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From: Valerie Malicki <valeriechristina@rocketmail.com>
Sent: Friday, August 22, 2014 1:36 PM
To: Puco ContactOPSB
Subject: Ref case #13-0990-EL-BGN;Brain response to low-frequency noise emissions
Attachments: windturbinesyndrome.com-Inconvenient_Truths_Wind_Turbine_Syndrome_CounterPunch_Magazine.pdf; WTSbrain-color.pdf; Pierpont-c.v.-9-23-13.pdf

Categories: Red Category

Dear Ohio Power Siting Board,

Attached you will find Dr. Nina Pierpont's credentials(PhD from Princeton, Johns Hopkins Medical School, Yale with honors, and more, see attached).

Her work attached provides the physiological response of the soft tissue in the ear and brain to low-frequency noise.

Dr. Pierpont writes, "In my wind turbine study, 7 out of 10 school-age children and teens did worse in school *during exposure to turbines, compared to before or after, including unexpected problems in* reading, math, concentration, and test performance, noticed by teachers and parents. Teachers sent notes home asking what was wrong with children."

She writes, "Over 90% of my sample of affected people, both adults and children, had cognitive difficulties during wind exposure--problems that lingered and resolved slowly after exposure ended."

In summary, "A population-level survey in Maine now shows increased alerting in the presence of wind turbine noise disturbs sleep, even when people do not recall being awakened. **A population-level survey in Maine now shows clear disturbances of sleep and mental well-being out to 1400m (4600 ft) from turbines, with diminishing effects out to 5 km (3 miles).**

Again, why does Windlab want to insist that they place 13 turbines within 3 miles of South Central schools, and 18(!) within 3 miles of the Mennonite school?!?!

Massive amounts of research, by highly credentialed professionals around the world - independent professionals, who never wanted to be labeled "anti-wind" blah blah blah, but are simply reporting on their findings. Individuals who press on, despite intense persecution from greedy stakeholders in these money-making projects (cloaked as being environmentally-friendly, what a joke!, they pour truckload after truckload of concrete in the ground and chop up birds for starters). Individuals who, like myself, are simply clinicians who are bound by beneficence and non-beneficence. The duty to DO good, and the duty to DO NO HARM. I am bound by this ethic as a Licensed Professional Clinical Counselor, and am very aware of this solemn duty.

It would behoove the OPSB to take seriously the BONA FIDE RESEARCH that these industrial, commercial wind turbines MUST BE PROPERLY SITED - NOT NEAR PEOPLE! SITING IS THE CRUX OF THE ISSUE.

In light of the above findings, I again beseech you, as a parent with hopes of sending my children to our beautiful local school, PLEASE DO NOT ISSUE ANY WIND CERTIFICATES UNTIL CURRENT, INDEPENDENT, ADEQUATE RESEARCH PROVES INDUSTRIAL WIND IS SAFE FOR OUR LOCAL SCHOOLCHILDREN.

Imagine a medical doctor issuing medication to your wife or pregnant loved one, stating, "Well its not proven to be safe, but if there is a problem(like a birth defect, a missing limb, no eyeballs, long-lasting brain damage, DEATH of your child, etc.) you can just file a complaint." It is unthinkable!!

IN THE SAME WAY, THE IMPACT OF THE PERMANANCY OF THIS PROJECT, DEMANDS MORE INFORMATION BE FORTHCOMING BEFORE A CERTIFICATE TO BUILD IS GRANTED.

WE DEMAND A MORATORIUM ON ALL WIND CERTIFICATES. YOU MUST REVIEW THE ATTACHED PDF DOCUMENTS WITH SCRUTINY. THANK YOU IN ADVANCE FOR DOING SO.

Respectfully,

Valerie C. Malicki, MA, LPCC

"Inconvenient Truths: Wind Turbine Syndrome" (CounterPunch Magazine)

—Nina Pierpont, MD, PhD, CounterPunch Magazine (10/31/10)

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Wind turbines majestically threshing the wind—what marvels of human engineering! To stand beneath one is breathtaking. To live near one can be hell on earth. So I have been told by countless people who suddenly find themselves grievously ill from the subtle yet devastating infrasonic jackhammer generated by these "clean, green, renewable energy" giants.

The explanation may be tucked away in the inner ear in a cluster of tiny, interconnected organs with a remarkable evolutionary pedigree. The vestibular organs—the semicircular canals, saccule, and utricle—function as Mother Nature's gyroscope, controlling our sense of motion, position, and balance, including our spatial thinking. (Remember when you got carsick as a kid? Or seasick?)

Humans share these enigmatic organs with a host of other backboned species, including fish and amphibians. Some scientists indeed see them as a kind of pan-species master key for an extraordinarily broad range of brain function—amounting to a sixth sense.

One of those functions, it now appears, is to register and respond to the sounds and vibrations (infrasound) we don't consciously hear, but feel—as from wind turbines. For many people, the response is swift and disastrous.

Sometimes it's advantageous being a country doctor. Six years ago I began hearing health complaints from people living in the shadow of these gigantic turbines. At first it was merely local and regional, then global. Tellingly, virtually everyone described the same constellation of symptoms. Symptoms that were being triggered, I began to suspect, by vestibular dysregulation. (1) Sleep disturbance. Not simply awakened, but awakening in a panic ("flight or fight" response). (2) Headache. (3) Tinnitus. (4) Ear pressure. (5) Dizziness. (6) Vertigo. (7) Nausea. (8) Visual blurring. (9) Tachycardia. (10) Irritability. (11) Problems with concentration and memory. (12) Panic episodes associated with sensations of internal pulsation or quivering, which arise while awake or asleep. (This latter involving other, non-vestibular organs of balance, motion, and position sense.)

None of these people had experienced these symptoms to any appreciable degree before the turbines became operational. All said their symptoms disappeared rapidly whenever they spent several days away from home. All said the symptoms reappeared when they returned home.

Many had supported the wind farm project before all this happened. Now, some became so ill, they literally abandoned their homes—locked the door and left.

Taking my cue from a British country doctor who was reporting identical "wind turbine" symptoms among her patients, I did what clinicians call a case series. I interviewed 10 families (38 people) both here and abroad, who had either left their homes or were about to leave. I found a statistically significant correlation between the telltale symptoms and pre-existing motion sensitivity, inner ear damage, and migraine disorder. Each is a risk factor for what I now christened Wind Turbine Syndrome. My data suggest, further, that young children and adults beyond age 50 are also at substantial risk.

The response from ear, nose, throat clinicians (otolaryngologists and neuro-otologists) was immediate and encouraging. One was Dr. F. Owen Black, a highly regarded neuro-otologist who consults for the US Navy and NASA on vestibular dysregulation.

Another was Dr. Alec Salt at the Washington University School of Medicine, who recently published an NIH-funded, peer-reviewed study demonstrating that the cochlea (which links to the vestibular organs) responds to infrasound without registering it as sound. Infrasound, in fact, increases pressure inside both the cochlea and vestibular organs, distorting both balance and hearing.

Salt thus effectively shatters the dogma that "*what you can't hear, can't hurt you* ." It can indeed hurt you. The growing uproar among wind turbine neighbors testifies to this inconvenient truth.

My role is over. My waiting room is full. It's time for governments to study this wind-generated scourge whose cure is simple. A 2 km setback (larger in hilly or mountainous terrain) fixes it. Wind developers, not unexpectedly, refuse to acknowledge the problem. They ridicule it as hysteria and NIMBYism ("Not In My Back Yard!")—and refuse to build their machines 2 km (1.24 miles) away from homes.

"It's difficult to get a man to understand something when his salary depends upon his not understanding it," suggestec Upton Sinclair. Perhaps so. In that case, expect more empty houses and (easily avoidable) suffering.

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Nina Pierpont, MD, PhD, is a pediatrician and author of "Wind Turbine Syndrome: A Report on a Natural Experiment" (2009). She is the keynote speaker at this weekend's international symposium in Picton, Ontario, "The Global Wind Industry and Adverse Health Effects: Loss of Social Justice?"

Wind Turbine Syndrome & the Brain

Nina Pierpont, MD, PhD

November 15, 2010

The following is the text of Pierpont's keynote address before the "First International Symposium on the Global Wind Industry and Adverse Health Effects: Loss of Social Justice?" in Picton, Ontario, Canada, October 30, 2010. It is followed by a discussion of several other relevant talks at the symposium by Drs. Alec Salt, Michael Nissenbaum, Christopher Hanning, and Mr. Richard James.

Abstract

The latest research, as discussed below, suggests the following mechanism for Wind Turbine Syndrome: air-borne or body-borne low-frequency sound directly stimulates the inner ear, with physiologic responses of both cochlea (hearing organ) and otolith organs (saccule and utricle—organs of balance and motion detection).

Research has now proved conclusively that physiologic responses in the *cochlea suppress the hearing response to low-frequency* sound but still send signals to the brain, signals whose function is, at present, mostly *unknown. The physiologic response of the cochlea* to turbine noise is also a trigger for tinnitus and the brain-cell-level reorganization that *tinnitus represents—reorganization that can have an impact on language* processing and the profound learning processes related to language *processing.*

New research also demonstrates that the "motion-detecting" otolith organs of mammals also respond to air-borne low-frequency sound. Physiologic responses and signals from the otolith organs are known to generate a wide range of brain responses, including dizziness and nausea (seasickness, even without the movement), fear and alerting (startle, wakefulness), and difficulties with visually-based problem-solving.

Increased alerting in the presence of wind turbine noise disturbs sleep, even when people do not recall being awakened. A population-level survey in Maine now shows clear disturbances of sleep and mental well-being out to 1400 m (4600 ft) from turbines, with diminishing effects out to 5 km (3 miles).

Sensory systems change brain functioning

I confess I have an odd medical practice. I'm a pediatrician by training, but I'm fascinated by brains and development, and essentially practice psychiatry and child development. I'm interested in how to help children's brains grow well, and, at the other end of the spectrum, in what derails normal brain functioning in normal people—like Wind Turbine Syndrome—and how to get that functioning back on track.

So much of brain function is about the sensory systems—vision, hearing, touch—and what the brain does to take basic sensory signals from all over the body and turn them into a coherent picture of where this particular creature—oneself—is at this particular time, and what needs to happen next to meet its needs. Those needs range from the basic and physiologic—like breathing and pumping blood in the right amounts to the different parts of the body—to complex social and language-based needs, like figuring out what your spouse really meant by that last thing he said. Our sensory systems mediate all of these needs.

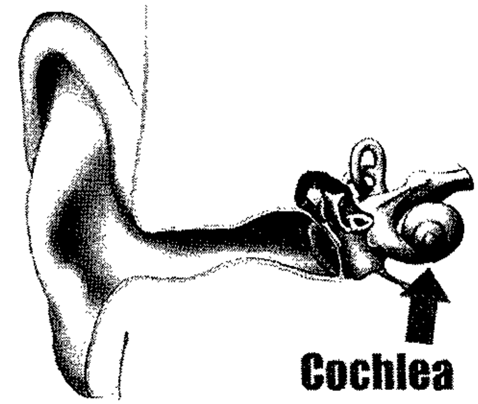
Sensory systems change brain functioning. They affect not only what a person or animal feels or thinks at that very moment, but also how that brain will function in the future, even the near future. This is called neuroplasticity, the neural basis of learning, for which Eric Kandel won the Nobel prize in 2000.[1]

Tinnitus:
The brain makes up sound where no sound exists

Take, for example, tinnitus, or ringing in the ears—an important sensory problem in Wind Turbine Syndrome. Ringing, buzzing, sizzling, or waterfall noises—my study subjects described all of these, sometimes in the head as well as the ears.

58% of the adults and older teens in my sample of affected families had tinnitus. In the general population, it's 4%. People with a prior history of hearing loss or industrial noise exposure were especially likely to get tinnitus, but other people in the study also got it, without these risk factors.

Among people with tinnitus in general, many have damage to their cochlea, the snail-shaped organ of hearing in the inner ear. Because of this damage, many researchers have heretofore thought that tinnitus originates in the cochlea as distorted hearing signals—the cochlea being somehow able to produce nerve signals of sound without the sound being there in the environment.



We are now getting quite a different picture of tinnitus. People with auditory nerves (meaning the nerve from the cochlea to the brain) that have been *completely* cut (for example, because of a tumor on the nerve) also have tinnitus, although, again, there is no input from the cochlea to the brain at all.

Recently, functional imaging studies (like MRI or PET scans) of people with tinnitus have supported the idea that tinnitus arises not in the ear, but in the parts of the brain that process sound. The trigger is an absence of input from the cochlea or parts of the cochlea. Essentially, your brain makes up sound where no sound exists.

It's like phantom pain that people get when they have lost a limb. There is no nerve input from the limb because it's gone; nevertheless, the person experiences the limb hurting.

The NEW ENGLAND JOURNAL of MEDICINE

Tinnitus is like this—it's phantom noise. It can be an excruciating and unpleasant sensation.

This type of change in the brain (like what happens with tinnitus) happens quickly. We learn this from a journal as unimpeachable as the *New England Journal of Medicine*, the gold standard in America for medical research. Describing the pathophysiology of tinnitus, a review article published in 2002 stated:

> Hearing loss leads to a reorganization of the pathways in the central [brain] auditory system. These changes may occur rapidly and lead to abnormal interactions between auditory and other central [brain] pathways.[2]

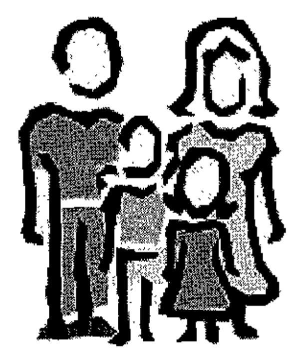
What's happening here is that the cells in the brain are making new connections, not good connections. It's like chaos in the brain, and the result is hearing a noise that isn't really there.

Wind Turbine Syndrome & tinnitus

Now listen to this story from *Wind Turbine Syndrome*.[3] A real Canadian family, family A in my study. We'll call them the Smiths. We'll call them Frank, Marlene, and their 2½ year old boy, Justin.

Frank, age 32, is a healthy fisherman who owns his own boat. Turbines, 10 in a row pointing at the house, the closest 1 km away, go online. For the first three weeks, Frank has repetitive popping in his ears, like pressure changes. After three weeks, a continuous headache starts whenever he's at home. It resolves after several hours every time he leaves the house, and comes back within several hours of coming home. Several weeks after the headache started, tinnitus starts and worsens over the duration of the 5-month exposure, until the family abandoned their home and rented a house in town.

Marlene, his wife, a 33-year-old accountant, likewise noticed repetitive popping in her ears for the first three weeks. She also noticed she couldn't hear as well as before. After three weeks, the tinnitus began. The tinnitus continued and worsened over time during the 5 months of exposure, varying according to how much she was at home and how loud the turbines were. After the exposure ended, she told me, the tinnitus resolved, but she noticed a new difficulty understanding conversation in a noisy room. She noticed she had to watch the speaker's face more closely.



During exposure, young Justin, a healthy 2½-year-old, pulled on his ears and got cranky at the same times that adults in the family noticed more headache and tinnitus. His language development was good before, during, and after exposure, but his mother noticed during exposure that the child began to confuse T with K sounds and W with L sounds, which he had not done before. This sound confusion was ongoing six weeks after exposure ended, when I interviewed the parents.

Let's match the research to the clinical account—match medical science to this real family. These two adults experienced pressure changes in their ears for some weeks, one with some loss of hearing. They then developed tinnitus. The tinnitus resolved when the noise exposure ended, but Marlene still noticed subtle differences in her own auditory processing and in her child's, Justin's.

Picking out one voice against background noise is an example of brain (or central) auditory processing, which means how your brain takes signals coming from your ears and puts them together into language, music, the song of a hermit thrush, or other recognizable and meaningful sounds.

To pick out one sound from background noise, your brain processes simultaneous signals from both ears, integrating the signals into a new type of perception that transcends what either ear can do alone. (It's sort of like depth perception with two eyes.)

Hearing in background noise is one aspect of brain auditory processing, and one that audiologists often test. Distinguishing language sounds is another critical part of how the brain processes sound, especially for children learning language.

So, what do we have? We have the *New England Journal* telling us that auditory pathways in the brain reorganize rapidly when there are deficits in the input from the ears, producing tinnitus. (Let's not ignore that this "reorganization" represents deterioration in function—not an improvement. Contrast this to the process of brain organization that occurs as a child learns language.) We have this research on the one hand, and on the other, younger healthy adults telling us their observations of their own hearing and hearing-related processes as they passed through a substantial bout of noise exposure.

Marlene described the noise, by the way, as, "Not noisy like a chainsaw; more like pulsating annoyance. To another person it wouldn't sound loud."

I suspect that in a child as young as Justin, 2½, who was removed from exposure so quickly, this process is entirely reversible. But such effects are less likely to be reversible with older age or longer exposure. That's a basic principle of how brains develop.

> NOISE EXPOSURE, EVEN AT RELATIVELY LOW SOUND LEVELS, FOULS UP THE PARTS OF THE BRAIN RESPONSIBLE FOR FIGURING OUT LANGUAGE SOUNDS, AND THE PARTS RESPONSIBLE FOR UNDERSTANDING AND LEARNING AND REMEMBERING THINGS WE HEAR OR READ

I'm basing this interpretation of the Smith's experience on the tinnitus research and also on another area of research—on the effects of other types of environmental noise (like airport or traffic noise) on children's learning.

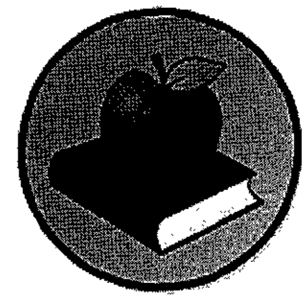
Learning to read is a language-intensive process that is especially sensitive to the effects of noise in school or at home. This effect is distinct from the effects of noise on attention or working memory,[4] and is correlated with measures of sound processing such as speech recognition.[5]

In one study, for example, a German city closed an old airport and built a new one. Researchers had the opportunity to follow the reading skills of both sets of children over time. Those living near the airport that closed showed improvement in their reading. The ones near the new airport slowed down in their learning after the airport opened.[6]

Another study looked at the effects of noise on both reading and auditory processing in children who lived in an apartment building next to a busy highway. Auditory processing, again, is what your brain does with the signals from your ears to turn them into meaningful language or other sounds.

The higher the children lived in the building, the quieter were their apartments and the better their reading and auditory discrimination scores, which means, for example, distinguishing the word *goat* from *boat*. The study factored out the effects of parent education and income, and then found that children exposed to more noise were more delayed in their reading. The amount of delay in reading was explained by how badly the children were doing distinguishing language sounds from each other, which also worsened with more noise.[7]

In other words, the presence of noise in the environment degraded how these children's brains processed language sounds, which in turn degraded their ability to learn to read. It wasn't that the noise just kept them from hearing things they needed to learn; the noise actually harmed their brain's ability to process language, even when that language was coming in through their eyes, as it does when we read.



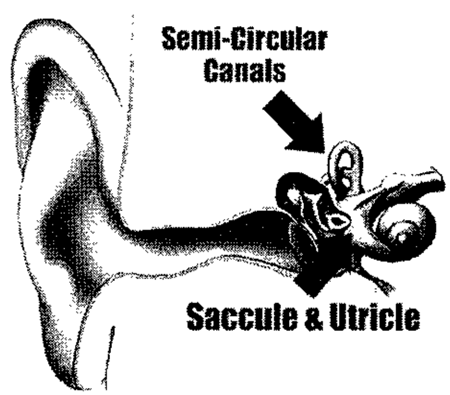
Moreover, these effects of noise on reading occur at sound levels far less than those needed to produce hearing damage.[8] Children at higher grade levels are more affected, and longer exposure produces larger deficits, other studies have shown.[9]

In my wind turbine study, 7 out of the 10 school-age children and teens did worse in school during exposure to turbines, compared to before or after, including unexpected problems in reading, math, concentration, and test performance, noticed by both teachers and parents. Teachers sent notes home asking what was wrong with the children.

Subtle as these effects are, they have serious implications. Noise exposure, even at relatively low sound levels, fouls up the parts of the brain responsible for figuring out language sounds (what we call language processing) and the parts responsible for understanding and learning and remembering things we hear or read (what we call language-based learning).

Let me emphasize: Noise exposure, even at low levels that don't damage hearing, can do this.

The Balance Organs: A protean presence in the brain, in terms of what types of sensations they draw on and how the information is used by the brain



There is another set of organs in the inner ear, the organs of balance (called the vestibular organs), consisting of the utricle and saccule (the two otolith or "ear rock" organs, where microscopic stones control our perception of gravity and movement in a straight line) and the semicircular canals, which detect rotations of the head in three planes.

The balance system is probably the least well known of all the senses for both the general public and physicians. It's a different kind of sense. It has some dedicated organs (the vestibular organs in the inner ear, just described), but these organs do not function on their own, not without the cooperation (and brain integration) of multiple sensory signals from all over the body.

We use this sense not just for balance (staying upright), but also for telling where we are in space and how fast and in what direction the different parts of our bodies are moving, at all times.

The vestibular sense feeds back instantaneously, for example, on the eye movement muscles and on posture-maintaining muscles in the neck and back. It also adapts to gravity by controlling tension in the arteries and smaller blood vessels all over the body, and how hard the heart is pumping, to keep the blood evenly distributed whether you are standing up, lying down, or standing on your head.

Balance and motion detection requires input from the eyes, from stretch receptors in the muscles and joints all over the body, from touch receptors in the skin, and, it is now known, from stretch and pressure receptors in and around internal organs and the great blood vessels in the chest and abdomen.[10] As well as requiring signals from the inner ear—the utricle, saccule, and semicircular canals.

This is a remarkable feat of brain integration, especially when the signals don't all agree with one another. The brain has to figure out which signals to downweight or ignore if they don't all agree, or if the signals from one channel are distorted.

Even fish have otolith organs and semicircular canals. The cochlea, or specialized hearing organ, evolved later, our type specifically in mammals. The brain essentially grew up, through evolution, with vestibular neurons and signals already in place. As a consequence, our systems for detecting movement, gravity, pressure, and vibration have a protean presence in the brain, going everywhere, both in terms of what types of sensations they draw on, and how the information is used by the brain.

In fish and amphibians, the otolith organs are much better detectors of low-frequency noise and vibration than are these animals' own versions of sound-detecting organs.[11,12] We now know that even in mice—a mammal—low-frequency, air-borne sound is detected by the otolith organs.[13] In humans, detection of low frequency sound by the otolith organs has been shown only using bone-conducted sound, meaning a source of vibration placed right against the head.

At 100 Hz, the tone of a moderately low note on the piano, healthy adults can detect a bone-conducted vibration at 15 dB below their own normal hearing thresholds, probably through the utricle.[14,15] "Detection" in this case means that the vibration triggers an automatic reflex in muscles around the eyes or in the neck, a response that can only be due, we know, to vestibular stimulation.

All this by way of saying that we are getting nearer to understanding the pathophysiological mechanisms causing Wind Turbine Syndrome.

Wind Turbine Syndrome resembles inner ear pathology witnessed by otolaryngologists

The symptoms of Wind Turbine Syndrome directly mirror the symptom clusters that practicing otolaryngologists have seen for years in patients with balance problems due to vestibular inner ear pathology.[16,17] With vestibular pathology, however, the symptoms are not known to come and go with noise exposure. Very importantly, the symptoms associated with vestibular pathology are not just about balance or dizziness, as I'll review in a moment. Indeed, the symptoms clinically reveal the linkages between the balance-processing parts of the brain, and cognition and memory—linkages only now being described through experiments and functional brain imaging.

Over 90% of my sample of affected people, both adults and children, had cognitive difficulties during wind turbine exposure—problems that lingered and resolved slowly after exposure ended. These included difficulties with reading, math, spelling, writing, multitasking in kitchen and home, remembering a series of errands, maintaining a train of thought in a telephone conversation, following the plot of a TV show, following recipes, and following directions to put together furniture.

Balance-disordered patients in clinical practice also struggle with short-term memory, concentration, multitasking, arithmetic, and reading. Patients with inner ear fluid leakages, for example, present with symptoms of dizziness, headache, stiff neck, and disturbed sleep, accompanied by marked mental performance deficits compared to baseline.[18]

This kind of inner ear leakage can be set off by whiplash injuries, mild head trauma, or pressure trauma to the ear. The fluid leak is associated with an imbalance of fluid pressures in the inner ear, known as endolymphatic hydrops, which distorts both balance and hearing. (Ménière's disease, in which balance and hearing disturbances fluctuate, is endolymphatic hydrops that comes and goes for unknown reasons.)

Tellingly, Dr. Alec Salt, who will speak next on infrasound effects on the inner ear, has discovered experimentally that infrasound exposure causes temporary endolymphatic hydrops.[19] This is a possible mechanism for the balance disturbances, tinnitus, headache, and cognitive problems of Wind Turbine Syndrome.

The balance system is closely linked to emotions, especially fear, anxiety, and panic

So far, I have talked about how the absence or distortion of *hearing signals* from the inner ear affects thinking and learning at the brain level, and how distortion of *balance signals* from the inner ear affects thinking, memory, and concentration at the brain level. There is one more subject in this cluster of sensory/brain-function linkages, which I would like to discuss.

The balance system is closely linked to emotions, especially fear, anxiety, and panic. When my foot slides on ice under some new snow and I fling my arms out to regain balance, I have a moment of panic. My husband has fear of heights for reasons directly attributable to his brain's style of balance signal integration. I don't, and love to sit on the edge of cliffs over the ocean, watching seabirds.

When he sees me doing this, or if he gets near the edge himself or goes to the top of a tall building, he feels dizzy and nauseated (which are direct balance problem symptoms) and also panicked and irrational—afraid that he or I might fall or even jump off.

(I didn't have a full sense of this until recently, he's so controlled and calm, but now I understand why he doesn't want to take me back to Newfoundland—where there are huge, wonderful seabird cliffs…)

In some studies of balance-anxiety linkages, up to 80% of people with panic disorder have measurable disorders of balance processing. The places where people panic are those in which they "lose their bearings," so to speak, due to distortion of balance signals and their own brains' particular style of dealing with distorted balance signals. Grocery stores have been always a big culprit.

In my wind turbine study, 2/3 of the adult subjects (14 out of 21) experienced a highly disturbing collection of symptoms when exposed to high levels of turbine noise. They felt movement inside their chests, described as quivering, jitteriness, or pulsation, and then an uncomfortable urge to flee—to get out of there. Or, if the feeling awoke them at night, panic, with racing heart, a feeling they could not breathe, or the sense that there just had been an alarming noise—like a window breaking—and that they had to get up to check the house.

Wind Turbine Syndrome panic symptoms linked to previous history of motion sensitivity

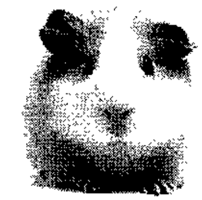
None of these people had had panic attacks in their lives before. Several had histories of anxiety or depression, but altogether, among all the adults in the study, a previous mental health problem was not significantly associated with the presence of this panic symptom. What was associated with the panic symptom, with a highly significant statistical relationship, was a previous history of motion sensitivity.

Even a tough cowboy from Missouri, a welder who raises horses, had this symptom awakening him at night near turbines. Once he and his family moved into town, he slept like a baby. No more panic awakening. (It was his wife who had to tell me about it, however.) Even the physician in my study had this symptom. Toddlers and preschool children in my study had a similar symptom—awakening in the night in states of high alarm and unable to go back to bed or to sleep.

In short, noise impinging on the ear is not just about hearing, we are learning, but also about how the brain organizes itself around sound.

Summary

- Wind turbine noise causes tinnitus in many exposed people. Tinnitus at the physiologic level is the result of a change in sound processing by the brain.
- Other types of environmental noise have been shown to impair children's learning by changing how they process language sounds. Families exposed to wind turbines noticed deterioration in their children's thinking and learning abilities during exposure. Adults also had problems with thinking, memory, and concentration during exposure.
- Other clinical and brain studies have shown that diminished thinking and performance are tied to malfunctioning of the vestibular portion of the inner ear.
- Distorted balance signaling has a close connection with panic and anxiety in a variety of situations, a linkage that may explain how panic in the night crops up in previously non-panicked but motion-sensitive people exposed to wind turbines.



Alec Salt, PhD, demolishes A-weighting noise measurements, while demonstrating that the ear has a physiological response to low frequency noise at the intensities produced by wind turbines

Professor Alec Salt is a cochlear physiologist, a laboratory scientist in the Department of Otolaryngology at the Washington University School of Medicine in St. Louis. He and his students study the fluids and physiology of the cochlea (the hearing part of the inner ear) in guinea pigs.

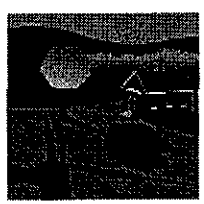
For years, Salt and his colleagues have used infrasound to change the way parts of the cochlea behave—not because they were interested in infrasound, but because it has physiologic effects which are useful in their studies of cochlear fluids and cells.

In the last year or so, Dr. Salt documented that the two types of sensory cells in the cochlea, the inner and outer hair cells, *react differently to infrasound.* The inner hair cells, which are the ones that send hearing signals to the brain, do not respond to infrasound, but the outer hair cells do.

Infrasound, he discovered, makes the outer hair cells move in such a way that they prevent the inner hair cells from responding. The outer hair cells also send neural signals to the brain and to other outer hair cells, but it is not clear what these signals do once they reach the brain. One thing we do know is that they don't convey sound stimuli, themselves. Some evidence suggests they may play a role in mediating the perception of loud sounds in the cochlear nucleus, the first relay point for sound impulses in the brain.[20,21]

What's significant for Wind Turbine Syndrome is Dr. Salt's discovery that the cochlea does indeed respond to infrasound, and sends signals to the brain in response to infrasound, but the anatomy and cellular responses of the outer hair cells actively prevent us from hearing the infrasound.

Wondering whether these findings had any significance to people and their diseases, Dr. Salt searched the medical literature last winter and came across Wind Turbine Syndrome. He subsequently published a research article linking his findings to the symptoms or clinical manifestations of Wind Turbine Syndrome.[22]



It's worth emphasizing that Professor Salt is an outstanding educator, as is clear from his website. There is a lot to be learned here about the inner ear, complete with moving, colored, 3-D simulations.

His recent research article *is posted here, with a user-friendly discussion of* its significance. There is also a link to the website of the National Institutes of Health, where his research is featured. He has also posted the slides from his presentation at the Picton conference on October 30.

In his presentation, Dr. Salt compared measured wind turbine sound spectra, not only to the human hearing response curve (as the wind industry consultants do), but *also* to the separate response curves of the *inner* and *outer hair* cells, showing that wind turbine low-frequency noise and infrasound are easily detectable by the normal cochlea. He also demonstrates how A-weighted sound level measurements specifically exclude the low frequencies significant in wind turbine health effects, effectively demolishing the credibility of A-weighted noise measurements.

Dr. Salt's research is exciting and useful because it pointedly disproves the wind industry's assertion that the infrasound produced by wind turbines is not relevant to human health because it is, they claim, below the hearing threshold of most people. On the contrary, the ear has a physiological response to low frequency noise at the intensities produced by wind turbines, even when this noise cannot be heard.

A physiologic response opens the door, of course, to clinical effects.

With regard to the mechanism of Wind Turbine Syndrome, we are now in the interesting position of having, on the one hand, a demonstrated cochlear response to infrasound without a known brain response. On the other hand, if we consider the vestibular (balance) organs in the inner ear (which share physiology and fluid connections with the cochlea), we know a lot about brain responses. There is a large scientific literature on what the brain does with normal or distorted vestibular signals with regard to sensations, symptoms, brain cell pathways, and functional and experimental problems.[23]

We also know that the symptom complex of Wind Turbine Syndrome is very similar to the symptoms of vestibular dysfunction.

What is lacking is direct evidence for air-borne infrasound stimulating the hair cells of the vestibular organs. Dr. Salt told us in his conference talk that the vestibular hair cells are "tuned" (meaning, have their best response) to body-borne vibrations at infrasonic frequencies, but that no one has yet looked at the responses of these cells to "acoustic" (meaning, air-borne) infrasound coming in through the outer and middle ear.

"Jumping mice": Mammalian balance organs detect air-borne low-frequency sound using their otolith organs (saccule & utricle)

I suspect it's only a matter of time—and short time, at that—before some research group shows air-borne infrasound stimulating the vestibular hair cells, or shows a human vestibular response to air-borne infrasound. I base my prediction in part on a new article Dr. Salt sent to me immediately after the conference, titled, "The vestibular system mediates sensation of low-frequency sounds in mice."[24] In it, the authors explain how the "ancestral acoustic sensitivity" of the saccule has been retained not only in fish and amphibians, but also, according to recent evidence, in birds and mammals.

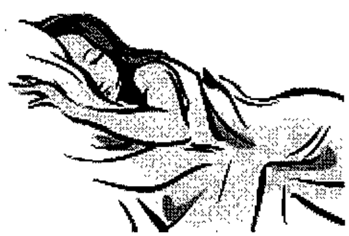
The authors demonstrate how mouse otolith organs respond to air-borne, low-frequency sounds below the detection range of the mouse cochlea.

Mice jump when startled by a beep. They startle more, with a more vigorous jump, in the presence of a low- or mid-frequency background sound. The authors measured this "startle response"—how much the mice jumped—quantitatively on little electronic platforms. Genetically normal mice jump more in response to either low- or mid-frequency background sound, but the authors also tested mice which, for genetic reasons, never developed the otoconia (little stones) in their otolith organs (utricle & saccule). Significantly, these otolith-deficient mice did the extra-large jumps only when the background sound stimulus fell within the frequency range of the mouse cochlea. They didn't detect the low-frequency background sound stimuli the way the mice with functioning otolith organs did.

Jumping mice. The authors of this study have demonstrated that mammalian ears, using their otolith organs of balance and motion detection, detect air-borne low-frequency sound at frequencies too low to be heard by their cochleas. This makes them startle more. Now consider "jumping people"—startled right out of bed in the middle of the night in the presence of sub-audible, low-frequency noise, or infrasound, from wind turbines.

Evidence like this suggests the following mechanism for Wind Turbine Syndrome: air-borne or body-borne low-frequency sound directly stimulates the inner ear, with physiologic responses of both cochlea and otolith organs.

Physiologic responses in the cochlea suppress the hearing response to low-frequency sound but still send some signals to the brain, signals whose function is, at present, mostly unknown. The physiologic response of the cochlea to turbine noise is also a trigger for tinnitus and the brain-cell-level reorganization that tinnitus represents—reorganization that can have an impact on language processing and the learning processes related to language processing. Physiologic responses and signals from the otolith organs tie into a wide range of known brain responses to vestibular signals, including dizziness and nausea (seasickness without the movement), fear and alerting (startle, wakefulness), and difficulties with visually-based problem-solving.



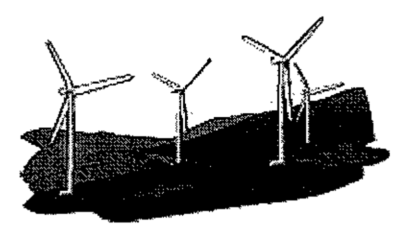
Christopher Hanning, MD, and sleep arousal

The interaction between sleep and these ear-brain mechanisms is interesting. Wind turbines create a particularly disturbing kind of noise with high alert potential, Dr. Chris Hanning, a sleep specialist, explained at the conference.

Our sleep is disturbed not only when we wake up completely, but also by subclinical arousals—in which the body and brain move into a lighter phase of sleep without waking all the way up. This type of disturbance requires even less noise than full awakening, but still disrupts sleep and its restorative properties for mood, memory, thinking, alertness, and coordination.

People vary in how deeply they sleep, and how resistant they are to awakening or arousal by noise. We can reliably measure how much people are disturbed during sleep using questionnaires about their daytime functioning.

Rick James, Noise Control Engineer: Sick Building Syndrome



Turning to noise studies around wind turbines, noise control engineer Rick James presented sound monitoring data showing the disturbing, high-alert qualities of wind turbine noise: high levels of low frequency noise and infrasound, and the pulsating quality of the low frequency noise and infrasound. Both the audible noise and the infrasound from turbines are subject to "amplitude modulation" (meaning, the loudness goes up and down)—a quality that adds markedly to its disturbing character.

The arrangement and spacing of turbines in clusters also affects how much noise they make, because a second turbine, beating in the downwind turbulence of the first turbine, makes more noise.

Mr. James reviewed research from the 1980's and '90's on illness in office workers, induced by low-frequency noise from mal-aligned fans or vibrating ducts in the heating, ventilation, and air conditioning systems of large buildings. Research on these specialized cases of "Sick Building Syndrome" focused on the detrimental effects of low frequency noise on work productivity, and included experimental assessment of low frequency noise effects on concentration and mood.[25]

A word of caution, however. The term "Sick Building Syndrome" is associated most commonly with problems of indoor air quality (including particulates, allergens, infectious particles, solvent odor, and the amount of fresh air), and the syndrome includes irritation of the skin, eyes, and respiratory tract, as well as fatigue, headache, poor concentration, nausea, and dizziness.[26] The latter symptoms are commonly associated with low frequency noise exposure in other contexts, whereas skin and mucous membrane irritation are not.

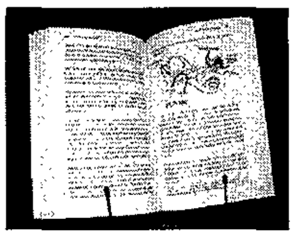
In other words, although Wind Turbine Syndrome shares the noise-related aspects of Sick Building Syndrome, the two terms are not the same.

Michael Nissenbaum, MD, reports that surveyed subjects up to 3 miles from turbines showed effects on sleep and mood that varied directly with distance from the turbines

Finally, Dr. Michael Nissenbaum, a Maine physician, presented results of a study of 79 adults living up to three miles from wind turbines in Maine, who completed (what are clinically called) validated questionnaires on sleep disturbance and general physical and mental well-being, divided into study and control groups based on distance from turbines.

Dr. Nissenbaum found differences between the study and control groups in several sleep quality indices, and in the mental health component of the general questionnaire. Even more remarkable, when he pooled the data from study and control groups, he found a dose-response relationship out to about 5 km (3 miles) from turbines. Subjects up to 3 miles from turbines, whether they were initially considered to be in the study or control groups, showed effects on sleep and mood that varied directly with distance from the turbines, Dr. Nissenbaum reported.

This is a valuable study. The surveys required information only about the subjects' current state of sleep and well-being, without reference to the turbines. The impact of turbine noise is apparently seen much farther away than the 1.5-2 km minimum setback proposed by many researchers (including me), although there was a drop-off in symptoms beyond 1.4 km. The questionnaires did not sample the full range of Wind Turbine Syndrome symptoms, but provide a standardized and quantified measure of one important symptom—sleep disturbance—and of general medical and mental health in relation to turbines.



The "Humanness" of Wind Turbine Syndrome

Such is the state of Wind Turbine Syndrome research a year after I published "Wind Turbine Syndrome: A Report on a Natural Experiment." As I said earlier, we have made substantial progress in figuring out the mechanism and other parameters of this industrial plague.

It's worth pointing out that, with one notable exception, none of this was done with government or industry or foundation support —either financial or moral support. Just the opposite, governments (at all levels) and the wind energy industry have actively tried to thwart this research. But—this pleases me immensely—it was accomplished despite their opposition.

The exception being the National Institutes of Health, which funded Dr. Salt's research. All praise to the NIH!

A final word. For me, it was both sobering and energizing to talk, again, with victims of Wind Turbine Syndrome at the conference. At times, distracted by political and journalistic "noise," I forget how serious WTS actually is.

Separately, a man and a woman from different countries told me quietly of their thoughts of committing suicide. Both are older with good marriages and productive lives and adequate resources. One has been driven from her home by relentless nausea and vomiting, and the other is made ill whenever he returns home.

While governments, the wind industry and its scientific and clinical hirelings, and the media continue to belittle and deny the experience of these individuals—Lord knows, the media is filled with denial, ridicule, and venom (Google "Wind Turbine Syndrome")—I am reminded, once more, that the physical, mental, social, and financial consequences of this perfectly correctible condition are appalling.

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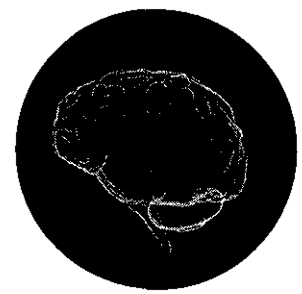

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September 23, 2013

Education

1991	M.D.	The Johns Hopkins University School of Medicine
1985	Ph.D.	Princeton University (Behavioral Ecology)
1981	M.A.	Princeton University (Behavioral Ecology)
1977	B.A.	Yale University (cum laude)

Post-Doctoral Training

1992 to 94	Pediatrics	Dartmouth-Hitchcock Medical Center, Lebanon, NH
1991 to 92	Pediatrics	Children's National Medical Center, Washington, DC
1985 to 86	Ornithology	American Museum of Natural History, New York, NY

Licensure and Certification

1997	Licensed Physician, New York (# 206679)
1994	Diplomate, American Board of Pediatrics (recertified 2008, expires 2015)
1994	Licensed Physician, Alaska (expired)

Hospital or Affiliated Institution Appointments

2004 to	Consulting Pediatrician Alice Hyde Medical Center, Malone, NY
2000 to 03	Senior Attending in Pediatrics Bassett Healthcare, Cooperstown, NY
1997 to 00	Attending Pediatrician Alice Hyde Medical Center, Malone, NY
1995 to 96	Chief of Pediatrics Yukon-Kuskokwim Delta Regional Hospital, Bethel, AK (Yup'ik Eskimo)
1994 to 95	Staff Pediatrician Yukon-Kuskokwim Delta Regional Hospital, Bethel, AK

Other Professional Positions

2004 to	Private Practice (Solo) Behavioral/Developmental Pediatrics and Psychiatry Malone, NY
1998 to 00	Private Practice (Solo) Pediatrics Malone, NY
1997 to 00	Staff Pediatrician St. Regis Mohawk Health Services, Hogansburg, NY
1997 to 98	Staff Pediatrician North Country Children's Clinic, Malone, NY

Academic Appointments

2000 to 03	Assistant Clinical Professor of Pediatrics Columbia University College of Physicians and Surgeons

Continuing Education

2012	Psychiatry in 2012 (Harvard, 20 hours)
2011	Primary Care Internal Medicine (Harvard, 42.5 hours)
2011	Addictions in 2011 (Harvard, 14.5 hours)

2009	Spectrum of Developmental Disabilities XXX I: A Pragmatic View of the Social Brain (Johns Hopkins, 18.25 hours)
2008	IntermediateTraining in the Psychological Treatment of Children with Trauma-Attachment Problems - Daniel A. Hughes, Ph.D. (32 hours)
2007	Training in the Psychological Treatment of Children with Trauma-Attachment Problems - Daniel A. Hughes, Ph.D. (32 hours)
2006	Workshop in Basic Pediatric Hypnosis (20 hours)
2006	Introductory Theraplay Training (27 hours)
2005	Psychiatry: Comprehensive Update and Board Preparation (Harvard, 51 hours)
2005	ADHD Across the Life Span (Harvard, 22 hours)
2004	Gesell Developmental Evaluation, Anthony Malone, M.D., Latham, NY (6 days)
2002	Promoting Student Success (Melvin Levine, M.D., U. of N. Carolina, 20.5 hours)
2002	Psychiatric Neuroscience Home Study Course (Harvard, 16.5 hours)
2000	Child and Adolescent Psychopharmacology (Harvard, 20 hours)
1998	Clinical Diagnosis and Treatment of Fetal Alcohol Syndrome (7.5 hours)
1997	Pediatric and Adolescent Gynecology (Harvard, 14 hours)

Awards and Honors

1984	National Science Foundation Dissertation Grant (Princeton)
1979 to 82	National Science Foundation Predoctoral Fellowship (Princeton)
1979, 80	Dunlop Prize, Biology Department, Princeton University
1981 to 83	Research grants from the National Academy of Sciences, American Museum of Natural History, American Ornithologists' Union, and others
1973	National Merit Scholar to Yale University

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9/9/06	ADHD: Young Children, Self-Regulation, and Look-Alike Problems
9/23/06	ADHD: Older Children: Mental Energy and Consistency
10/7/06	ADHD: In One Ear and Out the Other (Processing Controls)
10/23/06	What Elephants Teach Us about Children
11/4/06	ADHD: Look Before You Leap (Production Controls)
11/18/06	Mapping the World onto the Brain: Neurological Templates for Learning
12/2/06	Childhood Adverse Experiences and Long-Term Health (ACE Study)
12/16/06	Autism from the Inside (Temple Grandin)
1/7/07	Mirror Neurons and Autism
1/20/06	Autism, Asperger's, and Non-Verbal Learning Disabilities
2/3/07	Concussions: Short- and Long-Term Effects
2/17/03	Play + Therapy = Theraplay
3/3/07	Sick Of Poverty: Poverty, Stress, and Health
3/17/07	TV, Video Games, and Kids
4/3/07	Punished by Rewards: Research on Behaviorism
4/21/07	The Genius of Inner Motivation
5/12/07	Warbler Wave: Healing and Nature
5/26/07	Plan B: Collaborative Problem Solving
6/9/07	Try Collaborative Problem Solving