Air quality impacts on psychological and cognitive well-being

University of Birmingham, School of Geography, Earth & Environmental Sciences (GEES) and School of Psychology

Supervisors: Professor A. Robert MacKenzie (GEES); Professor Jane Raymond (Psychology); Professor Kimron Shapiro (Psychology);

Funded PhD project: the funding provided for this project stipulates that only UK students are eligible.

Summary

The overall aim of this PhD project is to investigate links between air quality and psychological and cognitive well-being by innovatively linking environmental science with psychological science.

The project is fully funded (fees, living costs/stipend, research costs) through the NERC Air Pollution and Human Health / NCAS Air Quality Studentships programme. Applications will be reviewed as they are received, with a final deadline of 31 March 2016. The studentship will start in Autumn 2016.

Background

A significant fraction of deaths globally from non-communicable diseases — i.e., cardiovascular and pulmonary disease, respiratory disease and cancers — can be attributed to indoor and outdoor air pollution (UNEP message for World Health Assembly 67). Ambient (outdoor) air pollution — predominantly nitrogen dioxide (NO₂) and particulate matter (PM) in urban areas —
is now, according to the World Health Organisation, the world's largest single environmental health risk.

Although there have been very large reductions in sulfur dioxide and large particle pollution in London since the devastating “smogs” of the 1950s and 1960s, some pollutants, including NO₂ and PM (particularly PM2.5 – particulate matter of aerodynamic diameter less than 2.5 µm) remain intractable (Brimblecombe, 2006). Technical solutions focused on tailpipe pollutant removal are controversial and subject to manipulation (Scheirmeier, 2015) and appear not to have yielded the desired or expected air quality improvements (EEA, 2014).

Evidence is growing to show that high levels of air pollution can cause deficits in cognitive abilities (Suglia et al., 2008), increase risk of cognitive decline in aging (Weuve et al., 2012), and produce alarming changes to neurons in critical brain areas needed for learning and memory (Fonken et al., 2011). Such damage can occur with exposure to both fine and coarse particulate and may not be an indirect result of the well-established cardiovascular impacts of air pollution. Rather, airborne particles may enter the brain via nerve fibres in the olfactory system, causing inflammation in the frontal lobes of the brain (areas needed for higher level cognitive functions). Brain inflammation has been linked to Alzheimer’s and Parkinson’s Diseases and other diseases, such as arthritis and obesity that are associated with long-term inflammation of the body and are often accompanied by cognitive deficits. Acute inflammation of the body has been shown to lead to cognitive impairment, even in young adults (Brydon et al., 2008), a finding which suggests that short-term exposure to air pollution can have cognitive consequences via acute inflammation.

The project

This PhD project will examine links between air quality, levels of inflammation in the body, and cognitive function. The project will be jointly supervised by senior scientists working across both environmental and cognitive domains. The emphasis will be on the short-term effects of good/poor air quality and its potential effects on concurrent and subsequent cognitive deficits.

The studentship complements ongoing NERC-funded research in air pollution and human health by utilizing novel technology (portable EEG/tCS) to develop novel non-invasive neurological biomarkers for the effects of air pollution on cognitive function. Neurological biomarkers carry time-dependent information that is often not available from standard biochemical assays, and so offer the opportunity to investigate the linearity of stress response (i.e., the extent to which the overall stress response resulting from exposure to highly variable urban air quality ‘averages out’ to the response expected from spatial or temporal averaging of the pollutant concentration).

Supervision

The Doctoral Researcher will be supervised by Professors Rob MacKenzie, Jane Raymond, and Kim Shapiro, and will join strong cohorts of doctoral researchers in the Schools of GEES and Psychology. Over 40 postdoctoral researchers and PhD students in the atmospheric science / air quality research team at Birmingham provide a vibrant research environment as does the Visual Experience Lab (VEL) of Prof Shapiro and Dr Raymond, which currently has 14 researchers ranging from postgraduate to postdoctoral. The student will participate in planning and
performing field and laboratory measurements with novel portable EEG equipment provided by research partner StarLab Barcelona SLU.

The Research Environment

The School of Psychology at the University of Birmingham was rated in the top five Schools of its kind in REF 2014. The School supports 45 staff whose expertise ranges across virtually all aspects of the discipline. Opportunities for postgraduate instruction are varied and designed to train students in both the practical and theoretical aspects of Psychology with a particular emphasis on cognitive neuroscience, for which the School was singled out for its expertise in comments made by the REF 2014 panel. The School has its own MRI scanner as well as 5 electrophysiological (ERP/EEG) labs, staffed by academic and technical experts. Professors Raymond and Shapiro maintain a vibrant joint laboratory, the Visual Experience Lab (VEL), which currently has 14 students ranging from postgraduate to postdoctoral.

The School of Geography, Earth & Environmental Sciences at Birmingham includes 6 research-active teaching staff in Air Pollution and Atmospheric Chemistry, and 4 in Meteorology and Climate. This makes us one of the larger centres for research in atmospheric science in the UK and the only centre to specialise in the science of air pollution. Lab, field, and personal analytical instruments for ambient aerosol and gas measurement are maintained by full-time technical staff. The School hosts a NCAS Unit which has proved very productive in conducting field-based research and analysing the data from field campaigns.

Both Schools maintain lively seminar series that postgraduates are required to attend. Both research groups hold lab meetings where all students are required to present their research, serving to stimulate students in a competitive but positive manner.

Project partners

We are very fortunate to be able to collaborate closely with StarLab Barcelona SLU, the originators of the portable EEG/tCS equipment (‘Enobio’) that we will use to study brain function in real-time in dynamically changing pollution environments. Starlab will provide help in-kind to the project as follows:
1. Co-supervision;
2. Advice and guidance on deployment of the Enobio portable EEG equipment;
3. Advice and guidance on EEG signal processing;
4. Hosting the student during study visits of up to 4 weeks in total; and
5. A 3-month loan of an extra Enobio device if required.

In addition to our supervisory team, we have established a small network of practitioner adviser-advocates. Building on ongoing active collaborations, this network will enable additional stakeholder engagement and dissemination at regional, national, and international levels, involving the following colleagues, each with exceptionally high professional profiles: Nick Grayson, Climate Change and Sustainability Manager, Birmingham City Council; Sue James AA Dipl RIBA, organiser of the Trees and Design Action Group; and Timothy Beatley PhD, Teresa Heinz Professor of Sustainable Communities, University of Virginia.
Prospective applicants are encouraged to contact Professor MacKenzie (a.r.mackenzie@bham.ac.uk) or Dr Raymond (j.raymond@bham.ac.uk) for informal discussion.

**Funding Notes**

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**References**


