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THE MUNICH AIRPORT NOISE STUDY - EFFECTS OF CHRONIC AIRCRAFT NOISE ON CHILDREN'S PERCEPTION AND COGNITION

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ABSTRACT
Before the opening of the new Munich International Airport in May 1992 and the close down of the old airport, children at both sites were recruited into aircraft noise groups (aircraft noise at present or to come) and matched control groups with little aircraft noise. A total of 327 children took part in one data collection wave before and two waves after the switch over of airports. A number of physiological and psychological tests were performed at each wave. Among the perceptual and cognitive tasks, long-term memory and mastery of a difficult German word list was impaired in the aircraft noise group at the new airport, and was improved in the formerly noise exposed group at the old airport. Running memory improved after the old airport was closed. At the new airport, ratings of annoyance remained at a higher level for the experimental group, as did the signal-to-noise ratios in a listening task.

1 - INTRODUCTION AND METHOD

The shutdown of the former Munich International Airport in May 1992 and the inauguration of the current one at the same time have provided an unprecedented opportunity to investigate in a longitudinal, prospective design the psycho-physiological, perceptual cognitive, motivational, and quality of life effects of noise exposure on children. The broad, long-term objective of this research program is to understand how chronic environmental stress from aircraft noise affects children.

Beginning in the fall of 1991, before the change over of airports, children at both sites were recruited into experimental and control groups. The two experimental groups were comprised of the children at the old airport that were exposed to high levels of aircraft noise, and the children who were to be so exposed at the new airport. The two control groups were selected from areas that were not or would not be exposed to much aircraft noise. The control groups were matched with their respective experimental groups on the basis of sociodemographic characteristics. One wave of data collection occurred prior to the change over of airports, the second wave one year later, and the third wave two years later. The children were aged 9-12 years when the study started. Three hundred twenty-seven children took part in all three measurement waves. At each wave they were tested individually in silence for 1.5 hr on two consecutive day in a specially designed air-conditioned and sound-attenuated trailer. The trailer has four closed booths that accommodate a child and an experimenter.

In the present paper longitudinal results from the set of perceptual and cognitive tasks will be presented. For other results and more details about the study, see [1] and [2].

All children went through a simplified audiometric screening task, run from a computer based device. Annoyance ratings were established by training the children to use a magnitude estimation procedure, by first jumping outside the trailer (max, 50%, 25% etc.) and to "jump" with their fingers on a 200 mm

scale when later presented with three replications of three kinds of sounds (broadband, aircraft, road traffic) at five sound levels (42-90 dBA L_{eq}).
A computer controlled signal-to-noise task was designed to assess speech discrimination against different noise backgrounds. A passage of a story was first read from a tape-recorder against a silent background and the children were instructed to choose a comfortable listening sound-level by pushing "+" and "−" buttons. The level chosen defined the L_{eq}-level at which segments of non-fluctuating pink-like broad-band noise, and fluctuating aircraft and road noise were subsequently played in the background. In the foreground the story was heard, the sound-level of which dropping randomly by 10 dBA. The children were instructed to readjust the level of the voice after the drops with the + and − buttons, to the subjective criterion that they could understand what was said if they concentrated.
In the reaction time task, random sequences of red and green lights were to be responded by pressing one or the other of two buttons. Two 5 min. sessions were run with each child. The first session was in silence and the second one in 85 dBA L_{eq} fluctuating aircraft noise.
The running memory task consisted of strings of consonants presented over headphones at the rate of one per second. Randomly, the sequence was stopped and the children were asked to recall as many consonants as they could in the correct position.
An easy version of an embedded figures' task [3] was used. The children were presented a page with twelve complex figures. On the top, five simple figures were presented, and the task was to pick out which one of the five simple figures were embedded in the complex ones.
Long-term recall tests with scoring manuals were developed for each measurement wave. On the first day the children read the text in intermittent noise and on the second day two they were tested in silence for recall with open-ended questions. This test was adapted from Hygge [4], who reported impairment of one week long-term recall in children exposed to 15 min acute aircraft and road noise.
A standardized German reading test [5] was used. The children read paragraphs and word lists of increasing difficulty. Errors and speed were scored.

2 - RESULTS

Audiometric screening did not indicate any impairments as a result of aircraft noise exposure.
The results for the long-term memory task and the difficult part of the German word list were very similar. See Fig. 1 for the long-term memory data. An initially poorer performance in the aircraft noise exposed children at the old airport, develops into a negligible difference between the groups in wave 3. At the new airport, an initially negligible difference between the groups developed into significantly poorer performance in the aircraft noise exposed group at wave 3.
For the difficult sections of the German reading task there were trends similar to that of the difficult word list, but they did not pass the statistical significance tests.

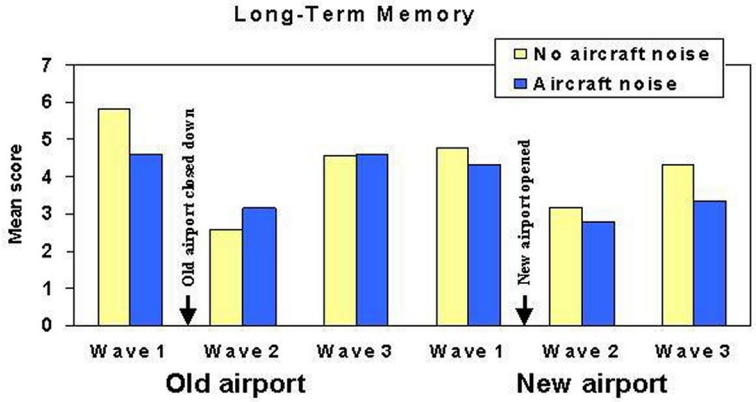

Figure 1: Long-term memory.

In the running memory task, see Fig. 2, the results from the old airport showed recovery from a somewhat poorer performance in the aircraft noise group to the level of the control group in wave 3. At the new airport, the introduction of the aircraft noise after wave 1 did not significantly affect performance.
For the embedded figures task and for the reaction time task there were no significant interactions involving aircraft noise exposure and data collection wave.
Auditory discrimination against different noise backgrounds, in the signal-to-noise task, indicated improvement with age at the old airport, but no differential improvement between the groups. See Fig.

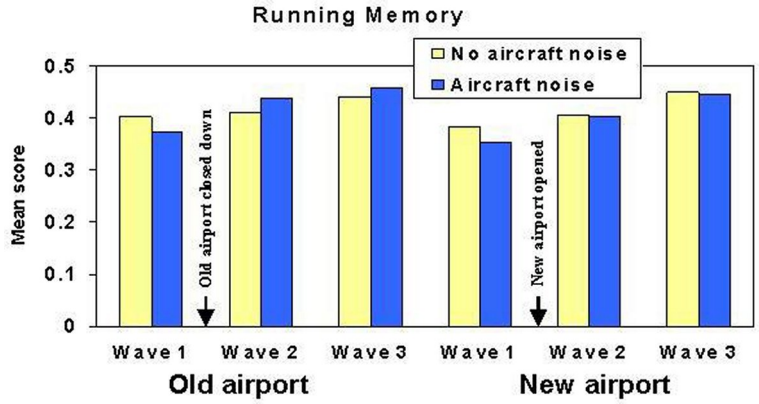

Figure 2: Running memory.

3. (For the signal-to-noise task no data are given for Wave 2 due to apparatus failure). At the new airport, the aircraft noise seems to block the improvement in auditory discrimination that comes with age. The were no significant interactions involving aircraft noise exposure and type of background noise (broadband, aircraft, road traffic).

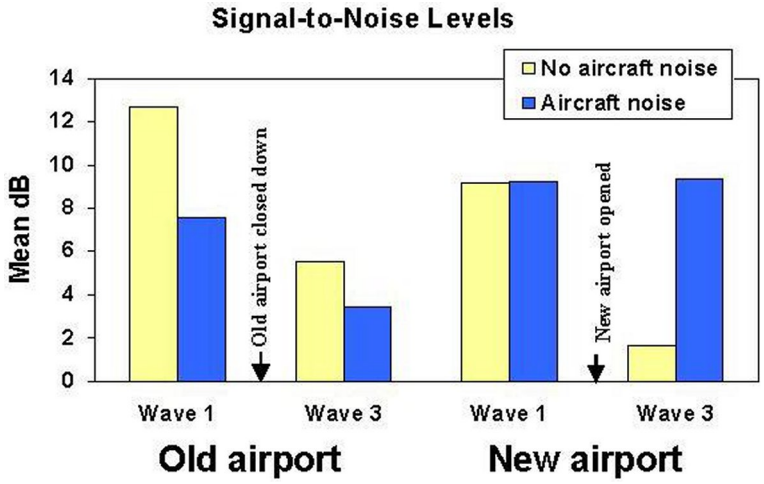

Figure 3: Signal-to-noise levels.

The type of the noise (broadband, aircraft and road traffic noise) played some role in the development of annoyance ratings across measurement waves. At the new airport, there was more of a gradual decline in the ratings of the loudest sounds for the broadband and road traffic noise in the control group than in the experimental group. At the old airport, there were no significant interactions involving aircraft noise exposure and data collection wave. Master scaling (calibrating each individual against the group mean and variation) of the annoyance ratings did not basically change the result pattern.

3 - CONCLUSIONS

Two of the cognitive tasks, recall and language mastery, showed the doubly replicated aircraft noise effect of disappearing when the old airport was closed down and coming forth when the new airport started to operate. This is a very strong empirical foundation for the conclusion that cognitive tasks requiring central language processing are particularly sensitive to noise. For the age span studied (9-12 years) these effects were reversible but of course we don't know how much of the reversibility is locked that age group.

Other cognitive and perceptual measures showed show some, but not double effects of the chronic aircraft noise exposure. Memory span in running memory improved when the old airport closed down. Improvement with age in the auditory discrimination task (signal-to-noise) was delayed in the exposed children at the new airport. Declines with age of annoyance ratings were held back in the same group.

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