Urban Mind: Using Smartphone Technologies to Investigate the Impact of the Urban Environment on Mental Health in Real Time

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Nomad Projects
Using machine learning to optimise treatment in individual patients

Training Phase:

Group 1 (relapse) → Pattern Classifier → Discriminating Pattern
Group 2 (no-relapse) → Pattern Classifier

Testing Phase:

New Patient → Pattern Classifier → Group 1 or Group 2?
Phytology
In 2014, 50% of the global population resided in urban areas.

66% of people will live in cities by 2050.
More than half of the world's population now lives in cities, making the creation of a healthy urban environment a major policy priority. Cities have both health risks and benefits, but mental health is negatively affected; mood and anxiety disorders are more prevalent in city dwellers and the incidence of schizophrenia is strongly increased in people born and raised in cities. Although these findings have been widely attributed to the urban social environment, the neural processes that could mediate such associations are unknown. Here we show, using functional magnetic resonance imaging in three independent experiments, that urban upbringing and perinatal living have dissociable impacts on social evaluative stress processing in humans. Current city living was associated with increased amygdala activity, whereas urban upbringing affected the perigenital anterior cingulate cortex, a key region for regulation of amygdala activity, negative affect and stress. These findings were regionally and behaviorally specific, as no other brain structures were affected and no urbanicity effect was seen during control experiments involving cognitive processing without stress. Our results identify distinct neural mechanisms for an established environmental risk factor, link the urban environment for the first time to social stress processing, suggest that brain regions differ in vulnerability to this risk factor across the lifespan, and indicate that experimental interrogation of epidemiological associations is a promising strategy in social neuroscience.

Urbanization, a process that started in North America and Western Europe but is now mainly occurring in developing nations, is a major socio-ecological change confronting mankind. By 2050, 69% of humans will live in urban areas. Although city dwellers, on average, are wealthier and receive improved sanitation, nutrition, contraception and health services, including social defeat and chronic social stress, might constitute such a factor. Consequently, many authors have proposed that social stress processing in the urban environment underlies the greater risk for mental illness, and contributes to the manifestation of these disorders in adults. To test experimentally the hypothesis that urban living and upbringing modulate neural processing of acute social evaluative stress, we studied the neural responses of healthy German volunteers undergoing such stress during functional magnetic resonance imaging (fMRI). We confirmed our findings in a second study using a different social stress paradigm and then tested for cognitive specificity by assessing the effect of urbanicity on brain activation during cognitive processing without stress. Importantly, our subjects did not have a mental disorder nor were they at high risk for one; the link to these illnesses from the environmental risk factor that we studied is established by the epidemiological evidence discussed earlier.

In our first (discovery) study, we used the Montreal Imaging Stress Task (MIST®), a social stress paradigm where participants solve arithmetic tasks under time pressure. Difficulty was varied adaptively to keep success rates—usually presented on a 'performance scale'—at between 25-40%. Study investigators provided further negative feedback after each test segment through headphones. Subjective stress levels were measured before and after the session using a visual analog scale, and effects of the MIST on salivary cortisol, heart rate and blood pressure were recorded repeatedly. Urbanicity was quantified as follows: city with more than 100,000 inhabitants (3); town with more than 10,000 inhabitants (2); and rural area (1). For urban upbringing, these numbers were multiplied by the number of years living in the area up to age fifteen and added. Thirty-two participants with rural as well as urban upbringing and labelling entered the final analysis (Supplementary material).
Tendency to view urbanisation as a mental health challenge...
• What specific factors within the urban environment affect mental health?
• What are the underlying mechanisms through which these factors affect mental health?
• How do these factors interact with the sociodemographic background and lifestyle of the individual?
Using smartphone technologies: The Urban Mind app

- Addresses the issues of previous environmental research
- 2.1 billion smartphone users in 2016
- Flexible and accessible research tool
How to use the app

- Download from the Apple App Store or Google Play
- Provide informed consent
- Complete the baseline questionnaire
- Complete 3 assessments per day over a 14-day period
Ecological Momentary Assessment (EMA)

- Sensory
- Nature
- Safety
- Social inclusivity
- Planning inclusivity
- Deprivation
- Mental wellbeing
Ecological Momentary Assessment (EMA)

- Sensory
- Nature
- Safety
- Social inclusivity
- Planning inclusivity
- Deprivation
- Mental wellbeing
Photograph

- Photograph of the ground
Location Data

- Background location tracking
- Foreground location tracking
How your mental wellbeing differed for **indoors / outdoors.**

- Confident: [ ] [ ] [ ] [ ] [ ]
- Relaxed: [ ] [ ] [ ] [ ] [ ]
- Happy: [ ] [ ] [ ] [ ] [ ]
- Connected with other people: [ ] [ ] [ ] [ ] [ ]
- Energetic: [ ] [ ] [ ] [ ] [ ]

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How your mental wellbeing differed for **noisy / not noisy.**

- Confident: [ ] [ ] [ ] [ ] [ ]
- Relaxed: [ ] [ ] [ ] [ ] [ ]
- Happy: [ ] [ ] [ ] [ ] [ ]
- Connected with other people: [ ] [ ] [ ] [ ] [ ]
- Energetic: [ ] [ ] [ ] [ ] [ ]

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How your mental wellbeing differed for **contact with nature / not in contact with nature.**

- Confident: [ ] [ ] [ ] [ ] [ ]
- Relaxed: [ ] [ ] [ ] [ ] [ ]
- Happy: [ ] [ ] [ ] [ ] [ ]
- Connected with other people: [ ] [ ] [ ] [ ] [ ]
- Energetic: [ ] [ ] [ ] [ ] [ ]
London
Mental wellbeing scores
Effects of natural features on mental wellbeing

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean Difference</th>
<th>95% Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you indoors or outdoors?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can you see trees?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can you hear birds singing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can you see or hear water?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can you see the sky?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you feel in contact with nature?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percentage of completed assessments
Effects of natural features on mental wellbeing

- Were still evident 7.5 hours after a single exposure

- Were more pronounced in people with high trait impulsivity – a psychological characteristic associated with higher vulnerability to a range of mental health disorders

- interacted with the social environment (e.g. feeling safe / unsafe)
Urban Mind: Using Smartphone Technologies to Investigate the Impact of Nature on Mental Well-Being in Real Time

Ioannis Bakolis, Ryan Hammond, Michael Smythe, Johanna Gibbons, Neil Davidson, Stefania Tognini, and Andrea Michelli

Existing evidence on the beneficial effects of nature on mental health comes from studies using cross-sectional designs. We developed a smartphone-based tool (Urban Mind, www.urbanmind.info) to examine how exposure to natural features within the built environment affects mental well-being in real time. The tool was used to monitor 108 individuals who completed 1013 assessments over a 1-week period. Significant immediate and lagged associations with mental well-being were found for several natural features. These associations were stronger in people with higher trait impulsivity, a psychological measure of one's tendency to behave with little forethought or consideration of the consequences, which is indicative of a higher risk of developing mental-health issues. Our investigation suggests that the benefits of nature on mental well-being are time-bounded and interact with an individual's vulnerability to mental issues. These findings have potential implications for the promotion of global mental health and its design.

Keywords: nature, mental well-being, mental health, smartphones, ecological momentary assessment

Over three-and-a-half billion people, more than half the world’s population, live in urban areas. This number is rising fast in both developed and developing countries, and it is expected that 60% of the global population will live in cities by 2050 (UN/ESA 2014). This ongoing urbanization has major implications for global mental health, because people who live in urban environments are at higher risk of a range of mental-health issues, including depression, generalized anxiety disorders, psychosis, and addictive disorders (Post et al. 2009; Kallen 2011; Lederbogen et al. 2011). Crucially, the observation of a dose-dependent effect provides support for a causal relationship, rather than a mere association, between urban living and risk for mental illness (Polenske and Mortensen 2001; Haldin 2013). Further living and even promote mental health. For example, living in urban areas with natural features such as trees, gardens, parks, birds, and water is associated with higher levels of mental well-being and reduced incidence of chronic mental illness (van den Berg et al. 2016, van Dillen et al. 2012, Amell-Burt et al. 2013, Mattock et al. 2013, Richahdson et al. 2013, White et al. 2013, Amell-Burt et al. 2014, Alexeev et al. 2015, Mantler and Logan 2015, Taylor et al. 2015, Trigemien-Mah et al. 2015, Cox et al. 2017). A number of biologically plausible theories have been proposed to explain this effect, including attention-restoration theory (Kaplan S 1996), stress-reduction theory (Ulrich et al. 1991), and biophilia theory (Wilson 1984). The existing literature on the beneficial impact of nature
Using analytics to integrate the “micro” and the “macro”

*Individual*

*Environment*
How could the results be used?

- From the perspective of mental health care, the results could inform the development and roll-out of scalable interventions aimed at promoting mental health amongst urban and rural populations.

- From the perspective of urban planning and design, the results will provide a much-needed evidence-base to inform future policies aimed at improving mental wellbeing in urban and rural populations.
Thamesmead redevelopment, South-East London
The Urban Mind team

Arts & Culture
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Help us grow healthier cities

• Please take part in our project. Search for Urban Mind in the Google Play Store or Apple App Store.

• For more information, visit https://urbanmind.info

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