The Neurophysiological Model of Tinnitus
*A Practical Perspective*

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**Discussion Points**

**The Pathogenesis of Tinnitus**
- Tinnitus Cycle
- Detailed Description of Cycle
- Components Related to the Patient Experience

**Treatment Considerations**
- Hearing Loss
- Hyperacusis

**Patient Case Studies**
- Treatment Candidacy

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**Tinnitus Pathogenesis**

**Tinnitus Cycle**

- Auditory Perception
- Attention and Awareness
- Emotional Response

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Tinnitus Pathogenesis

Auditory Deprivation

- Estimated 90% of people with tinnitus have hearing loss
  - Evidence of damage to the Auditory System
  - Can be very mild or more severe presentation
- Auditory centers of the brain starve for input
- Leads to compensation mechanism of these centers
- Over excitation of neurons
- Tinnitus signal generated and perceived


Tinnitus Pathogenesis

Auditory Deprivation

The Patient that is Straining to Hear

- Perception of tinnitus exacerbated
- Hearing loss further reveals this underlining ‘hum’
  - 93.7% of subjects reported tinnitus in an anechoic chamber


Tinnitus Pathogenesis

Auditory Deprivation

The Patient that is Straining to Hear

- Net effect is compounded
- Auditory centers are further starved for input
- Tinnitus perception is increased
- Loudness Tolerance issues arise
  - Neurological Central Gain increased
- Addressing communication needs are a critical when considering treatment
Tinnitus Pathogenesis

Auditory Compensation Mechanism

- Increased Central Gain
- Decreased Sound Tolerance
- Hyperacusis

Amplified internal sound

Low level sound

relief

Tinnitus Pathogenesis

Neurological Evidence

- Auditory centers are an important player
- Higher processing centers are in control
- Severing the VIII nerve unsuccessful
- Akin to phantom limb
- Tinnitus viewed as a phantom auditory perception

relief

Tinnitus Pathogenesis

Tinnitus Cycle

Auditory Perception

Attention and Awareness

Emotional Response

relief
**Sub-Cortical Awareness Processing**

**Awareness**
- Auto Action
- Other Brain Centers
- Subconscious Filtering

**Sounds**
- Tiger
- Storm
- Baby Crying
- Train
- Fridge

**Tinnitus Pathogenesis**

**Awareness**
- Brain incorrectly labels the tinnitus as important
- Tinnitus is something harmful/threatening
- Phobic response
- Not a conscious decision
- Can result from a past trauma or traumatic event
  - Not always productive to dissect
  - Treatment and recommendations can be the same

**Sub-Cortical Awareness Processing**

**Awareness**
- Auto Action
- Other Brain Centers
- Subconscious Filtering

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Tinnitus Pathogenesis

Tinnitus Cycle

Auditory Perception ➔ Attention and Awareness ➔ Emotional Response

Emotional Response
- Due to the significance the brain has placed on the tinnitus
  - Activation of the Autonomic Nervous System (ANS)
  - Limbic System
- Response is often physiological
  - Heart rate quickening
  - Increased respiration rate
  - Perspiration
- Psychological Component
  - Hopelessness
  - Loss of control
  - Guilt
  - Fear

Treatment Considerations
Treatment Considerations

Patient Quality of Life Impact

- “If you didn’t have your tinnitus, how would life be different?”
  - Patient specific needs
  - Tinnitus Reaction Questionnaire (TRQ)
- “What are your goals for treatment?”
  - Decipher whether this is truly a tinnitus issue
  - Hearing loss/tinnitus confusion
  - Expectation Management
  - Direction as to intervention method

Hyperacusis

- Prevalence estimates of individuals vary
- Patient has constructed their own “normal”
  - Often overlooked by the clinician
- Equally disturbing, often more so than the tinnitus
- Debilitating and limiting

Hyperacusis must be targeted first with treatment before tinnitus can be effectively addressed
- Catch 22!
Treatment Considerations

Duration and the Emotional Component

When to act
- Duration of tinnitus may take a back seat to the amount of “baggage” associated with tinnitus
- 30 year duration but developed coping strategies
- 3 month duration – life has stopped
- Medical/Surgical Clearance
- Impact will dictate your clinical decisions

Neuromonics Treatment

1) Customized acoustic stimuli
2) Engineered Treatment Device
3) Interactive Counselling

“Tools”: Usage / Dosage Log
Neuromonics: Mechanism of Action

**Auditory**
1. Perception
   - Wide-frequency acoustic stimulus, customized for each patient’s hearing profile (binaural, stereo)

**Attentional**
2. Attention
   - Desensitization
   - Intermittent tinnitus interaction (dynamic stimulus). Graded increase in exposure, in relaxed state

**Emotional**
3. Reaction
   - Relaxation & Relief
   - Pleasant, relaxing music. Relief from tinnitus perception. Counseling/support

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**Trial 3: Qualitative Outcomes**

Percent of Participants* Reporting **MODERATE** or **LARGE** Benefit
(2 Stage Group, 12 months)

- Relief from tinnitus
- Improved ability to fall asleep
- A sense of control of tinnitus
- Improved ability to relax

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**Patient Satisfaction**

- Relief from tinnitus: 97%
- Improved ability to fall asleep: 94%
- A sense of control of tinnitus: 94%
- Improved ability to relax: 94%

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*Participants with pre-treatment TRQ of at least 17

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Neuromonics Advantages

- Rapid relief & sense of control
- Improved relaxation and sleep
- Reduced awareness and disturbance
- Improved tolerance of loud sounds
- Long-term benefit

Patient Case Studies

Case Study #1

- TRQ=11
- LDL’s= 65-75
- Awareness= 80%
- Disturbance= 5%
- Hearing Loss= mild HF SNHL
- Quality of life impacts
  - Profession- piano tuner
  - Changing careers since tinnitus exacerbated by work
  - Going back to school
- Rank order= 1 tinnitus, 2 sound sensitivity, 3 hearing loss
Case Study #1
Candidacy Considerations:

- How did this patient interpret “disturbing”?
  - Is he really disturbed only 5%?
  - Low TRQ: could he be under-reporting?
  - Questions with responses of “3” or “4”?
- Why is he so bothered at work?
  - Sound sensitivity?
  - Is he a good candidate?

Case Study #2

- TRQ=88
- LDL’s=80’s
- Awareness=100%
- Disturbance=100%
- Scored “2” on suicidal ideation question on TRQ
- Currently undergoing treatment for PTSD and other psychological issues
- Sleep difficulties
- Hearing loss= moderate SNHL (aided)
- Retired
- Rank order= 1 Tinnitus, 2 Sound Sensitivity, 3 Hearing Loss
- Quality of Life impacts:
  - Tinnitus “driving him crazy”

Case Study #2
Candidacy Considerations:

- Psychological issues?
  - Currently receiving services?
  - Coordinating with behavioral health?
- 4 Frequency PTA at 500, 1000, 2000 and 4000 Hz?
  - Is his PTA greater than 50 dB?
  - Considerations for “high hearing loss”?
  - Response with demo device?
- Loudness Sensitivity issues?
- Life impacts?
  - Is he a good candidate?
Conclusion

- Patient specific education is key
  - Formulating your treatment plan
  - Working to eliminate the stress response
- Global Approach
  - Tinnitus
  - Hearing Loss
  - Hyperacusis
  - Psychological needs
- Education + Plan = Hope for Patients
  - Important and rewarding aspect of clinical practice!