

Quality of Life
Health
Development

NORAH

Knowledge No. 4

NORAH noise impact study

Child Study: Impact of aviation noise on children

Results

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Results

“NORAH Knowledge” provides information on the methods and results of the NORAH noise impact study. The aim of this series is to communicate to as many people as possible what exactly NORAH is researching. This is why there is an explanation in the glossary at the end for all terms marked “Glossary”. If you would like to receive further issues of “NORAH Knowledge”, please use the enclosed order form.

The NORAH Study examines the long term effects of traffic noise (Glossary) on health, quality of life and childhood development in the Rhine-Main Region. The initiator of the study is the Airport and Region Forum (AFR). The scientists were accompanied from the start by an external Scientific Advisory Board for Quality Assurance (WBQ). This is what distinguishes NORAH from similar, predecessor studies. The study addresses some of the most topical issues currently being dealt with by international noise impact research. It also covers a wider range of investigation aspects than previous studies. In order to find out more about how human beings respond to traffic noise, the NORAH scientists also looked at the medical histories of more than one million people, and reconstructed the noise exposure over the last 18 years at 900,000 addresses in the Rhine-Main Region. A total of five sub-studies form the core of the NORAH Study. Each one builds on the current international state of research, and attempts to understand more precisely how traffic noise affects people. In this edition of NORAH Knowledge we present the results of the Child Study, one of the five sub-studies. The Child Study is an advance publication; the main part of the study will be published in autumn 2015. NORAH Knowledge No. 1 contains detailed information on the methods and tasks of the Child Study.

NORAH (“Noise Related Annoyance, Cognition, and Health”) is the most extensive investigation into the effects of exposure to aviation, road and rail noise that has ever been carried out in Germany. It is being conducted by nine independent scientific institutes from all over Germany. The client is the Umwelt- und Nachbarschaftshaus, a subsidiary of the Land of Hessen and part of the Frankfurt Airport and Region Forum. Alongside the land of Hessen, communities, Fraport AG and Lufthansa were also involved in the financing.

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Further information on the NORAH Study can be found on the Internet at

www.laermstudie.de.

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CENTRAL RESULTS OF THE CHILD STUDY – SUMMARY

What impact does aviation noise have on childhood development and quality of life? The NORAH Child Study attempted to find an answer to this question. To do this, the scientists on the NORAH team conducted tests, surveys and measurements at 29 schools, in 85 school classes, with 1,243 children, 1,185 parents and teachers in the Rhine-Main Region. The study focuses on learning to read, the health and wellbeing at school of the children as well as the noise exposure when learning at home and in school. It thus builds directly on earlier studies at other locations and attempts to answer some as yet open questions.

Aviation noise reduces reading performance

In areas with high exposure to aviation noise, primary school children learn to read more slowly than children in quiet areas. In the second grade children examined, an increase of the continuous sound level ([📖 Glossary](#)) by ten decibels ([📖 Glossary](#)) delayed acquisition of reading skills by one month. The connection is linear: the higher the exposure, the greater the negative effect on development. NORAH was unable to verify direct effects of aviation noise on precursor skills for reading acquisition such as phonological awareness or listening comprehension.

More on this on page 6.

Quality of life in terms of school and health slightly affected

The overall quality of life of the children surveyed in the Rhine-Main Region is high – most of the second-grade children feel very well; they are healthy and enjoy going to school. Children in areas with high exposure to noise do not feel quite as well as children in quieter areas. In addition to this, parents surveyed in areas with relatively high aviation noise exposure stated more frequently that their child was taking prescribed medication or had been diagnosed with a speech or language disorder. The children concerned were no different, however, to the other children in terms of their ability to learn to read.

For more on this see page 8.

Aviation noise disturbs lessons

Teachers from areas with relatively high aviation noise exposure reported unanimously that the noise causes considerable disturbances to lessons. Classes are interrupted in various ways by aviation, often distracting the children's attention. More than one third of the children from these schools are sometimes unable to hear the teacher properly due to aviation noise.

For more on this see page 12.

WHAT DID THE CHILD STUDY EXAMINE?

If children are permanently exposed to aviation noise, this can have a negative impact on their intellectual development and their learning performance. Various previous studies have come to this conclusion. In particular, the ability to read appeared to suffer under the influence of aviation noise. However, these older studies did not take into account several confounding factors (📖 [Glossary](#)) that might have influenced the result. Also, they were carried out in areas with very different and considerably higher noise exposure.

The greatest difficulty in the investigation of learning performance under the influence of aviation noise: we know from numerous educational studies that learning performance is determined by a wide range of different factors. Among other things, the socioeconomic status (📖 [Glossary](#)), for example the educational standard and the income of the parents, as well as their origins, can have a clear statistical influence on the learning performance of the children. The scientists have to take all of these factors into account and filter them out if they want to find out what impact aviation noise has on learning to read.

The scientists in the Child Study tried to answer the following questions:

- ▶ Is it possible to identify a negative impact of aviation noise on intellectual abilities such as reading acquisition, linguistic skills, attention or memory of children in the Rhine-Main Region?
- ▶ How exactly does aviation noise at school affect lessons?
- ▶ To what extent does aviation noise affect the wellbeing of the children at home and at school?
- ▶ How large is the influence of aviation noise relative to other factors?

The selection of schools and children

The scientists first divided up the Rhine-Main Region into different “noise level classes”, i.e. into regions where a certain continuous noise level (📖 [Glossary](#)) prevails during the day. Schools in all four areas were asked to participate. A total of 1,243 second-grade boys and girls took part in the investigation, around the same number in each sound level class. The schools with the lowest level of aviation noise exposure had a continuous noise level during the day of 39 decibels (📖 [Glossary](#)). In the schools with the highest level of exposure, the continuous noise level was 59 decibels. At the time of the investigation, there were no primary schools in the Rhine-Main Region with higher exposure to aviation noise than the primary schools in the highest sound level class.

In order to investigate how well the children can read, the scientists used standardized tests which are also used in other learning studies. The study also wanted to examine the thesis that exposure of children to aviation noise has an effect on the precursor skills for reading acquisition which normally develop at a pre-school age. These skills – for example listening comprehension – are important for learning to read later. The NORAH team also asked the children, their parents and the teachers about the wellbeing and the quality of life of the children and about the extent of the negative effect they feel aviation noise has on them.

**1,243 boys and girls
in second grade,
continuous noise
level during the day
between 39 and
59 dB (A)**



Kirstin Bergström

Individual noise calculations

In order to identify a connection between the performance of the children and the noise exposure, it is important to know as precisely as possible which noise level each individual child is exposed to at home and at school. This is why the NORAH acoustics team carried out extensive noise calculations for the Child Study. This was based on the radar records of all flight movements in the Rhine-Main Region for the last 15 years. These were used to calculate the individual aviation noise exposures in the twelve months before the data collection for all the residential and school addresses of the children in anonymized form. In their evaluations the NORAH scientists also took into account the existing sound insulation and the reverberation times in the classrooms. The acoustic team also calculated the noise exposure due to rail and road noise where the children live and at school.

The current state of research

One of the most important studies carried out before NORAH on the impact of aviation noise on children is the so-called RANCH Study. In 2001 this study investigated similar questions at the airports of Amsterdam, Madrid and London, and discovered a connection between aviation noise and reading performance. Some of the results of the RANCH Study were contradictory, however. Also, they cannot be fully applied to the current situation in Germany because the noise levels in the RANCH Study were much higher. One important assumption of RANCH and other studies is that if aviation noise has any impact on school performance, then most likely on learning to read, because this has to do with language processing. This is why both RANCH and NORAH focussed precisely on this aspect.

Overview: What did the Child Study investigate and how?

What was investigated?	Method
<ul style="list-style-type: none"> Aviation, rail and road noise exposure at school and at home 	Data calculated by the NORAH acoustics team
<ul style="list-style-type: none"> Building and room acoustics of the classrooms 	Estimation methods for determination of the reverberation time and the noise insulation
Reading ability and precursor skills <ul style="list-style-type: none"> Reading skills Short and long-term memory for linguistic information Phonological awareness Speech perception Attention Non-language skills 	Standardized group tests in the class
Quality of life and environment <ul style="list-style-type: none"> Wellbeing at school and at home, classroom atmosphere, socioeconomic status 	Child survey, parent questionnaire, teacher questionnaire
Noise exposure at school and at home	Child survey, parent questionnaire, teacher questionnaire



The scientists used standardized tests to examine the reading ability and the precursor skills of the second-grade children.



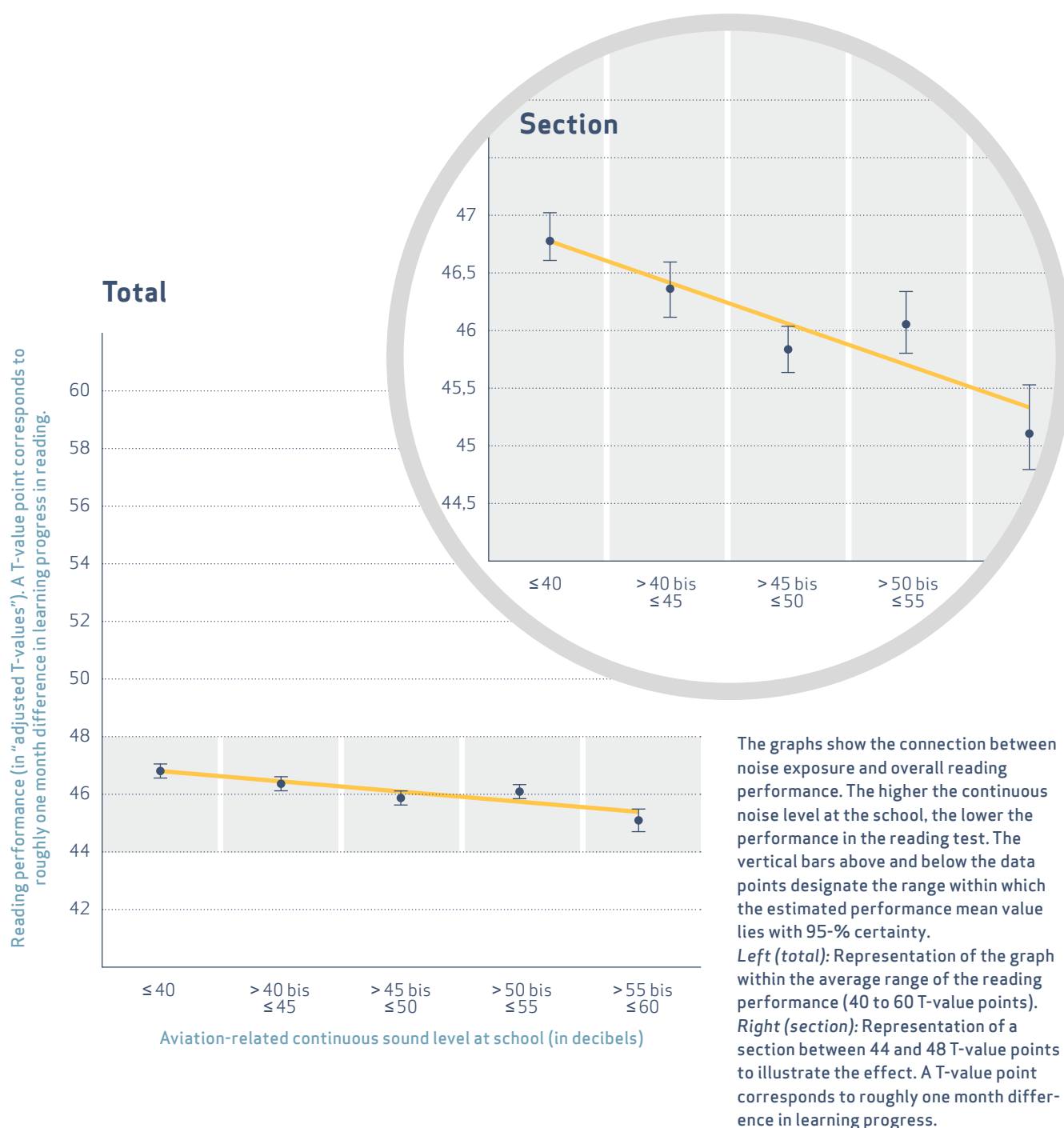
Twin Design/Shutterstock

THE EFFECTS OF AVIATION NOISE ON LEARNING TO READ

Aviation noise has an effect on the reading performance of children who are in the learning-to-read phase. The connection is linear: the higher the exposure, the greater the negative effect on development. In the second-grade children examined by the study, an increase of the continuous noise level (see [Glossary](#)) by ten decibels (see [Glossary](#)) delayed learning to read by one month. An increase of the continuous noise level by 20 decibels led on average to a delay of two months. For the investigation area of the NORAH study, this means that the delay is around two months in the areas with the highest exposure to aviation noise.

What else has an influence on learning to read?

The NORAH Study not only investigated the effects of aviation noise on learning to read but also other factors whose influence on learning is known – for example German-language skills or the number of children's books in the home. This was the only way to determine exactly the extent of the effect of aviation noise on learning to read. With these data the scientists were also able to show that some of the factors investigated in the study had a greater impact than aviation noise on learning to read. For example, children who have a lot of books were four months ahead in reading texts compared with children who do not own their own books. It is not possible to make a direct comparison here, however, because parents can decide themselves how much help they want to give their children in learning to read. They do not have any influence, however, on the aviation noise.



The NORAH scientists were unable to establish any statistically significant connection ([Glossary "Significance"](#)) between aviation noise and learning to read in children with a migration background. This result should not, however, lead to any hasty conclusions. The authors of the study suspect that it is due to a statistical effect: it is possible that there are so many factors confounded in this sub-group that it was no longer possible to reliably identify effects of aviation noise.

The result certainly does not mean that children with a migration background are insensitive to aviation noise.

If we look at only the children without a migration background, an increase of the continuous noise level by ten decibels led to a delay of 1.5 months in learning to read. This means that the difference between the children most exposed and the children least exposed in the investigation area was three months.







Still unknown: the reasons for the reading deficit

Up to now, researchers have not been able to explain exactly how aviation noise impairs the ability to learn to read. Some scientists suspect that the noise exposure has an effect on the development of the so-called precursor skills – skills that children acquire at a pre-school age. This includes for example “phonological awareness”, which allows us to identify the sounds in words, and good listening comprehension. NORAH Study examined this thesis. The result: the scientists were unable to identify any link between aviation noise and the precursor skills.

THE QUALITY OF LIFE OF THE CHILDREN IN THE RHINE-MAIN REGION

The NORAH-scientists were not only interested in the reading performances, but also in the general health and quality of life of the children. The questions they asked the children and their parents concerned, for example, the sleep quality or the mental and physical wellbeing. The results show that the quality of life of the children in the investigation area is generally very high. The children and parents with relatively high exposure to aviation noise, however, assessed the health and quality of life of the children as slightly poorer than those with low exposure. Although the difference is small, it is statistically significant ([Glossary “Significance”](#)): with an increase of the aviation noise by ten decibels, the quality of life fell on the three to five-point assessment scales by an average of 0.1 scale points.

No effects verified on precursor skills

															
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In the so-called picture test, the children were asked to put a line through everything that begins with B, and mark all of the other pictures with a dot. This allowed the NORAH scientists to examine how quickly children can call up words from their memory and make a decision on the sound of the first letter (B or not B).

Noun fonts/ Eugen Traeger Verlag

The quality of life from the point of view of the children

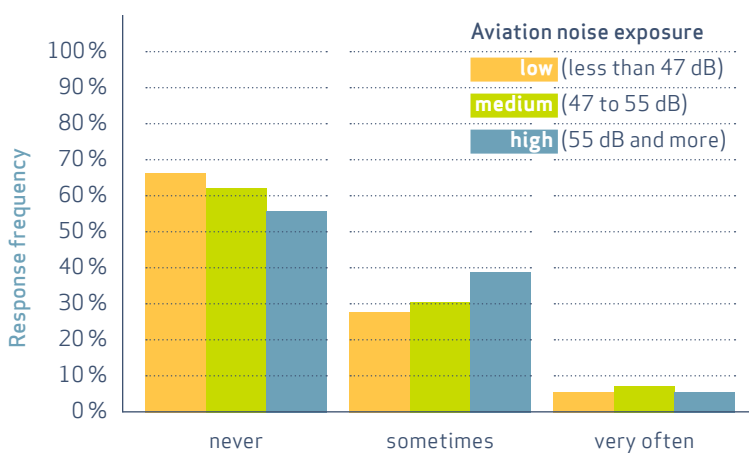
In order to find out how the children assess their physical and mental quality of life, the scientists asked them to answer various questions relating to the last week. Among other things, children were asked whether they had suffered from headaches or tummy problems in this time, whether they slept well, and whether they had been bored. To answer the questions they could choose from “never”, “sometimes”, or “very often”. It was shown that there was a statistically significant effect of the aviation noise on the responses.

In the group of children with the lowest level of noise exposure, 67 percent stated that they never had headaches or tummy aches. In the group of children with the highest level of noise exposure only 56 percent said this. The scientists were able to statistically rule out any other differences between the groups – e.g. different socioeconomic status ([Glossary](#)) – that might have had an influence on the children’s responses.

The results were similar when the children were asked whether they had slept well in the past week. In the group with the highest level of noise exposure, 20 percent of the children stated that they “never” slept well – compared with 15 percent of the children with only low exposure to aviation noise. The parents, however, gave a different assessment of the sleep quality of their children: their responses to the question about their children’s sleep do not indicate any connection with aviation noise.

To assess their mental wellbeing, the children were asked, among other thing, whether they had been bored in the past week. The result: the more aviation noise, the more likely the children were to state that they had been bored in the last week. An increase in the aviation noise by ten decibels ([Glossary](#)) led to a deterioration of 0.14 on a three-point scale. Only around 40 percent of the children with high noise exposure stated that they were never bored, compared with 53 percent of the children in areas with low aviation noise exposure.

“In the last week I had headaches or tummy ache.”



Responses of the children to the statement “In the last week I had headaches or tummy ache” in the groups with low, medium and high aviation noise exposure. Children in the areas with high exposure were less likely to state that they had “never” suffered from headaches or tummy ache.

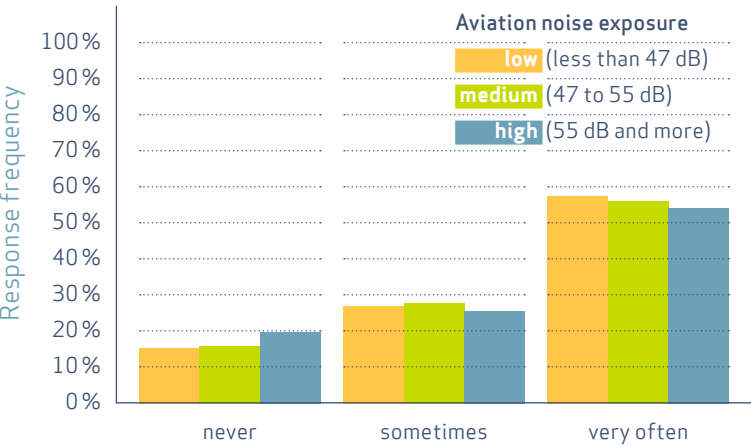
More medication and speech or language disorders

A total of 1,185 parents answered the scientists' questions about the health and the wellbeing of their children. They also provided information on the disorders which their children suffer and about absence times from school. In most of these answers the scientists were unable to identify any differences that could be attributed aviation noise.

For two questions, however, there proved to be a connection between the parents' answers and the aviation noise exposure. Ten percent of the parents in areas with relatively high noise exposure state that their children are currently taking prescribed medication. In the residential areas with medium exposure it was only four percent, and in the regions with low exposure just under six percent.

In areas with relatively high noise exposure, 14 percent answered "yes" to the question: "Has a doctor ever diagnosed a language or speech disorder in your child?" In areas with low noise exposure, only 10 percent gave this answer, in the residential areas with medium exposure it was 8 percent. These results are statistically unequivocal. It was not asked, however, what the exact nature of the disorder was. By comparison: in Germany as a whole the frequency of speech or language disorders in children ranges, depending on the diagnosis criterion, between 2 and 15 percent. The connection should thus be made the subject of further investigation. It is important to know that the children described as being diagnosed by their parents did not differ in their reading performance to the rest of the group.

"In the last week I slept well."



Responses of the children to the statement "In the last week I slept well" in the groups with low, medium and high aviation noise exposure. Children in the areas with high exposure stated somewhat more frequently that they were "never" able to sleep well in the last week.



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How happy are the children at school in the Rhine-Main Region?

Some studies show that a high level of noise exposure at school can also influence the attitudes of the children to school and learning. This is why the NORAH Study also looked at the “school-related quality of life”. For this purpose the children responded to statements such as for example “I am happy learning new things” and “I feel well at school”. The result showed a statistically significant ([Glossary “Significance”](#)), but very low influence of aviation noise on the responses. Children exposed to relatively high levels of aviation noise are slightly less positive towards learning and school. The difference amounts to just one eighth of a scale point on a four-point scale.

The parents and teachers were also asked about the school satisfaction of the children and about the atmosphere in the classroom. This did not show any significant connection with aviation noise.

DOES AVIATION NOISE DISTURB LESSONS?

The degree of annoyance caused by noise is subjective: the same sound can bother one person more than it does another. This is why it is not possible to deduce from the noise level alone how burdened people feel by aviation noise. In order to find this out within the framework of the Child Study, the scientists asked parents, children and teachers whether and, if yes, to what extent, the aviation noise disturbed children when learning.

Noise exposure from the point of view of the children

In order to find out whether the children felt disturbed by aviation noise, the scientists asked them several questions. For example, the NORAH team asked the second-grade pupils to assess the statement “The noise of the planes disturbs my lessons.” They could choose from four possible answers: “strongly disagree”, “partly disagree”, “partly agree” and “strongly agree”. In the group of children whose schools were exposed to a relatively high level of aviation noise, 27 percent stated that the noise disturbs their lessons. Only 7 percent of the children in the group with low noise exposures gave the same answer. Communication in the classroom also suffers from aviation noise: 38 percent of the children – i.e. more than one third – at the schools with high exposure stated that they were sometimes unable to hear the teacher properly due to aviation noise.

The point of view of the teachers

From the teachers the NORAH scientists wanted to know how aviation noise affects classes – for example, how often it leads to interruption of lessons. The teachers in the areas with relatively high aviation noise exposure reported unanimously that the noise causes a considerable disturbance of lessons: 24 percent stated here that they have to interrupt lessons due to aviation noise “very often”, a further 29 percent answered with “often”. In the areas with low noise exposure, nobody chose the answers “very often” or “often” or “sometimes”.

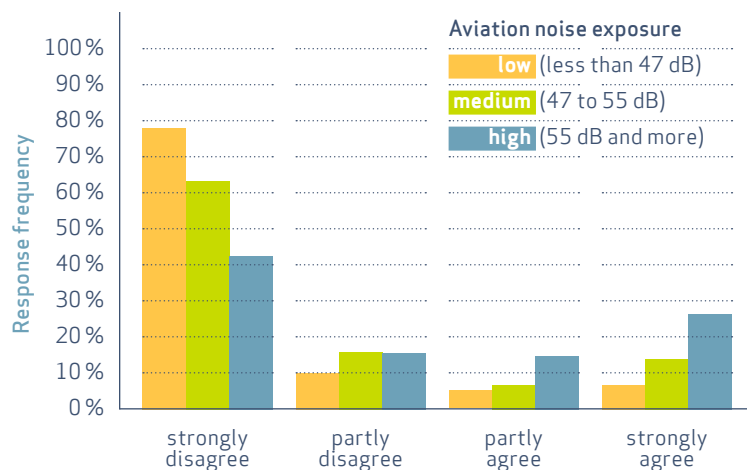
Questions regarding the teaching process showed a connection with aviation noise exposure: 52 percent of the teachers in the areas with high exposure said that the children were “often” or “very often” distracted from their lessons due to aviation noise, 57 percent said they always keep the windows closed even when the weather is warm. 76 percent stated that aviation noise could be heard “often” or “very often” even with the windows closed. Outdoor activities at schools with high aviation noise exposure are also less common: 38

percent of the teachers in these areas agreed fully or partly with the statement “Due to aviation noise I am less likely to undertake outdoor activities with the class” – compared with three percent at the schools with medium exposure. Nobody chose these answer options at the schools with low exposure.

Aircraft and other noise sources

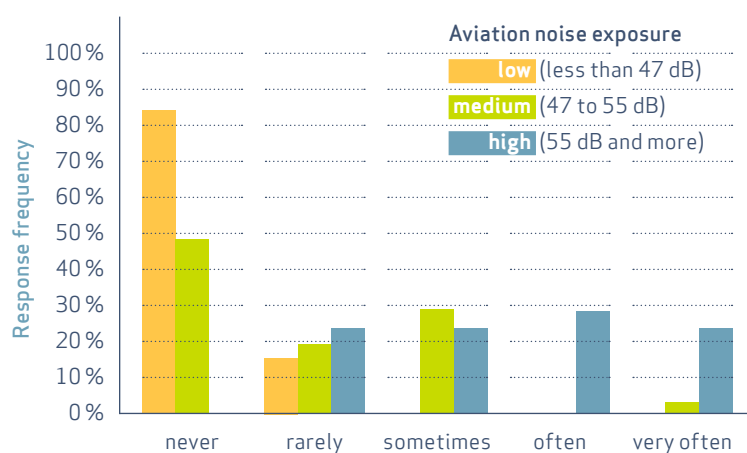
Even where there is no aviation noise, schools are not quiet places: noise penetrates into the classroom from the playground and from the other classrooms. In order to estimate which role aviation noise plays compared with other noise sources, the scientists asked the teachers to estimate which types of noise their classes are exposed to and to what extent. For each source of noise the teachers estimated the degree of class disturbance on a five-point scale, where 1 stood for “no disturbance” and 5 for a “very high disturbance”. The result: teachers perceive noise from the playground or from the other classrooms as disturbances of their class. However, at schools with relatively high aviation noise exposure, from the point of view of the teachers the greatest disturbance by far is aviation noise: On the five-point scale the answers for this type of noise reach an average value of 4.5. In order to make the clearest possible statements about the impact of aviation noise, the NORAH Study did not include any schools with very high exposure to road or rail traffic noise. This is why the teachers assessed the disturbance of classes due to these types of noise as relatively low. This, however, cannot be generalized. In the Rhine-Main Region there are also schools with very high exposure to road or rail noise.

“The noise of the planes disturbs my lessons.”



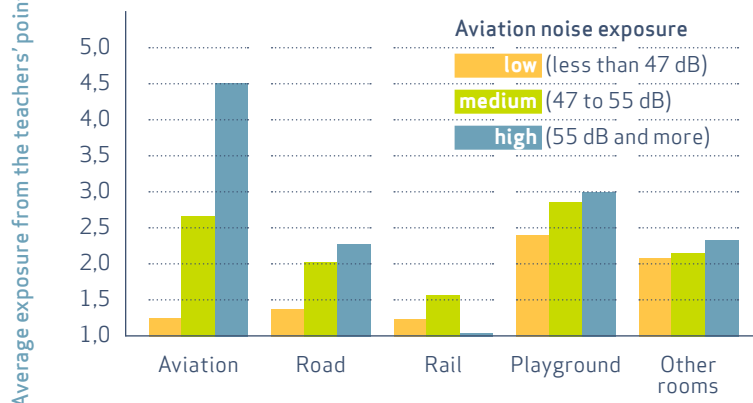
Responses of the children to the statement “The noise of the planes disturbs my lessons” in the groups with low, medium and high aviation noise exposure.

“Due to the aviation noise I have to interrupt the lesson/my speech for a moment.”



Responses of the teachers to the statement “Due to the aviation noise I have to interrupt the lesson/my speech for a moment” in the groups with low, medium and high aviation noise exposure at school. Almost one quarter of teachers in high-exposure areas state that they have to interrupt lessons due to aviation noise “very often”.

“Which type of noise disturbs lessons and to what extent?”



Teacher assessment of the disturbance of lessons due to various noise sources at schools with low, medium and high exposure to aviation noise (mean values: 1 = no burden, 5 = very high burden). According to the teachers at schools with high exposure to aviation noise, this is more disruptive of lessons than noise from the playground or other rooms.

INTERVIEW WITH THE STUDY DIRECTOR PROF. MARIA KLATTE



Thomas Schinauer

Director of the Child Study: Psychologist
Prof. Dr. Maria Klatte from the Technical University of Kaiserslautern

Prof. Dr. Maria Klatte is the director of the Child Study. In an interview with “NORAH Knowledge” the psychologist from the Technical University of Kaiserslautern talks about her assessment of the results.

Did any of the results of the NORAH Child Study surprise you?

There is already a whole range of studies on this issue. The children in those studies, however, were subject to much higher levels of exposure to aviation noise, spectacularly higher levels. Nonetheless, only very minor effects could be identified. With this pre-knowledge we were not sure at the start of the study whether we would even be able to detect any effects on the reading performance of the children. We had not expected that statistically significant effects could be verified despite the low levels of exposure.

Were the other results as you expected them to be?

No, for example the increased frequency of medically diagnosed speech and language disorders and intake of medication: that is a result of the parent survey. We did not expect that this would show up so clearly. This is something we really need to pursue further to find out what exactly is behind it.

In your opinion, how serious are these speech and language disorders?

We do not know exactly which type of disorders led to the differences shown in our study. But we did examine whether the children who, according to their parents, had a speech or language disorder differ from the other children in terms of their reading performance. This is not the case. This is why we do not believe that we are looking at very serious disorders here. But we do not know exactly, and this is why there have to be follow-up investigations.

If parents hear about your study and start asking themselves whether their child is worse off than children in quieter areas: what would you tell them?

We asked the parents and the children about the physical and mental wellbeing of the children. This was represented as very positive by both groups. Children exposed to aviation noise do not feel bad, but they do feel a tiny bit less good. Other factors certainly have a greater influence on the wellbeing of the children. Nonetheless, the effect is statistically significant. And we cannot tell how that will develop in the long term if the children have to live and learn under the influence of aviation noise.

You identified a delay in learning to read of up to two months in second-grade pupils. Does this mean that children living near an airport are less likely to complete secondary school or generally have fewer chances?

It is not possible to answer that with any certainty because we do not know how the relatively small difference in the second-grade pupils will turn out in the long term. First we have to say that the identified statistical effect on the reading performance is small. There are other influencing factors that are far more important. But we do not know how that will develop. We also surveyed the school directors of the participating schools. We asked them which proportion of the children in their school go on to secondary school from primary. We did not find any difference here: in the schools exposed to high levels of aviation noise that participated in the study, on average the same proportion of children went on to secondary school as in the schools with lower exposure.



Monkey Business Images/Shutterstock

You also spoke to teachers ...

Yes, the clarity of the results of the teacher survey were a surprise. We know that interruptions of the teaching flow are very unfavourable for children at this age. Up to now, research has focused mainly on reading performance. But these frequent interruptions can, of course, also have an unfavourable effect on other subjects.



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OUTLOOK: WHAT HAPPENS AFTER THE CHILD STUDY?

The Child Study within the framework of NORAH delivered several important insights which will help us to understand how aviation noise affects the intellectual development and the quality of life of children. We now know, for example, with very high probability, that aviation noise impairs learning to read. But the Child Study also threw up some new questions. Further studies are necessary to provide the answers to these.

One of the unanswered questions is: in what way exactly does aviation noise affect learning to read? The NORAH Study was unable to confirm that the important precursor skills for reading acquisition develop less well under the influence of aviation noise. This is why scientists now have to postulate new theories and examine them in suitable studies.

Another question that has newly arisen within the framework of NORAH concerns the health and quality of life of the children. Parents from the residential areas with high exposure to aviation noise stated more frequently that their child was taking prescribed medication at the time of the survey or had been diagnosed as having a speech or language disorder. The Child Study did not, however, investigate which medication was being taken or whether certain language or speech disorders are particularly frequent. These questions – which have never been raised by any previous study – must also be made the subject of further studies.

We also have to answer the question as to the further development of the children concerned – in particular if they continue to be exposed to aviation noise. Will the effect of the aviation noise get worse, will it remain the same, will it become less or disappear altogether? The NORAH Study cannot make any statement on this because it has not followed the progress of the children concerned. A so-called longitudinal study which would register the performance of the same children at various points of time in the future – for example in a few years – could provide answers to these questions.

Glossary

Further explanations can be found in the glossary at www.laermstudie.de.

Continuous sound level

The equivalent continuous sound level (in short: L_{pAeq}) is a measure for the average noise exposure over a certain period in which frequency, duration and level of the individual sound events are taken into account. The L_{pAeq} is the basis for the determination of noise protection zones pursuant to the aviation noise act – separated according to day (6 – 22 hrs) and night (22 – 6 hrs). The L_{pAeq} is stated in decibels (dB).

Decibel

Decibel (dB) is a physical unit of measurement used, among other things, for the sound pressure level. The NORAH Study uses the so-called A-weighted sound pressure level. This means that when the sound event was measured, frequencies were weighted with a filter designed to replicate human hearing. The “A” in the expression L_{pAeq} is a reference to the use of the A-weighting.

Significance

In statistics we speak of a significant result if there is only a very low probability (usually less than 5 %) of it being a random effect. The significance can be checked using statistical methods.

Socioeconomic status

Socioeconomic status is an artificial term that attempts to summarize an individual's economic and social position in society. In the NORAH Study the socioeconomic status was determined with the aid of the so-called “Scheuch-Winkler Index”. This is calculated from the three factors: net income, education and qualification and professional position.

Confounding

Confounding occurs when a phenomenon depends on two or more conditions that are mutually influencing. If, for example, we want to investigate whether frequent tooth brushing prevents tooth decay in children, it would not be sufficient merely to examine the brushing behaviour and the dental status. This is because children who frequently brush their teeth are most likely actively encouraged to do so by their parents (few of them do it of their own accord). The same parents will probably allow their children fewer sweets. It could be that the healthier teeth are not due to frequent brushing but to a healthier diet. We can only find this out by examining both.

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Concept, text and design

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