

Wind Farms and Human Health

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Conclusions

- 1. Infrasound and inaudible noise from wind turbines are not a health problem.**
- 2. Effects of wind turbine noise on health are mediated through annoyance from audible noise, particularly if aerodynamic fluctuations occur (swish).**
- 3. Attitude to a noise source is a large factor in annoyance from the source.**
- 4. The Wind Turbine Syndrome is the result of annoyance by audible noise from wind turbines, similar to annoyance from any other noise source.**

Typical complaint

Kent Breeze Windfarm, Ontario:

Claims of serious effects on health

“These effects are more likely than not caused by exposure to infrasound and/or low frequency noise and/or audible noise and/or visual impact and/or shadow flicker produced by industrial wind turbines.”

Frequency Ranges

Low frequencies

Infrasound 0Hz to 20Hz

Low frequency noise 20Hz ~ 200Hz

Low frequency noise: 5Hz to 160Hz

Higher frequencies

20Hz to 20kHz

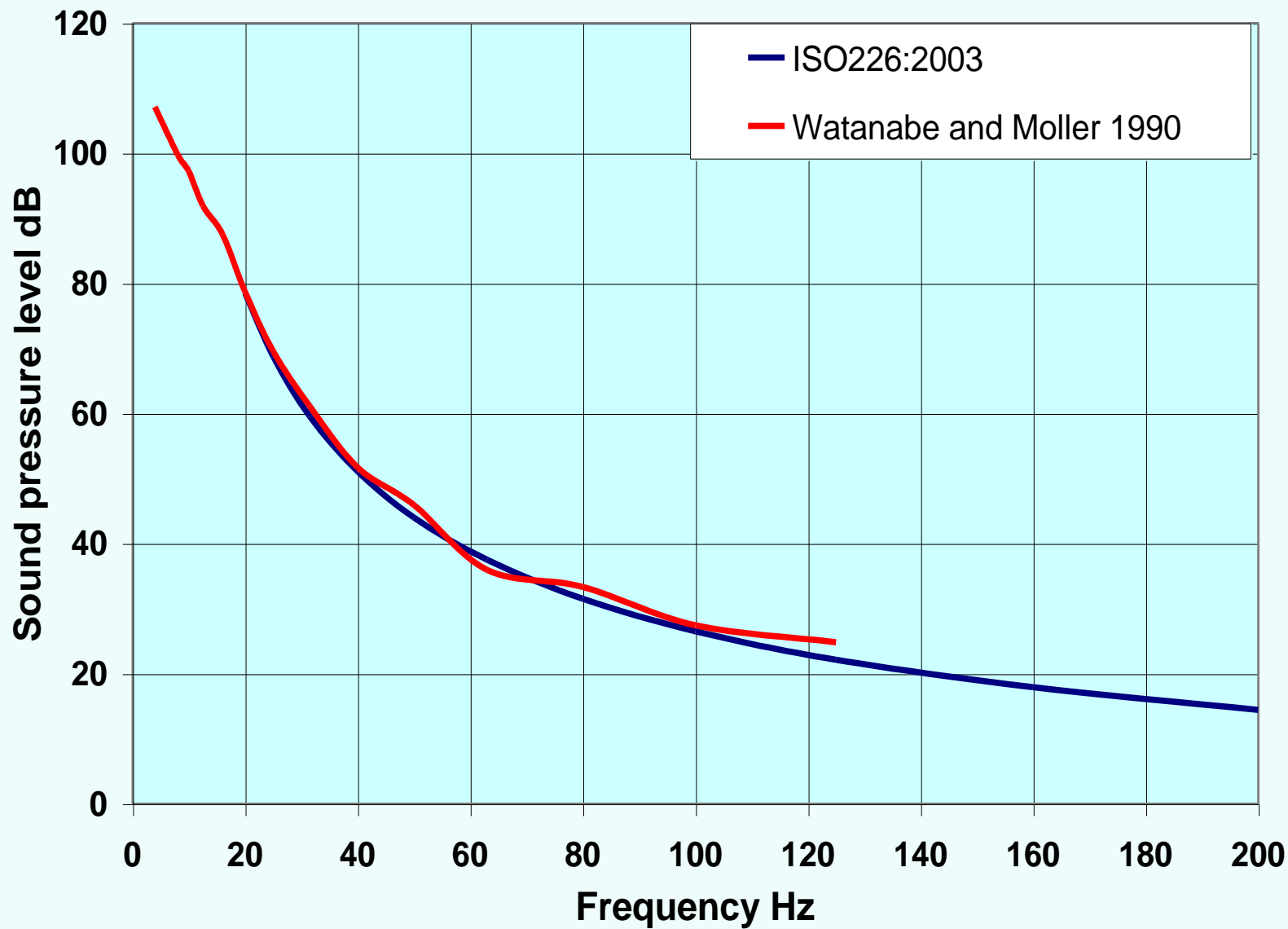
Practical range

20Hz to ~ 4 kHz

Bottom C₁ of piano ~ 33Hz: Middle C₄ of piano ~ 260Hz

Top C₈ of piano ~ 4200Hz

LF Hearing Threshold



**How did infrasound and low frequency
noise get their bad name as a
health hazard?**

**We have to study the past in order to understand
the present**

Exaggerations and misconceptions

The whole of the popular image of infrasound and low frequency noise is riddled with misconceptions, media hype and strange stories lurking in dark corners of the internet – the mythology of infrasound

See: Leventhall, G. (2006): Infrasound from Wind Turbines – Fact, Fiction or Deception *Canadian Acoustics* 34(2), 29 - 36.

Here's one of the strange stories:

Marie Celeste

Why the crew abandoned the Marie Celeste

The mystery was unsolved for decades, until it became clear that infrasound was the explanation of the phenomenon. As it turned out, infrasound of seven hertz emitted by ocean waves under some definite conditions was the reason of it. But infrasound of seven hertz is terrible for people: they may go mad and throw themselves overboard to save their lives.

<http://ghosts.monstrous.com/infrasound.htm>

The Start of the Mythology

Gavreau: CNRS Marseille

Two publications:

**Infrasons: generateur, detecteurs,
proprietes physique, effets biologique.**

Acustica 17, 1-10, 1966

Infrasound. Science Journal

4, 33-37, 1968

Infrasounds are not difficult to study but they are potentially harmful. For example one of my colleagues.... designed a powerful emitter One of his larger whistles emitting at **2600Hz** had an acoustic power of **1kW**.....This proved sufficient to make him a life-long invalid.

...after the test we became aware of a painful 'resonance' within our bodies.... this sound [196Hz] at 160 decibels..... acting directly on the body produced intense friction between internal organs. Presumably if the test had lasted longer than five minutes, internal haemorrhage would have occurred.

The effects of low frequency sound and infrasound are noxious. However, we found one exception: the intense vibration of the nasal cavities produced by our whistle (340Hz, 155 decibels) had favourable effects! In one case, a subject recovered a sense of smell which he had lost some years back and was able to breathe more easily.

Exposures in Gavreau's papers on Infrasound

2600Hz	-	not specified
340Hz	-	155dB
196Hz	-	160dB
37Hz	-	not specified
7Hz	-	not specified

French: LFN = Infrasound

“Onshore wind farms are a health hazard to people living near them because of the low-frequency noise that they emit, according to new medical studies.”

A French translation of this article for use by objectors' groups opens with

“De nouvelles études médicales indiquent que les éoliennes terrestres représentent un risque pour la santé des gens habitant à proximité, à cause de l'émission d'infrasons.”

Miller, C. (24 January 2004): Wind farms 'make people sick who live up to a mile away'. Sunday Telegraph

Infrasound and the Public - 1

The silent sound menaces drivers

Daily Mirror 19 Oct 1969

Does infrasound make drivers drunk ?

New Scientist 16 March 1972

Brain tumours caused by noise

The Times 29 Sept 1973

Infrasound and the Public - 2

Crowd control by light and sound

The Guardian 3 Oct 1973

Danger in unheard car sounds

The Observer 21 April 1974

The silent killer all around us

Evening News 25 May 1974

Infrasound and the Public - 3

**“Supernature” A natural History of the Supernatural
by Lyall Watson – 1973**

“The technician who gave the giant whistle its first trial blast fell down dead on the spot. A post mortem revealed that all his internal organs had been mashed into an amorphous jelly by the vibrations”. In a controlled experiment, Gavreau “broke the windows of every building within a half mile of the test site” and two generators "focused on a particular point even five miles away produce a resonance that can knock a building down as effectively as a major earthquake".

[Page 93]

Infrasound at NASA

Apollo Space Program 1960s-1970s

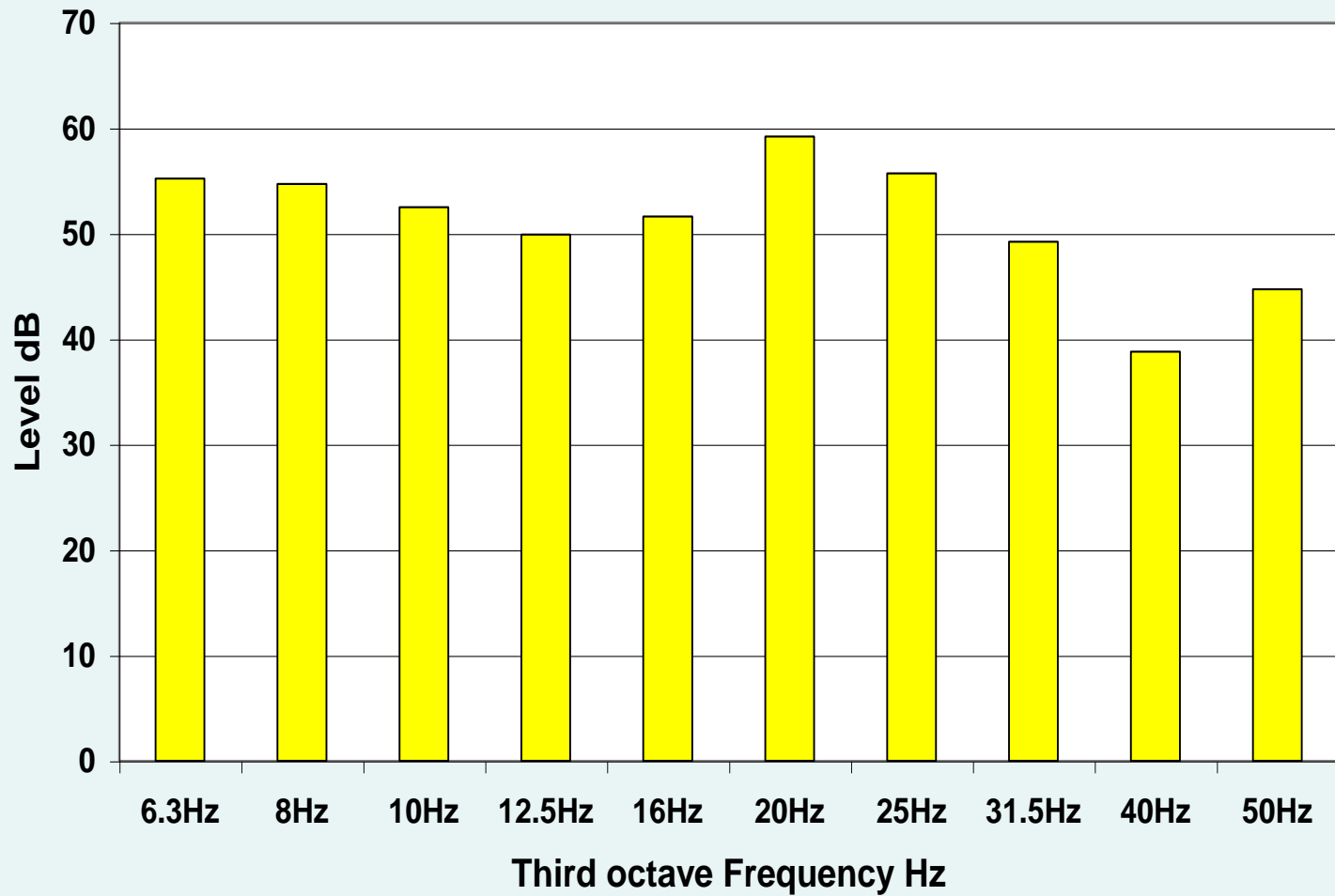
Investigated short term tolerance to tones and noise bands 140 –150dB, frequency range up to 100Hz.

Concluded that subjects with ear protection could tolerate both broadband and discrete frequency noise in the range 1Hz to 100Hz at sound pressure levels up to 150dB.

Later work suggests that, for 24 hour exposure, levels of 120-130dB are tolerable below 20Hz

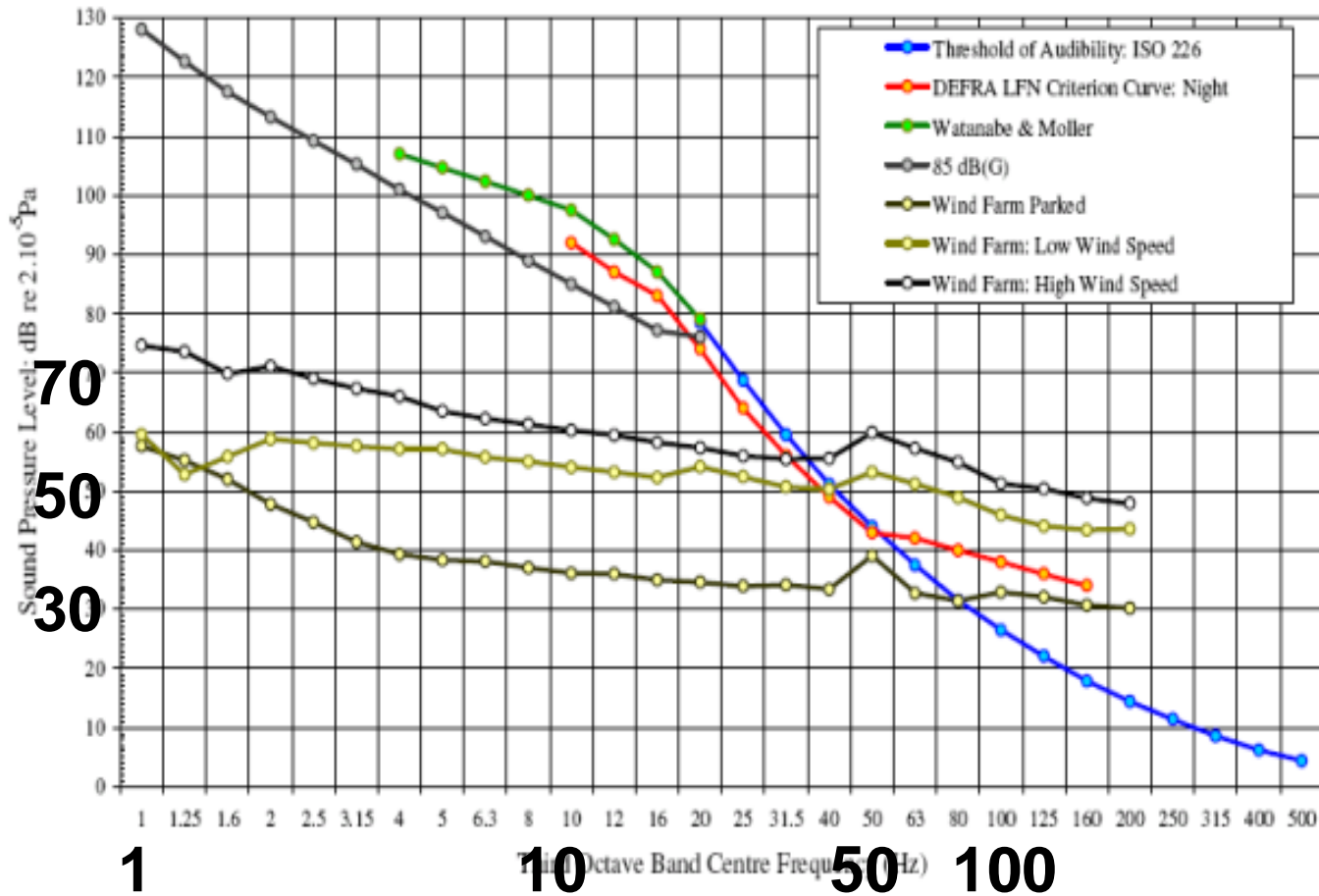
There was no scare story and no media interest

[Note 120dB for 24 hours gives the same “Noise Dose” as 60dB for ~ 2740 years]



Typical urban infrasound - quiet location

Low Frequency Noise Assessment Wind Farm: External Noise Levels Ground Board



Recent Work by Alec Salt

Annoyance and WT Infrasound 1

“The reason why wind turbine noise is more annoying than a refrigerator is because the wind turbine produces high levels of INFRASOUND !”

“We need to stop ignoring the infrasound component of wind turbine noise and find out why it bothers people !!”

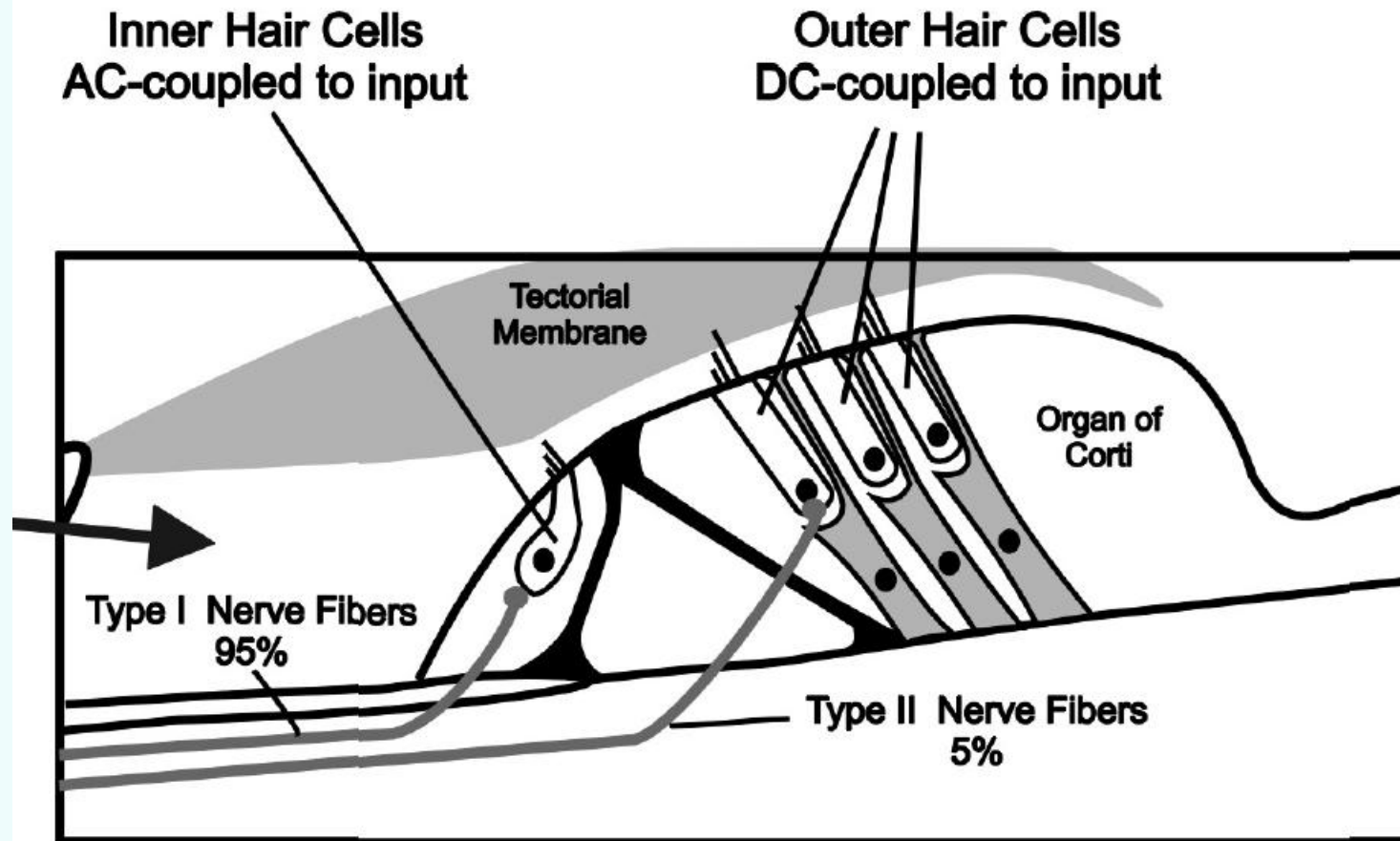
Alec Salt <http://oto2.wustl.edu/cochlea/wind.html>

Annoyance and infrasound 2

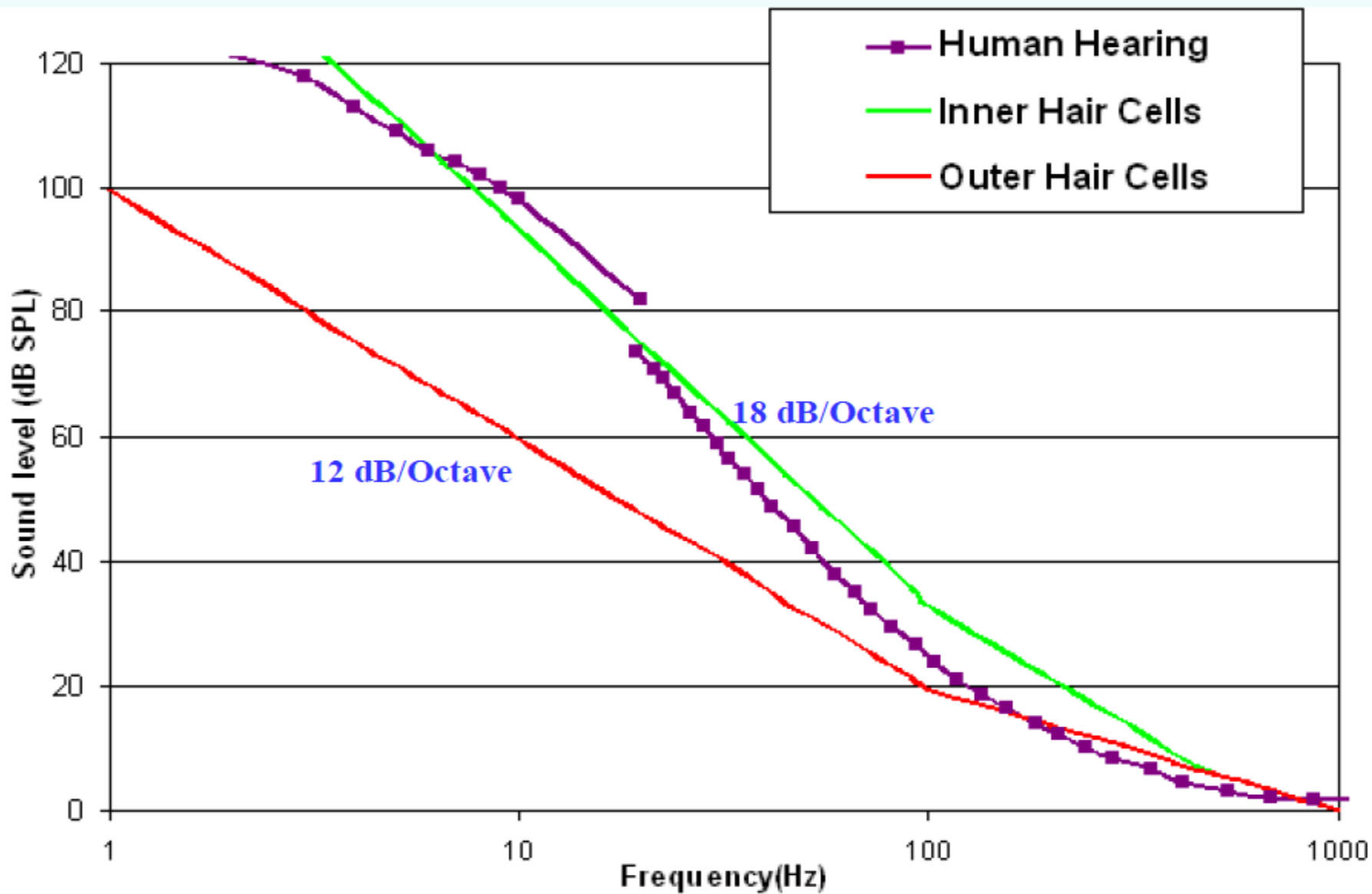
The fact that some inner ear components (such as the OHC) may respond to infrasound at the frequencies and levels generated by wind turbines does not necessarily mean that they will be perceived or disturb function in any way

**Salt and Hullar 2010 Responses of the ear to low frequency sounds, infrasound and wind turbines.
Hearing Research 268 12-21.**

Inner and Outer Hair Cells



Threshold outer hair cells



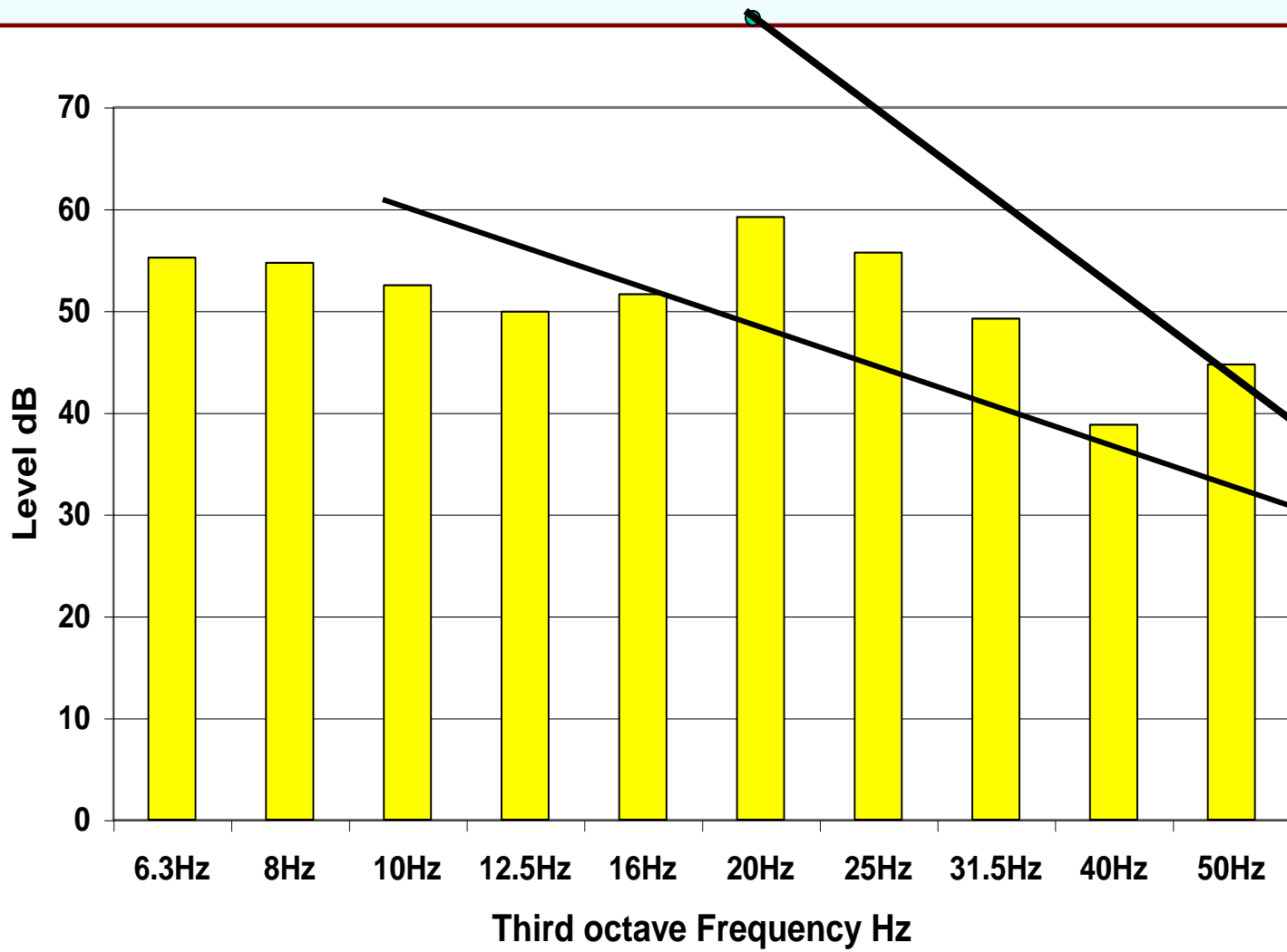
Why are our OHCs too sensitive at LF and their response blocked?

Is it down to evolution?

At very low frequencies, greater sensitivity would lead to unwanted environmental infrasound and LF noise becoming audible.

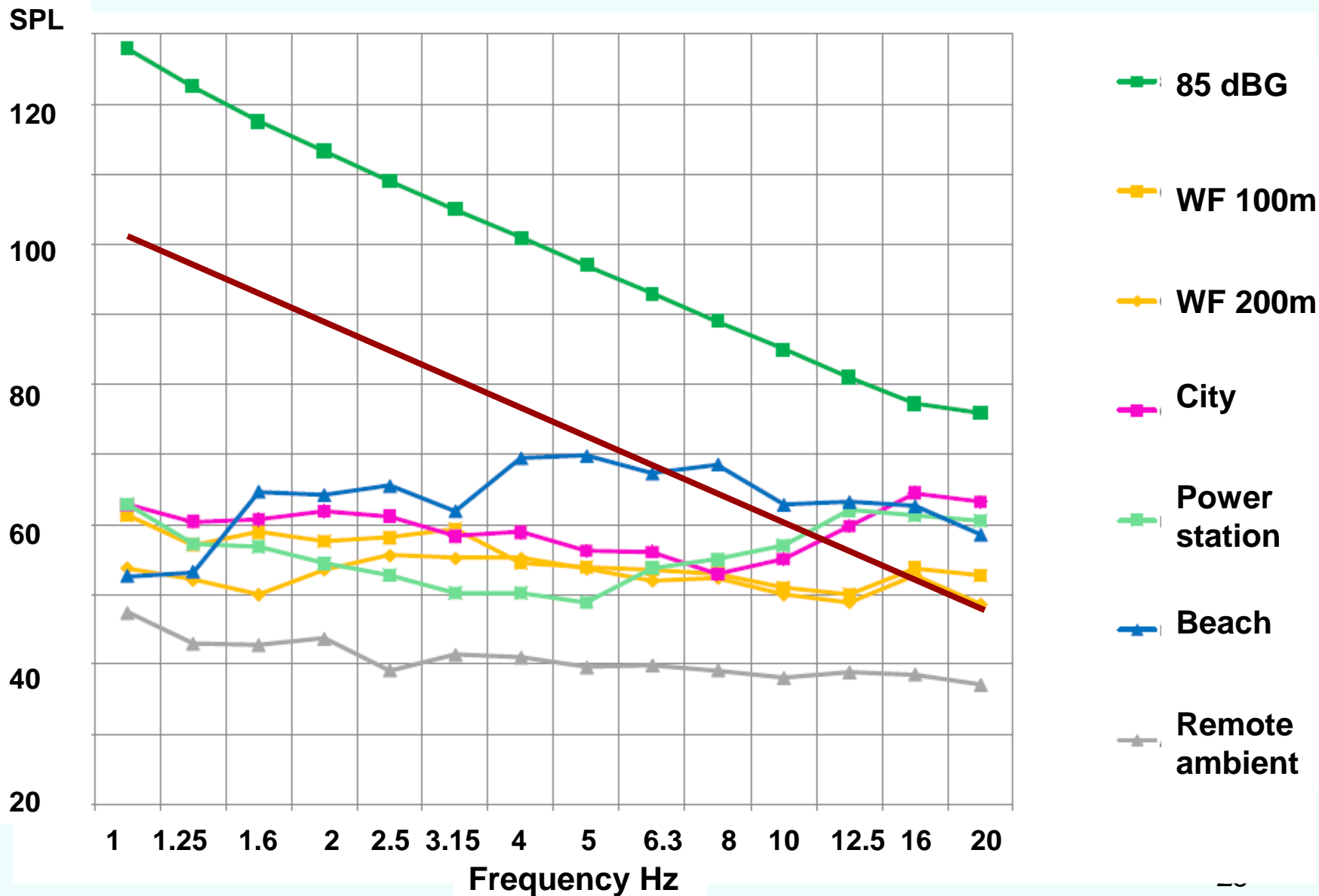
Will an evolutionary development also be harmful?

Urban dwellers do not report problems from infrasound



Typical urban infrasound – quiet location

Measurements of infrasound (SONUS)



The story so far

- **No disturbance from infrasound from wind turbines. (Not everybody will agree).**
- **Levels similar to other environments.**
- **People developing an interest in infrasound take their information from the internet, which is a very unreliable source of information.**



Wind Turbine Syndrome

A Report on a Natural Experiment

Nina Pierpont, MD, PhD

Wind Turbine Syndrome

**Must be specific to Wind Turbines,
not just another example of a
general effect.**

**Based on Pierpont's understanding
of the action of infrasound on
vestibular systems in the body**

Pierpont's Acoustics

NP has shown a very poor understanding of acoustics

Misquotes, misuses and manipulates her references

Her infrasound basis for the health effects in the WTS can be described as “pitiful” “dubious” “junk science”

She becomes understandable only when we appreciate that NP is a campaigner first and a scientist second.

And very good at campaigning!

But very bad at acoustics!

However.....

However.....

Pierpont's weakness in acoustics does *not* mean that there is no effect on health from audible wind turbine noise.

What we have to aim for is a proper understanding of why low levels of wind turbine noise sometimes lead to a response which is greater than expected

And what can be done about it.

But first.....

Wind Turbines & Infrasound: What the latest research says

“At night the wind turbines cause a low pitched thumping [i.e., infrasonic] sound superimposed on a broadband ‘noisy’ sound, the ‘thumps’ occurring at the rate at which blades pass a turbine tower.... The number and severity of noise complaints near the wind park are at least in part explained by the two main findings of this study: actual sound levels are considerably higher than predicted, and wind turbines can produce sound with an impulsive character.”

-- Professor Frits G.P. van den Berg, University of Groningen, the Netherlands, November 2004 (see excerpts from research articles, below)

Assumed Mechanism for WTS

- 1. Inaudible low level infrasound at 1-2Hz activates the vestibular system and vibrates the chest**
- 2. Inaudible low level infrasound at 4- 8Hz vibrates the body and disturbs the diaphragm etc, leading to visceral vibratory vestibular disturbance - VVVD**

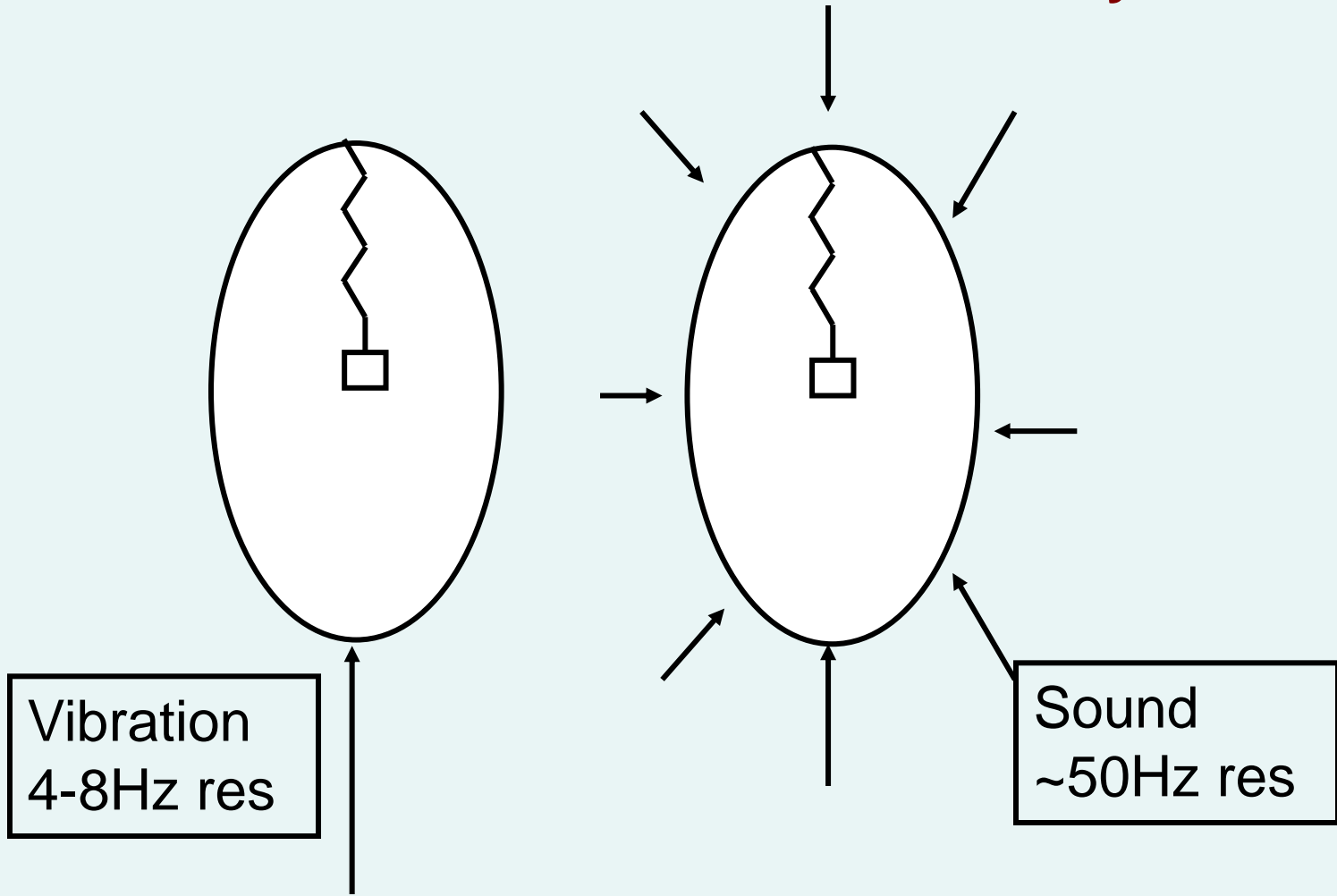
Book pages 13 and 78

**1-2Hz from wind turbines -
Disturbs vestibular system and is felt
in the chest**

**Here is a heart,
beating in the 1-2Hz range**



Action Vibration and Sound on Body



From Pierpont's web page- 1

“In an article titled “Tuning and sensitivity of the human vestibular system to **low-frequency vibration**,” three British scientists have demonstrated that the inner ear is “extremely sensitive” to **extremely low levels of low frequency noise.....**

“This is precisely what Nina Pierpont has been talking about. This new research offers substantial support for her claim that *a perturbed vestibular apparatus* is one of the keys to explaining Wind Turbine Syndrome.....”

<http://www.windturbinesyndrome.com/news/2009/new-scientific-study-supports-dr-pierponts-research/>

From Pierpont's web page 2

Quotation from Todd et al paper:

“The **very low [noise] thresholds** we found are remarkable as they suggest that humans possess a frog- or fish-like **sensory mechanism** which appears to **exceed the cochlea for detection of substrate-borne low-frequency vibration** and which until now has not been properly recognised.... A fundamental question is also raised as to the possible behavioral consequences ... such a mechanism may have”.

[noise] not in the original. Inserted by Pierpont

Todds Response – Independent on Sunday 9th August 2009

Our research is being cited to support the case that "wind turbine syndrome" is related to a disturbance of vestibular apparatus produced by **low-frequency components of the acoustic radiations** from wind turbines. **Our work does not provide the direct evidence suggested.** We described a sensitivity of the vestibular system to **low-frequency vibration of the head**, at about 100Hz, and **not air-conducted sound.**

At present I do not believe that there is any direct evidence to show that any of the above acoustico- physiological mechanisms are activated by the radiations from wind turbines. Even if the vestibular system were activated in a controlled acoustic environment, it is not necessarily the case that it would produce pathological effects. Until such evidence is available I have an open mind on "wind turbine syndrome"

Internal body sounds/vibration

- **The body is a noisy system at low frequencies.**
- **Heart, circulation, muscle vibrations etc can be picked up externally, as radiated sound or surface vibration.**
- **Body sounds are used for diagnosis e.g. heart murmur, breathing sounds etc.**
- **Measurements of body vibrations in noise show masking by internal body sounds at LF.**
- **External sounds entering the body are masked by internal sounds**

Case studies

Based on results of telephone interviews - 10 families < 40 members

Criticised on epidemiological grounds of self selection, small number etc

Results already well known - not new, except for predisposition due to existing health problems

Symptoms of WTS

Symptoms include sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering which arise while awake or asleep.

Book page 193

WTSyndrome

sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering which arise while awake or asleep”

Noise annoyance

insomnia; headache; pressure in the ears or head;

Dizziness; nausea;

eye strain; fatigue; distraction;

nose bleeds;

feeling vibration; muscle spasms;

palpitations; skin burning; stress; tension etc

Evidence

There is no evidence for the hypotheses on effects of infrasound on health on which the Wind Turbine Syndrome is based.

Infrasound at the levels produced by WTs does not have the effects attributed to it.

Effects included in the WTS are well known as stress effects from audible noise

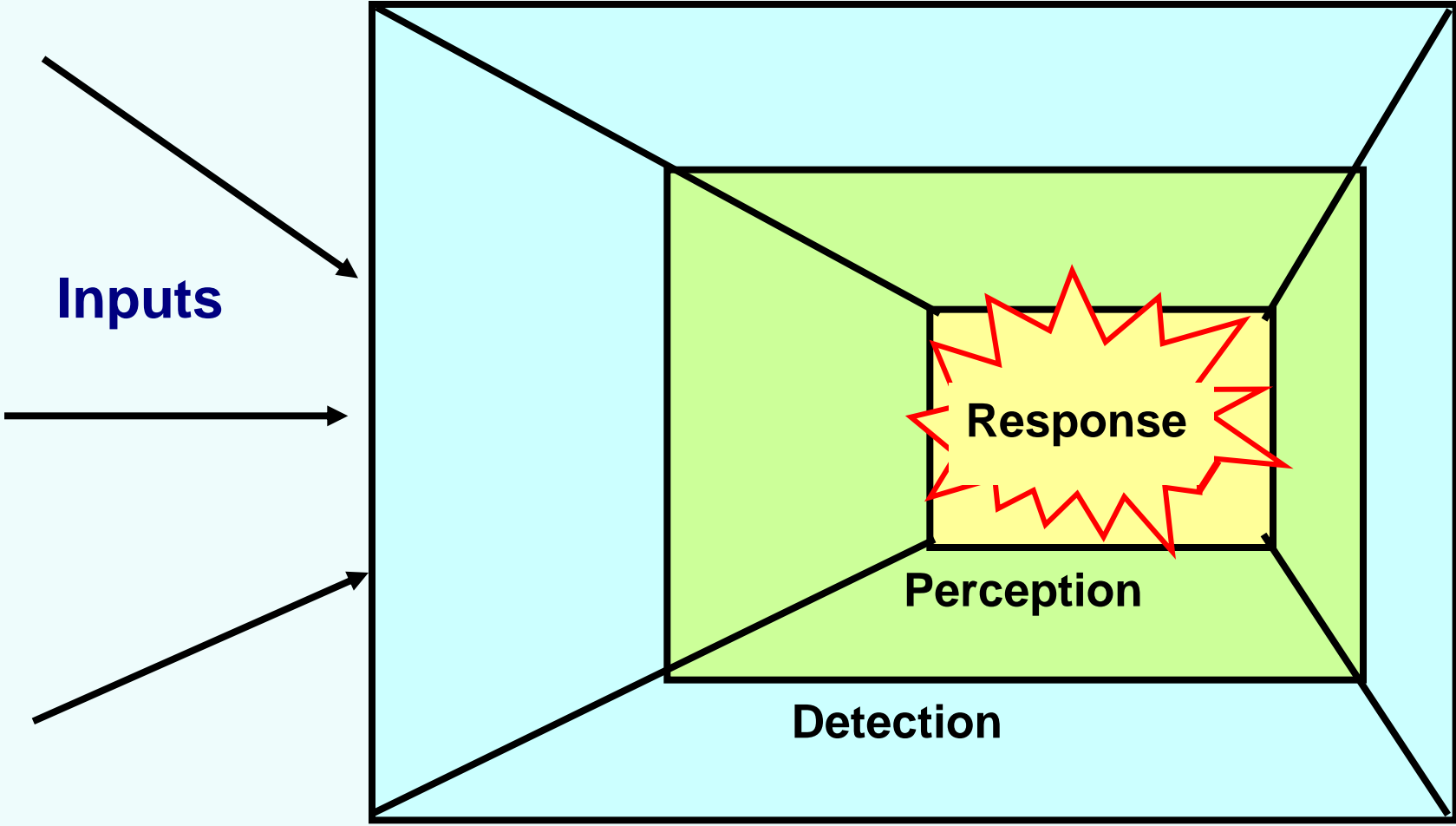
A quote from Pierpont

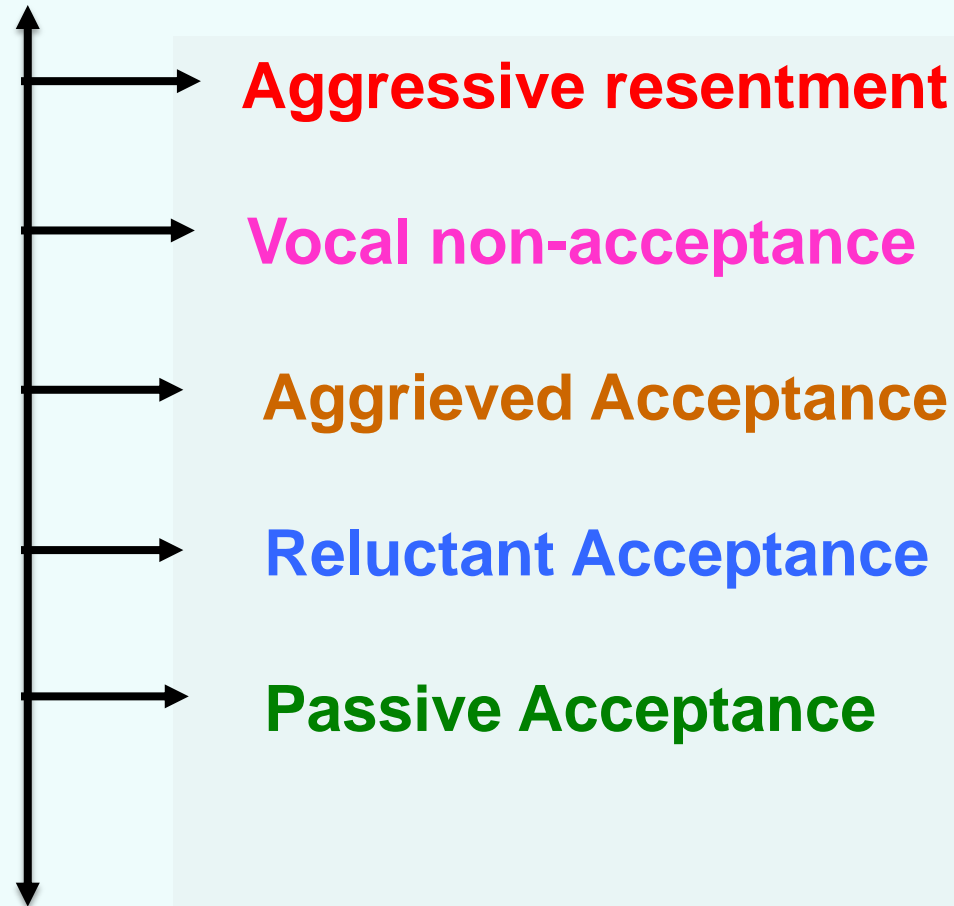
Wind Turbine Syndrome pg 252

“Let me be emphatic. You can’t start with an implausible hypothesis or a flawed data set and get a result which means anything”

Subjective Response to Noise

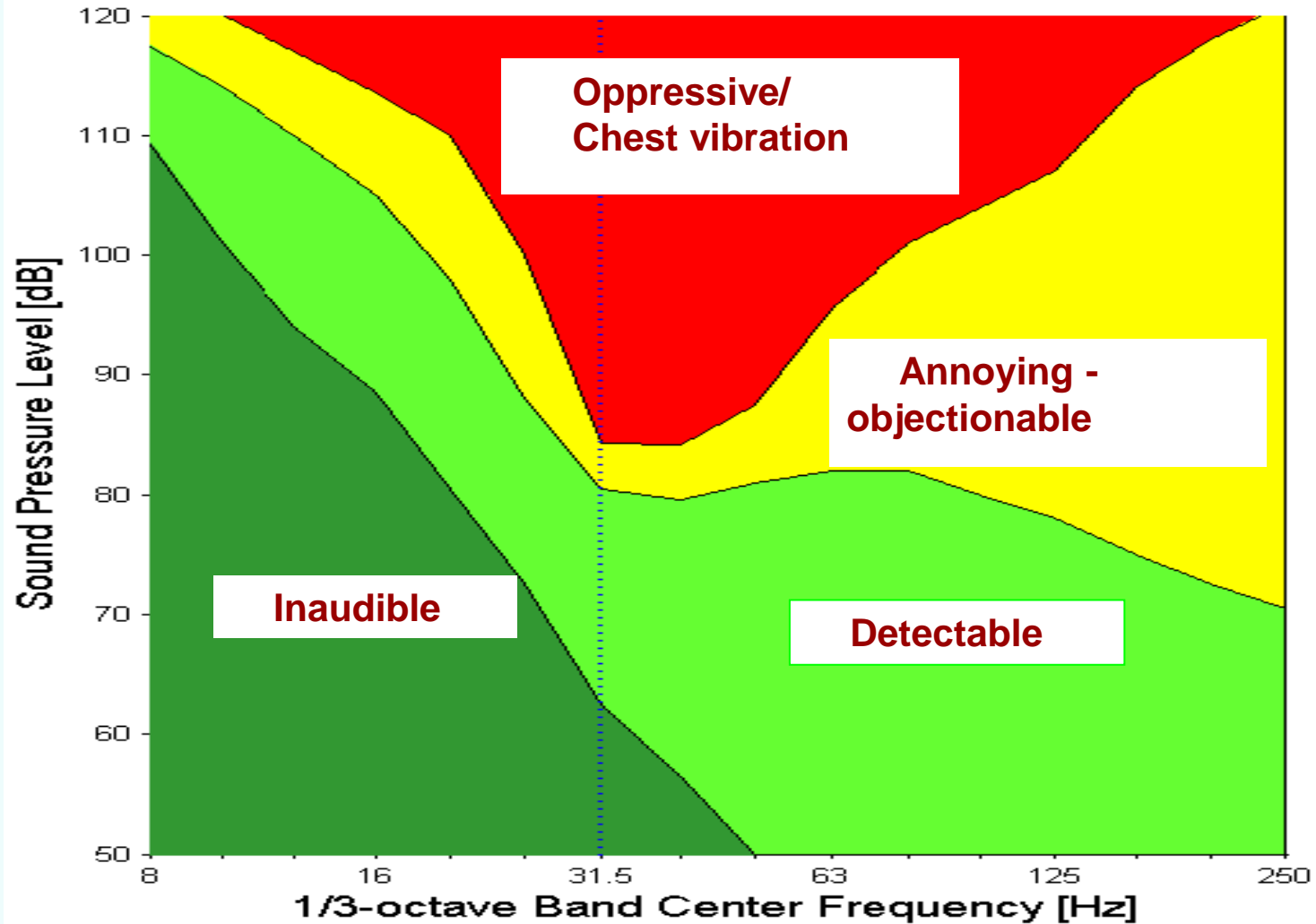
The Response Chain





Response scale

Audibility and response



External low frequency noise which might produce a response indoors

Stress and Health

Somatoform disorders

Stress levels which we cannot cope with lead to physical problems such as nausea, pains, dizziness, trembling.

Stress from unwanted noise may have these effects in a small number of people

Attitudes to a Noise

Attitude is a large component of response

“Variables that may modify reaction to noise, such as noise sensitivity and attitude to the noise source, account for more variation than does noise exposure” (Job, 1988)

“Fear has a very large impact on annoyance. Persons who experience fear related to the transportation that causes the noise report higher annoyance compared to persons who do not experience such fear” (Miedema and Vos, 1999)

Also relevant to wind turbines

Pierpont on Attitudes to Noise

Responding to suggestions that attitudes are important

Page 4 “Responses like these are a pity. They are rubbish. There is nothing “psychoacoustic” or malingering about it.

Page 195 “It is important to emphasise that these symptoms are not psychological (as if people were fabricating them): they are neurological.

Page 294 “These days I limit my practice to behavioral medicine, seeing both adults and (chiefly) children

Coping with Noise

People with noise problems can be helped to cope with the noise through relaxation, desensitisation and cognitive behavioural therapy.

We have been carrying out this work for the past 5~6 years for Defra – a UK Government Department.

But participants must be ready and willing to be helped.

See www.copingwithnoise.org

Conclusions

- 1. Infrasound from wind turbines is not a health problem.**
- 2. Effects of wind turbine noise on health are mediated through annoyance from audible noise, particularly if aerodynamic fluctuations occur (swish).**
- 3. Attitude to a noise source is a large factor in annoyance from the source.**
- 4. The Wind Turbine Syndrome is the result of stress from annoyance by audible noise from wind turbines, similar to annoyance from any other noise source.**

**Rural Wind Farms, New South
Wales Parliament. Legislative Council, 2009 (December)**

7.56 The Committee notes the concerns expressed by Inquiry participants regarding 'Wind Turbine Syndrome'. The Committee further notes that research findings of 'Wind Turbine Syndrome' have not been published in a peer-reviewed journal.

7.57 The Committee is concerned that the significance of 'Wind Turbine Syndrome' is being unnecessarily exaggerated because Dr Pierpont is a medical doctor and has published a book on the issue, rather than any scientific merit of such a syndrome. As a result, a degree of fear is being instilled in communities that may host wind turbines. The Committee is concerned that, based on evidence received, this unwarranted fear may be causing greater health impacts than the presence of any actual 'Wind Turbine Syndrome'. Page 121