

# **A Novel Demonstration of Steganography using Auditory Masking**

Kate Griffith and Max Model

**What do you hear?**



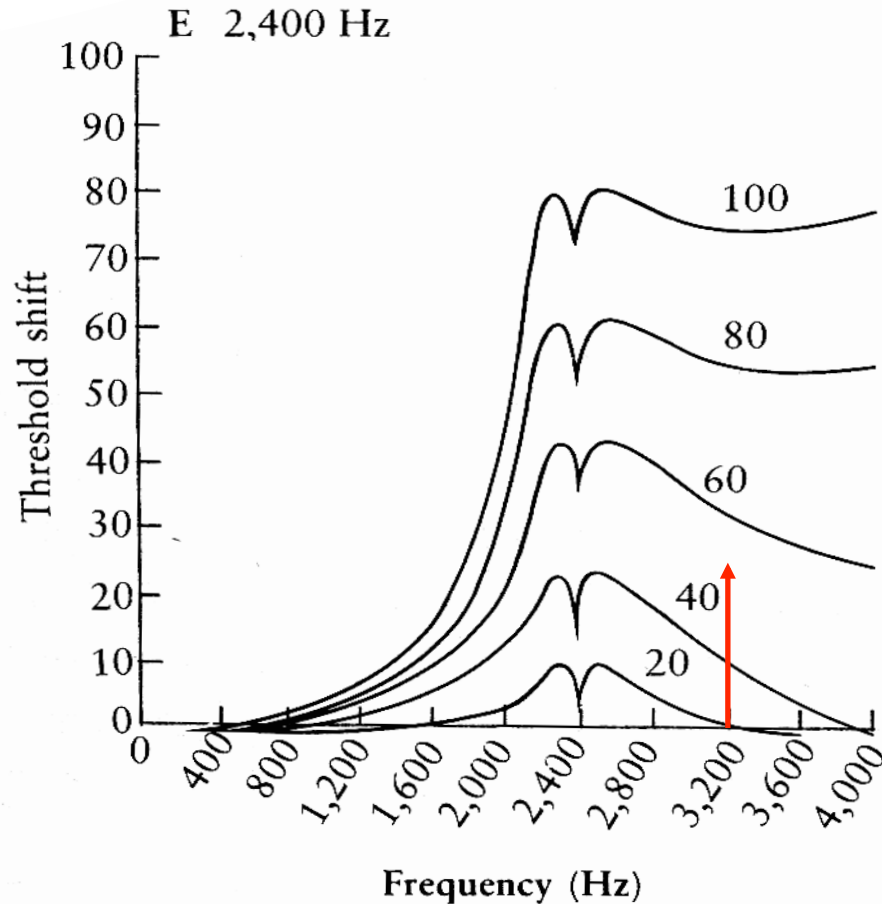
# Steganography

- The concealing of information in an otherwise non-secret medium
- Steganography is derived from the Greek word that means “covered writing”
- The first written report of the use of steganography is attributed to the Greek historian Herodotus, which involved camouflaging a secret message within a hare corpse being delivered as a hunting trophy
- Today, steganography is a timely subject enabling digital espionage and the transfer of malware

## Questions Addressed

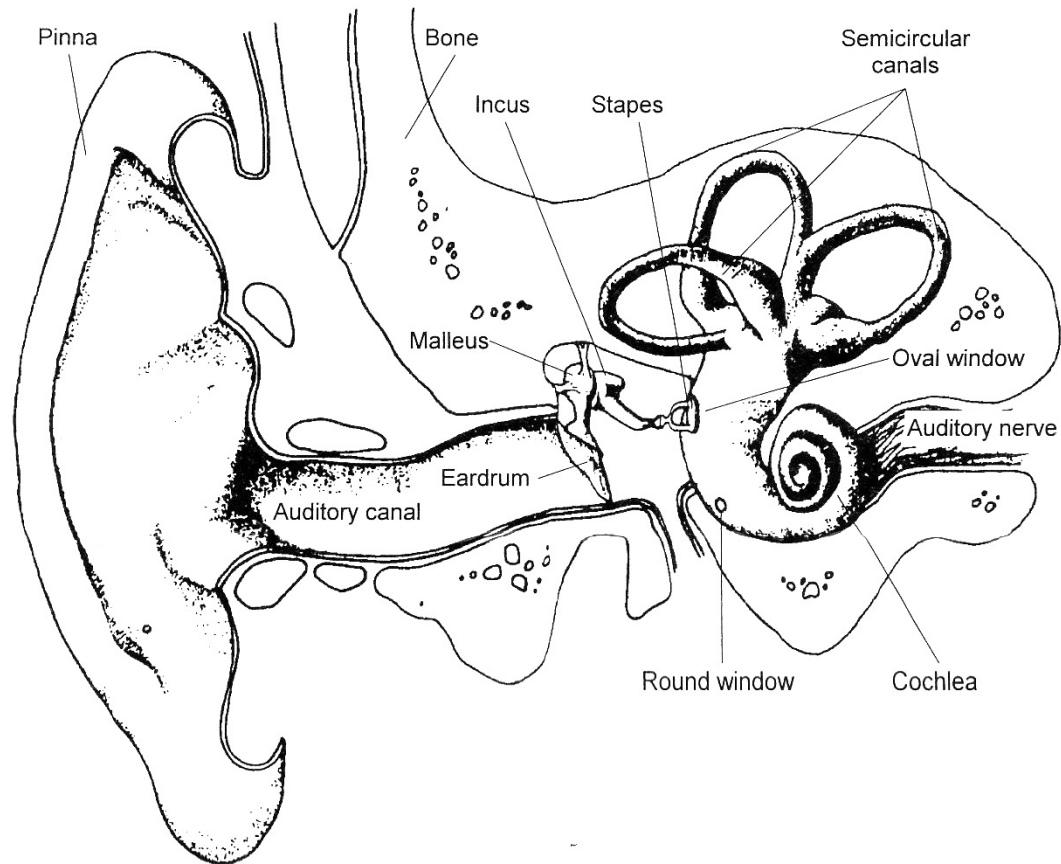
- Everyone knows a loud sound can mask a soft sound; Can this basic fact be used for steganographic transmission?
- Can we build a laboratory device that can hide a Morse code signal behind a ordinary music track?
- How accurately can this masked data be retrieved?

# Masking Curves Enable Steganography Scheme



Pierce, John R. *The Science of Musical Sound*. Revised ed., New York, NY, Scientific American Books, 1992.  
Original work by Wegel and Lane Bell Labs 1924

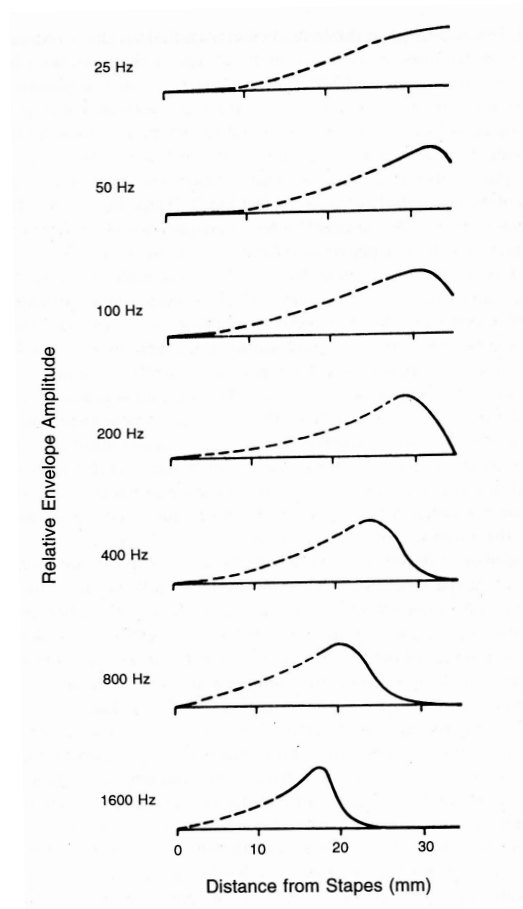
# Masking is a Consequence of the Anatomy of the Ear



Moore, Brian C.J. *An Introduction to the Psychology of Hearing*. Fifth ed., Bingley, UK, Emerald Group, 2008.

# Frequency Localization In the Cochlea

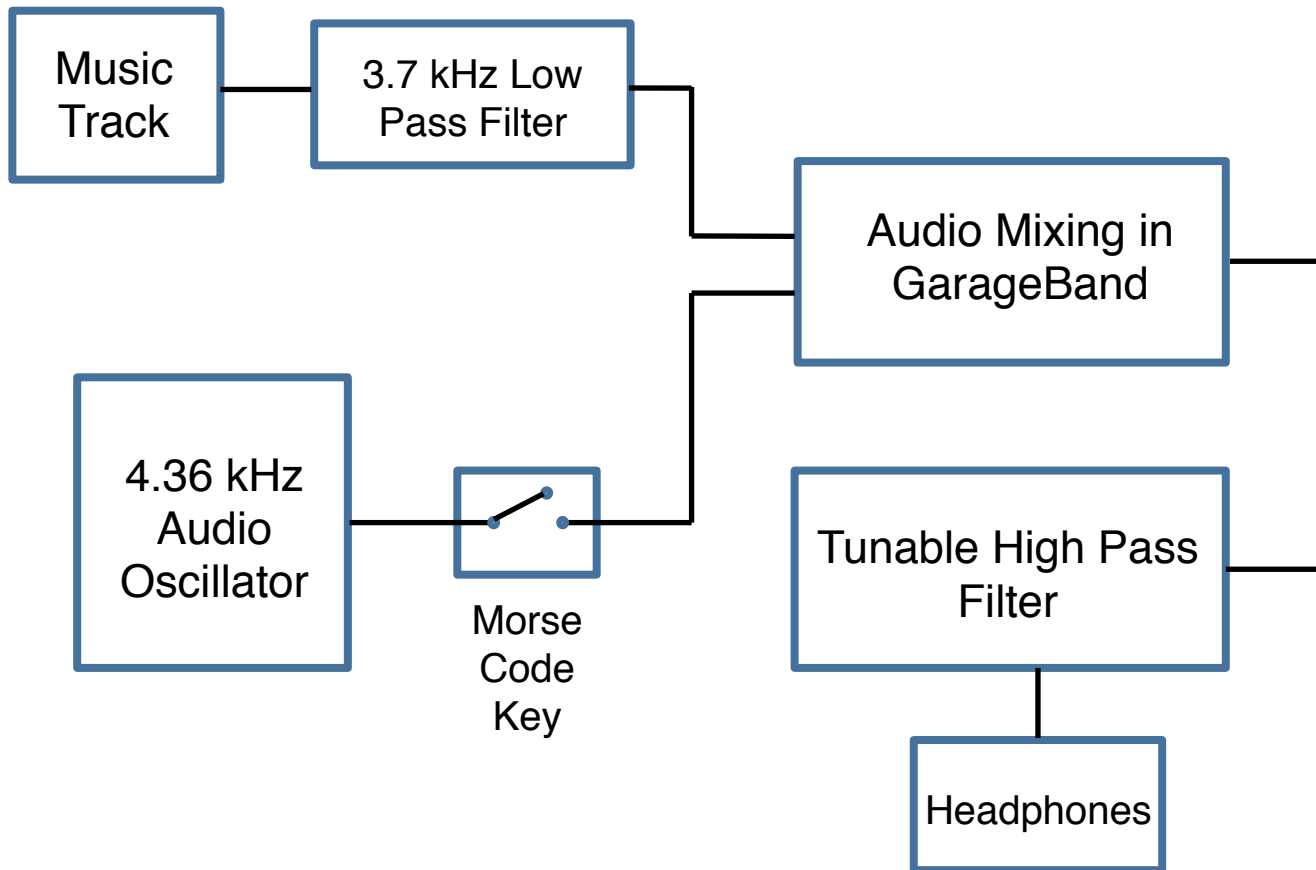
Stapes  
(Entry Side)



Apex  
(Cochlea End)

Moore, Brian C.J. *An Introduction to the Psychology of Hearing*. Fifth ed., Bingley, UK, Emerald Group, 2008.

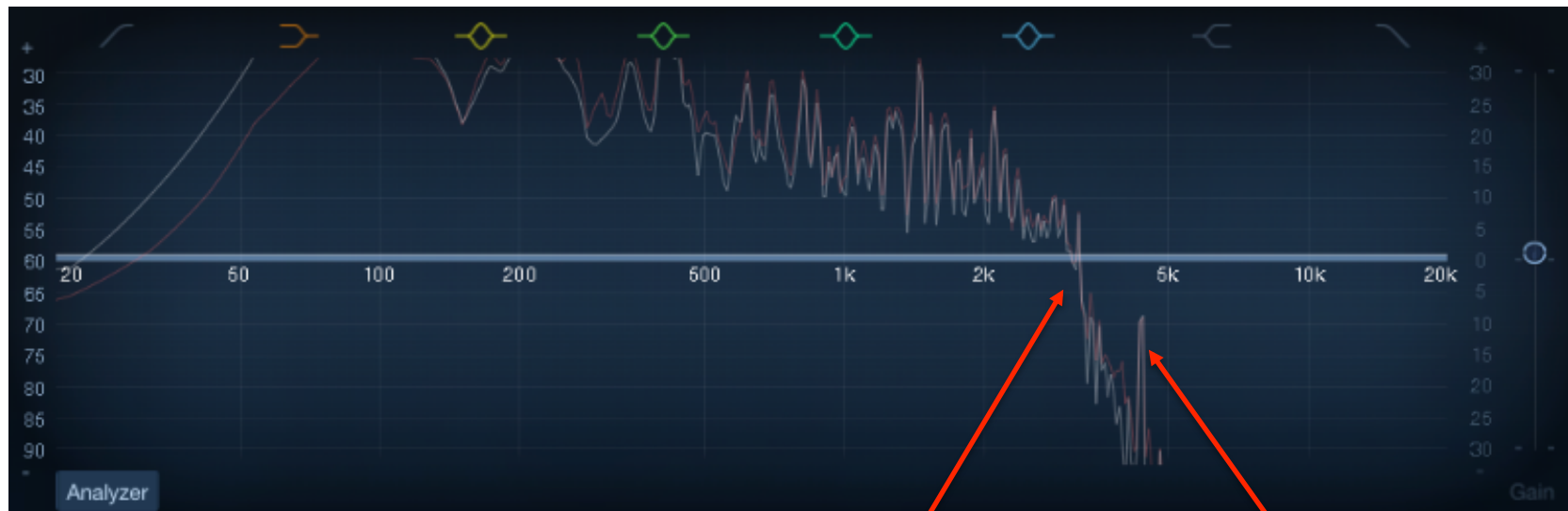
# Experimental Apparatus



Music Track (Masker): 70 dB  
Morse Code Track (Signal): 25 dB



# Combined Track Frequency Spectrum



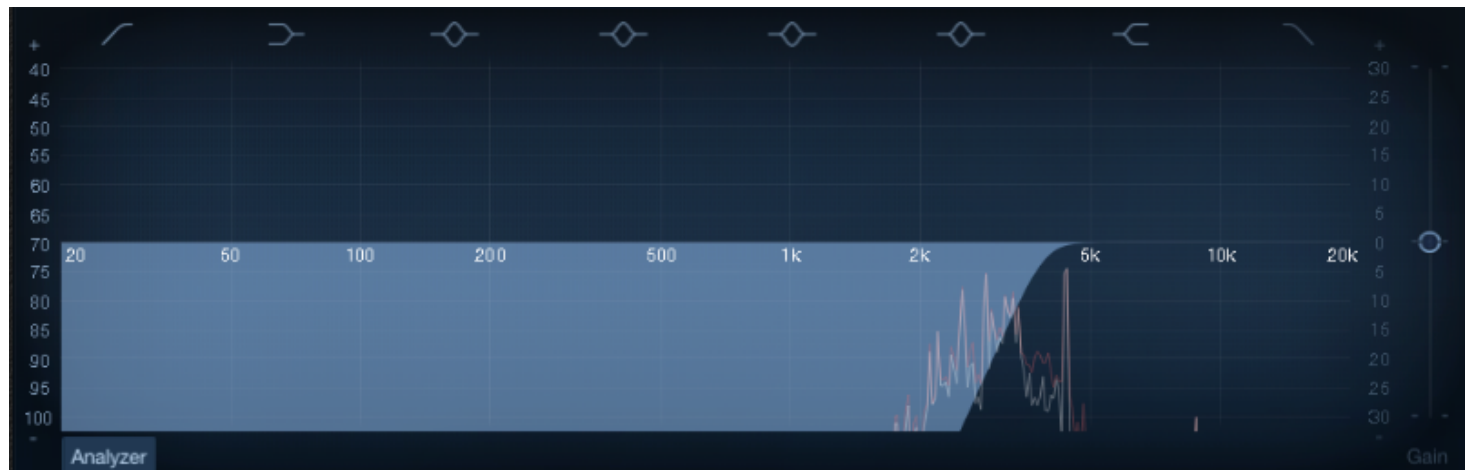
Low pass cutoff  
at 3.7 kHz  
(70 dB)

4.4 kHz  
Signal (25 dB)



We are applying a high pass filter, which filters out segments of the audio but does not modify or distort the original track.

**Now what do you hear?**



# Human Perception Test

- 28 students were tested (ages 15-18)
- The subjects were then asked to transcribe and translate the signal using a Morse Code chart
- Each response was recorded anonymously
  - **0%** of students initially detected the masked signal
  - **96%** of students heard the signal after the filter was applied, without being prompted.
  - **86%** of students were able to decode the signal.

## **Conclusions and Future Directions**

- Steganography was successfully achieved in a novel fashion.
- A high-volume low-pitch audio track masked the presence of a low-volume high-pitch track.
- Using a high pass filter, a masked signal was able to be retrieved.
- In the future, the limits of data speed (bandwidth) will be explored.