2007). Previous research on the behavioral responses to a state of ego depletion showed that ego depletion leads to overeating, overspending, prejudice, aggression and passivity (e.g., DeWall et al., 2007; Sheehan and Lau-Barraco, 2016). The tendency for passivity and behavioral inertia likely stems from the need to recuperate depleted mental and physical energies. In fact, previous studies have shown that replenishing lost self-regulatory resources is indeed served by rest and/or sleep (Frieze et al., 2011; Tyler and Burns, 2008), which are activities that could be typically compromised during a hot summer in addition to and in synergy with the UHI. Nevertheless, it has been pointed out that recovery from a state of ego depletion is possible through specific enjoyable activities that can replenish consumed resources (e.g., Baumeister et al., 1998; Baumeister and Vohs, 2016). Some authors have suggested, for example, that contact with nature could be considered as an activity replenishing burned resources (Chow and Lau, 2014). Thus, according also to theories and empirical research on restorative environments, we argue that visiting urban green areas serves as a mechanism that might replenish the lost self-regulatory resources of urban residents (e.g., Baumeister and Vohs, 2016; Chow and Lau, 2014).

1.3. The present study

A number of environmental studies have shown that contact with nature positively affects human wellbeing (Carrus et al., 2013, 2015; Laforteza et al., 2009; Noelke et al., 2016; Scopelliti et al., 2016). Psychological research has also pointed out that exposure to nature counteracts ego depletion, thus replenishing mental and energy resources consumed through a previous demanding task (Baumeister and Vohs, 2016; Chow and Lau, 2014). Nonetheless, little is known about the mechanisms underlying the relationships between contact with nature, ego depletion and human wellbeing. Thus, the main aim of the present research consists of understanding whether and how ego depletion might play a role in the relationship between visiting urban natural areas, such as Parco Nord Milano (PNM), and wellbeing. Drawing on previous research (e.g., Baumeister and Vohs, 2016; Carrus et al., 2013, 2015; Chow and Lau, 2014) we tested three hypotheses: (a) a higher frequency of visits to PNM is associated with a lower level of ego depletion; (b) a higher level of ego depletion is associated with a lower level of wellbeing; and (c) a higher frequency of visits to PNM is related to less ego depletion which, in turn, is related to greater wellbeing. The theoretical account behind our hypotheses is that contact with nature might replenish the cognitive resources and energy consumed during hot summer days and, thus promoting wellbeing. To test our hypotheses, we measured people's wellbeing using a well-established Wellbeing Index recommended by the WHO (WHO-5; Bonsignore et al., 2001). Moreover, we carried out the present study at the end of the 2015 summer season, a period that is more likely to deplete individuals' psychological resources because of the hotter air

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