

# THE OKINAWA STUDY: EFFECT OF CHRONIC AIRCRAFT NOISE EXPOSURE ON MEMORY OF SCHOOL CHILDREN

K. Hiramatsu<sup>1</sup>, T. Tokuyama<sup>2</sup>, T. Matsui<sup>3</sup>, T. Miyakita<sup>4</sup>, Y. Osada<sup>5</sup> & T. Yamamoto<sup>6</sup>  
<sup>1</sup>Mukogawa Women's University, <sup>2</sup>Okinawa Prefectural College of Nursing, <sup>3</sup>Asahikawa Medical College, <sup>4</sup>Kumamoto University, <sup>5</sup>Institute of Public Health, <sup>6</sup>Kyoto University, Japan

**Introduction** Impact of chronic aircraft noise exposure on school-aged children's memory was investigated around two military airfields in Okinawa, Japan.

**Method** Of 8 primary schools located in noise-impact urban area surrounding Kadena Air Base and Futenma Air Station and 3 schools in quiet area in Okinawa, 2,269 children from 8 to 11 yrs of age attended short- and long-term memory tests. The aircraft noise exposure at the school sites are shown in Table 1. In the short-term memory test, each child read two non-verbal Japanese syllables and heard random digits reproduced by a tape recorder in his or her classroom. In the long-term memory test, the child heard a fictitious story. The child also underwent an articulation test, which aimed to make a check of the quality of listening condition of the classroom, and a learning motivation test. Tests were carried out for 2 consecutive days. On the first day, auditory and visual short-term memory tests and a long-term memory test were conducted. On the second day, an articulation test, a long-term memory test and a learning motivation test were performed. The long-term memory tests used common 15 questions and the 2nd day test did additional 5 questions.

Logistic regression analysis was applied to analyse the results of the tests with the independent variables of aircraft noise exposure, grade, sex, number of lessons taking after school, score of listening test of non-verbal syllables and learning motivation test.

Table 1 Number of schools having attended the tests

$L_{dn}$	KAB	FAS
70-75	3(554)	0
65-70	1(132)	1(210)
60-75	2(421)	
-75	0	1(299)
Cntl.	3(653)	

Figures in the parentheses are the number of children.

Table 2 Significance probability of the trend test between test score and  $L_{dn}$

Independent variable applied for logistic analysis		Kadena A.B.	Futenma A.S.
Short-term memory	Auditory; digits, 7 tasks	0.6471	0.3104
	Visual; non-verbal syllables, 9 tasks	0.5768	0.3301
	The 1st day test; 15 questions	0.3127	0.3091
Long-term memory	Difference in the 15 same questions between the 1st and the 2nd day tests	0.9778	0.9564
	Additional 5 questions used in the 2nd day test	0.0132*	0.0017**

\*:p<0.05, \*\*:p<0.01.

**Results** The results of articulation test demonstrated no significant differences in the hearing condition among the classrooms used for the tests. The significance probabilities obtained in the trend test by means of logistic regression analysis are listed in Table 2. As can be seen from the table, no significant increase of odds ratio was found against  $L_{dn}$  concerning the short-term memory score and the long-term memory score of 15 questions presented in the 1st day and the 2nd day tests. Significant trend of increase of odds ratio was found against  $L_{dn}$  concerning the 5

questions presented in the 2nd day long-term memory test.

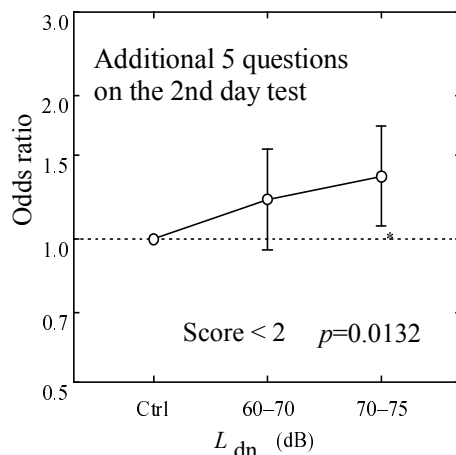


Figure 1 Odds ratio of low score by  $L_{dn}$  around the Kadena airfield.

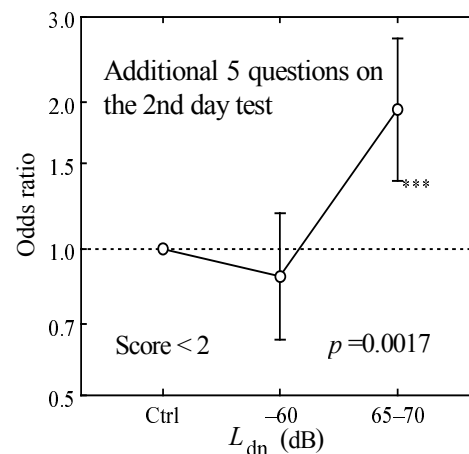


Figure 2 Odds ratio of low score by  $L_{dn}$  around the Futenma airfield.

Figures 1 and 2 illustrate the odds ratios for the 5 questions as functions of  $L_{dn}$ . Vertical bars in the figures indicate 95% confidence intervals of the odds ratio.

**Discussion** Learning ability is determined by the social and educational environmental factors besides the natural talent. Prior studies have uncovered noise exposure inhibits performance and learning which results in lower learning ability of the children living in noisy environment. The result obtained in the present study is in line with the prior studies and suggests that chronic aircraft noise exposure lowers the ability of long-term memory of school children and as a result they run the risk of making lower learning ability of schoolwork. It also is consistent with the study of Evans et al. [1] who reported poorer long-term memory observed among young children living near former Munich airport than among those of the control and it was not fully recovered one or more years after the close down of the airport.

Bruce et al. [2] state that stress affects cognition in a number of ways, when acting slowly via glucocorticoids which biphasically modulate synaptic plasticity over hours and also produce longer-term changes in dendric structure that last for weeks. Moreover, prolonged exposure to stress leads to loss of neurons, particularly in the hippocampus. Their study suggests poorer long-term memory observed among young children living around the airfields in the present study might be related to the changes that glucocorticoids effect in the hippocampus.

**Keywords:** aircraft noise, long-term memory, children.

### Acknowledgements

The authors wish to express their gratitude to Prof GW Evans for his generous and invaluable advice and encouragement.

**References** [1]GW Evans et al., *Psychol Science* **6**, 333-338 (1995).

[2]SM Bruce and RM Sapolsky, *Current opinion in Neurobiology* **5**:205-216 (1995).