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Abstract

Research linking loud sounds to hearing loss in youngsters is now widespread, resulting in the issuance of warnings to protect children's hearing. However, studies attesting to the adverse effects of intrusive sounds and noise on children's overall mental and physical health and well-being have not received similar attention. This, despite the fact that many studies have demonstrated that intrusive noises such as those from passing road traffic, nearby rail systems, and overhead aircraft can adversely affect children's cardiovascular system, memory, language development, and learning acquisition. While some schools in the United States have received funds to abate intrusive aircraft noise, for example, many schools still expose children to noises from passing traffic and overhead aircraft. Discussion focuses on the harmful effects of noise on children, what has to be done to remedy the situation, and the need for action to lessen the impacts of noise from all sources. Furthermore, based on our knowledge of the harmful effects of noise on children's health and the growing body of evidence to suggest the potential harmful effects of industrial wind turbine noise, it is strongly urged that further studies be conducted on the impacts of industrial wind turbines on their health, as well as the health of their parents, before forging ahead in siting industrial wind turbines.

Keywords

health, cognition, language, learning, wind turbines, transportation, well-being

Introduction

Thirty-six years ago, when my then 8-year-old daughter learned I was looking at the impact of passing train noise on children's classroom learning, she asked me why I was conducting this study because it seemed obvious to her that passing train noise disrupting children's learning every 4 to 5 minutes for 30 seconds would affect their learning ability. I responded that someone had to demonstrate the impact of the noise on classroom learning with solid data, explaining the meaning of data to my daughter.

Assessing the Impacts of Noise on Children's Learning

My initial study on noise/learning link examined the impact of elevated train noise on reading ability in a school situated 220 feet from an adjacent elevated train structure. Eighty trains passed the school during the hours between 9 a.m. and 3 p.m. each weekday and disrupted the classes on the side of the building facing the tract every $4\frac{1}{2}$ minutes for 30 seconds. The sound level in a classroom rose to 89 dBA from 59 dBA when the train passed, forcing the teacher to scream to be heard or to stop teaching until the train passed. In 1973, the New York Department of Air Resources reported that 11% of classroom teaching time was lost because of passing trains.

Reading scores were examined for 4 years comparing the scores of the children in the classrooms exposed to train noise with children attending classrooms on the quiet side of the building. Reading scores of children on the noisy side of the building lagged behind their peers on the quiet side from 3 months in the lower grades to as much as 1 year in the sixth grade. Whether the cause was the lost teaching time, the distraction of the trains, or the fact that the children took the tests in the noisy rooms, the fact remains that children in the noisy classrooms demonstrated poorer reading scores than children on the quiet side of the building. My results were published in an article in 1975 in the *Journal of Environment and Behavior* (Bronzaft & McCarthy, 1975).

Responding to Effects of Noise on Learning

The reaction to this study in New York City was overwhelming. Newspaper accounts of the study plus statements by public officials highlighted the findings broadly. This reaction made

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it easier for me to approach the Transit Authority and ask the agency to select the tracks adjacent to P.S. 98 to test the effectiveness of rubber padding in quieting noisy elevated trains. When the pads were in place, the principal of the school and I asked the Board of Education to install noise abatement materials in three of the noisiest classrooms at P.S. 98. The noise reduction as a result of the two abatement techniques was 6 to 8 dBA. When asked to return to the school by a public official to conduct a study after the installation of noise abatement materials, I did so nervously. However, when I compared the reading scores of children in classrooms facing the tracks with those on the quiet side of the building, children on both sides of the building were reading at comparable levels. This study clearly demonstrated that when you correct a noise problem, children benefit (Bronzaft, 1981).

Research on Effects of Noise on Children's Learning Expands

Subsequent years saw additional research on the effects of noise on children's learning. Wachs and Gruen (1982) noted that noisy households can disrupt a child's development and warned parents about shouting and playing televisions and stereo systems too loudly. The U.S. Federal Interagency Committee on Aviation Noise (FICAN) concluded, after summarizing the findings of 20 studies, including my study in 1975, that aircraft noise can interfere with reading, speech acquisition, and noise (FICAN, 2000). Lercher, Evans, and Meis (2003) examined ambient neighborhood noises and found that chronic noise exposure was significantly related to poor incidental and intentional memory in children. S. A. Stansfeld et al. (2005) reported that an investigation of school children in the Netherlands, Spain, and the United Kingdom indicated that aircraft noise could impair cognitive development, especially reading comprehension. Recent studies by Matheson et al. (2010) and S. Stansfeld, Hygge, Clark, and Tamuno (2010) add to our knowledge of the adverse effects of road traffic and aircraft noise exposure on children's learning abilities, particularly in the school setting.

In my book *Top of the Class*, published in 1996, which examined the lives of high academic achievers, I learned from these high academic achievers that they were reared in homes that respected quiet (Bronzaft, 1996). Quiet areas were provided for them to read, study, and learn. Their parents tended not to discipline them with shouting and loud voices but rather used lowered, stern voices to correct their behavior. We could say that a quieter environment served these high academic achievers well.

Greater Awareness of Noise/Learning Link?

U.S. President Obama understands that noise can affect classroom learning. In a speech before Congress in February 2009, the President identified a young woman in the audience named

Ty'Sheoma Bethea who attended a school in Dillon, South Carolina. In identifying the elements impeding on the learning in her classroom, he noted that "they have to stop teaching six times a day because the train barrels by their classroom." The American National Standards Institute in 2002 set acoustical standards for classrooms, stressing the importance of a proper acoustical school environment. In 2009, the House Education and Labor Committee of the U.S. Congress passed a bill that would introduce measures designed to reduce or eliminate exposure to classroom noise, as part of the Green High Performing School Facilities Act, but this legislation has not yet become law.

My daughter, now 44 years old, wonders why after years of research demonstrating a link between noise and children's learning, we need to conduct further research as suggested by the U.S. Federal Aviation Administration's (FAA) proposed study on the effects of aircraft noise on classroom learning (Airport Cooperation Research Program, Project Number 02-26). She believes there is enough research demonstrating an adverse effect of noise on learning and we should move, without hesitation, to creating quieter classroom environments rather than using funds to conduct further studies. Despite the fact that I serve on the Transportation Research Board committee that is overseeing the FAA-funded research on airport noise and children's schoolroom learning, I tend to agree with my daughter's conclusion. In 2011, there definitely is sufficient research linking noise to impaired learning and we should work toward improving the school learning environment.

Impacts on Children Beyond Learning

It should be pointed out even if the child were able to overcome the adverse effect of noise in the classroom, the need to do so may create stress and discomfort for the child, which in the long run can have an adverse effects on his or her health. In my 1974 study, the children interviewed expressed their unhappiness at the passing trains. One child, when interviewed for television, said, "I wish the trains wouldn't run anymore."

Noise has been associated with physiological problems in children. Studies on the adverse effects of loud sounds and noise on children's hearing have been well documented. Yet youngsters continue to expose themselves to loud video games, loud concerts, and so on. An example of the effects of long-term exposure to loud music is Pete Townshend, a member of the rock band "The Who," who has experienced hearing problems himself because of his exposure. Yet hearing loss is not the only physiological impact of noise. Evans and Lapore (1993) reviewed the nonauditory effects of noise and concluded that children living near or attending a school near a major airport were more likely to experience elevated blood pressure. Passchier-Vermeer and Passchier (2000) wrote that road traffic and aircraft noise have been found to affect children's cardiovascular system. The U.S. government over

30 years ago in its "Noise: A Health Problem" pamphlet stated that children in homes and schools exposed to aircraft noise had higher blood pressure than children in quieter environments (U.S. Environmental Protection Agency, 1978). Although this booklet pointed out back then that more studies were needed to strengthen this finding, it concluded with the statement that "this finding is cause for concern."

When Parents Are Stressed, Children May Suffer!

Another point that I would like to make concerning the impacts of noise on children's lives deals with the effects noise has on their parents. There are sufficient studies linking noise to adverse health effects (Bronzaft & Hagler, 2010) in adults. Even if we were to argue that the best data linking noise to well-being centers on a diminished quality of life rather than specific health ailments, as noted by the World Health Organization, then living near a noisy source would most likely diminish quality of life. Good health is not merely the absence of symptoms; it is the ability to experience a decent quality of life. Parents experiencing this poorer quality of life, or suffering from a noise-related ailment, may have less patience with their children and, as a result, express more anger at their misdeeds. I need not illustrate further how good parent-child relationships affect the health and well-being of children. If noise prevents a parent from getting a good night's sleep because of overhead aircraft, then one could expect this tired parent to be less able to deal with the obligations of parenthood.

Going Beyond Existing Findings on Noise Impacts

How does my discussion of the impacts of noise, largely measured on the dbA scale, on children's mental and physical health relate to the topic of wind turbine noise, including sound levels measured on the A scale as well as potential impacts from low-frequency sound. What I think we can learn from the research on the effects of noise on children is that before changes are made based on research findings, authorities demand solid data with huge samples. Occasionally, there are exceptions, as I experienced in the case of the New York Transit Authority and the New York City Board of Education actions to abate the noise at the school in which I had conducted my research on noise and learning. Although studies such as mine did influence the U.S. FAA to abate noise at schools lying within a designated noise area, it is difficult for schools to receive this abatement, largely because the noise metrics used by the FAA limit the numbers of schools that may be eligible. Thus, far too little has been done in the United States to lessen the effects of intruding noises from traffic, trains, and aircraft, despite a growing body of literature linking noise to adverse impacts on children's mental and physical health. With respect to wind turbine noise, the solid data

we now have regarding the noise/health link in children should serve to warn about the potential harm of wind turbine noise and caution should be exerted before building industrial wind turbines near people's homes.

How Valid Are the Data in Support of Wind Turbines?

Before the academically reviewed journal articles are written and published, researchers explore problems employing observations and interviews. Before I conducted my research as noted above, parents of the children at P.S. 98 had long complained about the noise from the trains but no action was taken until after the findings of my research were published. However, I want to add that many public officials in New York City joined in our efforts to quiet the tracks next to the school and that hastened the abatement. Similarly, Dr. Pierpont (2009) was responding to resident complaints when she undertook her observations and interviews of residents living with wind turbine noise. Dr. Pierpont's observations, and those of other speakers who presented at the recent First International Symposium on the Global Wind Industry and Adverse Health Effects held in Ontario, Canada, are being questioned because they appear to be based on small numbers of residents. The validity and reliability of these observations are also being criticized because they lack comparisons with control groups. In the early days of psychology, Dr. Freud took careful notes on his patients' complaints and he relied on observations and interviews as he formulated his theory of human behavior. In time Dr. Freud, one of the great minds of the 20th century, developed a theory of human behavior, as well as a method to treat psychological problems. More traditional studies of his theories followed afterwards. Observations and interviews generally proceed questionnaires and testing that result in correlative data to be analyzed and evaluated.

The dismissal of the adverse effects of noise on residents living with wind turbine noise has largely come from the wind power industry, which has supported this claim with reports by acousticians, doctors, and engineers whom they have hired to write on the noise/health relationship. Yet there exist reports written by researchers that suggest that both the wind industry and governments in favor of wind turbine energy have erred in concluding that noise from wind turbines cannot affect physical and mental well-being. Dr. Frits van den Berg (2004), a Dutch physicist, claims that the methods used to predict the noise from large turbines are inappropriate and, thus, the conclusions drawn from findings based on these methods have to be questioned. Dr. van den Berg believes that the measurements of wind turbine noise near people's homes in quieter environments at night may be underestimated by as many as 10 dBA. Dr. van den Berg's conclusions have been supported earlier by Pedersen and Halmstad (2003). Studies such as these deserve to be examined more closely and, at the very least, suggest that additional studies be conducted to evaluate the impacts of wind turbine noise, including the low-frequency sounds, on individuals.

A Growing Interest in the Impacts of Wind Turbine Noise

Garret Keizer in his book *The Unwanted Sound of Everything We Want* (2010) states that while he is not an expert on wind turbine noise, he can still write as an individual who personally researched the issue of noise and wind power, including the works of van den Berg and Pedersen, for his book. He also personally visited residents in Maine who described how the wind turbine noise affected their lives. Mr. Keizer concluded that “wind turbines produce a devilishly complex form of noise that, combined with the imprudent siting of certain wind installations, is making some people sick.” (p.221) Additionally, Mr. Keizer, in thinking about future environmental debates, states that “in debates over wind energy, noise will be front and center.” (p.221)

In a *New York Times* article (Zeller, 2010), Mr. Zeller gives voice to residents who have had their quality of life diminished by nearby wind turbines, but then adds that “for the most extreme claims, there is little independent backing.” Unfortunately, the only studies he cites are those from American Wind Energy Association, a trade group, and its Canadian counterpart, which concluded that “there is no evidence that the audible and sub-audible sounds emitted by wind turbines have a direct adverse physiological effects.” The *New York Times* published two additional articles shortly afterwards (Wald, 2010; Wald & Zeller, 2010) on wind power energy. Additionally, President Barack Obama mentioned wind power as an alternative energy source that we must pursue in his State of the Union address in early January 2011. That Mr. Keizer’s noise book, and the soon to be published book *Why Noise Matters* (Stewart, 2011), contain sections on wind turbine noise and that several stories on wind power have recently appeared in the *New York Times* indicate a both a growing interest in wind power as an alternative energy source as well as a source for potential harm from noise.

A Call for More Research

Yet this interest in harnessing wind power must be accompanied by research to resolve the issues of the potential harm of wind turbine noise on individuals living nearby. Research should also be conducted on the cost-effectiveness of harnessing the wind among other concerns. From past experience, I would venture to guess that the eagerness to move to wind power on the part of industry and governments internationally will result in a reluctance to support research that may conclude that caution is required when locating wind turbines close to residential communities. Of course, I speak from an American perspective where history has demonstrated how quickly Americans adopt new products, without requisite research on harmful effects, and how reluctantly they relinquish these products when evidence proves that they may be harmful. Similarly, when it comes to environmental concerns, the United States often errs on the side of

industry, as noted by a *New York Times* editorial (“Questions About Fracturing,” 2010), and proceeds with activities that might be harmful to the environment. In this editorial, the concern is hydraulic fracturing, which has been implicated in a number of water pollution cases. The drilling industry, like the wind power industry, states that its technology is “fundamentally sound” but the editorial adds: “We need more credible assurances this time.” Yet the United States is most likely not alone in requiring *overwhelming* evidence to remove dangerous products or to proceed with dangerous technology.

Enough Evidence to Issue Warnings About the Hazards of Wind Turbine Noise

The U.S. Environmental Protection Agency released a booklet in 1978 that contained a section entitled “Special Effects on Children” and cited my research on the impacts of noise on children’s classroom learning. The booklet in its final word section concludes: “It is finally clear that noise is a significant hazard to public health. Truly, noise is more than an annoyance.” In 2009, the U.S. Environmental Protection Agency (<http://www.epa.gov/air/noise.html>) issued a pamphlet entitled “Say What” for middle school students, which states, “Noise can not only harm your hearing—it can also make it hard to concentrate while reading or doing homework, make you frustrated, prevent you from falling asleep, and make it hard to communicate with your family and friends.”

Yet, despite declarative statements in government publications, and I could have added others to those cited above, the U.S. government is still assessing the impact of aircraft noise on children’s learning and still thinking about passing legislation to quiet the nation’s schools. With the American educational system falling behind the systems of other nations, especially evidenced in the lower number of people graduating from college, it is indeed egregious to allow our school children’s education to be adversely affected by noise both inside and outside the school as well as the home. It would also be egregious to fail to consider the impacts of new sources of noise, for example, industrial wind turbines on their health.

Dr. William H. Stewart, the former Surgeon General of the United States, in a keynote talk to a 1969 Conference on Noise as a Public Health Hazard stated the following: “Must we wait until we prove every link in the chain of causation. In protecting health, absolute proof comes late. To wait for it is to invite disaster or to prolong suffering unnecessarily.” I was taught that an ounce of prevention was worth more than a pound of cure. I believe we should explore the potential harmful noise effects of industrial wind turbines before we adopt this energy source; taking corrective action many years down the road, when the proof is overwhelming, would be, as Dr. Stewart says, “prolonging suffering unnecessarily.”

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Bio

Arline L. Bronzaft is a Professor Emerita of Lehman College, City University of New York. She serves on the Mayor's GrowNYC, having been named to this organization by three previous Mayors as well. Dr. Bronzaft is the author of landmark research on the effects of elevated train noise on children's classroom learning; has examined the impacts of airport-related noise on quality of life; and has published articles on noise in environmental books, academic journals and the more popular press. In 2007, she assisted in the updating of the New York City Noise Code.