

## WalkOut: Effects of a forest vs. urban walk (#27365)

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### 1) Have any data been collected for this study already?

No, no data have been collected for this study yet.

### 2) What's the main question being asked or hypothesis being tested in this study?

The main goal of this study is to examine influence of exposure to urban environment and nature environment on stress and its neural correlates.

The following research questions will be addressed:

Does exposure to nature and urban environment has an effect on:

- stress level
- working memory capacity
- rumination and
- mood (positive and negative affect)?

We expect decrease in stress level, rumination and negative affect, as well as increase in working memory capacity and positive affect, after exposure to nature environment relative to urban environment.

### 3) Describe the key dependent variable(s) specifying how they will be measured.

The main construct of interest is stress level, that will be observed with neural, behavioural and physiological measures.

In order to examine the neural correlates of stress, brain activity will be measured in three different fMRI tasks: Montreal Imaging Stress Task (MIST), Fearful faces Task (including supra- and subliminal presentation of fearful faces), Social-evaluative Threat (SET) task). Except for the SET task, the tasks will be measured before and after the exposure to nature/urban environment. We think that the SET cannot be repeated in this short time frame, therefore it will only be assessed after the walk. We will focus on stress-related regions such as amygdala, anterior cingulate cortex and dorsolateral prefrontal cortex (1, 2) as regions of interest. We use a pre-post-test design to control for the baseline stress response before the intervention. On the other hand by stressing participants before the intervention, the study design may actually comply with the theoretical assumption that nature exposition shows its restorative power mostly when the individual is in a stressed state (Attention Restoration Theory by Kaplan & Kaplan (3) and Stress Reduction Theory by Ulrich (4)).

Our behavioural measure of stress is the Perceived Stress Scale (rephrased for the moment), filled out by participants before and after the exposure to the nature/urban environment.

Physiological measures of stress are galvanic skin response and heart rate, measured using a portable device that participants wear on their wrist during the walk in in the nature/urban environment.

Other dependent variables are:

- working memory capacity (measured with Digit Span task – backwards)
- self-reported level of rumination (measured with rumination portion of the Reflection Rumination Questionnaire and by means of three questions administered directly after the fMRI resting state assessment)
- and mood (measured with Positive and Negative Affect Schedule).

These variables will be collected at pretest and posttest.

1. Haddad L, Schafer A, Streit F, Lederbogen F, Grimm O, Wust S, Deuschle M, Kirsch P, Tost H, Meyer-Lindenberg A. Brain structure correlates of urban upbringing, an environmental risk factor for schizophrenia. *Schizophr Bull.* 2015;41:115-122.
2. Lederbogen F, Kirsch P, Haddad L, Streit F, Tost H, Schuch P, Wust S, Pruessner JC, Rietschel M, Deuschle M, Meyer-Lindenberg A. City living and urban upbringing affect neural social stress processing in humans. *Nature.* 2011;474:498-501.
3. Kaplan R, Kaplan S: The experience of nature. A psychological perspective. NY, Cambridge University Press; 1989.
4. Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, Zelson M. Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology.* 1991;11:201-230.

### 4) How many and which conditions will participants be assigned to?

Two conditions: urban environment (city walk) and nature environment (forest walk).

### 5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.

On the acquired fMRI data we will first perform whole brain analyses using GLM. Additionally we will focus on amygdala, anterior cingulate cortex and dorsolateral prefrontal cortex as regions of interest.

Behavioural data will be analyzed using two-way ANOVA with time as a within-subject factor (before vs. after the walk) and environment as a between-subject factor (urban vs. nature environment).

Physiological stress measures (heart rate and galvanic skin response) will be analyzed using one-way ANOVA with environment as a factor (urban vs. nature

environment).

Demographic variables, data regarding experience with nature and urban environments, perceived restorativeness scale, as well as subjective experience during and after the walk are also acquired, that will serve as covariates in the analyses.

**6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

We will exclude participants if they are 2.5 SD above or below the mean.

**7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.**

65 participants. A sample size estimation using G\*Power resulted in the need of 54 participants to enable a medium effect size. We decided to acquire a few more participants to make sure that potential drop-outs due to movement in the scanner etc. will not reduce our sample size below the number that we decided on.

**8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)**

Secondary analyses:

We do set out to extend on the findings published by Bratman (5) showing a reduction of subgenual prefrontal activity and rumination after a nature walk (using ASL) using our resting state fMRI data.

As an exploratory analysis we will look at short-term changes in brain structure, since a recent study suggests that such rapid changes may exist (6).

5. Bratman GN, Hamilton JP, Hahn KS, Daily GC, Gross JJ. Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proc Natl Acad Sci U S A*. 2015;112:8567-8572.

6. Mansson KNT, Cortes DS, Manzouri A, Li TQ, Hau S, Fischer H. Viewing Pictures Triggers Rapid Morphological Enlargement in the Human Visual Cortex. *Cereb Cortex*. 2019.