EXPLORATION OF NEURAL CORRELATES OF RESTORATIVE ENVIRONMENT EXPOSURE THROUGH fMRI

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Neuro-scientific assessments are relevant to determine the influence of the environment on human wellbeing (1). Little is known regarding neural correlates of the central nervous system processes that results from restorative environment exposure.

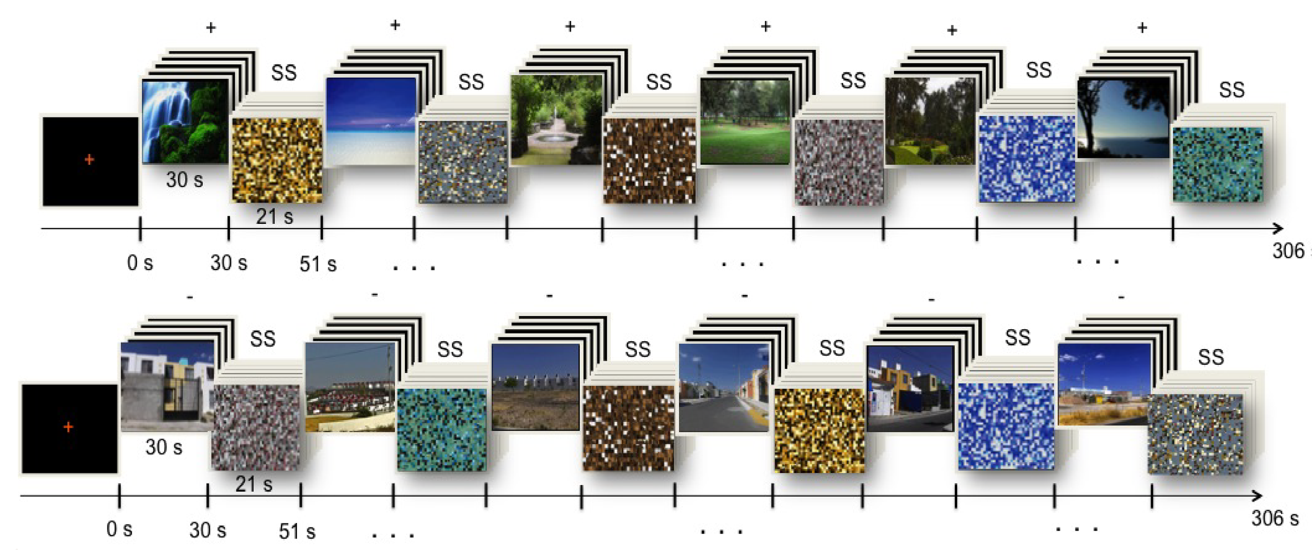

Fig. 1. Schematic representation of the experimental design for one fMRI session. Note: (+) High restorative images and (-) low restorative images. Each block (+ or -) lasted 30 seconds and each stimulus was presented for 6 seconds. SP Scrambled Pictures. Images of built and natural landscapes alternated with highly scrambled versions. Each block SP block lasted 21 seconds and each stimulus was presented for 3 seconds.

METHODS

Participants: Sixteen right-handed subjects (males, mean age 33.63 years; SD 11.63) with normal vision and no history of neurological or psychiatric illness. Written informed consent was obtained.

Visual stimuli and psychological measures:

a) *Stress manipulation.* Exposure to a frightening movie: Faces of Death #1 (4.54 min).
b) *Exposure to restorative environment* with high (HRP; e.g. natural environments) and low restorative potential (LRP; e.g, built without nature). (2)
in a five minutes block design fashion (see Fig. 1)
c) *Restorative experience*. Self-reported stress (stress list-SL) (3)

Behavioral data analyses. Subjective pre and postscan ratings were compared by a non parametric test of ANOVA with three factors: baseline measure (SL1); pretest measure (SL2, after viewing stressful movie, before viewing restorative images) and post-test measure (SL3).

fMRI Image Acquisition and Data Analysis

Data were acquired with GE 3.0T MR750 scanner using echo planar sequence imaging (repetition time - TR 3000 ms) blood oxygen level dependent (EPI-BOLD), field of view 256 mm, 64 x 64 matrix. All the functional images were transferred to off line workstations and analyzed using FSL (V4.1.9, FMRIB, OXFORD, UK).

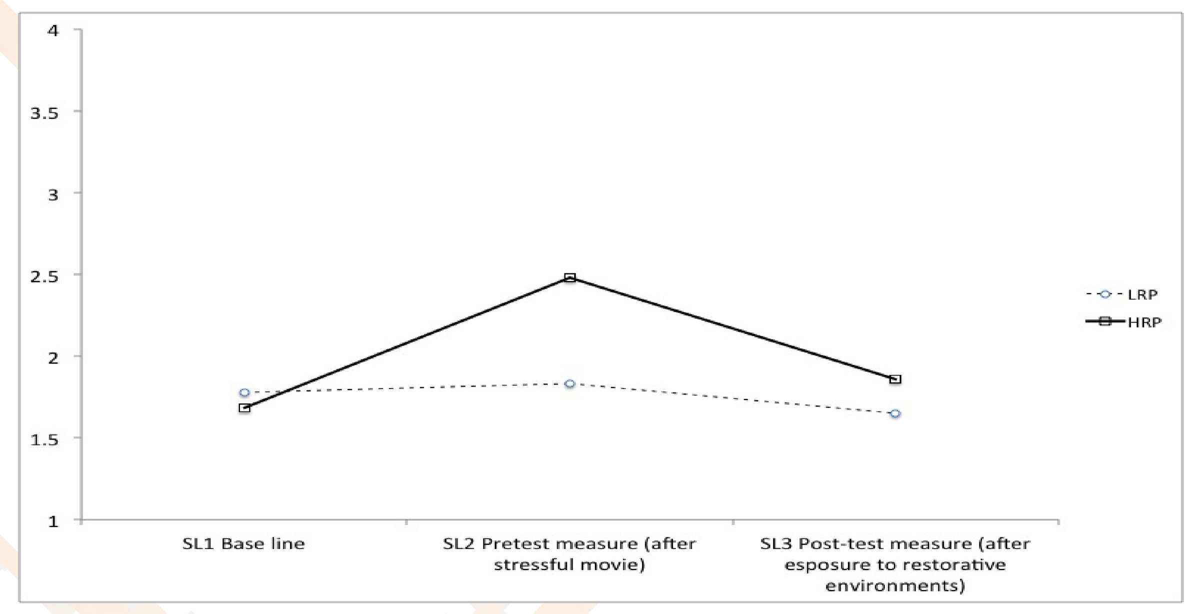

Fig. 2. Measures of stress level between the tree condition in LRP and HRP conditions.

RESULTS

Stress recovery

According to a Friedman test, stress ratings for the initial state (SL1); pretest measure (SL2) and post-test measure (SL3) differed significantly (Chi Square =10.75; gl 2, $p < 0.05$) among the tree conditions in the HRP condition (Fig. 2). This findings suggest a process of stress recovery of participants. No significative differences were found between the tree conditions in the LRP manipulation.

FMRI data

Table 1 summarises the areas activated in association with the exposure to HRP environments, LRP and the common areas of activation (See Table 1 and Figures 3 and 4).

Table 1. Activated brain regions associated during the view of restorative pictures

Location	BA	R/L	x	y	z
a) HRP exposure[a]					
Cuneus	18	R	24	-76	30
Parahippocampal Gyrus	28	L	-26	-12	-28
Parahippocampal Gyrus	35	R	26	-14	-28
Precuneus	7	R	20	-56	60
Inferior Occipital Gyrus	19	L	-38	-76	-4
a) LRP exposure[b]					
Cuneus	19	R	-28	-86	36
Inferior Occipital Gyrus	19	R	40	-72	-4
c) HRP and LRP					
Middle frontal gyrus	9	R	37	43	34
Parahippocampal Gyrus	19	L	-18	-42	-4

Note: a (n=8); b (n=8). Coordinates refer to the Montreal Neurological Institute stereotaxic space.
HRP= High restorative potential; LRP = Low restorative potential

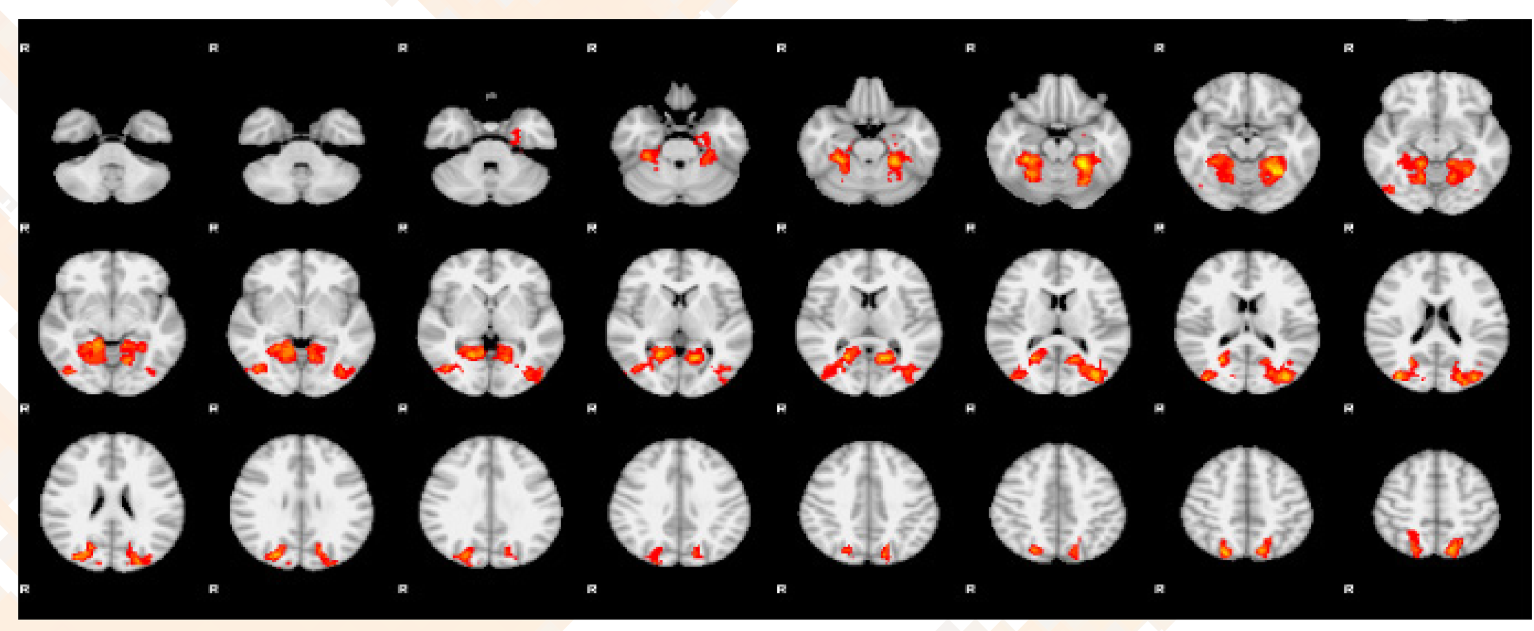

Fig. 3. The brain areas activated during the exposure to *HRP* environment

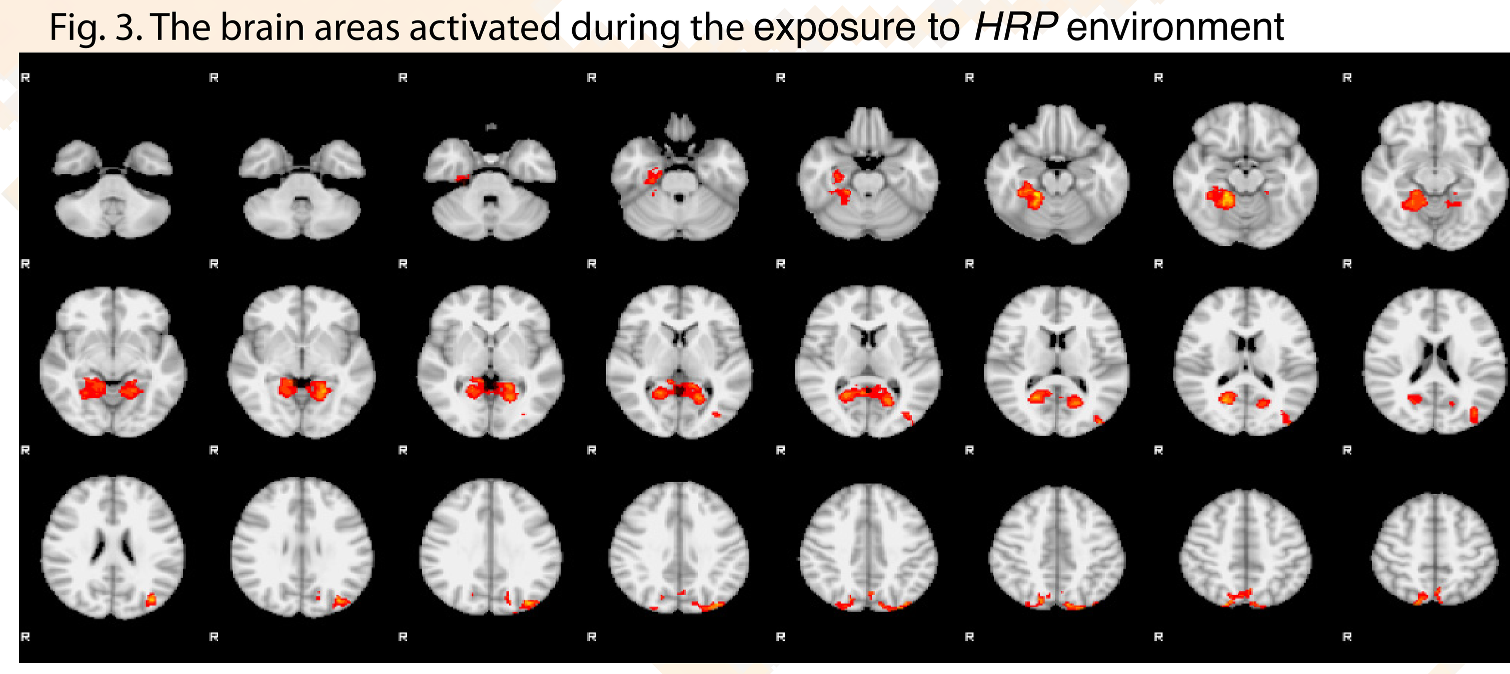

Fig. 4. The brain areas activated during the *exposure to LRP* environment

Significant increases in neural activation associated with the HRP exposure were found in the occipital cortex with foci in the rigth cuneus and left inferior occipital gyrus. Parietal lobe: right precuneus. Temporal lobe: bilateral parahipocampal gyrus. In the LRP condition neural activations were found in the occipital cortex: right cuneus and right occipital gyrus. Common areas of activation include the right frontal occipital gyrus and the left parahipocampal gyrus.

DISCUSSION

This study evaluated cerebral areas of the human brain associated with HRP and LRP picture stimulation using a 3.0 Tesla fMRI. Subjective pre and post-scan ratings shows a restorative influence of natural environments (HRP) over built settings (LRP). Posterior occipital visual processing areas, such as V2 (BA 18/ B19) exhibit activation when emotional and neutral conditions are contrasted (4).The results could also imply increased visual attention in response to higher perception of restorative potential.The precuneus, has been implicated in high-level cognitive functions, including episodic memory, self-related processing, processing intentions related to the self and aspects of consciousness (5). This area have been found active during the viewing of natural scenarios (6) The parahippocampal gyrus becomes highly active when human subjects view passively topographical scene stimuli such as images of landscapes, cityscapes, or rooms (i.e. images of "places") (7). High activity in the parahippocampal cortex may be experienced as pleasurable and activity in this area may subserve the spontaneous selection of visual experience (8). Inferior occipital gyrus play an important role in emotional cognitive processes and are thought to be sensitive to the approach withdrawal emotion specifically.

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