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AIRCRAFT NOISE AT SCHOOL AND CHILD PERFORMANCE AND HEALTH INITIAL RESULTS FROM THE WEST LONDON SCHOOLS STUDY

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ABSTRACT
Preliminary results on noise perception, annoyance and self-assessed health are reported from a cross-sectional study of 451 children attending 10 schools exposed to high levels of chronic aircraft noise (>63 dBA 16hr Leq) and 10 schools exposed to lower aircraft noise exposure (<57 dBA 16hr Leq), well matched across noise for age, sex and socioeconomic position. Children from high noise schools heard more aircraft noise and were more annoyed by aircraft noise than children from low noise schools, but did not differ substantially on road traffic noise annoyance. Self- assessed health was not associated with noise exposure. Further analyses in this study will examine aircraft noise exposure in relation to cognitive outcomes, adjusting for confounding, using multi-level modeling to take into account school level as well as individual level factors.

1 - INTRODUCTION
Previous research suggests that children's cognitive performance and health are adversely affected by chronic noise exposure [1,2,3,4,5,6]. However, cognitive performance is also influenced by school quality and social deprivation, which may confound noise effects. It is possible that noise effects could be explained by higher levels of social disadvantage in noise exposed areas. In this case noise exposure could be merely an indicator of the real factor causing impaired school performance, namely social deprivation. But the association may be more complex than this: aircraft noise exposure may be one of the many ways in which the effects of social disadvantage and health are mediated, noise is thus part of the explanation why social disadvantage influences health. Alternatively social disadvantage and noise exposure may have independent effects on school performance with the possibility that noise moderates the effect of social disadvantage on health. An additional confounding factor is school quality. Even among primary schools from relatively socially homogenous areas schools may differ according to quality of headteachers, teachers, morale, organization and educational results. By increasing the number of schools and children relative to the previous study around Heathrow Airport [7], the aim of this study is to test whether the noise effects on annoyance and school performance previously found in children are attributable to noise and to test possible mechanisms. This paper presents the methods and preliminary results on noise annoyance and health.

2 - DESIGN AND METHODS

2.1 - Design and procedure
In this cross-sectional field study, the cognitive performance and stress responses of children attending 10 primary schools exposed to high levels of aircraft noise (>63 dBA 16hr Leq) were compared with 10

matched control schools exposed to lower levels of aircraft noise (<57 dBA 16hr Leq) around Heathrow Airport in West London, UK. Schools were matched across high and low aircraft noise exposure by: age, sex, socio-economic status of school catchment, ethnicity of school catchment and sound level at the school from non-aircraft environmental noise sources. The cognitive performance tests and health questionnaires were group administered in the classroom. The children were already randomly selected into mixed ability classes. Teachers and parents of all the school children were given a questionnaire to complete. Noise measurements were conducted in the schools at the time of testing to assess acute noise exposure. Personal dosimetry to assess individual exposure was measured in a subsample. An overnight urinary sample was collected from a subsample of the children to measure catecholamines and cortisol. Qualitative interviews were conducted with a subsample of children to explore children's perception of noise exposure and feelings of annoyance.

2.2 - Outcome measures

Perceived noise

Self−reported noise exposure at school and at home was measured with 7 questions from 4 sources of environmental noise (road traffic, neighbors (home only), aircraft and train). The children were asked: 'Do you hear (***noise source***) around your ***school/home***?' and they replied yes or no.

Annoyance

Noise annoyance was measured with 4 child adapted standard questions [8]. These questions assessed the level of annoyance on a 5 point likert scale (not at all, a little, quite a bit, very much, extremely) and a 10 point scale (0 not at all annoyed, 10 extremely annoyed) felt by the child when they heard aircraft noise and road traffic noise at home and school, in the last 12 months. These questions produce two scores: a) a likert scale the higher the score the higher the noise annoyance (range $1-5$ for likert scale) and b) a ten point scale the higher the score the greater the annoyance (0-10).

Self-rated general health and symptoms

Self-reported health was measured by using standard self-report questions that were read aloud to the children. Self reported general health was measured with this question: 'In general, would you say your health was?' and they replied either very good, good, fair, poor (with the higher the score the poorer the health). The children were asked to report how often they suffered from: headaches, tiredness and trouble sleeping in the past two weeks as either: often, sometimes, never (higher the score the more prevalent the symptom).

2.3 - Analysis

Preliminary descriptive analyses are reported in this paper for: response rate, description of the sample, perception of noise, annoyance and self-rated health.

3 - RESULTS

The overall response rate to the study was high (82%) (Table 1) with no evidence of differential response rates across noise exposure. Refusal to take part only accounted for just over 5% of the sample.

Response Options	High Noise Eligible Sample N=284	Low Noise Eligible Sample N=265	Total
Participated	236 (83.1%)	215 (81.1%)	451 (82.1%)
Declined (parent)	9 (3.2%)	18 (6.8%)	27 (4.9%)
Declined (child)	3 (1.1%)	1 (0.4%)	4 (0.7%)
Holiday	1 (0.4%)	1 (0.4%)	2 (0.4%)
Sick	9 (3.2%)	13 (4.9%)	22 (4.0%)
Non-responders (no slip returned)	26 (9.2%)	17 (6.4%)	43 (7.8%)

Table 1: Response rate.

3.1 - Sample and response rate

The samples were well matched by age and the proportion of boys and girls was very similar across high and low noise schools. Children from high noise schools were more likely to be non-White and to speak a language other than English as their first language at home (Table 2). Nevertheless, although it was difficult to match on ethnicity across high and low noise areas, as the noise exposed areas east of the airport contained predominantly ethnic minority populations, it was more possible to match for

level of social disadvantage. Schools were originally matched on the proportion of families in each school eligible for free school meals, an index of eligibility for social benefits. This careful matching is echoed in results across noise for two measures of social disadvantage obtained from the parent's questionnaire: employment status and income. The proportion of households where the head of household was in full employment, and the proportion of households with low income did not differ across high and low exposure areas (Table 2).

Socio-Demographic Characteristic	High Noise	Low Noise	Chi-square
Total	N=236	N=215	P-value
Age	8 years - 8 months	8 years - 9 months	N/A
Girls	50% (119)	48% (103)	
Boys	50% (117)	52% (112)	P=0.33
White	32% (52)	46% (75)	
Non-White	68% (110)	54% (88)*	P=0.014
English − Main Language Spoken at Home	41% (66)	58% (94)	
Non-English	60% (96)	42% (69)*	P=0.003
Head of household in full-time employment	68% (114)	73% (120)	
Head of household not in full-time employment	32% (54)	27% (44)	P=0.35
Low household income (> £12,000)	29% (39)	22% (32)	
High household income (< £12 000)	70% (96)	78% (115)	P=0.22

Table 2: The sociodemographic characteristics of the high and low noise child samples: frequencies and proportions, continuity correction chi-square p-value (* P>0.05; Note: 30% missing data for race, language and employment status, 40% missing data for income).

3.2 - Perception of noise

The majority of children in high noise schools heard aircraft noise at school (95%) and at home (94%) (Table 3). High noise school children heard significantly more aircraft noise than low noise school children. On the other hand, children from both high and low noise schools were exposed to fairly similar levels of exposure to other noises at school and at home, although unexpectedly children in low noise schools were exposed to significantly more road traffic noise than children in high noise schools.

Perception of noise	High Noise Schools	Low Noise Schools	Chi-Square p-value
At School			
Aircraft	95% (221)	72%(152)	P=0.0001
Road	47% (108)	59%(126)	P=0.01
Rail	14% (33)	14%(30)	P=0.99
At Home			
Aircraft	94% (218)	69%(147)	P=0.0001
Road	67% (155)	73%(155)	P=0.18
Rail	15% (35)	21%(45)	P=0.11
Neighbors	58% (136)	65%(139)	P=0.14

Table 3: Perception of noise: proportion of children who could hear these noise sources at school and home.

3.3 - Annoyance

Annoyance levels to aircraft noise were significantly higher on both the 5- and 10-point scales among children in the high noise schools compared to the low noise schools (Table 4). This applied to aircraft noise annoyance both at school and at home. In contrast levels of annoyance to road traffic noise both at school and at home did not differ significantly across high and low noise schools.

Annoyance Outcome		High Noise Schools	Low Noise Schools	F statistic, df, and p-value
Aircraft noise annoyance at school	5 point scale	3.22	2.61	F(1,442)=19.64; P=0.0001
	10 point scale	5.48	4.05	F(1,441)=15.75; P=0.0001
Aircraft noise annoyance at home	5 points	3.16	2.51	F(1,441)=19.06; P=0.0001
	10 points	5.39	3.63	F(1,441)=21.45; P=0.0001
Road Traffic noise annoyance at school	5 points	2.40	2.5	F(1,442)=0.52; P=0.47
	10 points	3.51	3.81	F(1,442)=0.76; P=0.38
Road Traffic noise annoyance at home	5 points	2.45	2.55	F(1,444)=0.47; P=0.49
	10 points	3.43	3.94	F(1,440)=1.93; P=0.17

Table 4: Annoyance outcome mean scores adjusted for age in the 10 high-noise schools, the 10 low-noise schools (NB: exclusions not entered and no multi-level models).

3.4 - Self-reported health

There was no evidence that these self-reported measures of general physical health were influenced by aircraft noise exposure. Mean levels of self reported general health and three types of child self-reported symptoms plausibly related to noise exposure (headaches, tiredness, and sleeping problems) showed very little difference across children from high and low noise schools. In fact, against expectation, tiredness in the last two weeks was more frequent among children from low noise schools.

Self reported Health	High Noise Schools mean	Low Noise Schools mean	F statistic, df, and p-value
Self reported general health	1.63	1.63	F(1,443)=0.004; P=0.95
Headaches in the last 2 weeks	1.97	1.90	F(1,443)=0.96; P=0.33
Tiredness in the last 2 weeks	2.00	2.15	F(1,444)=4.49; P=0.035
Sleeping Problems in the last 2 weeks	1.81	1.92	F(1,444)=1.91; P=0.17

Table 5: Self reported health: mean scores across high and low noise schools.

4 - SUMMARY CONCLUSIONS

This paper presents the preliminary results from the West London Schools Study on noise perception, noise annoyance and self-reported health comparing the responses of children from schools exposed to high and low levels of aircraft noise. Attempts were made to improve on the previous study around Heathrow Airport [7] and reduce possible biases related to differences between schools in school quality and general levels of social deprivation. This was achieved by choosing larger numbers of schools, and by careful matching for socioeconomic position between high and low noise exposed schools using eligibility for free school meals as the matching criterion. This seems to have been successful as levels of unemployment and low family income did not differ between high and low noise school children. Further analyses using more sophisticated composite indices of social deprivation will be carried out in due course. Good matching was not achieved for main language spoken at home, but as the previous study suggested [7] this may not have such a crucial effect on school performance outcomes as social deprivation.

Children from high noise schools both heard more aircraft noise and were more annoyed by it than children from low noise exposed schools. These results have added validity because their perceptions and their annoyance levels in relation to road and rail traffic did not differ much across high and low aircraft noise

exposed schools. These results replicate the earlier findings from the Schools Health and Environment Study [7]. It is not clear whether high levels of aircraft noise annoyance in children have longer term health implications for children, certainly they seem to be an indication of short term disturbance of quality of life. In these preliminary results aircraft noise exposure does not seem to influence simple measures of self-reported symptoms and overall health.
Further analyses in this study will examine aircraft noise exposure in relation to cognitive outcomes (reading comprehension, memory, sustained attention) and self-reported stress and catecholamine and cortisol secretion. We will adjust these analyses for potential confounding factors including age, main language spoken at home, parental educational attainment and composite indices of social deprivation and use multi-level modeling to take into account school level as well as individual level factors. We will also test whether other environmental factors including length of time exposed to aircraft noise, home noise exposure and crowding at home moderate the association between aircraft noise exposure and cognitive impairments. The potential mediating effects of sustained attention on the noise effects will also be assessed. Finally, we will examine whether there is any evidence that noise effects differ according to level of social deprivation and gender.

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REFERENCES

1. **S. Cohen, G.W. Evans, D.S. Krantz and D. Stokols**, Physiological, motivational and cognitive effects of aircraft noise on children: Moving from the laboratory to the field, *American Psychologist*, Vol. 35, pp. 231-243, 1980

2. **G.W. Evans and S.J. Lepore**, Nonauditory effects of noise on children, *Children's Environment*, Vol. 10, pp. 31-51, 1993

3. **G.W. Evans, S. Hygge and M. Bullinger**, Chronic noise and psychological stress, *Psychological Science*, Vol. 6 (6), pp. 333-338, 1995

4. **G.W. Evans, S.J. Lepore, B.R. Shejwal and M.N. Palsane**, Chronic residential crowding and children's well-being: an ecological perspective, *Child Dev*, Vol. 69 (6), pp. 1514-1523, 1998

5. **G.W. Evans and L. Maxwell**, Chronic noise exposure and reading deficits: The mediating effects of language acquisition, *Environment and Behavior*, Vol. 29 (5), pp. 638-656, 1997

6. **M.M. Haines, S.A. Stansfeld, R.F.S. Job and B. Berglund**, Chronic aircraft noise exposure and stress responses and cognitive performance in school children, *Psychological Medicine (under review)*

7. **M.M. Haines, S.A. Stansfeld, B. Berglund and R.F.S. Job**, Chronic aircraft noise exposure and child cognitive performance and stress, In *Proceedings of the 7th International Conference on Noise as a Public Health Problem*, pp. 329-335, 1998

8. **J.M. Fields, R.G. de Jong, I.H. Flindell, T. Gjestland, R.F.S. Job, S. Jurra, et al**, Recommendation for shared annoyance questions in noise annoyance surveys, In *Proceedings of the 7th International Conference on Noise as a Public Health Problem*, pp. 481-486, 1998