

**Summary:**

# **Effect of noise on children in learning situations. A literature review**

## **Introduction**

Noise produced in modern society is an important source of annoyance for many people. For children the adverse effects of noise can be more severe than for grown-ups. As a part of a Research Council programme to reduce noise, a literature study of the effects of noise and acoustical conditions in schoolrooms on the cognitive performance of children has been undertaken. One of the aims of this research is to obtain information that in due time can be used as part of a national programme to improve the sound environment of children, especially classrooms.

## **Factors affecting the sound environment in classrooms**

Inferior acoustical conditions in a classroom can occur for several reasons. The classroom can be exposed to high noise levels from external noise sources (road traffic, aircraft, train, industrial and construction work) or internal sources such as noise from other classrooms, technical installations and noise produced by the children in the classroom themselves.

A high noise level reduces the signal/noise ratio (the sound level of what is being communicated relative to the sound level of the background) – making it more strenuous and difficult to grasp what is being communicated. The pupils cannot hear clearly what the teacher is saying because he/she is not speaking loud enough. Reflected sound from ceiling and walls (reverberation) can obscure the auditory sound information. A measure of this effect is the reverberation time, the time until an original sound impulse fades away.

The comprehension of a verbal communication depends on the linguistic and cognitive abilities of the person receiving the message. Adults and children with a good grasp of the language have the ability to fill in the gaps of an incomplete message and deduce its content. For smaller children this is more difficult or not possible. The effect of inferior acoustical conditions is thus largest for these children. For children with hearing problems, learning difficulties, with a different native language etc. the problem of comprehending a verbal message is exacerbated.

Teachers that are aware of the problems caused by the acoustical conditions in a classroom can reduce the adverse effects by speaking clearly and distinctly with a loud voice. Using a loud voice may, however, also result in voice problems, an occupational hazard for teachers.

While noise in classrooms have a predominantly adverse affect on the teaching environment, it should not be ruled out that a certain level of background noise also can serve to mask random and unexpected noises that otherwise would have been more distracting.

### **Acoustical conditions in classrooms**

WHO recommends that the background equivalent noise level should be under 35 dBA. However, studies in many countries have shown that the actual noise levels exceed this limit by far and that exposure to such high levels of external noise has the additional indirect effect of the teacher and pupils raising their voices in order to compensate for the background sound level. In order to assess the noise levels within a classroom it is therefore necessary to obtain information on the initial indoor noise background noise levels and the subsequent increase due to such compensation by teacher and pupils. In many cases, however, only the outdoor noise levels are available.

It is recommended that the Signal/Noise ratio should be between 10 and 15 dBA. The results from studies in actual classroom situations indicate that the Signal/noise ratio is much lower, and in some cases even negative. This makes it exceedingly difficult for the pupils to discern what the teacher is actually saying.

In Norway it is recommended that the reverberation time lie below 0.8 seconds, and below 0.6 seconds in nurseries and classrooms intended for children with hearing problems. In literature from America it is recommended that the reverberation time is below 0.4-0.6 seconds in classrooms. However, studies indicate that reverberation times can vary widely between classrooms, and that the reverberation time lies from 0.4 and up to 1.5 seconds).

A systematic mapping of the acoustical conditions in Norwegian classrooms has not been undertaken. It is to be feared that the conditions are not very different from those revealed in the studies undertaken in other countries. Due to Norway being more sparsely populated with reduced traffic density, snow during the winter, reduced outdoor activities, and the use of lighter building materials the acoustic conditions in classrooms may however deviate in both directions from that in other countries.

### **Noise and cognitive performance**

A range of studies on the relationship between noise (both chronic and acute) and the cognitive performance of children have been undertaken. This field of research is difficult and many of the studies are subject to methodological weaknesses. Nonetheless, some conclusions can be drawn:

*Auditory discrimination and reading skills.* Several studies show that chronic noise results in inferior reading skills. There is also some support for the hypothesis that the reduced reading ability is the result of noise impairing the ability to discriminate between different sounds, and the ability to apprehend spoken messages.

*Attention/distraction.* Acute noise can serve as a distractor reducing the concentration on the tasks at hand. However, it is not as clear whether chronic noise affects the child's ability to concentrate. Some studies indicate that chronic noise also results in a reduced ability to concentrate. This can be the indirect effect of reduced sleep and that tiredness during the day. Other results indicate that children can become used to noise, and that children exposed to chronic noise are less affected by acute noise than children having being brought up in a quieter noise environment.

*Memory.* In studies of the relationship between noise exposure and memory, it is usual to distinguish between implicit and explicit memory. Explicit memory is when the person remembers something he/she has been told to remember, while implicit memory tests is whether he/she can remember items or circumstances associated with the task but that were not part of the memory task itself. A further important distinction is between short term memory and long term memory.

The results indicate that both acute and chronic noise has little effect on explicit memory. The explanation for this can be that main effect of noise is in a reduction in the available attentional resources. This reduction will affect implicit memory more than explicit memory. There seems to be little effect of noise on short-term memory – however this result is based on only one study. Both acute and chronic noise seems to have an adverse effect on long-term memory.

Studies of the effects of noise on memory indicate, as did the studies on attention, that children can become used to noise. Children that were chronically exposed to noise showed a lesser degradation with respect to memory than children used to quieter conditions. In addition to the equivalent noise levels the pupils were exposed to, there were also differences between the effect of noise from different noise sources. Aircraft noise seemed to result in a larger negative effect than other noise sources.

*School performance.* Studies of the effect of chronic noise on performance show mixed results. The studies are also afflicted with serious methodological difficulties so that it is difficult to reach any definitive conclusions. Logically one would expect that since noise has an adverse effect on several cognitive functions that are important for acquiring knowledge, noise would result in reduced performance.

## **Effects of noise on stress**

Noise can function as a stressor. According to psychological stress theory, it is not only the noise itself that may have an adverse effect but also the strategies that people employ in order to cope with the stressor. In the case of a chronic noise exposure the coping efforts can have several adverse effects:

- Drain of resources. The coping activities represent a drain of psychic resources leaving less for other activities such as learning.
- Non-adaptive generalisation. Children that mentally shut out the noise, might inadvertently block auditory information and signals that are important

- Side-effects. Children can become so preoccupied with the noise that they pay too little attention to other adverse influences they might easily have remedied.
- Learnt helplessness. Children that repeatedly feel that they are not able cope with noise, may learn that putting in an effort is futile. They lose confidence in their own abilities to do something about noise. When generalised failure in this area can result also in failure to act appropriately in the face of other challenging situations.

*Motivation, learnt helplessness.* Chronic exposure to noise seems to result in reduced motivation for taking on new challenges and solve problems (learnt helplessness). Children exposed to high levels of noise do not perform as well and also quit their attempts at solving puzzles quicker than children having been exposed to less noise. As motivation is important for learning, this effect of noise can lead to inferior school performance in the long run.

#### *Noise and health*

In one study children that were exposed to high levels of chronic noise, were more often afflicted with health problems and had an inferior social adaptation than children that were exposed to less noise.

A high noise level in the classroom results in teachers and pupils having to strain their voices in order to be heard. If such strain persists over a certain time, it can lead to voice problems. Teachers are one of the occupational groups that most often have to seek help for voice problems. Also pupils may need such help.

High noise levels can result in hearing damage. This relationship is proven for adults, but the conclusions are not as clear when it comes to children.

## **Conclusion**

The main objective of children is to learn. Most of this learning takes place through attending verbal auditory information. Noise and inferior acoustical conditions make such learning difficult. The acoustical conditions in Norwegian classrooms are probably no better than what has been found in other countries. If so, many Norwegian children are subjected to learning situations that reduce their ability to perform and hamper their cognitive development.

Chronic noise can have a more lasting effect on children. Such noise can result in reduced motivation, inferior memory and reduced ability to extract auditory information, obtain proficiency in a language, acquire reading skills and possibly also results in reduced attention. All these effects are important for learning and noise can therefore result in a lowering of school performance.

Knowledge is important in today's society. There are therefore good reasons to ensure that children have an environment conducive of learning. Improving the acoustical conditions for children is an important part of this task.