CHAPTER 5

Noise: A Learning Barrier for Children

Everyone knows that noise that is loud enough can damage a person's hearing. This includes iPods and rock concerts. But those of you who live near loud factories, airports, busy highways, or train tracks know that noise can affect your whole life. A factory about a mile from my house has a ventilation system that makes it too loud for people who live close to sleep during the night. One neighbor wrote this noise diary in the on-line chat: "Tuesday: 1 AM thru 9:45 AM, LOUD, lowered volume at 8 AM. . . . Friday: Yippee . . . quiet all day and all night!"

What are the effects of living or going to school in high noise? In this chapter I concentrate mainly on the "nonauditory" effects of noise, or how noise affects well-being aside from its effects on our hearing organs. The nonauditory effects of noise in children fall in two main categories: reading and other aspects of cognitive performance, and stress-related responses such as annoyance, blood pressure, secretion of stress-related hormones, and mental health. These two categories are also linked to the auditory effects of noise. A very important auditory effect of noise is interference with the intelligibility of speech. Hearing other people talk is critical to children's early language development. But trying to hear someone talk in a noisy environment can also impair memory and other aspects of cognition. Cognitive performance can be impaired because of the extra effort required to decipher speech.[1] Mood can also become more negative, and the person feels tired or stressed.[2] Keep in mind that the auditory and nonauditory effects of noise are often interlaced.

Living or going to school in high noise can affect children's reading. Poor reading can cascade into poor overall academic performance and lack of motivation in school. One important principle of developmental psychology is that negative impacts early in life, if combined with other negative influences, can affect the direction of the rest of the child's development.[3] Poor reading is a negative factor that can lead to other academic and social problems. So anything

that affects children's early reading needs careful consideration. As you will see, the research regarding noise and reading is not unequivocal. Researchers do not agree about why noise can impede the process of learning to read. Some think noise affects children's ability to discern important speech sounds, an auditory effect of noise. Others think noise affects children's ability to concentrate or persist at difficult tasks, a nonauditory effect. Both of these processes could be involved. But regardless of the specific cause, poor reading can be the first in a chain of events that ultimately affect a child's later quality of life—educational attainment, employment and job performance, enjoyment of literature, exposure to a wide variety of ideas through books, and so on.

Another type of cascading effect on later development can begin with exposure to excessive noise prenatally or during early infancy. We have seen that prenatal exposures to PCBs (Chapter 3), mercury (Chapter 2), and pesticides and nicotine (Chapter 4) can alter a child's later functioning. Well-designed long-term studies of prenatal exposure to noise and later human development have not really been done yet. But, evidence from both animal and human research suggests that prenatal noise may have negative auditory and nonauditory effects on development.

After reviewing the research on how noise affects children's behavioral health and well-being, I examine U.S. noise policy and how it fails to consider the effects of noise on children's development. Before addressing the effects of noise on development, first I cover a little bit of technical information about sound and how it is measured.

How Sound Is Measured

Noise is the term for sounds that we do not want to hear. Sounds are alternating compressions and expansions (waves) transmitted through the air, water, or solids. Two characteristics of sound waves are important for understanding this chapter: frequency and amplitude.[4]

The *amplitude* or intensity of a sound is measured in *decibels*. This influences how loud a sound seems when we hear it. There are different decibel scales. The dBA scale weights the different frequencies of the sound in a way that takes the average sensitivity of human hearing into account. The distinction between amplitude and loudness is important. Amplitude in decibels is the scientist's measure of the physical intensity of the sound. Loudness is our perception of it. Loudness does not increase linearly with sound amplitude.

Decibel scales are log (base 10) scales of sound amplitude. In a log scale, each increase of 1 unit represents a multiplication of the previous unit by 10. In the dB scale an increase of 3 units reflects a doubling of the physical amplitude of the sound, or the amount of energy in the sound. But doubling the amplitude of a sound in dB does not double the perceived loudness. It takes