Edinburgh, Scotland
EURONOISE 2009
October 26-28

New directions in noise and health research

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ABSTRACT

There have been significant achievements in recent noise research in Europe but there are also new challenges in relation to the changing noise climate and emerging sources of noise. In the context of the European Noise Directive there is an opportunity to take a new perspective on noise exposure measurement. Increasingly the joint effects of noise and air pollution are being examined with a need for greater consideration of moderating factors in noise research. There is scope for learning from other disciplines in terms of research methods, analyses and measurement of health outcomes. Potential mechanisms such as the stress diathesis model should be examined more critically. Applying insights from genetics might alter our understanding of susceptibility to noise effects. The setting up of a new European Network on Noise and Health (ENNAH) will facilitate these developments and draw new researchers into the field from other relevant disciplines to invigorate the research culture. An important function of the new network will be to encourage the training of young researchers in noise and health. For too long noise and health research has been carried out in relative scientific isolation. It is hoped that these new developments will bring noise and health research further into the European scientific mainstream.

1. INTRODUCTION

There have been a number of recent reviews examining the impact of environmental noise on health[1-3]. Progress in this area of research has been aided by European funding for several large transnational studies whose results have stimulated considerable discussion[4-5]. At the same time the enormous undertaking of developing noise maps across Europe, an outcome of the European Noise Directive, and action plans associated with these maps, has highlighted the importance of having reliable and replicated evidence on whether and how environmental noise exposure influences human health and wellbeing.

Research on noise and health has often been carried out independently of mainstream biomedical research and sometimes separately from the traditions of social survey research. It has often been linked with public health and epidemiology and also experimental psychological research, but has developed separately from environmental research on toxicology. This is in contrast to research on another environmental pollutant, air pollution that has more successfully than noise research, employed many of the current approaches in biomedicine. With some notable exceptions noise researchers have worked fairly independently in Centres across Europe, often with very different disciplinary allegiances. Thus it has been difficult to create a critical mass of noise researchers working on the same research questions. At the same time communication between research groups has been greatly facilitated by regular ICBEN

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conferences, Internoise, Euronoise and ICA conferences and standardisation of noise measurement by I-INCE and the European Commission.

The soundscapes of environmental noise are changing. Transport sources such as aircraft overflights are becoming quieter but are also becoming more frequent. There are also new sources of noise such as wind farms that are growing in importance with the search for greener energy. Personal listening devices are almost universal among young people with contradictory opinions from experts as to whether they are a threat to hearing or not. In this context there is scope for a review of current evidence on noise and health effects and for an exploration of where noise and health research should go in the future. The European Commission has recently funded a new European Network on Noise and Health (ENNAH) with 33 partners across Europe. This paper will describe the plans for this network and put forward some initial ideas about new research directions for noise and health.

2. METHOD

This paper has two sections. First there is an account of the European Network on Noise and Health (ENNAH) based on the description of work submitted to the European Commission for the project. Secondly, there is a section describing some views on how noise research could be developed and the direction that noise research might take in the future.

3. THE NETWORK- ENNAH

The European Network on Noise and Health includes 33 partners from across Europe. It has been funded by the European Commission to establish a research network of European scientists working on environmental noise exposure and health. The initial objective will be to review the existing literature on environmental noise exposure and health focussing on consolidation of existing knowledge and the identification of gaps in the evidence and future research needs. A further objective is to ensure that the most up-to-date measures of noise exposure assessment are applied to health studies. The network will also assess complex analytical models of noise and health effects that take into account moderating factors such as the joint effects of air pollution and noise. Furthermore, the network will aim to improve the measurement of health outcomes relevant to noise research taking examples from other areas of biomedicine and extending analyses on existing large studies of noise and health. The network will also help to improve communication between researchers on noise and researchers on air quality. Ultimately, we aim to develop new designs for research on noise and health and to provide the EU with a new strategy for the development of noise and health in the future. An important element of the network is the exchange programme for junior researchers in noise and health designed to increase expertise among junior researchers in this important area. Throughout the 24 months of the Network we aim to disseminate the results to the EU, to national governments, to fellow researchers and users including research councils and the general public across Europe.

Structure of the network

The Network has been organised as seven workpackages. There will be a series of international workshops associated with each of the workpackages led by a workpackage leader. Each workpackage will produce a report for individual dissemination that will also contribute to the final report. Workshops will be arranged so as to maximise the collaboration of relevant expertise but also to bring together noise researchers with key experts from cross cutting or adjoining research fields that could inform future noise research. The second work package, which will initiate the network will carry out a state of the art review of current evidence of environmental noise effects on health. It is expected that this workpackage will highlight the new questions in noise research that need to be answered and which areas require the greatest in-depth enquiry. The third workpackage will focus on novel methods of noise exposure

measurement but will also include an assessment of noise maps and what these might offer for noise and health research. The fourth workpackage will begin to develop models of the mechanisms linking noise and health effects taking into account potential mediating factors such as annoyance and confounding factors such as social disadvantage. A very important aspect of this coordination and support action will be to take account of the large body of research on air pollution and health. This workpackage will have a major role trying to improve communication between noise pollution and air pollution researchers with the aim of developing new strategies to take both of these factors into account in future research. The fifth workpackage will deal with the measurement of health outcomes relevant to noise research including hypertension and coronary heart disease, mental health, cognition and learning, sleep, annoyance, psycho-physiological stress responses and some novel outcomes. The sixth workpackage aims to bring together the work from the previous workpackages and will identify and outline new strategies for noise and health research. This workpackage aims to develop an understanding of the underlying mechanisms linking environmental noise and specific health effects and the areas in which new research would be beneficial. The seventh work package will be responsible for developing an information strategy and for dissemination of the findings from the network. The final report will be suitable for both scientific stakeholders and the informed lay public. Overall, the idea is to share resources across the network as well ideas and good practice about noise research and develop a common vision for the future of noise and health research.

4. NEW APPROACHES TO NOISE AND HEALTH RESEARCH

This section of the paper highlights a few areas in which noise and health research might develop. It is not comprehensive but illustrates some areas that are promising for further research. Doubtless the new research network will also identify other priorities and will refine these initial ideas.

Research designs

Many epidemiological studies of noise and health for practical and financial reasons are cross-sectional in design. However, this research design is not well suited to exploring causal effects. Developing new cohort and case control studies and exploiting existing cohort studies could be advantageous in future noise research. Especially important is taking advantage of natural experiments in which populations are exposed to large changes in noise exposure where its impact on health can be assessed.

Noise exposure

Much noise and health research has relied on measurement of noise exposure based on energy averaged measures derived from a standardised typical exposure periods. These techniques are suitable for large-scale epidemiological comparisons of high and low noise exposure but do have disadvantages in terms of misclassification of noise exposure of individuals thus potentially weakening associations between noise exposure and health outcomes. Such measures generally assume continuous exposure to the noise source and do not take into account dynamic elements related to individuals moving in and out of noise exposure. With improvements in technology, there is scope for improving the individual assessment of noise exposure using dosimeters to get more precise indicators of individual noise exposure over time. Furthermore dosimeters can be linked to GIS systems so that individual noise exposure can be mapped geographically.

New health outcomes

The health outcomes examined in relation to noise exposure have been somewhat limited by the scope of previous research. Some health outcomes have been excluded partly because either they have not previously been considered or earlier studies have suggested they are not important, sometimes based on inadequate evidence. Research on other environmental

stressors suggests that disturbances in immune responses[6] and long term hormonal responses may be relevant to consider in the future in relation to health. Other conditions, such as diabetes mellitus and respiratory health[7], the latter traditionally associated with exposure to air pollution, should also receive further consideration. Reproductive health has received some attention in relation to noise but could be looked at once again. In future studies it will be important to look at the effects of air pollution and noise in some detail. It may be that air pollution is confounding the effects of noise on health or that noise is confounding the effects of air pollution on health[8]. It is also possible that both these agents are having independent or interactive effects[9].

Noise and neuroscience

Techniques in neuroscience, such as brain imaging, are becoming increasingly sophisticated. This has led to a greater understanding of the brain regions, for instance, the amygdala, involved in coping with stress and processing unpleasant emotions. In particular, exposure to unpleasant noise increases amygdala activity[10]. It is also the centre for acquisition of fear conditioning[11]. Acute noise exposure in Rhesus monkeys leads to impairment of prefrontal cortex activity associated with increased dopamine release[12]. A better understanding of brain pathways related to the emotional processing of environmental noise could lead to a greater understanding of how environmental noise potentially affects health. Noise research has not fully taken advantage of these developments in helping to understand the effects of noise on the brain.

Susceptibility to noise effects on health

One area that it is worth further examination is that of the identification and understanding of vulnerable groups to noise and health effects. A useful comparison will be susceptibility to noise effects in children and adults where developmental issues may be more relevant in children and ageing issues in adults. In general there has been insufficient research relating ageing to noise and health effects[13]. This is a relevant issue in the context of an increasingly ageing population in Europe. Many studies have found gender differences in health effects and it would be informative to analyse these in a systematic way.

The identification of gene-environment interactions in the behavioural sciences has opened up a new area of enquiry in which genetic make up may imply differential vulnerability to environmental stressors, including noise exposure. Recent hypotheses suggest that certain genetic alleles may not only confer vulnerability to ill-health in the face of environmental adversity but may also relate to behavioural advantage on exposure to positive environmental experiences[14]. This is reminiscent of conceptualisations of noise sensitivity in which undue to exposure to noise may increase annoyance and risk of psychological distress in sensitive individuals while at the same time sensitivity may be an indicator of a more discriminating responsiveness to the environment[15]. There is some recent evidence that noise sensitivity may have some genetic antecedents. It is well known that noise sensitivity is strongly related to trait anxiety which has a high degree of heritability. Noise sensitivity aggregates in families, again suggesting a significant genetic component.[16] Additionally the short allele (ss) of the serotonin transporter gene that has been associated with susceptibility to depression following life events is also associated with a stronger startle response to noise than the long allele[17]. Could it be that this is some indicator of sensitivity to noise? It is possible that noise sensitivity is an indicator of a genetically mediated susceptibility to environmental stressors. This would benefit from further investigation.

5. CONCLUSIONS

The effects of environmental noise on health, wellbeing and quality of life continue to be a fascinating area of trans-disciplinary scientific exploration. The study of the effects of 'unwanted sound' on human health acts as a model for the effects of other environmental stressors. Noise is a ubiquitous environmental pollutant and although its character may be changing the numbers of people exposed to noise in Europe are still increasing and it remains a topic of great relevance for public health. Further research to clarify the health effects of environmental noise exposure is an important priority for Europe and the new European Network on Noise and Health will bring together a critical mass of European researchers to facilitate the development of future research.

ACKNOWLEDGMENTS

I acknowledge the contribution of ENNAH network members to the Description of Work and thank Charlotte Clark for her comments on this paper.

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