Chronic Noise and Children

"Design of Child Care Centers and Effects of Noise on Young Children"

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There is a considerable amount of research documenting the effects of noise on children. The effects are largely negative. In this presentation I will briefly describe the findings of research in this field, discuss current research by Maxwell and Evans, and finally outline design issues related to noise and child care centers.

Nonauditory effects of noise (see Evans & Lepore, 1993 for a more detailed description)

Much of the research on noise and children concerns damage to the auditory system. While the possibility of hearing damage is, and should be, of concern to parents and educators, the nonauditory effects of noise on children also deserves attention. The literature on the latter topic falls into three categories; physiological effects, motivational effects, and cognitive effects.

Physiological effects Elevated blood pressure levels in school-aged children is associated with living or going to school near a major noise source (e.g., airport, traffic, trains). Although the blood pressure levels of children exposed to these major noise sources are within the normal range, they are higher than for children not exposed to major noise sources. These elevated blood pressure levels are of concern for two reasons. One, the levels do not habituate with continued exposure, and two, elevated pressure levels in children appear to continue this pattern into adulthood thereby increasing the risk for cardiovascular disease. The decibel levels in these studies ranged from 95 to 125 dBA peak. In each case the noise exposure was chronic.

Motivational effects Research findings suggest that exposure to uncontrollable noise may make children more vulnerable to learned helplessness. Learned helplessness means that the individual learns that the outcomes of it's behavior are independent of the actions of the individual. Most of this research has been with school-aged children, including kindergartners. One study found that children attending a school near a major airport were less likely to solve a challenging puzzle and to persist at it as well. Another study found that children exposed to noise were more likely to abdicate their choice for a reward to their teachers. The children decided to let the adult pick a prize for them rather than exercise their option to do so. Teachers in noisy schools also report greater difficulty in motivating children in their school work. Children often had less tolerance for frustration.

Limited work has been done with younger children. One study in a residential setting found that 12

month-old infants in noisy homes exhibited less mastery-oriented play behavior with their toys than their counterparts in quieter homes. The peak noise readings in the studies described above was 95 dBA.

Cognitive effects Most of the research on the nonauditory effects of noise on children has been on cognitive effects. The research has looked at memory, attention/perception, and academic achievement.

The research on **memory** and noise for children parallels that of adults; there appears to be little or no effects of noise on simple memory. This holds true for both chronic and acute exposure to noise. However, if the memory task requires special attention there does appear to be some negative effects of noise. In other words, if the individual has to pay particular attention because of the difficulty of the task, noise may interfere with the memory task. Noise levels in these studies were in the range of 22 - 78dBA.

The research on **attention** suggests that children exposed to chronic noise may suffer deficits in this area. Children exposed to chronic noise seem to develop cognitive strategies for coping with the distracting effect of noise. Young children (5 years old) from noisy residential environments seem to be better able to tune out distracting auditory stimuli when asked to perform a discrimination task in a noisy environment than children from quieter homes. Four year old children from noisy day care centers performed better under noisy conditions than children from quiet day care centers. These young children seem to be resistant to the distracting effects of noise because they tune out the noise. However, additional research suggests that as children get older (school-aged) this advantage disappears. In these studies older children from quieter environments were better at discrimination tasks done under noisy conditions. These children were able to screen out the noise and concentrate on important cues. Children from noisy environments learned to tune out auditory stimuli but in a nondiscriminatory way and tuned out important cues.

Noise seems to interfere with children's ability to discriminate between meaningful auditory stimuli, especially speech. Background noise, in particular irrelevant speech, interferes with children understanding the spoken word. This may have particular implications for children's academic performance.

Several studies have documented a link between noise and **academic achievement**, in particular reading. Acute noise appears to have little long term effects on reading or other intellectual activities; however, the research indicates that chronic noise has a negative effect on children's reading skills. There is also evidence to suggest that children from noisy homes and in noisy schools are at more of a disadvantage than children from quieter homes. Children with learning disabilities may also be more susceptible to the negative effects of chronic noise exposure.

A recent study by Evans & Maxwell (1997) identified a link between chronic noise exposure and reading. The noise source was a nearby airport; planes flew over the school on an average of every 6 minutes resulting in classroom decibel levels of 90. In this study children in the noisy school had poorer reading skills than children from the quiet school. The noisy school children also were not good at distinguishing speech masked by white noise but were able to distinguish specific sounds (e.g., cat meowing, baby crying). This finding suggests that there is selective screening out of auditory stimuli by children in chronic noise settings. Another possibility is that speech is used differently in noisy settings than in quiet settings and children miss learning certain language skills. Nevertheless language skills related to speech seem also to be related to reading skills. It is worth noting that the attentional research also found that noise interfered with children's discrimination of speech. All children were tested in quiet conditions in this study thereby confirming that chronic noise, and not acute noise, is related to academic achievement.

Current study (Maxwell & Evans)
The finding that certain language skills are related to reading skills and that noise is related to both led us to look at when these skills are being acquired. The current study looked at 4 year old children attending a day care center. In this study the noise source was the classroom itself due to the design of the center and classrooms. Ceiling were very high and no sound absorbent materials were used. Some classroom walls were not floor to ceiling thereby allowing noise from adjacent spaces to drift in. Teachers and administrators had identified the noise as excessive and had made arrangements to reduce the noise. Children were tested in as quiet conditions as possible before and after the noise abatement (sound absorbent panels installed in the ceiling). Several measures of pre-reading language skills were used. Teachers also rated children on their language skills.

The before and after decibel levels in the classrooms were:

Before	After
Peak: 96.8 - 99.1 dBA	87.2 - 95.2 dBA
Average: 75.8 - 77.1 dBA	69.4 - 73.9 dBA

In the quieter condition (note that decibel levels are still high - EPA recommends no higher than an average of 70 dBA) children were rated by their classroom teacher as having better language skills (e.g., child speaks well enough to be understood by others, child uses sentences, not just words) and the children performed better on a cognitive language skills measure.

The researchers were also interested in motivation since there was anecdotal evidence from the teachers that noise was affecting children's desire to participate in activities (other research supported this observation by these teachers). Children were given two puzzles, one could not be solved (given first) and the other was solvable. Children in the quiet condition took significantly less time to complete the solvable puzzle. Perhaps children in the quieter classrooms had better attentional skills enabling them to solve the puzzle quicker.

Implications for child care center design
Preschool classrooms (children ages 3-5) in four other child care centers were visited (2 in New York City, 2 in Ithaca, NY) to compare the noise levels and classroom design to that of the center in the study described above. In the classrooms with some soft surfaces (carpeting, pillows, curtains) noise levels were lower (average 65 -71 dBA). In classrooms with all hard surfaces and concrete columns dividing spaces the average noise level was 78 dBA with a peak of 90 dBA. Classrooms without buffers between them also generated more noise. A buffer could be a corridor or a wall. Adjacencies are also important. If common multipurpose spaces are located adjacent to classrooms, particular attention should be paid to acoustical design.

Ceiling heights are critical as well. In the center where the study was conducted ceiling heights were in some areas over 14 feet. While these heights created interesting looking spaces, they were problematic in terms of noise levels.

Conclusion
Chronic exposure to noise has been shown to be harmful to children of various ages. It can have especially detrimental effects on younger children when language and discrimination skills are forming. Sometimes major noise sources are not in the control of teachers or designers. However, as this study documents, sometimes the noise source is the design of the spaces. Designers should keep in mind the use of the spaces they are creating. In child care centers, spaces must allow for the fact that children need to make noise but the subsequent noise levels should not be harmful to them or others in the center.

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References

Evans, G.W. & Lepore, S.J., (1993). Nonauditory effects of noise on children: A critical review. Children's Environments, 10(1), pp.31-51.

Evans, G.W. & Maxwell, L., (1997). Chronic noise exposure and reading deficits: The mediating effects of language acquisition. Environment and Behavior, 29(5), pp.638-656.

Kryter, K.D., (1985). The effects of noise on man. New York: Academic Press, Inc.