Brain-to-brain synchrony in urban spaces: brains in the cities

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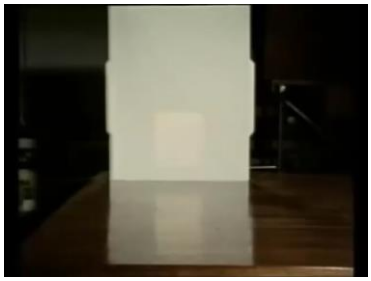
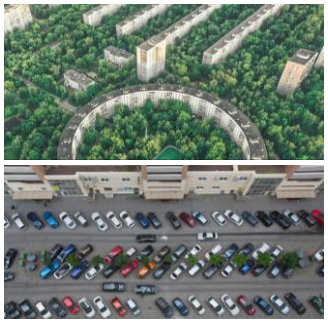
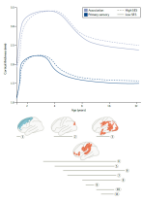
Blakemore & Cooper (1970)



Blakemore & Cooper (1970)



Associations between socio-economic status (SES) and cortical thickness.



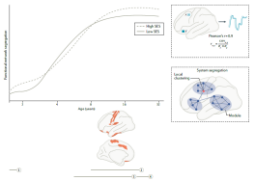
Socio-economic status (SES). A multidimensional construct, SES is typically measured at the household level (for example, parental income, education or occupation) or the neighbourhood level (for instance, neighbourhood crime rate, poverty levels or median income).

Blue indicate negative relationships between socio-economic status (SES) and cortical thickness.

Red indicate positive relationships between SES and cortical thickness.

Tooley et al., 2021

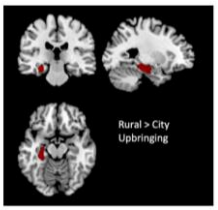
Associations between socio-economic status (SES) and functional brain network segregation.



Red indicate SES-associated differences in functional network segregation, with adolescents from higher-SES backgrounds showing stronger positive associations between age and segregation.

Tooley et al., 2021

Brain structure and habitat

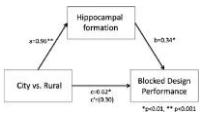


106 (14-year old) adolescents: (i) raised in rural areas and (ii) exclusively lived in cities.

Voxel-based morphometry revealed a group difference in left hippocampal formation (Rural > City), which was positively associated with cognitive performance in a spatial processing task.

Kühn et al., 2020

Brain structure and habitat



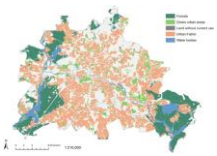
Moreover, significant group differences were observed in spatial processing (Rural > City).

A mediation analysis revealed that hippocampal formation accounted for more than half of the association between upbringing and spatial processing.

Block Design: the Wechsler intelligence scale for children (WISC-IV) (Wechsler, 2003) and the Spatial Working Memory Task from the Cambridge Neuropsychological Test Automated Battery (CANTAB) battery.

Kühn et al., 2020

Brain structure and habitat

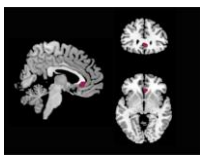


341 elderly residents of Berlin

Results reveal a significant positive association between the coverage of forest and amygdala integrity.

Kühn et al, 2017

Brain structure and habitat



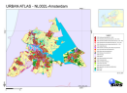
Blue = significant negative correlation with Urban Fabric

Red = significant correlation with Urban Green

A magnetic resonance imaging (MRI) session consisting of 341 older adults.

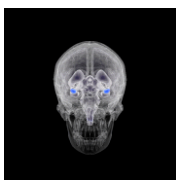
The land use data was taken from the European Urban Atlas, provided by the European Environment Agency.

A association between Urban Fabric coverage, Green coverage and grey matter volume in the ventral medial prefrontal cortex.

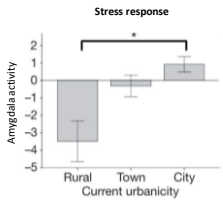


Kühn et al., 2021

Brain activity and habitat



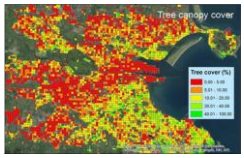
Current city living was associated with increased amygdala activity to social stress



Lederbogen et al., 2011

Residents of Ballsbridge, Dublin, are 20 times more likely to have a tree on their street than residents of the northern suburbs.

In Germany, the Netherlands, Portugal, low incomes, low levels of education and high unemployment reduce access to green spaces (Wüstemann and Kalisch, 2016; Schüle et al., 2017; de Vries et al., 2020; Hoffimann et al., 2017; Rehling et al., 2021).



WHO Europe

Mental fitness and habitat

Meta-analysis of data (2010) showed that the urbanization of the territory by 39% is associated with an increase in emotional disorders, by 21% with an increase in the risk of anxiety.

Depression ~1% among the Amish (Egeland and Hostetter, 1983)

Depression in the US as a whole ~15% (Riolo et al., 2005)

Mental fitness and habitat

+10 trees ➡ Health perception ≈ Additional 10 000 dollars ≈ Younger by 7 years

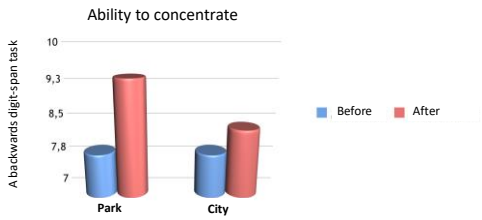
Kardan et al., 2015

Mental fitness and habitat

Measurement of the ability to concentrate (38 students) before and after a 50 min walk in the park Ann Arbor Arboretum

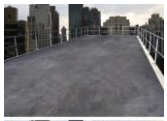
Berman et al., 2008

Mental fitness and habitat



Berman et al., 2008

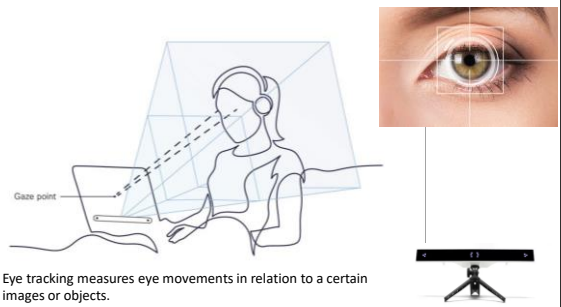
Mental fitness and habitat



During the break, half the participants were randomly allocated to view (40-second) a city scene with a "concrete roof", while the other half viewed the same city scene with a "green roof".

Participants who briefly viewed the green roof made significantly lower omission errors, and showed more consistent responding to the Sustained Attention Task compared to participants who viewed the concrete roof.

Lee et al., 2015



Eye tracking measures eye movements in relation to a certain images or objects.

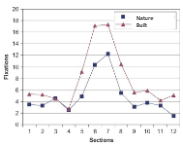
Stimuli

Regions of Interest (ROIs)

- The more people fixate on greenery, the more positively they evaluate shared courtyards.
- The more people fixate on parking lots, the less positively they evaluate shared courtyards.
- Green zones and parking lots differentially affect the preferences of people who own cars and those who do not.

Kerimova et al., 2022

Differential cognitive processing of habitats



Eye movements related to photos of Built spaces were characterized by greater exploration and a greater number of fixations compared to Green spaces, though viewing time was the same.

Berto et al., 2008

Differential cognitive processing of habitats

urban scene | old city scene | nature scene

A lower number of fixations while perceiving nature scenes than urban scenes.

It indicated difficulty in interpreting the urban scenes.

Franěk et al., 2018

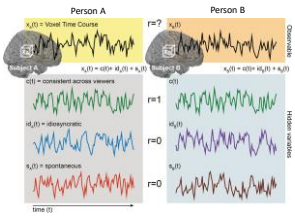
Brain activity IN habitat

- Natural environments robustly increase the power of alpha activity in the EEG (Chang et.al., 2008; Grassini et. al. 2019; Roe et. al., 2013; Ulrich, 1981).
- Mobile or stationary EEG recordings suggested that brain activity in green urban spaces indeed favors stress reduction and attention restoration (Aspinall et. al., 2015; Lin et al., 2020; Grassini et. al., 2019).






The logic of ISC analysis.



Brain activity is a mixture of three components: a consistent stimulus-evoked component (green), an idiosyncratic stimulus-evoked component (blue) and stimulus-unrelated idiosyncratic or noise component (red).

The relative proportion of these components determines the observed ISC.

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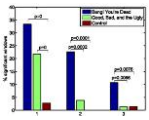
The EEG ISC can be interpreted as an index of audience engagement (Dmochowski et al., 2012) as 'emotionally laden attention'.

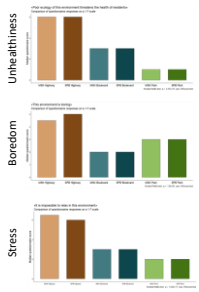



Jacek P. Dmochowski

Our study

- 30 subjects, (10 males), aged 19-47
- eight videos (five minutes each) — six videos of urban environments and two control videos: a *highway*, *boulevard* and city *park* in two different cities
- 64-electrode cap.
- Inter-subject Correlation Analyses. Correlated component analysis (CorrCA) was implemented to calculate ISCs for each video clip (for details, see Dmochowski et al., 2012).

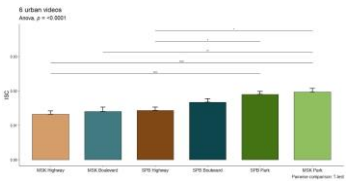

Representative frames of the urban walks.



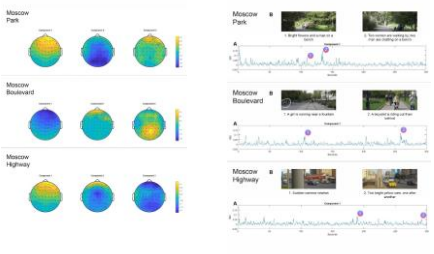
The mean evaluation ratings of environmental quality for six urban environments (videos).

Overall, in the current study participants rated parks as the most relaxing and least ecologically risky urban environment as compared to highways and boulevards.

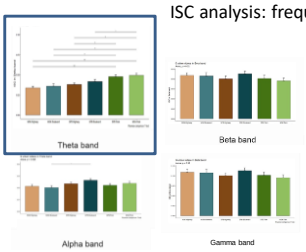
ISC analysis: average similarity across brain activity



ISC analysis: transient events



ISC analysis: frequency bands



For parks the strongest ISC was in the delta range.

It that been suggested to reflect the most evolutionary ancient and phylogenetically preserved cortical circuits particularly involved in basic motivation and reward (Knyazev, 2012).

Furthermore, delta activity can inhibit or amplify sensory input and play a role in efficiently encoding the stimulus (Schroeder et al., 2008; Handel and Haarmeier, 2009).

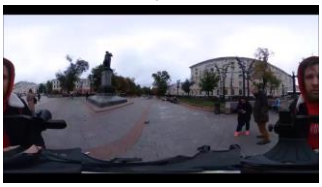
Summary

- We found that average similarity across brain activity was particularly strong during observation of parks as compared to observation of highways and boulevards.
- Such stronger intersubject brain synchronization indicates increasing similarity of mental states across individuals and stronger environmental engagement in green urban spaces.
- Parks increased intersubject synchronization particularly in the delta band that reflects the most evolutionary old and phylogenetically preserved cortical activity.
- Our results suggest that during urban walks in busy boulevards and highways people's attention is distracted, as indicated by a weaker brain synchronization between individuals. It may lead to cognitive fatigue.

Further direction: habitats & social decisions

- Children growing up in the least green urban areas tend to score higher on risk-taking than urban children in greener areas (Flouri et al., 2022).
- In a field experiment, passers-by who just walked across a park were more likely to help confederates who accidentally dropped a glove on the ground, than passers-by who were tested before entering the park (Guéguen et al., 2016)
- Compared to sitting in a windowless laboratory room, sitting in a park boosted feelings of interconnectedness (Neil et al., 2019).
- Incidental exposure to nature in the lab, by looking at pictures of nature instead of pictures of urban environments enhance prosociality (Weinsteinet al., 2009).
- Exposure to nature may increase cooperation, and, when considering environmental problems as social dilemmas, sustainable intentions and behavior. (Zelenski et al., 2015)

3D



Thank you for your attention