What Do Preschools Have in Common with Bridges and Airports?

Thursday, November 19, 2009 5:00 AM
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If you are heading into Manhattan, off the George Washington Bridge, you can't miss the Bridge Apartments, a cluster of four 32-story apartment buildings built right over the interstate. The buildings' 4,000 residents seem like nothing compared to the 300,000 cars that go whizzing underneath the buildings each day.

Built in 1964, the Apartments were to be a shining (aluminum-sided) monument to efforts in easing New York's chronic housing shortage. Nearly all the apartments were reserved for middle class families. But almost immediately, the development was controversial; people worried that the exhaust from the traffic might be a health hazard to the residents.

By1967, New York Senator Robert J. Kennedy was concerned enough that he stopped there to give a pro-environment speech, and Kennedy asked the National Center for Air Pollution to assess the carbon monoxide in and around the buildings.

Shortly after that, researchers began going floor-to-floor, checking on the well-being of school children who lived in the Apartments.

Something was definitely going on.

The kids living on the lower floors had predictably lower reading scores than the children who lived on the buildings' higher floors. In fact,it was a linear relationship: the lower the floor of the child's apartment, the lower his reading scores.

Also, the longer the children lived in the Apartments, the farther behind they were in reading, compared to their peers. Whatever it was that was happening, its effects were cumulative.

The scholars considered the National Center for Air Pollution's now-completed measurements. The carbon monoxide inside was seven times higher than in the air of the surrounding neighborhood.

But there wasn't any significant difference between floors. Compared to the higher-up kids, the kids on lower floors weren't getting the brunt of the smog. In fact, consistent with what we now know about CO rising inthe atmosphere, the scholars found that CO levels were actually fractionally higher at the buildings' highest levels. The lack of real difference in carbon monoxide between floors meant the scholars ruled out smog exposure as the cause of the lower-down kids' reading and speech deficits.

Traditionally, rents go up for a building's higher floors. So the researchers considered the possibility that kids living on higher floors had wealthier, more educated parents; if so, they'd be likely to score higher on the assessments. But the researchers ruled that out, too. Since the entire building was reserved for middle class families, the rents only differed by about $25.

What did predict the difference in reading between the lower-floor kids and the higher-ups? It wasn't air pollution – it was noise pollution. The lower-downs were exposed to exponentially more traffic noise. All day, everyday, the kids heard the endless honking of horns, the screeching of brakes, and the continuous roar of hundreds of thousands of engines zooming by.

Human hearing isn't sensitive to small changes in volume, which is why decibels are a logarithmic measurement. Every 10 decibel increase (one hash mark on your stereo) signals a doubling of the perceived volume. Leaves rustling are around 10 dB, while a jet engine taking off is at120 dB. Background noise at 45 dB is loud enough to interfere with the ability to understand speech.

On the Apartments' 32nd floor, the traffic volume was at about 55 dB. For the kids down on the eighth floor, the noise was up to 66 dB (twice as loud). So the pattern was really: the lower the kid's floor – the louder the noise – the slower the kid's reading progressed.

None of these kids had hearing problems: all the kids had hearing tests, and they sailed right through. But, in addition to their reading problems, the lower-down kids also weren't as good at auditory discrimination tasks. They couldn't hear the difference between words like "cope" and"coke."

This isn't the only study to find a relationship between environmental noise and a child's reading scores. Probably the most famous of these are studies about the children of Munich, Germany.

In 1992, the old airport was to be shuttered; a new, high tech international airport was to open across town. Before this transition, an international team of scholars studied 326 school children. Some lived in the vicinity of the old airport; some lived near the new airport site.

Like the lower-floor kids in the Apartments, the children near the old airport showed deficits in reading comprehension and word discrimination.

Once the old airport had closed, and the new airport had been in operation for a year, the researchers re-tested the children. For the kids who lived near the now-defunct old airport, their reading scores showed some improvement, but their speech perception was still poor. And as for the kids by the new airport, their reading comprehension had dropped since the airport's opening.

Airport noise isn't consistent, like street traffic. However, intermittent noise can also interfere with speech perception: the trouble begins at 55 dB. That was exactly the level of the ambient noise for kids living near the new Munich airport. (It rose to 62dB whenever planes were taking off.)

To further test the kids' ability to perceive speech, the researchers played a tape of a story being read. But at the same time, they also played a competing noise – traffic, airplanes taking off. The kids were told to increase the story's volume until it was loud enough that they could concentrate on it.

The kids near the new airport needed three times the signal to noise ratio before they could focus on the story.

For both the Apartments and Munich studies, on a physical level, the kids were fine. There was no hearing loss or other damage. But the children couldn't perceive a difference between spoken words. They couldn't hear speech in the presence of competing sounds. And their reading scores were lower.

Cornell professor Gary Evans is one of the world's leading researchers on how the environment affects children's development. And Evans – who was one of the scholars studying the children in Munich – believes the researchers have the explanation as to what is happening with these kids.

The answer is as simple as this: "The kids begin to tune the noise out."

According to Evans, children in extremely loud environments begin to mentally block out noise as unnecessary distraction. After a while, it just doesn't register anymore. But the kids are actually too good at this mental block.

"Their tuning out the noise is indiscriminate," continued Evans. "They don't just tune out the airport noise – they tune out all noise. Including speech."

To the point that the Munich kids could barely discern which sounds were speech and which were traffic noise.

Kids in noisy environments hear enough words that they learn to communicate. But they miss out on the additional language necessary to master the more sophisticated nuances of phonics, vocabulary, and structure.

In 2005, researchers published findings on the largest ever epidemiological study on the effects of noise on children's cognition and health. Researchers surveyed over 2,000 children living near three of the world's busiest airports: London Heathrow; Madrid Barajas; and Amsterdam Schiphol. At home and at school, these kids were living with airport noise as high as an explosive 77 dB.

After taking into account every other possible variable, the researchers concluded that the Spanish and Dutch kids near airports were doing much worse compared to their peers, nationally. Compared to the British average, the kids near Heathrow were a full eight months behind in reading ability.

Similar gaps have been found elsewhere, from kids in urban Los Angeles to middle class kids in rural Austria. Poor kids seem to have it worse, because they are more likely to get stuck living near flight paths, roads, or trains. But other than that, socioeconomic backgrounds don't really seem to be at issue. The only protective factor from noise is distance.

A group of scholars once looked at a New York City school located 220 feet away from an elevated subway train. Every 4 1/2 minutes, a train roared by at 89 dB. The sound would last for 30 seconds. The kids who had classes on the train-side of the school were up to 11 months behind those in classrooms on the other side of the building.

But it can take much less than a locomotive to thwart children's language ability.

In another study, Evans tracked the progress of children at a local preschool. Located in a small town, the preschool was in a quiet neighborhood – no traffic or other external sound issues to worry about.

The building was constructed specifically to be a preschool. But not just any old school. It was a knockout architectural space designed to appeal to the children of an affluent, educated community. Visually arresting, each classroom looked like a pint-sized version of an artist's loft. Walls jutted into the room. The cathedral-high ceilings had open wood beams. The water pipes were clear, so the kids could watch the way water travels.

All those gorgeous sharp lines, sleek surfaces, and vaulted ceilings became a problem.

The sound of the normal conversation ricocheted back and forth until it became an unbearable cacophony. Some of the classrooms were averaging 92 dB – louder than when the trains went by that New York City school. The littlest preschoolers couldn't take their naps, because the sound of the next classroom came right through the walls.

The designers got so caught up in their desire for the building to look fabulous that they defeated the school's purpose: learning.

Trying to remedy the situation, the school installed some sound-absorbent panels at the ceiling. The paneling only reduced the volume by 5 dB. It was still awfully loud.

But it was enough of a difference that the following year's preschoolers outperformed their predecessors on a battery of measures. They were scoring higher on letter, number and simple word recognition. They solved puzzles more quickly. Their teachers reported that the kids were speaking in more complete sentences. They understood more of what was being spoken to them, and they were better understood by others.

Evans has other examples of such studies – where it's amazing how quickly children improve after someone has taken a step to minimize a building's noise.

Which makes it all more tragic that, even though the research was there all along, it took forty years for the managers of the Apartments to act. It wasn't until 2004 that the buildings' single-pane windows were retrofitted with noise-minimizing double-pane glass.