THE EFFECT OF CHANGED NOISE LEVELS AT SYDNEY AIRPORT ON HEALTH OUTCOMES II: THE ROLE OF ANTICIPATION AND REACTION.

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ABSTRACT
Health effects of noise may be partly mediated by reaction to noise. Here we examine the role of reaction in mediating the health effects of increases in noise around Sydney Airport. We assess whether reaction also worsened, and its correlation with health effects. Earlier, we reported that within equivalent noise exposure areas, physical and psychological health (and reaction) are worse where exposure is expected to increase. Here we examine whether changes in exposure impact health over and above the impact of anticipating the change. We discuss the role of reaction in health effects, and the implications for mitigating these effects.

INTRODUCTION

Research examining the adverse physiological consequences of noise exposure on health [for reviews see 1,2], has typically been biased towards investigating the direct effects of noise on health. The main focus has been on the relationship between health and noise exposure, although the influence of various noise parameters (such as frequency and impulsivity) has also been investigated.

However, the relationship between noise exposure and many adverse physiological consequences may be at least partially mediated by psychological factors relating to noise exposure. For example, the possibility that negative reaction to the noise produces noise-related health problems over and above the direct effects of noise exposure has been recognized in several reviews [e.g. 2].

In support of this possibility, we have demonstrated that area differences in noise reaction relate to area differences in self-reported noise-related adverse physiological effects, *in the absence of area differences in noise exposure* [3]. Well-publicised, proposed changes to the configuration of the runways at Sydney Airport resulted in some areas with low noise expecting increases in noise exposure, whereas others expected no worsening, and also resulted in some areas with high noise expecting decreases in noise exposure, whereas others expected no improvement. Before the reconfiguration, and so *before any changes in noise exposure,* in areas with similar, low aircraft noise exposure, more negative reactions and more adverse physiological effects were observed in areas expecting increased noise, than in areas expecting no worsening. In areas with similar high aircraft noise exposure, less negative reactions and less adverse physiological effects were observed in areas anticipating decreased noise exposure, than in areas anticipating no improvement. Further, expected change in noise exposure significantly added to the prediction of self-reported physiological symptoms predicted by noise exposure in regression analyses.

In the present paper, we compare reaction before the reconfiguration to reaction *after the changes in noise exposure*, in order to consider whether changes parallel those observed for self-reported adverse physiological outcomes [4]. The relationship between changes in reaction and changes in physiological outcomes will be examined for the subset of respondents who were repeat-tested. We will also consider whether actual change in noise exposure adds significantly to the change produced by anticipating the change. We have argued that the present study addresses the concern that studies conducted in steady state noise areas may underestimate noise effects (Job et al., this volume), however our study may also; to the extent that anticipating changes in noise has biased “baseline” data.

METHODS

Subjects and Sample Selection

Residents were randomly selected from areas selected on the basis of location relative to Sydney (Kingsford Smith) Airport to produce a 2x2 design; initial noise level was "high" or "low" and noise level either changed (decreased or increased, respectively) or to remained unchanged, due to runway reconfiguration. Sampling aimed to achieve approximately equal representation of the four areas thus produced- "high to high" (High/High), "high to low" (High/Low), "low to low" (Low/Low), "low to high" (Low/High). From random starting points, every 7th residence along a predetermined path was approached, and one respondent selected within each household using the "last birthday" technique, without replacement.

Before the reconfiguration (pre-reconfiguration stage), 532 female and 482 male residents were interviewed. Up to one year after the reconfiguration (post-reconfiguration stage), 110 female and 108 male residents (not from the pre-reconfiguration sample) were interviewed. About 6 years after the reconfiguration (follow-up stage), 95 female and 71 male pre-reconfiguration respondents were re-interviewed. In addition, a further 232 female and 175 male participants from residences nearby and similar to the pre-reconfiguration residences were interviewed.

Materials

A structured interview (based on previous socio-acoustic surveys [5] and pilot results) assessed reactions to noise (dissatisfaction, affectedness, annoyance), health, attitudes to the noise source (local concerns, financial impact, misfeasance), noise sensitivity, demographic variables and noise-induced activity disturbance. Two questions assessed general reaction: (i) "Would you please ... estimate how much you personally, are affected overall by aircraft noise?"; (ii) "How dissatisfied are you with aircraft noise in this neighbourhood? Please ... estimate how much dissatisfaction you feel overall." A general reaction index was computed by averaging scores for these items. At the pre- and post-reconfiguration stages, three questions assessed annoyance: (i) "How much annoyance do you feel about aircraft noise?"; (ii) “How much annoyance do you feel overall because of these activity disturbances caused by aircraft noise?” (after subjects had identified which of a list of 12 daily activities aircraft noise disturbs) (iii) "How would you describe your general feelings about the aircraft noise in this neighbourhood?". Subjects responded using a card depicting a thermometer marked with numbers from 0 to 10 with an associated 5-point verbal scale (2="a little", 5="moderate", 7="a lot", 10="much"), except for the third question for which responses were: "highly", "considerably", "moderately", "slightly", "not at all" annoyed (scored from 4 to 0 in that order). To ensure that all questions were assessed on a 0-10 scale, scores for this question were multiplied by 2.5. At the follow-up stage the first question was omitted. An annoyance index was computed by averaging the items employed.

Procedure

Before the reconfiguration, a letter was first sent to each selected residence announcing the investigation. Then trained interviewers door-knocked at these residences and asked to speak to the person over 18 living at the residence who last had a birthday. If an eligible individual agreed to participate, the structured interview was conducted before they completed the questionnaires while the interviewer waited. Respondents were told that the researchers may want to re-interview them at a later time. At the post-reconfiguration stage, subjects were sampled employing the same selection technique as was employed at the pre-reconfiguration stage, with the additional requirement that subjects not have participated in the pre-reconfiguration stage. Around six years later (follow-up stage), people who had been interviewed at the pre-reconfiguration stage were telephoned to make an appointment for re-interview. Up to three attempts were made to contact each respondent. Respondents were re-interviewed in their homes, and again completed some questionnaires. In addition, a new sample was collected by door-knocking at residences nearby and similar to residences housing respondents from the pre-reconfiguration stage. Respondent selection from the residences proceeded as for the pre-reconfiguration stage.

RESULTS

Changes in Annoyance in Each Noise Change Area

Table 1. Mean (and standard deviation) scores on the annoyance index (3 item/2 item) at pre-reconfiguration, post-reconfiguration, and follow-up within each of the 4 noise change areas.=differs from pre-reconfiguration at .05 level, **=differs from pre-reconfiguration at .001 level.*

	High/High	Low/High	High/Low	Low/Low
Pre	6.89(2.50) / 6.62(2.70)	5.85(2.85) / 5.54(3.12)	6.62(2.86) / 6.36(3.01)	3.28(2.56) / 2.29(2.71)
Post	6.99 (1.86)	6.99 (1.65) *	5.14 (2.62) **	3.39 (3.27)
Follow-up	6.00 (2.97 *	5.48 (2.85)	6.24 (3.09)	4.21 (3.14) **

Separate two-tailed independent samples t-tests were conducted to compare pre- and post-reconfiguration means within each noise change area. Annoyance significantly increased from pre- to post-reconfiguration in the Low/High area (t_{277} = -2.76, p = .006), and significantly decreased from pre to post-reconfiguration in the High/Low area (t_{300} = 3.55, p < .001). Annoyance did not change significantly from pre- to post-reconfiguration in the High/High or the Low/Low area (t_{300} = -.29, p = .773, t_{170}= -.19, p = .849, respectively).

Follow-up study respondents who had participated at the pre-reconfiguration stage did not differ from follow-up study respondents who had not (t_{511} = .61, p = .540), and so these respondents were combined for further analysis.

Separate two-tailed independent samples t-tests were conducted to compare pre-reconfiguration and follow-up means within each noise change area. Annoyance significantly decreased from pre-reconfiguration to follow-up in the High/High area (t_{395} = 2.13, p = .034) and significantly increased from pre-reconfiguration to follow-up in the Low/Low area (t_{277} = -5.25, p < .001). Annoyance did not differ significantly from pre-reconfiguration to follow-up in the Low/High or the High/Low area (t_{368} = .19, p = .853, t_{384} = .36, p = .720, respectively).

Changes in General Reaction in Each Noise Change Area

Table 2. Mean (and standard deviation) scores on the general reaction index at pre-reconfiguration, post-reconfiguration, and follow-up within each of the 4 noise change areas.=differs from pre-reconfiguration at .05 level, **=differs from pre-reconfiguration at .001 level.*

	High/High	Low/High	High/Low	Low/Low
Pre	6.94 (2.75)	5.35 (2.95)	6.49 (3.02)	2.37 (2.51)
Post	8.30 (2.08) *	7.56 (2.36) **	2.44 (2.45) **	1.55 (2.06) *
Follow-up	6.38 (2.69) *	6.15 (2.57) *	6.41 (2.98)	4.50 (2.89) **

Separate two-tailed independent samples t-tests were conducted to compare pre- and post-reconfiguration means within each noise change area. General reaction significantly increased from pre- to post-reconfiguration in the High/High area ($t_{305} = -3.42$, $p = .001$) and the Low/High area ($t_{308} = -5.12$, $p < .001$), and significantly decreased from pre to post-reconfiguration in the High/Low area ($t_{309} = 9.58$, $p < .001$) and the Low/Low area ($t_{300} = 2.22$, $p = .027$).

Follow-up study respondents who had participated at the pre-reconfiguration stage did not differ from follow-up study respondents who had not ($t_{536} = .20$, $p = .842$), and so these respondents were combined for further analysis.

Separate two-tailed independent samples t-tests were conducted to compare pre-reconfiguration and follow-up means within each noise change area. General reaction was significantly greater at follow-up than at pre-reconfiguration in the Low/High and the Low/Low area ($t_{394} = -2.69$, $p = .008$, $t_{358} = -7.06$, $p < .001$, respectively). General reaction did not differ significantly from pre-configuration to follow-up in the High/High, or the High/Low area ($t_{398} = 1.96$, $p = .050$, $t_{393} = .26$, $p = .797$, respectively).

The percentage of subjects at least "highly affected" in terms of general reaction (i.e. with a general reaction score of at least 8) was determined at pre- and post-configuration within each of the 4 noise change areas [see Table 3].

*Table 3. Percentage of subjects at least highly affected (in terms of general reaction) at pre-reconfiguration, post- reconfiguration, and follow-up within each of the 4 noise change area. **=differs from pre-reconfiguration at .001 level.*

	High/High			Low/High			High/Low			Low/Low		
	Pre	Post **	F-up	Pre	Post **	F-up	Pre	Post **	F-up	Pre	Post	F-up **
≥8	44.1	77.4	34.9	24.5	56.6	29.5	42.5	1.7	42.7	2.8	0.0	20.0
<8	55.9	22.6	65.1	75.5	43.4	70.5	57.5	98.3	57.3	97.2	100	80.0

Separate Chi-squared analysis within each noise area was employed to compare the pre-reconfiguration with the post-reconfiguration and follow-up stages in terms of the percentage of subjects at least "highly affected" (versus less affected).

Significant increases were observed in the percentage "highly affected" at the post-reconfiguration stage for the High/High area ($\chi^2_{1, 307} = 19.41$, $p < .001$), the Low/High area ($\chi^2_{1, 310} = 21.55$, $p < .001$). Significant decreases were observed for the High/Low area ($\chi^2_{1,311} = 35.05$, $p < .001$). No significant change in response percentages was found for the Low/Low area ($\chi^2_{1, 302} = 1.49$, $p = .222$).

At the follow-up stage, the percentage of respondents "highly affected" increased significantly in the Low/Low area ($\chi^2_{1, 360} = 30.51$, $p < .001$), but not in the High/High, the Low/High, or the High/Low areas (highest nonsignificant $\chi^2_{1, 400} = 3.22$, $p = .073$).

Correlations of Annoyance and General Reaction with Health Outcomes Across All Noise Change Areas

*Table 4. Correlation (with n) of annoyance and general reaction with the symptoms index, depression and anxiety across the 4 noise change areas, at the pre-reconfiguration, post-reconfiguration, and follow-up stages. *=significant at .05 level, **=significant at .001 level.*

	Symptoms			Depression			Anxiety		
	Pre	Post	F-up	Pre	Post	F-up	Pre	Post	F-up
Annoyance	.670** (865)	.608** (185)	.668** (489)	.072* (861)	.066 (180)	.119* (479)	.092* (862)	.185* (179)	.173** (480)
General Reaction	.686** (1008)	.704** (217)	.647** (513)	.066* (1002)	.100 (212)	.149** (502)	.110** (1003)	.277** (211)	.180** (503)

Significant positive both annoyance and general reaction correlated significantly and positively with both self-reported noise-related symptoms and anxiety at all stages. Significant positive correlations with depression were observed only at the pre-reconfiguration and follow-up stages.

Correlations of Changes in Annoyance and General Reaction with Changes Health Outcomes Across All Noise Change Area, for Repeat-tested Subjects

*Table 5. Correlation (with n) of changes in annoyance and general reaction (from pre-reconfiguration to follow-up) with changes in the symptoms index, depression and anxiety (from pre-reconfiguration to follow-up) across the 4 noise change areas. *=significant at .05 level, **=significant at .001 level.*

	Symptoms	Depression	Anxiety
Change in Annoyance	.430** (131)	.118 (135)	.121 (136)
Change in General Reaction	.440** (150)	.190* (152)	.146 (153)

Change in annoyance and general correlated significantly and positively with change in symptoms. Only change in general reaction correlated significantly and positively with change in Depression. No significant correlation with change in anxiety was observed.

Effects of Actual and Expected Noise Change on Annoyance and General Reaction

To test whether actual change in noise added to the change in reaction caused by anticipating change in noise, a 2 (area: High/High versus High/Low) x 2 (stage: pre- versus post-reconfiguration) ANOVA and a 2 (area: Low/Low versus Low/High) x 2 (stage: pre- versus post-reconfiguration) ANOVA were conducted with both annoyance and general reaction as dependent variables.

Stage interacted significantly with area for the High/High versus High/Low comparisons of annoyance ($F_{603,1}$= 8.20, p=.004) and general reaction ($F_{617,1}$=86.19, P<.001). For the Low/Low versus Low/High comparison the interaction was only significant for general reaction ($F_{450,1}$=28.31, p=<.001; for annoyance: $F_{450,1}$= 2.11, p=.147). In all cases the expected area differences in reaction (High/High > High/Low and Low/Low<Low/High) were greater at the post-reconfiguration stage than at the pre-reconfiguration stage.

CONCLUSIONS

This paper has reported changes in various measures of reaction associated with the changes to the runway configuration at Sydney Airport, which were examined as part of the Sydney Airport Health Study. The planned comparisons of the four noise exposure areas was the logically ideal naturally occurring 2 by 2 design for investigating the effects of changes in noise exposure, and the noise exposure results were essentially in keeping with this design. However, due to a policy of "spreading" the noise and various changes to the allowed flight paths above Sydney, the Low/Low noise exposure areas *did* experience an increase in aircraft noise exposure. Thus, while still remaining a low exposure zone, the increased exposure (to still quite low levels, below NEF of 15) *did* result in increased reaction in the Low/Low areas.

The results from the baseline survey identified that even prior to any change in noise exposure, the anticipation of change appeared to result in significant difference in reaction, such that those with high noise exposure anticipating a reduction in noise, showed less reaction to the baseline noise and those in areas expecting an increase showed greater reaction [6]. The present results identify, via the significant interactions reported in the last section of the results, that the actual changes in noise exposure when they occurred produced further changes in reaction. Thus, although people may have been bracing for the changed noise exposure, their anticipation of the increased noise did not save them from more severe reaction when the noise actually increased.

Reviews and our data from the baseline phase of this study [7,8] suggest that general scales are psychometrically superior to scales based on annoyance alone. Consistent with this view, results based on general reaction revealed more differences across the three surveys.

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