

## Neural Activation Differences between Viewing Rural and Urban Images

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**Purpose:** Although human habitats have changed dramatically since the age of the caveman, we still seem to prefer more natural environments [1]. There is a great deal of research showing that participants experience greater stress and poorer psychological functioning after experiencing urban environments to more natural ones [2]. These comparative studies provide little information on the mechanisms behind this observation. To research this further the following study presented rural and urban images to participants in an fMRI scanner. The images shown were previously rated on attractiveness [1], so that responses to images matched and unmatched on attractiveness could be analysed.

**Methods:** Twenty-eight adults were included in the study. Forty rural and urban photograph images [1] were used as these have been rated on attractiveness by participants in a previous study [1]. These 40 images were presented randomly in one of two orders. See Figure 1 for a description of the activation paradigm.



Figure 1. The activation paradigm presented for viewing still photographs of rural and urban environments. Secs: seconds.

The stimuli were presented to participants in a 1.5 T Philips Gyroscan scanner with an active shielded magnet. During the entire stimulus presentation T2-weighted functional images were continuously acquired with 39 contiguous transverse slices 3.5 mm thick with a 0.2 mm gap; repetition time (TR) 3 seconds; echo time (TE) 45 ms; volume acquisition time (TA) 2.923 seconds; flip angle 90°; field of view: 230 x 230mm; 64 x 64 within-plane matrix. After the stimuli presentation a T1-weighted anatomical image was acquired from each participant with a resolution of 0.9 x 0.9 x 0.9 mm, taking approximately 3.5 minutes. Functional images were analysed using SPM8 software; a suite of MATLAB functions and subroutines with some externally compiled C routines. After pre-processing data was analysed to identify brain areas with increased BOLD signal activity whilst viewing urban to rural images and vice versa. This was repeated for images matched on attractiveness ratings. Brain activation was quantified using a whole-brain analysis with a dependent samples t-test ( $p < .001$ ) with a cluster size of 10 voxels and no corrections made for multiple comparisons.

### Results:

Results indicate that there are brain regions with significant additional activation to urban as opposed to rural image viewing (Figure 2). When images were matched on attractiveness ratings, the amount of activation following urban compared to rural image viewing decreased, although it was not completely removed. There was also additional activation of the insula (Figure 3). In contrast, no significant activation was seen following rural relative to urban image viewing.

### Discussion:

The relative activation patterns seen following urban and rural image viewing supports the prediction of Juricevic et al. [3] and research by Wilkins [4] [5] that during urban image viewing the brain needs to use more resources to process information. The general decrease of activation, when viewing urban relative to rural images that are matched for attractiveness suggests that image attractiveness mediates the activation differences and that to some extent features of the images are influencing the activation differences. This is also in line with the predictions of Ulrich [6]. It is unclear at this stage what these features are, although previous research suggests that it may be image familiarity [7] or deviation from the properties of natural images [3] [5]. This study in combination with previous literature supports using natural spaces to reduce stress and cognitive demand in response to urban environments.

### Conclusion:

This study provides support for anecdotal evidence that the brain processes rural and urban environments differently, and that processing urban environment requires greater exertion. As attractiveness seems to partially measure the factor/s contributing to greater neural activity in response to urban environments, further research should focus on factors relating to this to better understand the mechanism by which the brain processes and responds to urban and rural environments.

### References:

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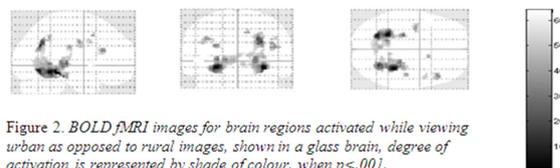


Figure 2. BOLD fMRI images for brain regions activated while viewing urban as opposed to rural images, shown in a glass brain, degree of activation is represented by shade of colour, when  $p < .001$ .

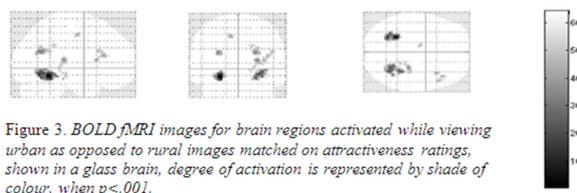


Figure 3. BOLD fMRI images for brain regions activated while viewing urban as opposed to rural images matched on attractiveness ratings, shown in a glass brain, degree of activation is represented by shade of colour, when  $p < .001$ .