# Aircraft noise and times of day possibilities of redistributing and influencing noise exposure

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## Introduction

Many residents living in close proximity to a series of large German airports are affected by the problem that part of the air traffic is undertaken during the night. Alongside the question as to the ill-effects levied on local residents by aircraft noise at night, the question also arises as to what extent common sense prevails in the concept of keeping the night hours mainly free of exposure in return for redistribution of the existing air traffic in the daytime hours between 6 a.m. and 10 p.m. An answer to this question would be required to take due account of the different activities of people at different times of day as well as daytime-dependent sensitivities against noise disturbances. Experience gleaned in Britain on this problem reveals that not only noise rescheduling needs to be considered in this discussion, but the spatial/dimensional redistribution of air traffic volume (e.g. regular changes of runways for takeoff and landing) as well.

## Human activities and times of day

The effects of aircraft noise on human beings are different depending on the time of day. Whereas disturbances of communication and working activities dominate during the day, the desire for recreational pursuits in the evening hours and for sleep at night are affected. The activities of humans and their stress endurance are regulated by their biological rhythm and dependent on the time of day. As well as an increase in sensitivity against noise-contingent disturbances in the evening and early hours of the night, dose-effect studies on aircraft flight noise reveal that people feel harassed to a greater extent at night than during the day by the same noise level (cf. Kastka, 1999; Höger et al., 2001). Particularly the so-called perimeter times of day gained appreciable importance in more recent scientific discussion (cf. mediation group at Frankfurt/Main airport, 2000). The initial assumption is that specific activities, prevalent in the early hours of the morning between 6 and 8 a.m. and in the early hours of the evening between 6 and 10 p.m., are particularly susceptible to disturbances by aircraft noise. In the early morning these comprise psychophysiological processes of adjustment of the human body's performance to the rhythm of the day, and in the evening the phases of recreation and bedtimes for children.

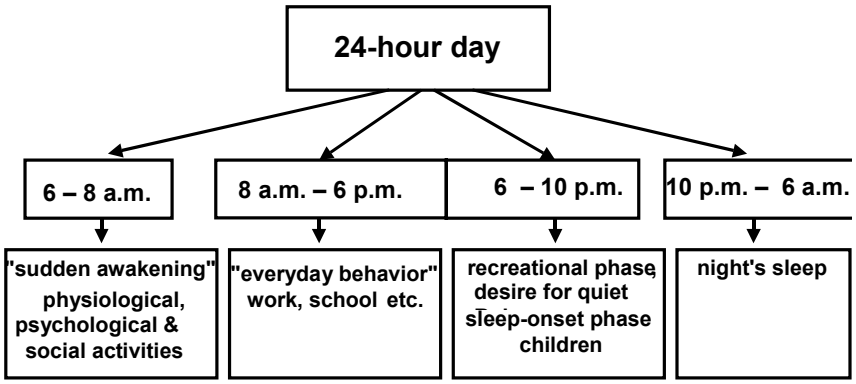


Fig. 1 Subdivision of the times of day relevant to aircraft flight noise.

Fig. 1 shows a subdivision with reference to 24-hour daily activities of humans. Those living in areas close to airports are affected by aircraft noise to different extents depending on these time periods.

## Distribution of the noise exposure over various times of day

In addition to disturbance susceptibility dependent on the time of day, the question arises about the distribution of the dose of noise throughout the day: Which situation is more favorable, distribution of the same dose of noise over a number of or a few heavily laden hours? Information on this is provided by a study from Reichart (1981). Within the framework of a long-term study the effects of sonic wave exposure over different periods of time was investigated. Test persons were exposed to the following noise conditions over four periods of 12 days each:

1. Sound exposure during the day, quiet at night,
2. Sound exposure during the night, quiet in the day,
3. Sound exposure during the day and quiet at night,
4. No sound exposure in the course of 24 hours (control conditions).

A mixture of road traffic noises, the noise of a steam pile-driver and of pneumatic drills was used as disturbance noise. The average sound level under the individual conditions of sound exposure was 76 dB(A) each time.
The test persons were required to perform a series of experimental tests at different times of day every two days during the trial phases. Among these tests were memory tests, a test for checking their ability to arrive at logical conclusions as well as a concentration and performance test (CP-test).

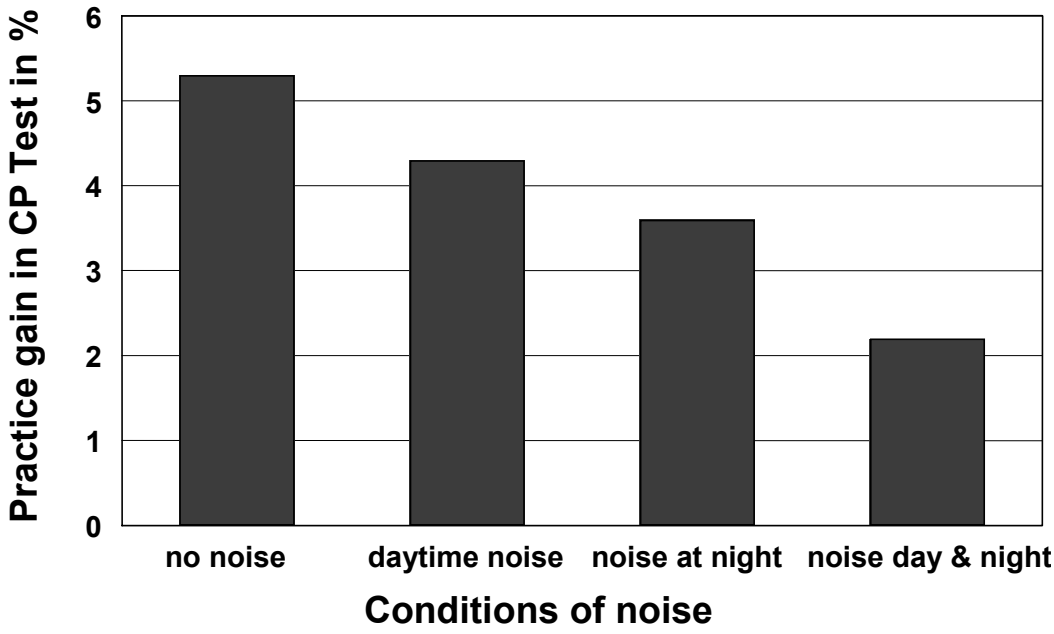


Fig. 2 Practice gain in the CP Test depending on the conditions of sound exposure.

Since the repeated application of tests leads to improvements through practice and measured increases in performance, practice gain was introduced as a variable of the investigations
Fig. 2 shows the practice gain for the concentration and performance test (CA test) depending on the different conditions of sound exposure. It is clear from the illustration that the growth rate of learning is greatest without sound exposure. If the test persons are exposed to sound during the day, the practice gain sinks. If sound exposure is exclusively at night the practice gain declines even further. The lowest growth rates of learning are recorded when the dose of noise is distributed both day and night. It can be concluded from the results that exposure to noise at night has

less favorable effects on performance behavior than the same exposure during the day. Least favorable is the situation when sound exposure stretches over the entire period of 24 hours a day. Transfer of these results to aircraft noise speaks for the upholding of periods at night which are free of sound exposure.

## Sensitivity towards aircraft noise day and night

As a result of the progressive "noisification" of the environment, a demand for peace and quiet or low-noise relaxation times has firmly established itself in the population. Above all, this demand for peace refers to the early hours of the evening and at night. The increased sensitivity against disturbances by noise at these times of day can be read off in terms of publicly uttered complaints. An analysis of the frequency of complaints in the vicinity of Frankfurt airport was carried out by Kastka (1999). The following illustration shows the complaint frequencies summarized in percent for the day and night periods in each case. At the same time, the graphics show the air traffic volume during both periods of time.
As is apparent from the illustration, the frequency of complaints is not proportionally associated with a reduction of the traffic volume at night, but rather reveals over-proportional characterization at night.

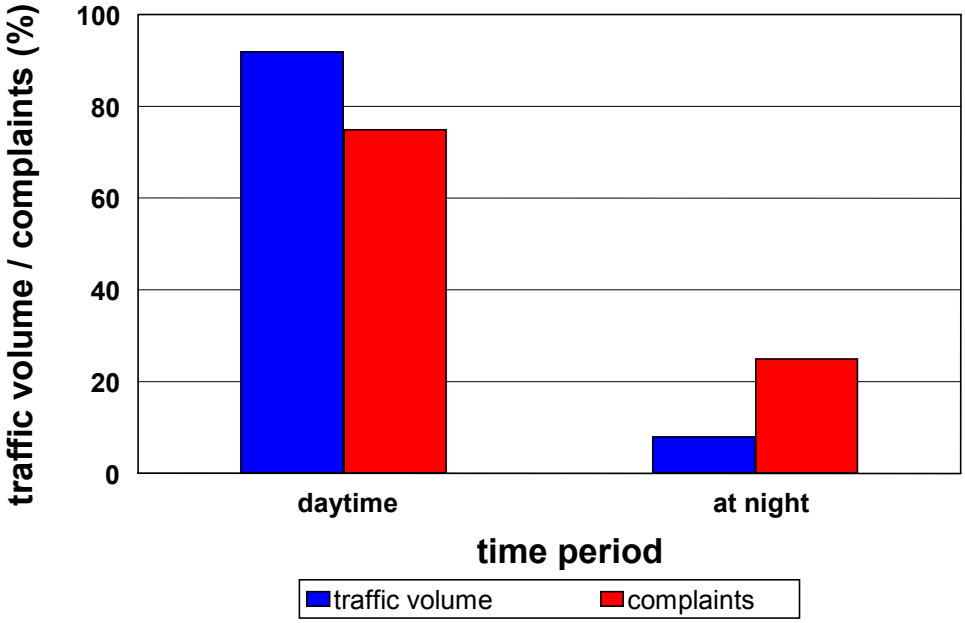


Fig. 3 Frequency of complaints and air traffic volume at Frankfurt airport for the daytime and night-time periods.

These findings makes it clear that residents in the vicinity react more sensitively to disturbances caused by aircraft noise at night than to exposure in the daytime. The reasons for this can be seen on the one hand in the demand for peace at night, and on the other hand in activities such as sleep onset which are particularly susceptible to disturbances by noise. The sensitivity change shown here is also reflected in the dose-effects curves for aircraft noise which reveal greater degrees of harassment by the same noise levels in the night-time period than in the daytime period (cf. Höger et al., 2001). Viewed collectively, these results assign particular significance to the night-time, where humans react more sensitively to aircraft noise than in the daytime.

## Possibilities of noise rescheduling and influence on the noise exposure

The representation shown above indicates that it would be sensible from the psychological viewpoint to keep the night free of exposure to flight noise. A consequential approach to this would be rescheduling the existing traffic to the daytime. But how would local residents react to changes in the noise situation after this timetable rearrangement?

An initial starting point for this was provided by a study at London's Heathrow airport (Flindell & Witter, 1999). In a field study, the runways for takeoff and landing were switched at regular intervals and the local residents questioned about the effects. An alternating switchover of takeoff and landing runways leads to a redistribution of the noise exposure over the area as a whole in the sense that, in contrast to normal operation, the noise exposure of part of the population decreases and that of another part increases. The questioning of the local residents produced two essential findings:

1. only 18% of those questioned noticed any difference at all in terms of the changed operating conditions of the airport and the associated changes in noise exposure;
2. among those people who noticed a change, 34% reported an improvement and, in opposition, 10% a deterioration of the situation.

The results indicate as a whole that rescheduling may be undertaken within a certain framework without any change in the subjective perception of the exposure situation by the majority of the population. No data are available, however, which might permit quantification of the reorganization potential. The question as to what extent night-flight operation could be rescheduled at other times of day is unanswerable on the basis of the existing information. Appropriate studies would be necessary for this purpose.

The switch of takeoff and landing runways according to the time of day are of course not the only possibilities of regulatory intervention in noise exposure. In their article on "noise management" at airports Flindell and Witter (1999) suggest a series of other measures with the purpose of protecting the population from aircraft noise – at night above all:

- arranging flight paths over thinly populated areas,
- optimization of flight paths with reference to their immission levels,
- laying down takeoff and landing quotas, especially during the night, for different types of aircraft, depending on their noise emission,
- laying down the total number of permissible takeoffs and landings during the night,
- penalty charges where emission levels specific to the type of aircraft are exceeded.

Taken as a whole, the measures are aimed at using all administrative possibilities to sink the noise exposure either directly or indirectly (e.g. by charges specific to noise emission). Using a mixture of the different rules significant reductions of flight noise exposure can be achieved – depending on the strictness of the criteria applied.