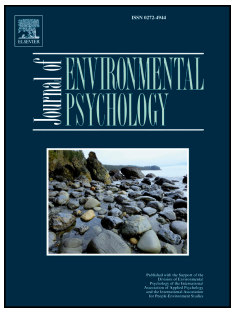

Nature can get it out of your mind the rumination reducing effects of contact with nature and the mediating role of awe and mood

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NATURE CAN GET IT OUT OF YOUR MIND

The rumination reducing effects of contact with nature and the mediating role of awe and mood

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BRIEF EMPIRICAL NOTE

NATURE CAN GET IT OUT OF YOUR MIND

The rumination reducing effects of contact with nature and the mediating role of awe and mood

ABSTRACT

Evidence has been found that contact with nature may reduce rumination in healthy individuals living in urban environments. This paper aims at i) testing whether one may replicate previous findings using a shorter duration of nature exposure, and ii) explore the possibility that a shift in attention away from self (notably induced by the emotion of awe), leading to mood restoration, may mediate such nature-rumination relationship.

We showed that a walk as short as 30-min in an urban park significantly reduced ruminative thinking in healthy participants, whereas a 30-min walk along a city transect devoid from natural elements did not. Also, we showed that the "walk in nature" significantly reduced negative mood and elicited more awe and more externally oriented thoughts than the "walk in city". Our mediation analysis did not show any direct effect of contact with nature on rumination levels. Instead, it showed that the more awe participants experienced while walking, the more negative affect was reduced, which then lead to reduced rumination. Also, our mediation analysis showed that nature can affect rumination via mood improvement only and irrespective of awe.

This study adds to previous research supporting the so-called "psychological ecosystem services" and calls for additional efforts aimed at exploring the extent to, and mechanism(s), by which contact with nature may affect rumination, notably in clinical populations.

KEYWORDS

Rumination; Nature; Awe; Mood; Mediation

1. INTRODUCTION

Rumination is one of the most maladaptive cognitive emotion regulation strategies and a key vulnerability factor of mental illness (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). This persistent and repetitive pattern of self-focused thinking, which includes analyzing reasons for negative mood and failure (Nolen-Hoeksema, 1991), is known to impair thinking, problem solving, and instrumental behavior (Watkins & Brown, 2002), while also predicting substance abuse (Skitch & Abela, 2008), eating disorders (Rawal, Park, & Williams, 2010), and self-harm (Borrill, Fox, Flynn, & Roger, 2009). Since negative mood leads to recurrent analysis and self-focus, and ruminative self-focus exacerbates negative mood (Nolen-Hoeksema & Morrow, 1993), high ruminators tend to get trapped in a reciprocal loop with negative mood and rumination sustaining each other (Watkins & Mason, 2002). Research also shows that rumination can sustain stress-induced increases in inflammation and cortisol, which adds to the clinical importance of interventions aimed at reducing rumination (Zoccola, Figueroa, Rabideau, Woody, & Benencia, 2014). In this respect, it was proposed that finding effective ways to reduce rumination might be most urgent in urbanized environments (Bratman, Hamilton, Hahn, Daily, & Gross, 2015). Indeed, when compared to rural areas, social problems and environmental stressors are generally more prevalent in urbanized environments (Peen, Schoevers, Beekmam, & Dekker, 2010).

Urbanization progresses around the globe and its potential to negatively impact on mental health is increasingly acknowledged (see Turner, Nakamura, & Dinetti (2004), Srivastava (2009), and Marques & Lima (2011)). At the same time, data are also accumulating of the beneficial psychological effects that may ensue from contact with nature (Bratman, Hamilton, and Daily (2012), Hartig, Mitchell, De Vries, and Frumkin (2014), and Fong, Hart, and James (2018)). A number of studies have found that spending time in nature, or just passively watch natural scenes, can lead to significant mood improvements (e.g., van den Berg, Koole, & van der Wulp, 2003; Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009) and even to changes in rumination. Bratman, Daily, Levy, and Gross (2015) randomly assigned healthy participants to a 50-min walk in either a natural or an urban environment and showed that contact with nature lead to significantly greater decreases in rumination. This was confirmed in a follow-up study

involving 90-min walks (Bratman *et al.,* 2015a). In both studies, it was proposed that nature may affect rumination by eliciting a shift in attention away from self that pulls individuals away from the tendency to engage in negative self-descriptive patterns of thought. This would lead to mood restoration and to subsequent reduced rumination. Accordingly, studies have shown that nature exposure can elicit awe, an emotion defined as a state of wonder and amazement that directs attention away from self and towards the environment (Keltner & Haidt, 2003; Shiota, Keltner, & Mossman, 2007). It's also been found that awe experiences elicited by nature exposure can serve as a pathway though which mood is improved via contact with nature (Joy & Bolderdijk, 2015). To date, however, and despite the burgeoning in research on awe - showing, notably, an association with more adaptive physiological profiles and increased wellbeing (e.g., Stellar *et al.,* 2015; Gordon *et al.,* 2017) - no attempt has been made to assess the involvement of this emotion (and resulting mood improvements) in the pathway linking contact with nature and rumination.

Following from the above, the aims of this study were two-fold: i) testing whether one could replicate previous findings that contact with nature can reduce rumination using a shorter exposure (30 min); and ii) testing a serial mediation model in which contact with nature elicits awe, which restores mood, eventually reducing rumination levels.

2. METHODS

2.1 Participants

Minimum sample size was determined using power analysis with G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007), with the following design specifications: $\alpha = .05$; $(1-\beta) = .95$; effect size $f = 0.25$; statistical test = ANOVA repeated measures, within-between interaction; number of groups: 2; number of measurements: 2. The estimated sample size was 54. We oversampled and recruited 62 adult participants using electronic adverts circulating on social media. Exclusion criteria included current or past diagnostic of neurologic or psychiatric disorders, and any physical disability or constraint that could be aggravated by, or impede, walking. Inclusion criteria included age above 18 years, normal or corrected-to normal vision, residing in an urban environment, and being familiar with the urban park in this study.

Participation included an initial telephone interview clarifying study eligibility, and the actual experimental session. Participants who fulfilled the inclusion criteria, received a link to an online questionnaire assessing demographic and trait data (see below). After that, the experimental session was scheduled. Participation involved no monetary compensation.

2.2 Experimental conditions

Participants were randomly allocated to one of two walking conditions matching each other with respect to starting point, duration (30 min) and distance (2 km) (Figure 1).
The "walk in nature" involved a predefined transect in the garden of Palácio de Cristal located next to the Institute of Biomedical Sciences of the University of Porto (Portugal) where this study took place. This garden is a mosaic of small gardens that extend away from the street and opens up to balconies over the river Douro. Along the transect, the dominant trees were Camellias, Laurels, Maples, Sycamores, Oaks, and Tilias.
The "walk in city" involved a transect devoid from natural elements, bordering the streets near the University.
Though all walks took place near the University, participation in this study was not limited to students.

Figure 1. Walking transects in this study. Images show what participants typically see in these transects.

2.3 Measures

Participants' general tendency to ruminate and nature relatedness (trait data) were assessed using, respectively, the Perseverative Thinking Questionnaire (PTQ; Ehring *et al.*, 2011) and the short version of the Nature Relatednedss Scale (NR-6; Nisbet & Zelenski; 2013). Pre- to post-walking changes in rumination and mood were assessed using the Brief State Rumination Inventory (BRSI; Marchetti, Mor, Chiorri, & Koster, 2018) and the PANAS (Crawford & Henry, 2004), respectively. Awe and externally oriented thoughts were assessed following previous studies (Shiota *et al*., 2007; Joye & Bolderdijk, 2015): participants rated, on a scale from 1 (not at all) to 7 (very much), the extent to which they felt awed (as defined in Keltner & Haidt (2003)) during the experimental condition (i.e., walking). Participants also rated on a similar scale from 1 to 7 the extent to which they had several externally oriented thoughts (Table 2). Finally, participants rated how challenging and tiring walking was (also on a scale from 1 to 7).

2.4 Experimental design and procedure

Upon arrival at the laboratory, participants provided informed consent and completed the PANAS and the BRSI questionnaires. They were then instructed about the walking condition they were allocated to. During walking, participants followed a researcher who kept a steady pace (4 km/h) along the transect. The same researcher accompanied all participants. Participants were told not to interact with the researcher in any way while walking, to turn off their mobile phones, and to focus on their surroundings. Participants returned to the laboratory and completed the PANAS and the BRSI again. Ratings of awe and externally oriented thoughts were collected at this point.

Importantly, all experimental sessions were scheduled around the same time of the day, i.e., between 3 pm and 5pm. This was done so to control for potential time of day effects (i.e., endogenous diurnal patterns in mood; Beute & Kort, 2018).

Ethical statement

This study was approved by the CHUP/ICBAS Ethics Committee (2019/CE/P003(281/CETI).

2.5 Statistical analysis

Baseline differences between conditions were inspected using independent sample *t*-tests. Pre-post walking changes in BRSI and PANAS scores were analyzed using repeated measures ANOVAs (within subject factor: "time" (before and following walking); between subject factor: "condition"). Condition pairwise comparisons were conducted with Bonferroni correction. Differences between conditions in awe and externally oriented thoughts were analyzed using independent sample *t*-tests. Statistical analyses were conducted using Statistical Package for Social Sciences (SPSS) for Windows version 22 (IBM Statistics). Assumptions of all the statistical tests were checked as appropriate. An alpha value of $p < .05$ was used.

3. RESULTS

Participants' characteristics at baseline are shown in Table 1. No significant baseline differences between conditions were observed for any of the study variables.

Table 1. Participants' characteristics at baseline. Normally distributed variables are expressed as mean (*SD*), non-normally distributed variables are expressed as median (min-max), and categorical variables were expressed as %. Environmental data respecting each condition are also shown.

	Walk in city (n=30)	Walk in nature (n=32)	Overall (N=62)	*p*	Cohen's *d*
Participants					
Age (years)	23 (18-59)	26 (19-68)	25 (18 - 68)	.922	.025
Gender (% of female)	66%	67%	66%	1.000	.000
PTQ score	33 (10)	37 (10)	35 (10)	.082	.449
NR-6 score	4 (3 - 5)	4 (3 - 5)	4 (3 - 5)	.100	.424
Positive affect score	28 (13 - 38)	30 (12 - 38)	29 (12 - 38)	.183	.343
Negative affect score	11 (10 - 18)	13 (10 - 24)	13 (10 - 24)	.099	.425
BRSI score	290 (151)	320 (161)	306 (156)	.452	.192
Environmental data					
Temperature (ºC)	19 (12 - 27)	20 (11 - 27)	19 (11 - 27)	.970	.010
Wind speed (km/h)	13 (6 - 24)	13 (10 - 16)	13 (6 - 24)	.088	.352

Atm. pressure (hPa)	1024 (1000 - 1030)	1025 (999 - 1029)	1025 (999 - 1030)	.735	.086

We found a significant interaction effect of Time and Condition on participants BRSI scores (F (1, 60) = 8.583, p = .005, $\eta 2_{p=}$ .125). Participants in the "walk in city" condition showed no changes in rumination from baseline (pre-walk: M = 290.17, 95% CI [233.29, 347.04]; post-walk: M = 298.37, 95% CI [225.43, 371.30]; p = .899; Cohen's d= .271) (Figure 2). As opposed, rumination in participants allocated to the "walk in nature" was significantly reduced (pre-walk: M = 310.13, 95% CI [265.06, 375.19]; post-walk: M = 196.94, 95% CI [126.32, 267.56); p < .001; Cohen's d= 3.764) (Figure 2).

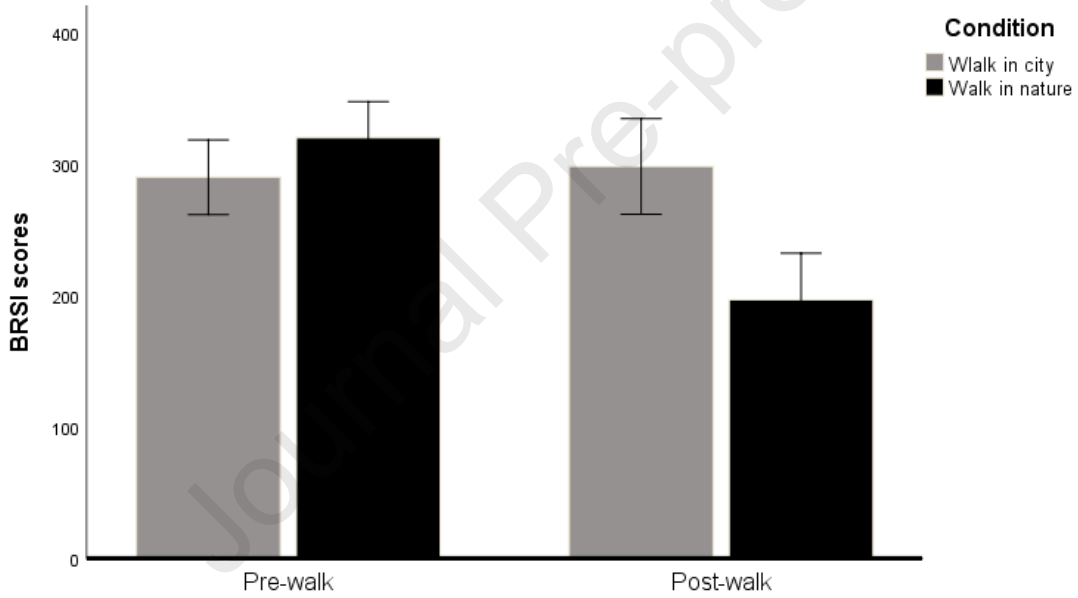

Figure 2. BRSI scores for participants in each experimental condition, at baseline and post-walk. Bars represent the mean ± SE.

We also found a significant interaction effect of 'time' and 'condition' on participants positive (F (1, 60) = 7.532, p = .008; $\eta 2_{p=}$ .112) and negative affect scores (F (1, 60) = 17.976, p < .001; $\eta 2_{p=}$ .231). Participants in the "walk in nature" condition showed no change in positive affect from pre- to post-walking (pre-walk: M = 28.97, 95% CI [26.45, 31.48]; post-walk: M = 30.91, 95% CI [27.93, 33.88]; p = .139, Cohen's d= 1.520) (Figure 3). Contrastingly, positive affect was significantly reduced in participants

allocated to the 'walk in city' condition (pre-walk: M = 26.53, 95% CI [23.94, 29.13]; post-walk: M = 22.83, 95% CI [19.76, 25.90]; p = .031, Cohen's d= 2.287) (Figure 3).

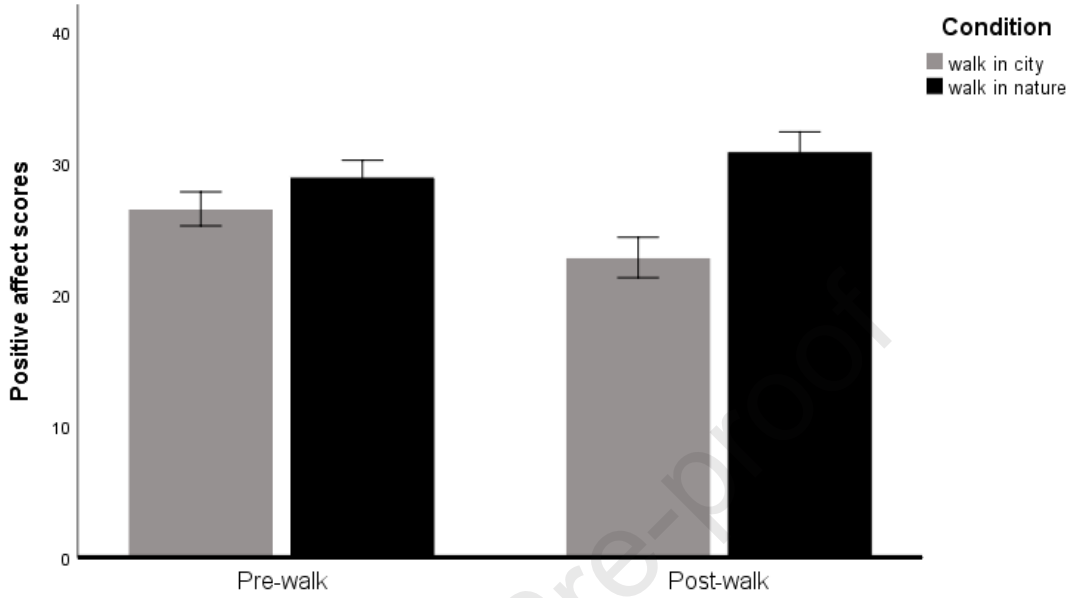

Figure 3. Positive affect scores for participants in each experimental condition, at baseline and post-walk. Bars represent the mean ± SE.

Negative affect showed an opposite pattern. It significantly decreased from pre- to post-walk in participants in the "walk in nature" condition (pre-walk: M = 13.84, 95% CI [12.67, 15.02); post-walk: M = 11.09, 95% CI [9.93, 12.26]; p <.001; Cohen's d = 6.275; Figure 4), but did not significantly change in participants in the "walk in city" condition (pre-walk: M = 12.43, 95% CI [11.22, 13.64]; post-walk: M = 14.07, 95% CI [12.87, 15.27]; p = .082; Cohen's d = 2.052; Figure 4).

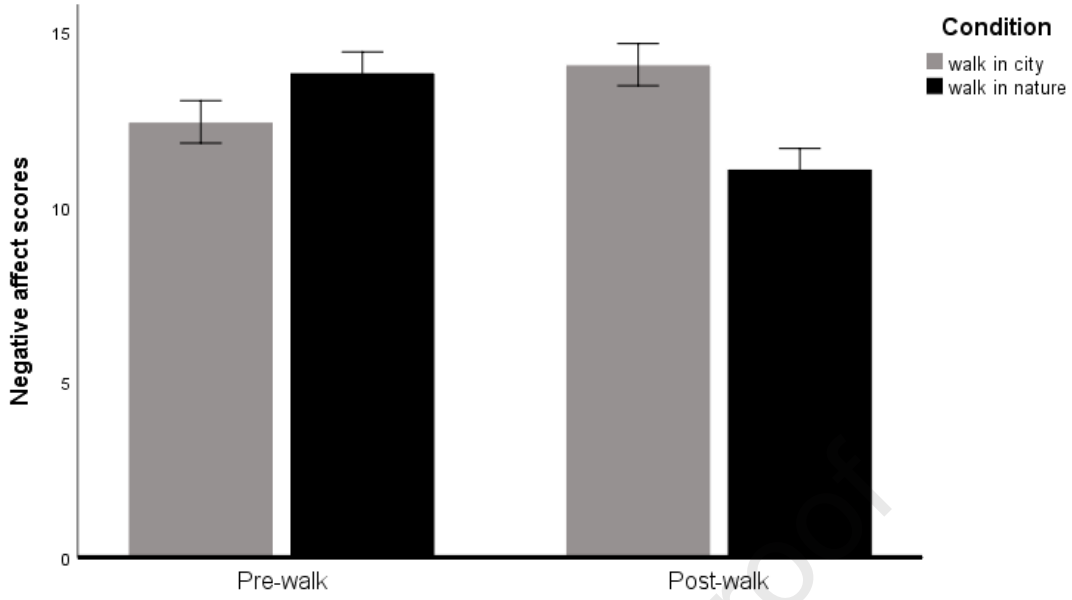

Figure 4. Negative affect scores for participants in each experimental condition, at baseline and post-walk. Bars represent the mean ± SE.

Significant correlations were found between ratings of awe and those of externally oriented thoughts, with the exception of feelings of smallness and insignificance (Table 2).

Table 2. Overall Spearman correlations between participants' ratings of awe and externally oriented thoughts.

		Appraisals during walking				
		Small	**Presence**	**Concerns**	**Connection**	**End**
Awe	Coefficient	.127	.623	.716	.705	.588
	p	.327	**<.001**	**<.001**	**<.001**	**<.001**
	95% CI	[-.127, .364]	[.443, .755]	[.568, .819]	[.553, .811]	[.397, .730]

Small: "I felt small or insignificant"
Presence: "I felt the presence of something greater than myself"
Concerns: "I was unaware of my day-to-day concerns"
Connection: "I felt closely connected to the world around me"
End: "I did not want the experience to end"

Participants in the 'walk in nature' condition reported significantly higher ratings of awe and externally oriented thoughts than participants in the "walk in city" condition

(Table 3). No differences between conditions were found regarding how challenging and tiring each experimental condition was rated (Table 3).

Table 3. Participants ratings of awe and externally oriented thoughts while walking. Data are shown as medians (Min-Max).

	Walk in city	**Walk in nature**	***p***	**Cohen's *d***
Awe	3 (1-6)	4 (2-6)	**.001**	.905
Felt small or insignificante	3 (1-5)	2 (1-6)	.906	.027
Felt presence of something greater than self	2 (1-6)	5 (1-7)	**<.001**	.948
Unaware of day-to-day concerns	3 (1-7)	5 (1-7)	**.003**	.811
Felt connected with the world around me	3 (1-7)	6 (1-7)	**.001**	.901
Did not want the experience to end	3 (1-7)	5 (1-7)	**.008**	.695
Challenging	2 (1-6)	3 (1-6)	.902	.029
Tiring	2 (1-6)	2 (1-6)	.952	.150

Mediation analysis

To explore the potential mechanism underlying the nature-rumination relation observed in this study, a serial mediation model was tested (Figure 2). We followed a mediation procedure based on nonparametric resampling known as bias-corrected bootstrapping, and used the PROCESS macro for SPSS (Hayes, 2013). In our model, BRSI scores for after walking were entered as the outcome variable, experimental condition was entered as the predictor variable (using walk in city as the reference condition), awe scores were entered as mediator 1, and negative affect scores for after walking were entered as mediator 2. Trait measures (PTQ and NR-6) as well as BRSI and negative affect scores for before walking were entered as covariates.

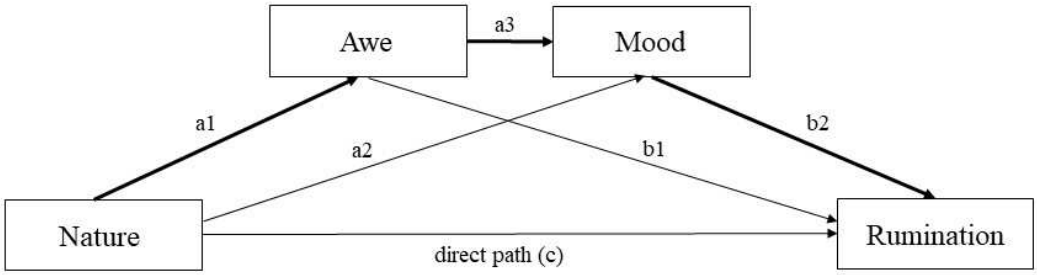

Figure 5. Proposed mediation model in which contact with nature has an impact on rumination through a causal path linking two mediators, awe and mood (path a1a3b2), or through indirect paths via only one mediator: awe (path a1b1) or mood (path a2b2). The direct path (c) represents the direct effect after controlling for the two mediators.

According to contemporary thinking, a bootstrap confidence interval for specific effects through a mediator or sets of mediators that does not include zero is sufficient to support a claim of mediation (Hayes, 2009). Obtained bootstrap confidence intervals in this study are shown in Table 4, along with effect coefficients. Results support two causal chains linking nature to rumination: one via awe and mood (path a1a3b2 in Figure 5), another via mood only (path a2b2 in Figure 5). As also shown in Table 4, no significant direct effect of exposure to nature on rumination was found (direct path in Figure 5); nor was the indirect path via awe alone (path a1b1 in Figure 5) significant.

Table 4. Results of the serial mediation analysis.

Independent variable	**Outcome variable**	**Effect coefficients**	**95% CI**
Condition (walk in city as ref.)	Awe	1.00	[.35, 1.66]*
Awe	Negative affect	-.84	[-1.47, -.21]*
Negative affect	Rumination	20.49	[6.23, 34,76]*
Condition (walk in city as ref.)	Rumination		
	- Direct effect	-20.50	[-115.22, 74,22]
	- Indirect effect via awe	-20.19	[-67.28, 12.79]
	- Indirect effect via mood	-49.57	[-101.66, -6.04]*
	- Indirect effect via awe and mood	-17.30	[-47.02, -.77]*

Note: N=62, 5000 bootstrap samples. Confidence intervals that do not include zero are marked with an asterisk.

4. DISCUSSION

Obtained results support previous findings in that contact with nature can elicit awe, uplift mood and (indirectly) reduce rumination in healthy individuals living in urban settings. The way rumination was assessed in this study is worth noting. As opposed to the Rumination Reflection Questionnaire used in previous studies by Bratman et al. (2015a, b), the BRSI here employed assesses a state - and not trait - that is dependent on situational cues (Marchetti *et al.*, 2018). Moreover, the BRSI is more related to brooding (which is the more maladaptive form of rumination) than to reflection (which has been associated with positive outcomes; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). This lends further weight to the reduction in rumination here observed. The lack of differences between groups with respect to participants' baseline traits, participants levels of connectedness with nature, and characteristics of the environment also strengthens the state-level findings of this study.

The fact that a walk as short as 30-min succeeded in reducing BRSI scores is to be highlighted from a self-management intervention perspective as it is recognized that clinicians should support patients with health promoting activities that are easy to implement even on most busy days (e.g., Boyd & Braun, 2007). Also relevant from an intervention perspective is the fact that the walk in the park benefited participants over and above the exercise itself, thus supporting recommendations for "green walking" (e.g., Whitham & Hunt, 2010). Indeed, the rhythm of walking was matched between conditions.

A common criticism to previous studies suggesting that contact with nature may impact human wellbeing is that removing individuals from habitual surroundings and exposing them to a new context can have psychophysiological effects that are unrelated to the natural elements of the newer context (as discussed in Bratman et al. (2012)). In the present study, all participants were familiar with and visited the urban park on a regular basis. Thus, obtained results cannot be attributed to some "novelty effect". Instead, the possibility remains that obtained findings may be about the particular sensorial experience in the park, including visual stimulation and sound reduction. In this respect,

interesting insights might be provided if future research replicating the research methodology could be planned to include objective assessments of how busy (with cars and/or people) the different walks are.

Supporting the idea that contact with nature engenders the type of positive distraction away from self that can uplift mood and reduce rumination (Bratman *et al*., 2015a), our mediation model revealed a serial effect in which the more awe participants experienced while walking, the higher the reduction in negative affect, which, in turn, appeared to disengage participants from ruminative thinking. Importantly, the indirect effect of nature on rumination via awe alone was not found significant. As opposed, a significant, indirect effect via mood - and irrespective of awe - was observed, which, interestingly, appeared stronger than the serial effect via awe *and* mood. These results may have at least two possible readings. First, mood restoration may play a more important role than awe in the path linking contact with nature to rumination – which would be relevant from an intervention perspective considering that awe is typically triggered by grand natural landscapes such as impressive mountain scenery (Joy & Bolderdijk, 2015). Second, mood restoration may not be dependent on the elicitation of awe – which would be in line with Ulrich's stress reduction theory that contact with nature can very rapidly and unconsciously uplift mood, perhaps by blocking negative thoughts and feelings, and foster a reduction in physiological arousal (Ulrich *et al*., 1991).

Importantly to notice, the suggested importance of mood in the path linking contact with nature to rumination appears in line with the "mood as input theory" (Watkins & Mason, 2002). As highlighted in Fisak, Kissinger-Knox, and Cibrian (2018), this theory predicts that persistence on a perseverative task, such as ruminative thinking, is strongly influenced by negative mood, which signals a lack of achievement or unsuccessful completion of the task leading the individual to perseverate, or ruminate, for an extended period of time. Mood restoration, therefore, might be crucial for individuals to disengage from ruminative thinking. Also important to notice is the fact that no direct effect of condition on rumination was found in the mediation analysis. Thus, this is the case of full or complete mediation wherein contact with nature exerts an impact on rumination via the mediators. This means that the effect of nature on rumination is dependent upon the mediators, and perhaps mood most particularly.

This study has some limitations adding to the relatively small sample size. First, we only tested healthy individuals and did not experimentally induce rumination. Rather, we expected participants to enter the study with a somewhat elevated level of

ruminative thinking resulting from living in an urban setting (as in the study by Bratman et al. (2015a)). It is thus uncertain whether the same pattern of results would emerge with higher levels of rumination at baseline. One way for future studies to address this issue would be by testing clinical populations. Second, we probed for awe by using only one item. This was because, to our knowledge, there is no validated instrument to assess this complex emotion (as already pointed out in Joy & Bolderdijk, 2015). However, the correlations here reported between awe and externally oriented thoughts suggest that we accurately capture this emotion. Third, we tested only for the immediate effects of one single "dose" of nature. No considerations can thus be made on whether the observed reduction in rumination might persist (nor for how long) following contact with nature. Future research could now address this issue, and notably monitor physiological markers linked with rumination on the medium and long term.

Despite its limitations, this study adds to existing research and gives further weigh to the claim that feasible investments in access to natural environments might yield important benefits for the mental capital of cities and nations (Bratman *et al.*, 2015a). Also, this study supports the idea that efforts in teaching citizens about the benefits of engaging with green spaces for their mental health might prove particularly fruitful from both health promotion and ecological perspectives. Though many individuals intuitively believe that nature is beneficial for their mental health, evidence has been found showing that people underestimate the degree to which even brief contact with nature may benefit their wellbeing (Nisbet & Zelenski, 2011). In this respect, teachers and primary care providers may be ideally positioned to be leaders in the dissemination of findings from research in Environmental Psychology. Acknowledging such findings may motivate people taking action in health promotion and restoration through the active use (and protection) of natural environments, thus contributing to humans' reconnection with nature.

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BRIEF EMPIRICAL NOTE

NATURE CAN GET IT OUT OF YOUR MIND

The rumination reducing effects of contact with nature and the mediating role of awe and mood

HIGHLIGHTS

We replicated previous findings that contact with nature can reduce rumination.

A walk as short as 30 min in an urban park was sufficient for effects to be observed.

Awe and mood were identified as mediators in the path linking nature to rumination.

The elicitation of awe might not be essential for rumination to be reduced.