

# Game Developers Conference®

February 28 - March 4, 2011  
Moscone Center, San Francisco  
[www.GDConf.com](http://www.GDConf.com)



# GDC<sup>®</sup>

# Psychoacoustic Real-Time Mixing: Seven Secrets You Need to Know

John Byrd

Gigantic Software

[www.giganticsoftware.com](http://www.giganticsoftware.com)



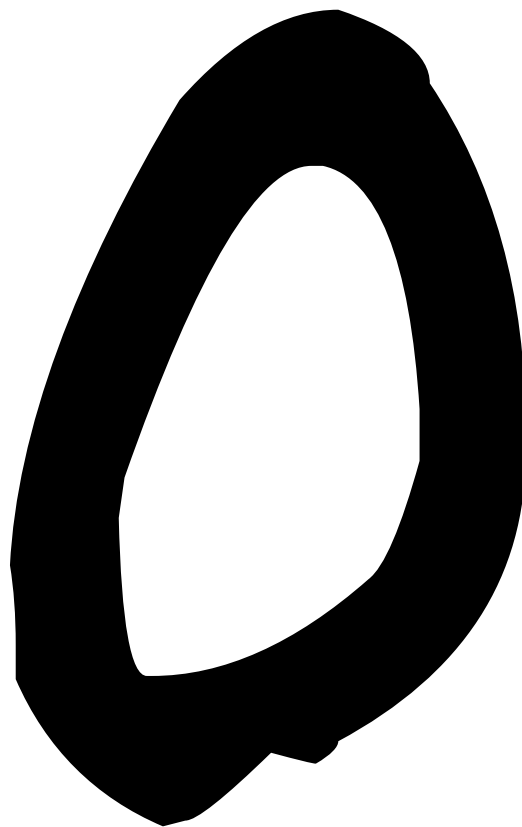




***Pink Noise***

0. Your Job (An Introduction)
1. Simultaneous Voice Masking
2. Dynamic Ducking
3. Reverberation
4. Positional Sounds
5. Looping Sounds
6. Low Frequency Effects
7. Cinematic Mixing





# Chapter 0

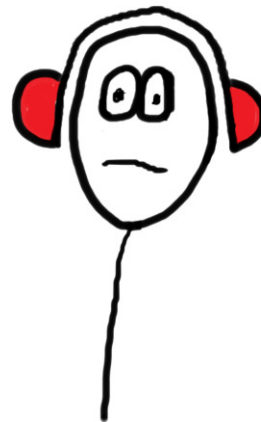
Your Job (An Introduction)

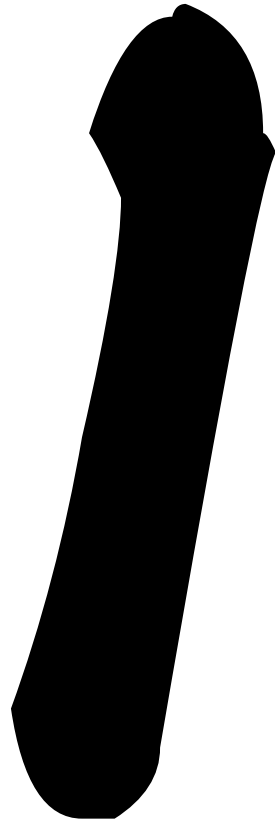






# *Sonic Expectations*





# Chapter 1

## Simultaneous Voice Masking



WHY DIDN'T YOU ASSIGN MACHINE  
GUN SOUNDS TO THE ZOMBIES?

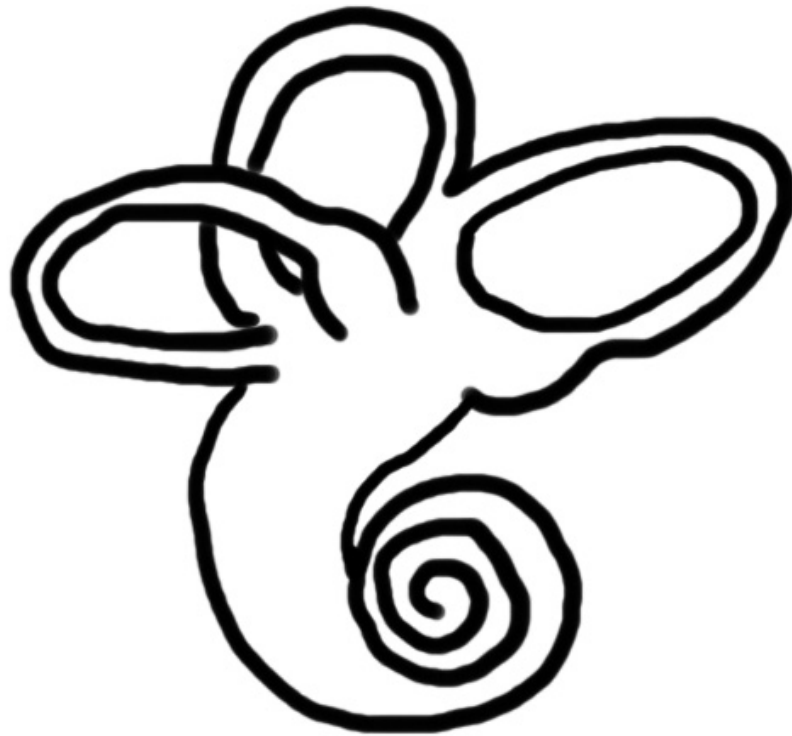
WHY CAN'T I HEAR IT IN THE  
GAME? TURN IT UP!



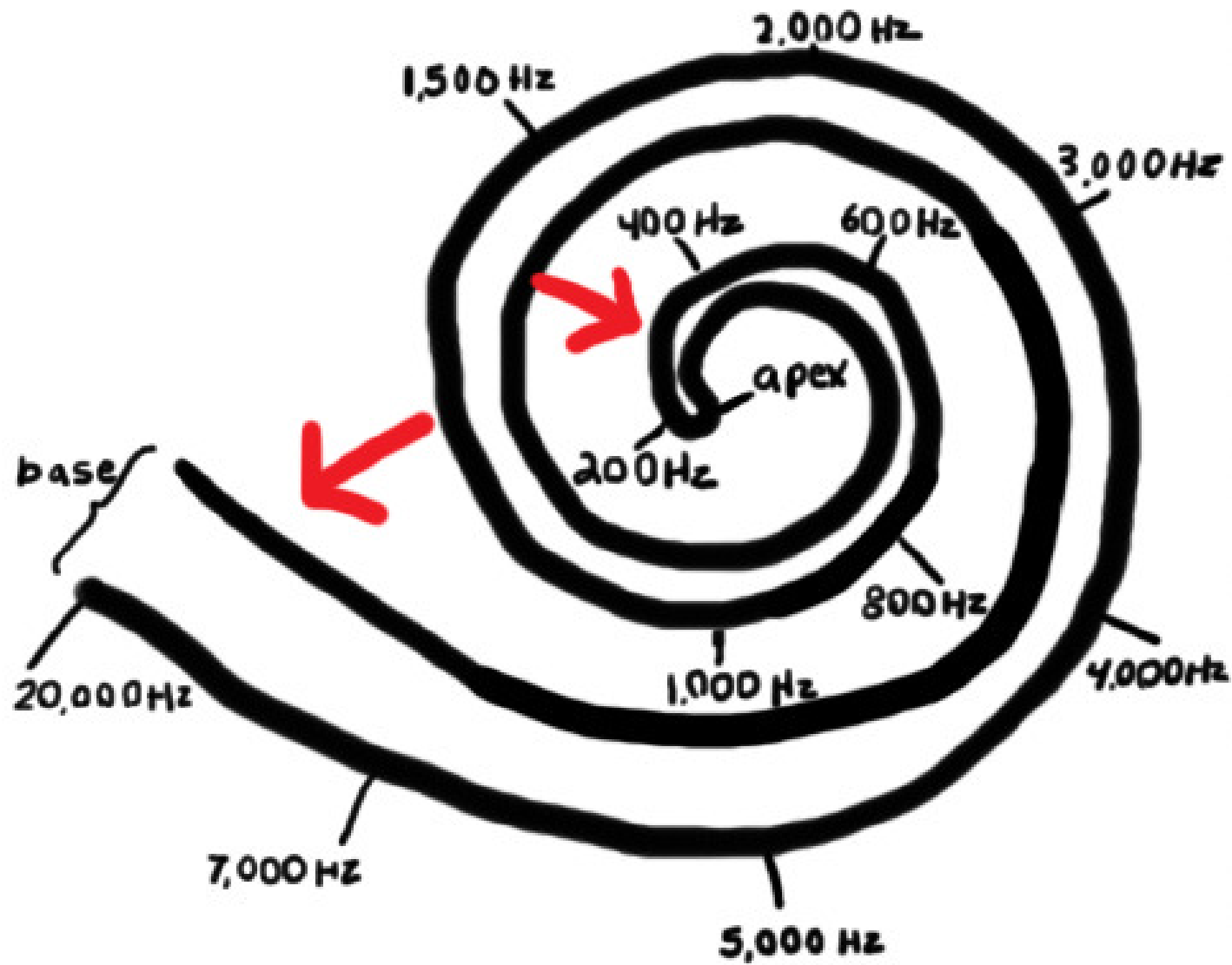
# Masking

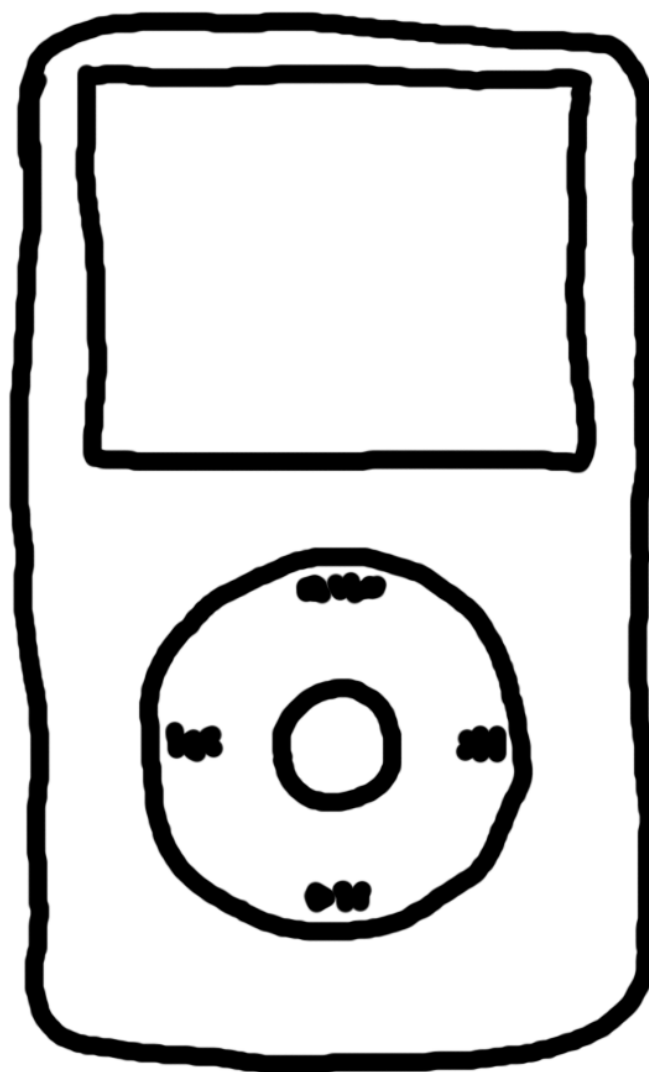


*This is a cochlea.*









# Masking

- Temporal Masking
- Pulsation Masking





WHY CAN'T I HEAR IT IN THE  
GAME? TURN IT UP!

The Fourier function is originally defined continuously. When programming this, we'll convert this integral to  $\Sigma$  form, and it will work on discrete, finite sets of numbers

Continuously correlates every possible frequency with the input

$$\int_{-\infty}^{\infty} f(x) e^{-2\pi i k x} dx$$

$$e^{-2\pi i k x}$$

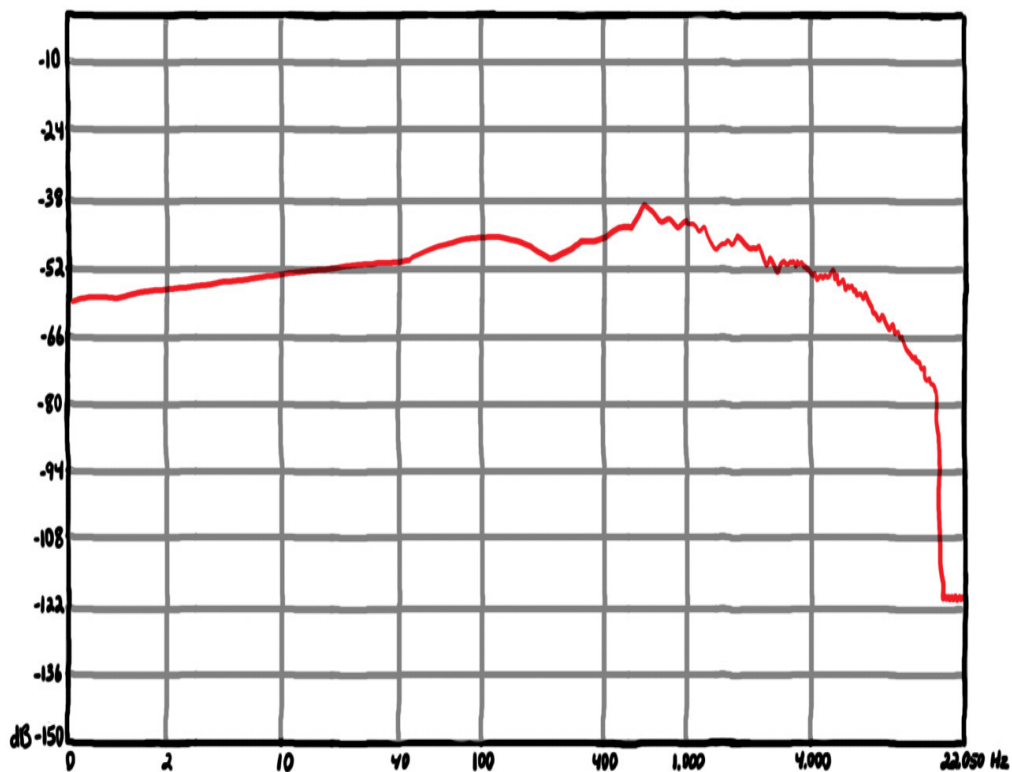
is a convenient short hand for saying:  
 $\cos(2\pi kx) - i \sin(2\pi kx)$

This whole thing is a sum of frequencies

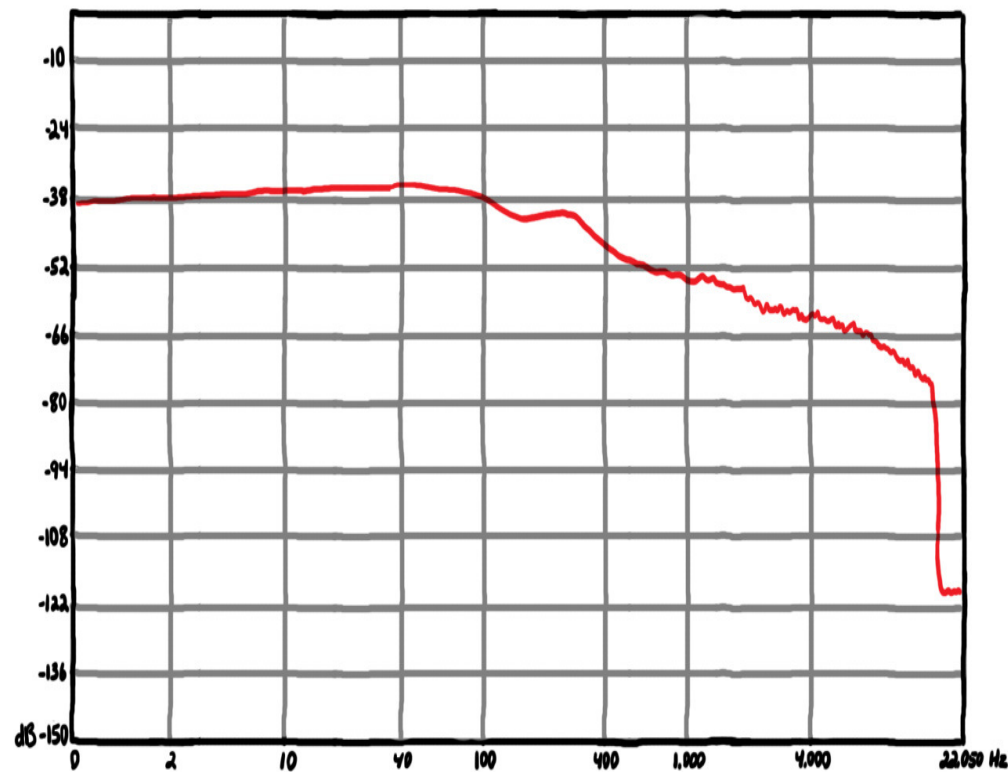
and that is a way of keeping track of the amplitude and phase shift of each frequency...real part is the amplitude, imaginary part is the phase shift



# Spectral Analysis



Zombie's F90

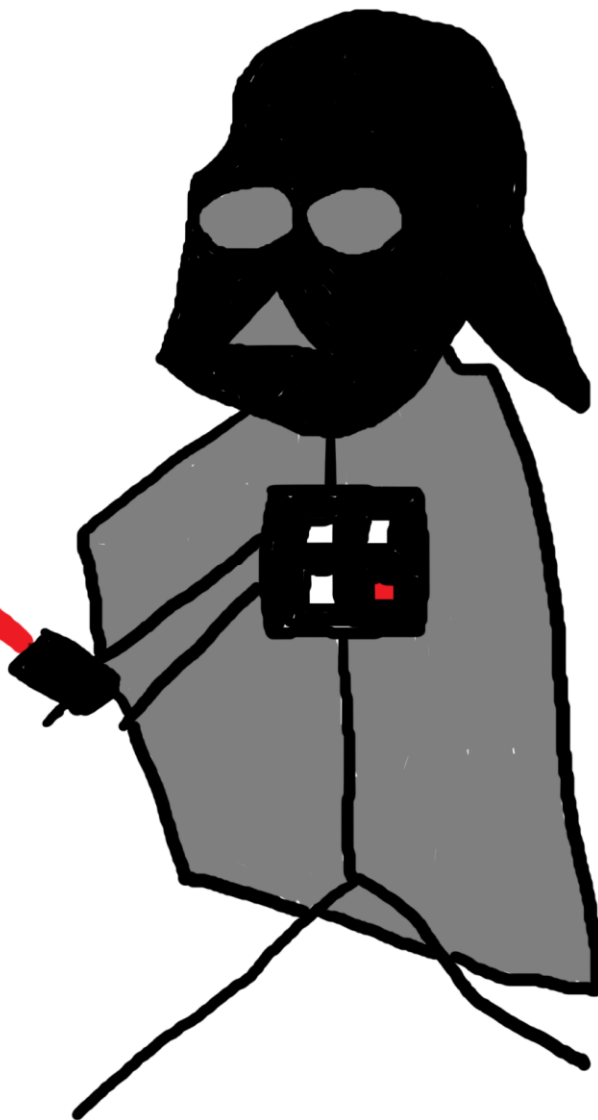
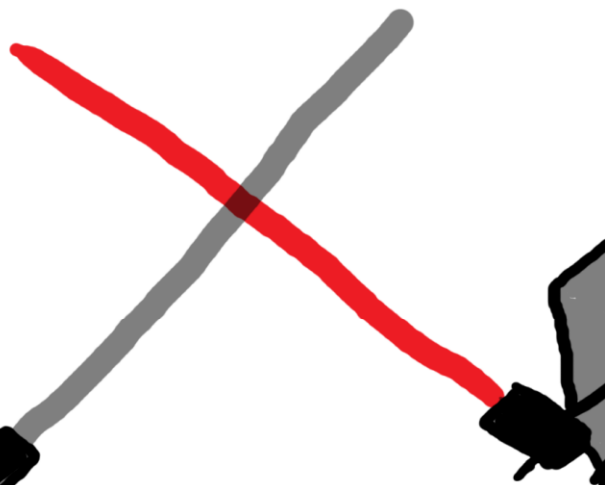


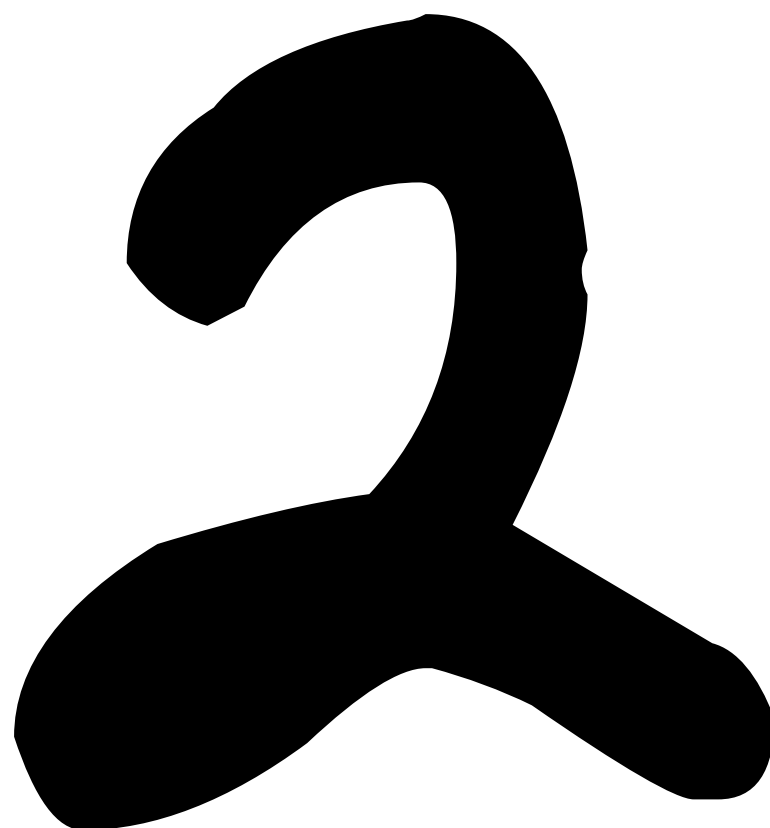
Player's Steyr Gun



WHY CAN'T I HEAR THE  
MUSIC? TURN IT UP!





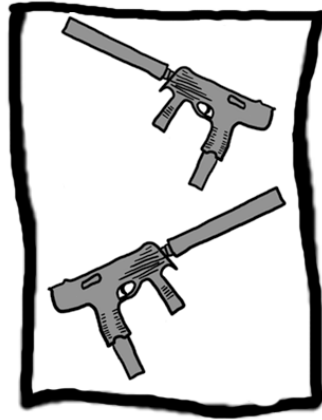





# Chapter 2

## Dynamic Ducking

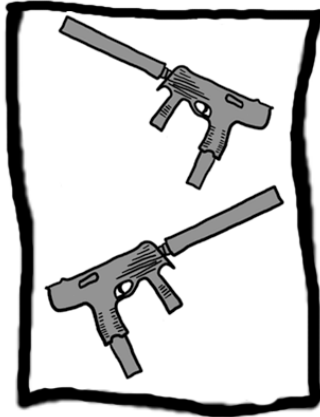
# A typical video game



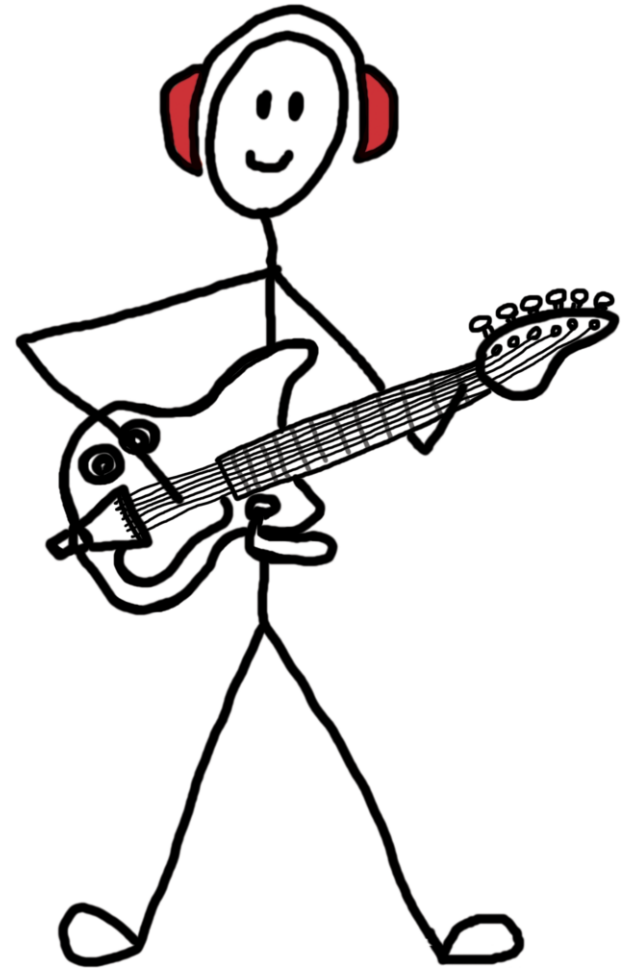
A simple line drawing of a stick figure wearing a suit and tie. The figure is pointing its right hand towards a large speech bubble on the right side of the image. The figure has a neutral expression with two small dots for eyes and a simple line for a mouth.

WHY CAN'T I HEAR THE  
VOICE OVER? TURN IT UP!

# Video Games



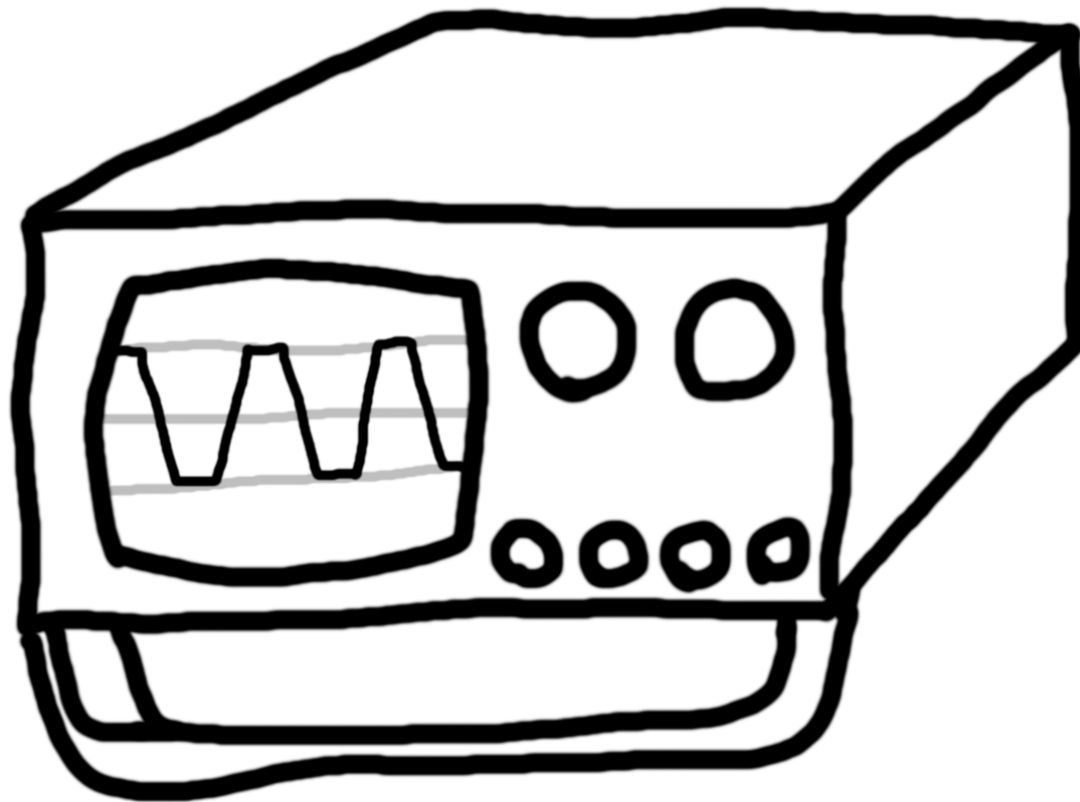
# *Distortion*



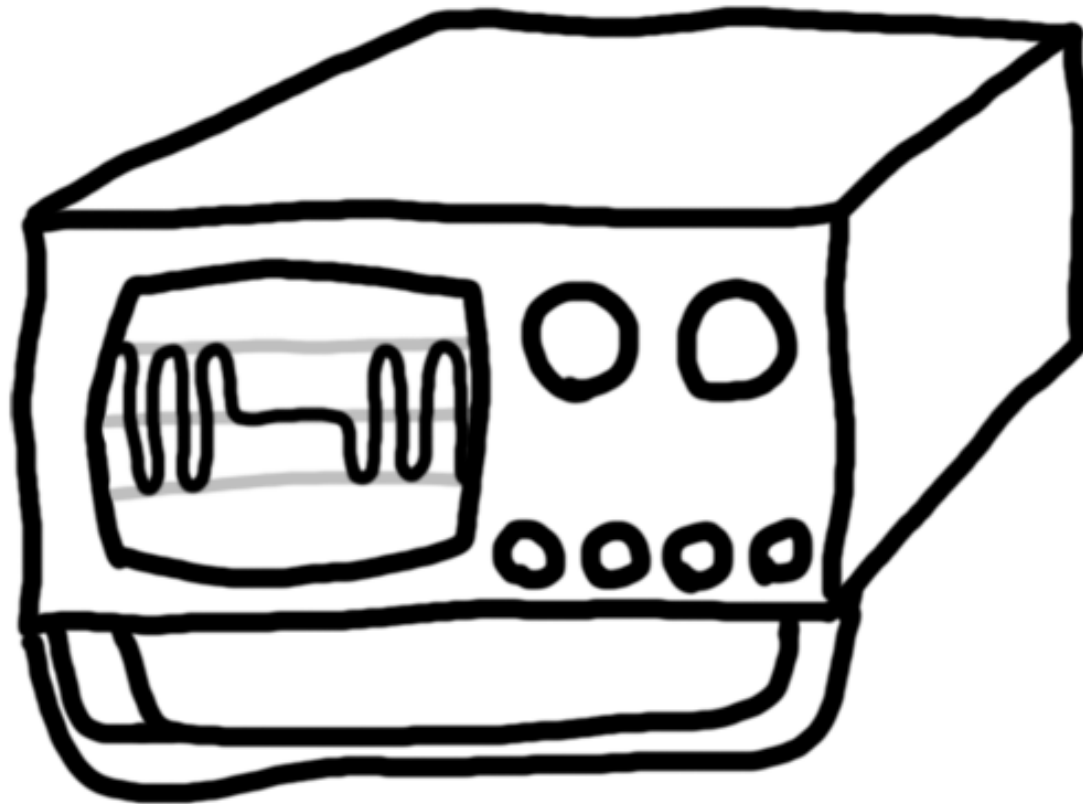
# Distortion

- Clipping
- Dropout
- Compression Artifacts

# Clipped Sine Wave

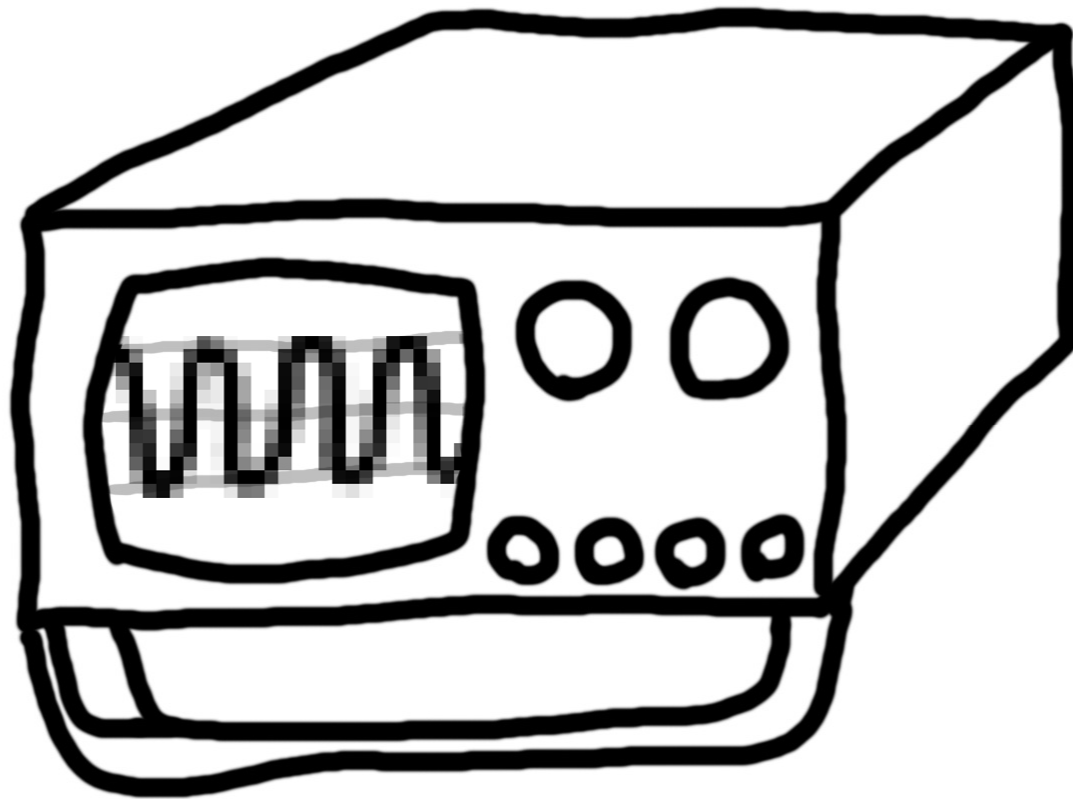


# Dropout





# Compression Artifacts



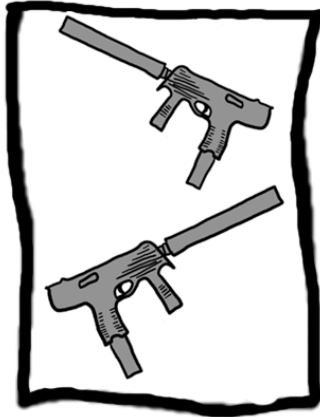
# Distortion

- Clipping
- Dropout
- Compression Artifacts

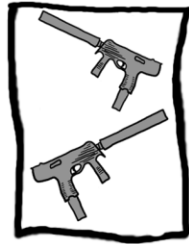
There's distortion  
in level 7

What kind of  
distortion?

# Video Games



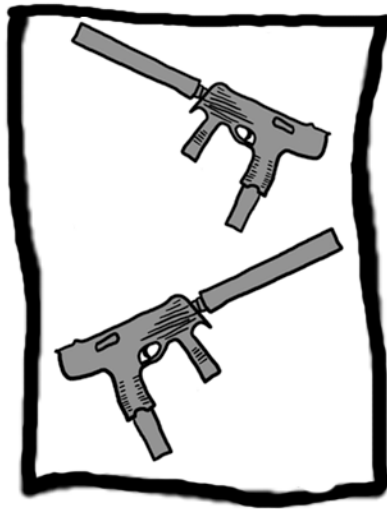
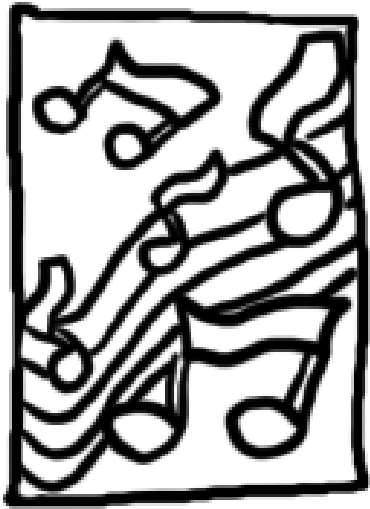
# Video Game Mix





WHY CAN'T I HEAR THE  
MUSIC? TURN IT UP!

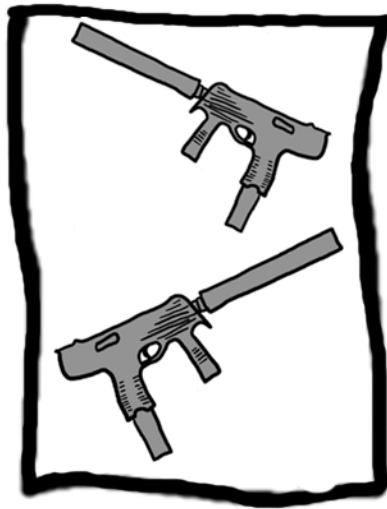
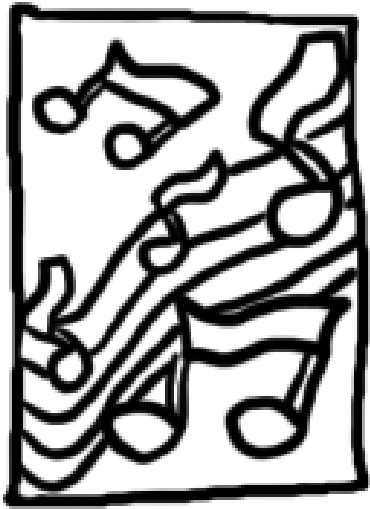
# Video Game Mix



Sync the video to the audio,  
not vice versa

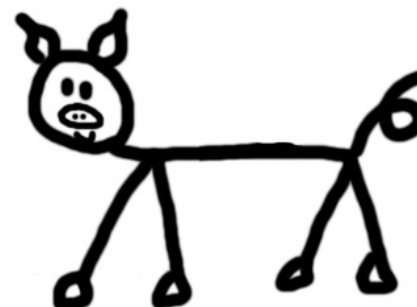
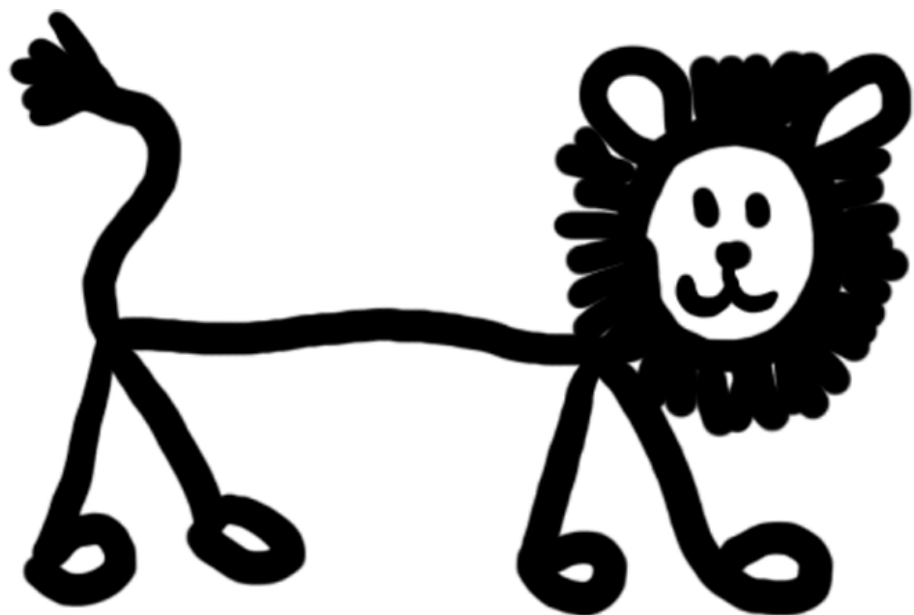


# Video Game Mix

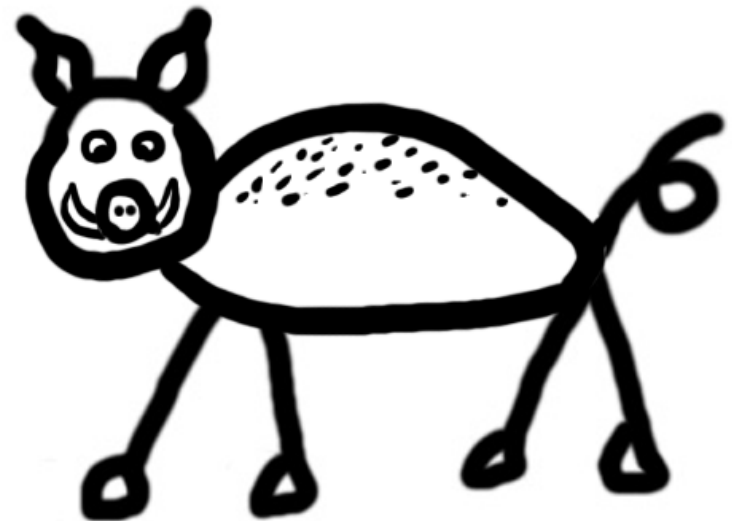
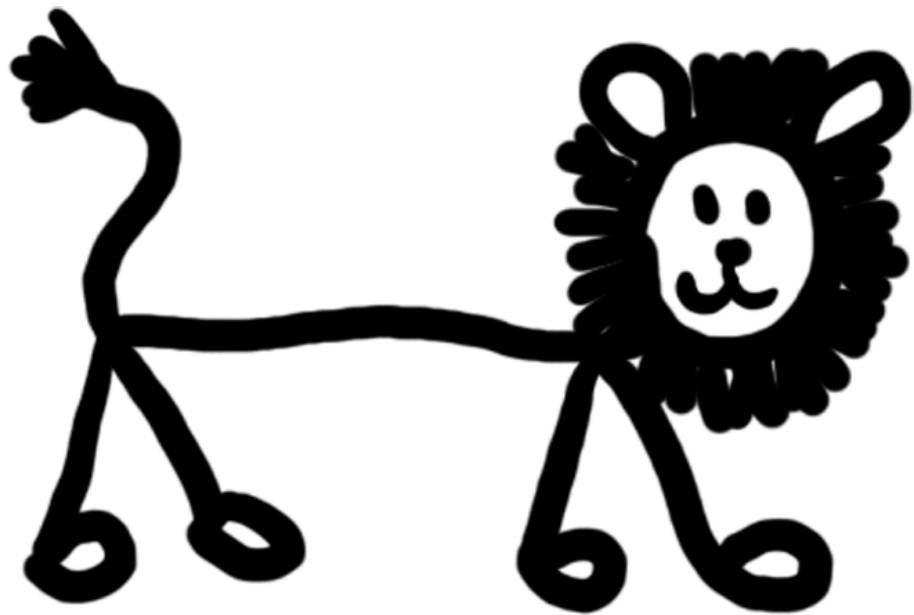




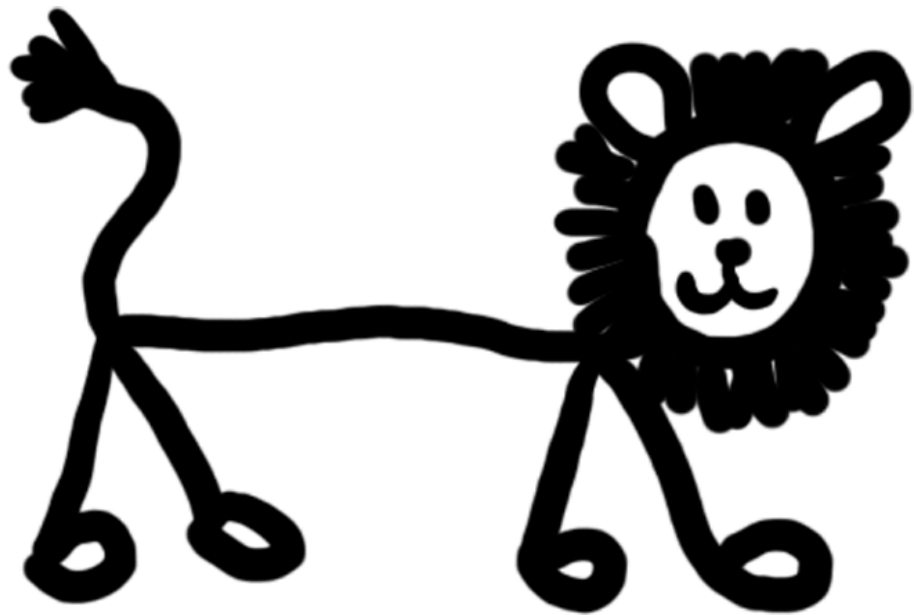
# Lions and Pigs



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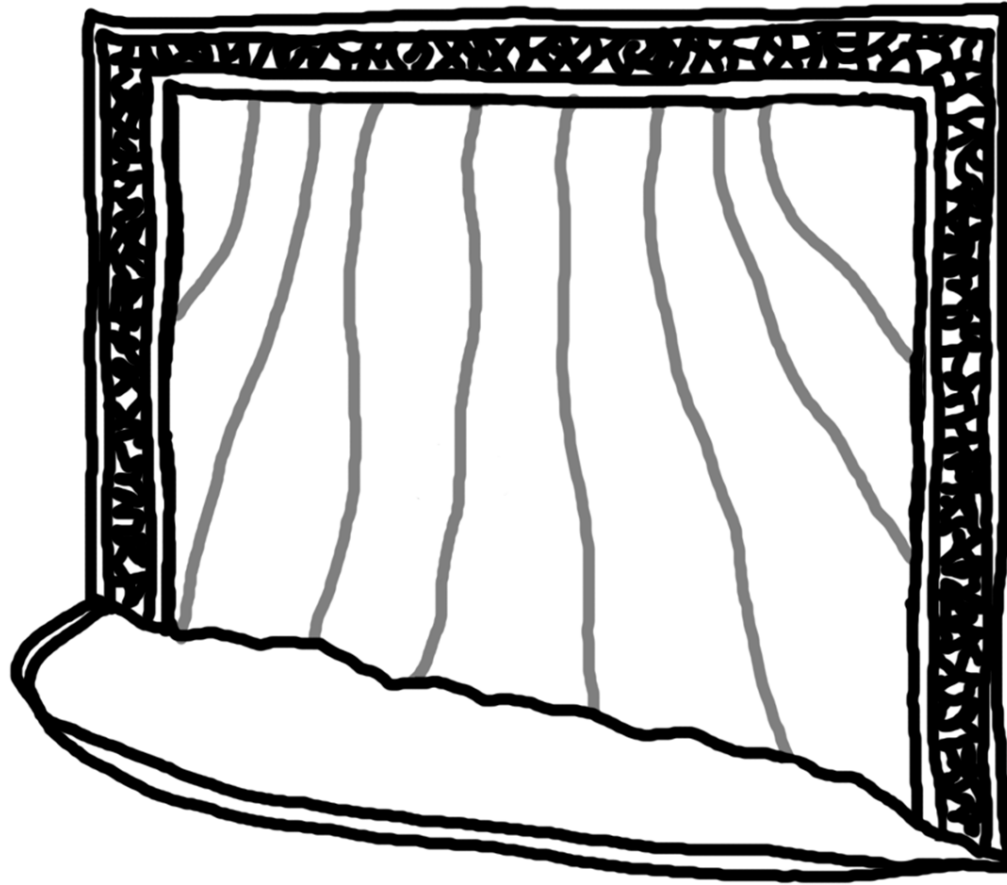
3

# Chapter 3

## Reverberation



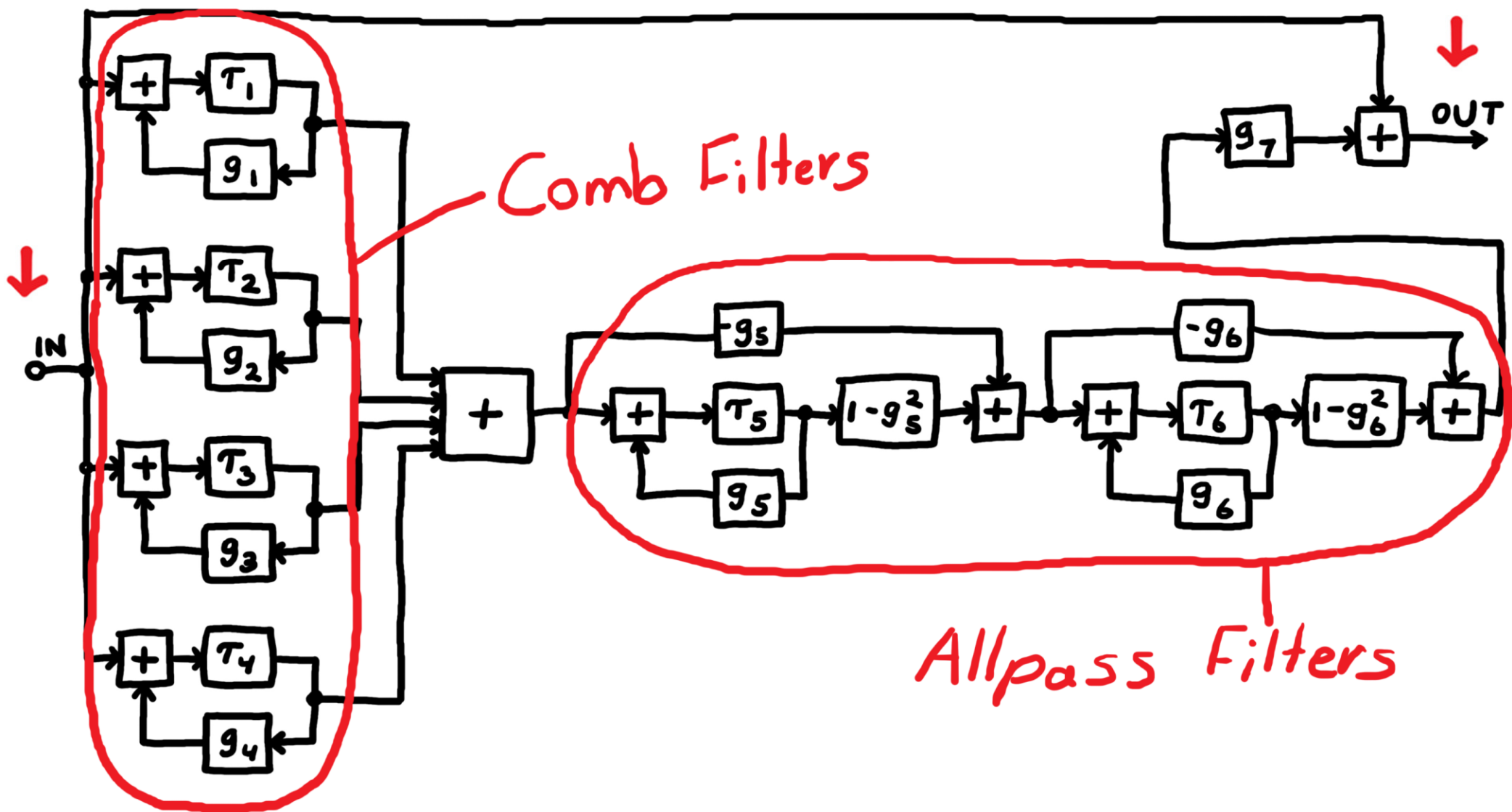




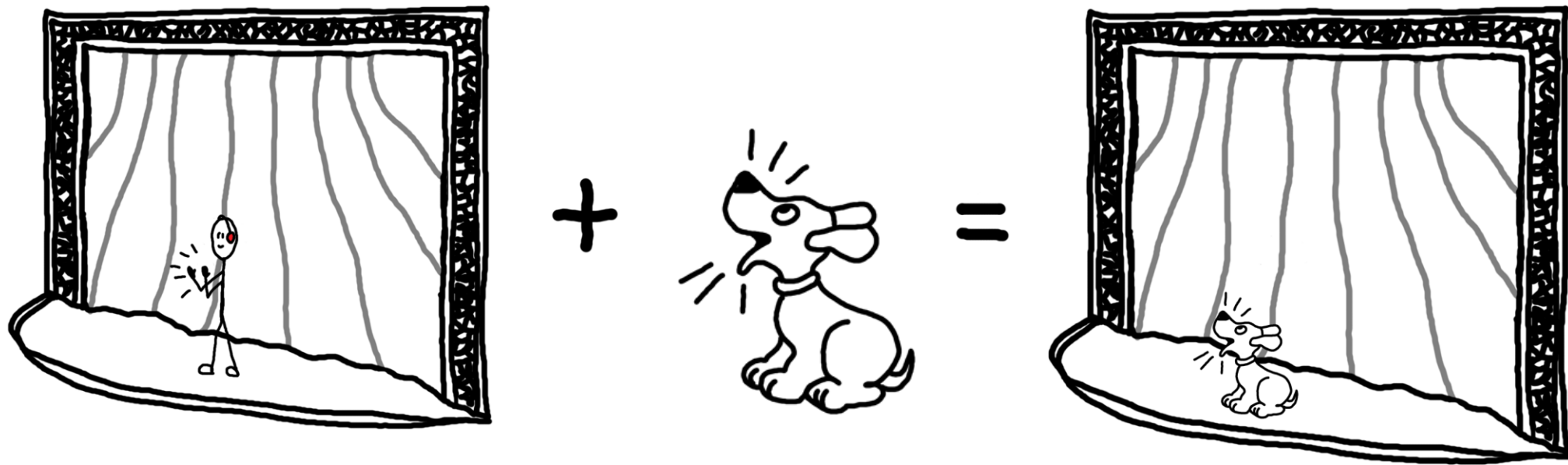
Concert Hall of  
 $100' \times 50' \times 20' = 3$  quadrillion operations /second!





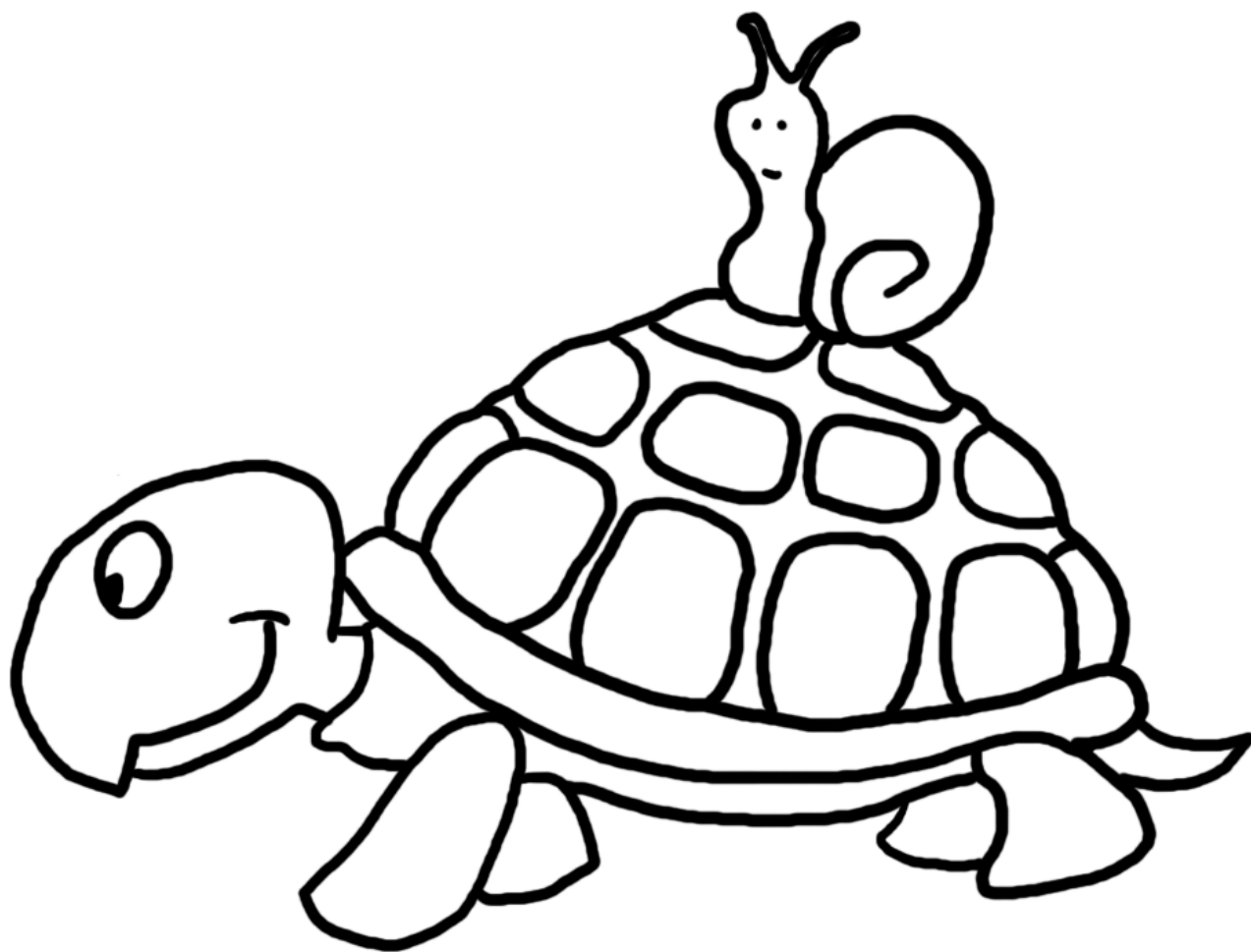


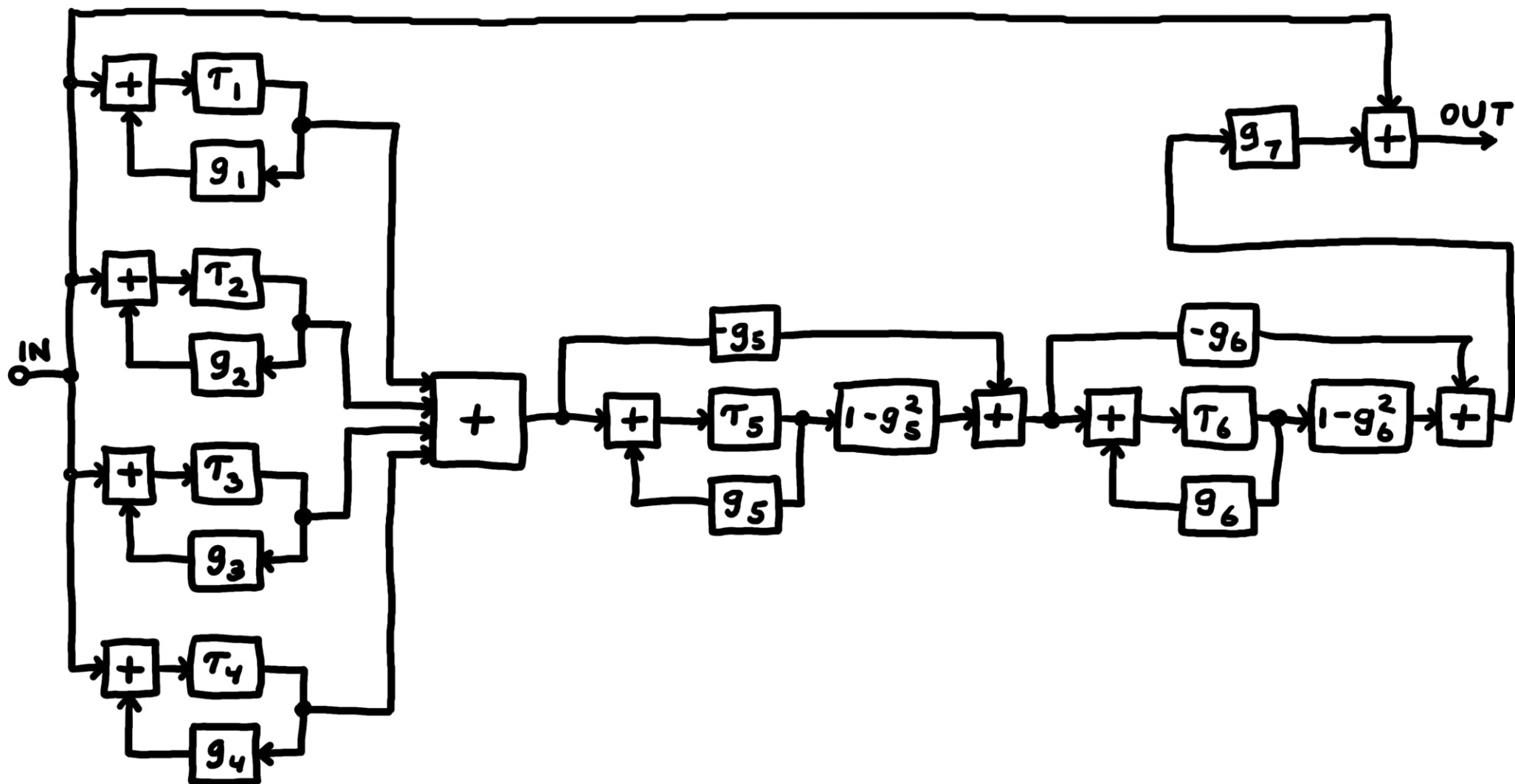
# Convolution Reverb



# Pierre Simon Laplace's 1773 Mathematics of convolution

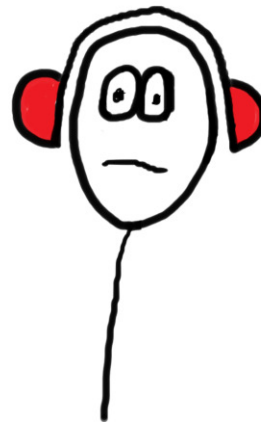
$$y_n = \sum_{k=-\infty}^{\infty} x_k h_{n-k}$$



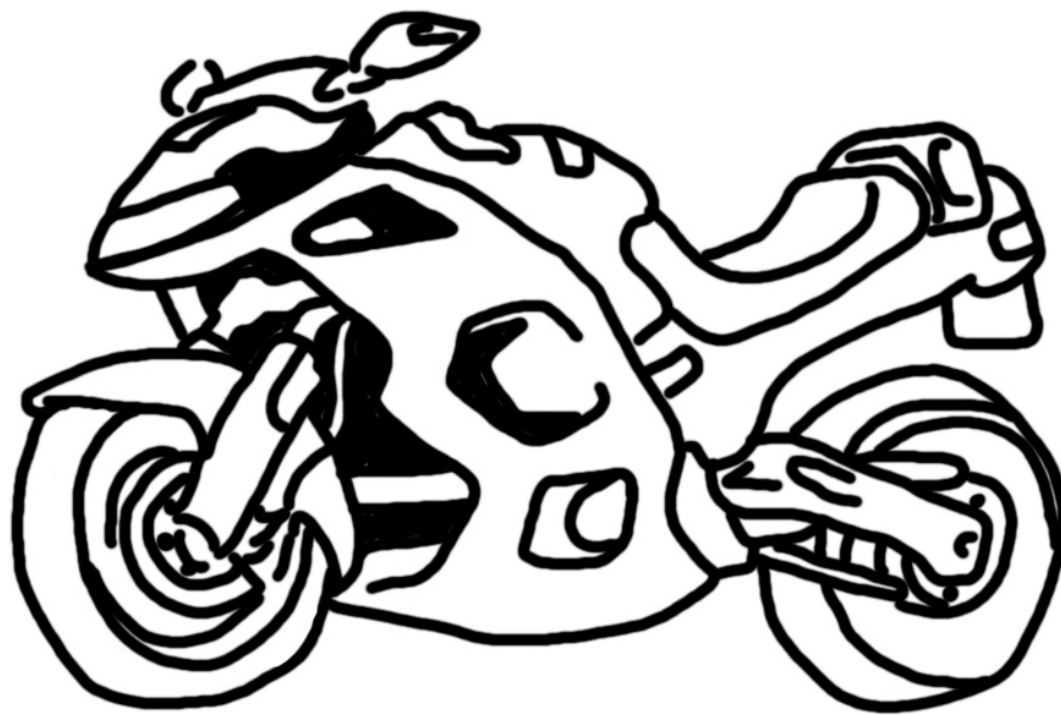




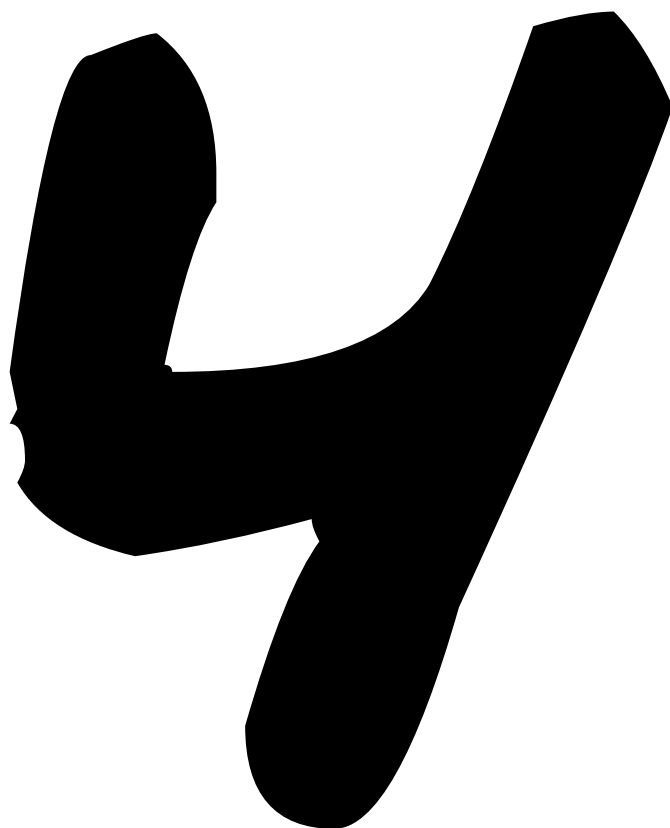
# *Sonic Expectations*



*Related story...*





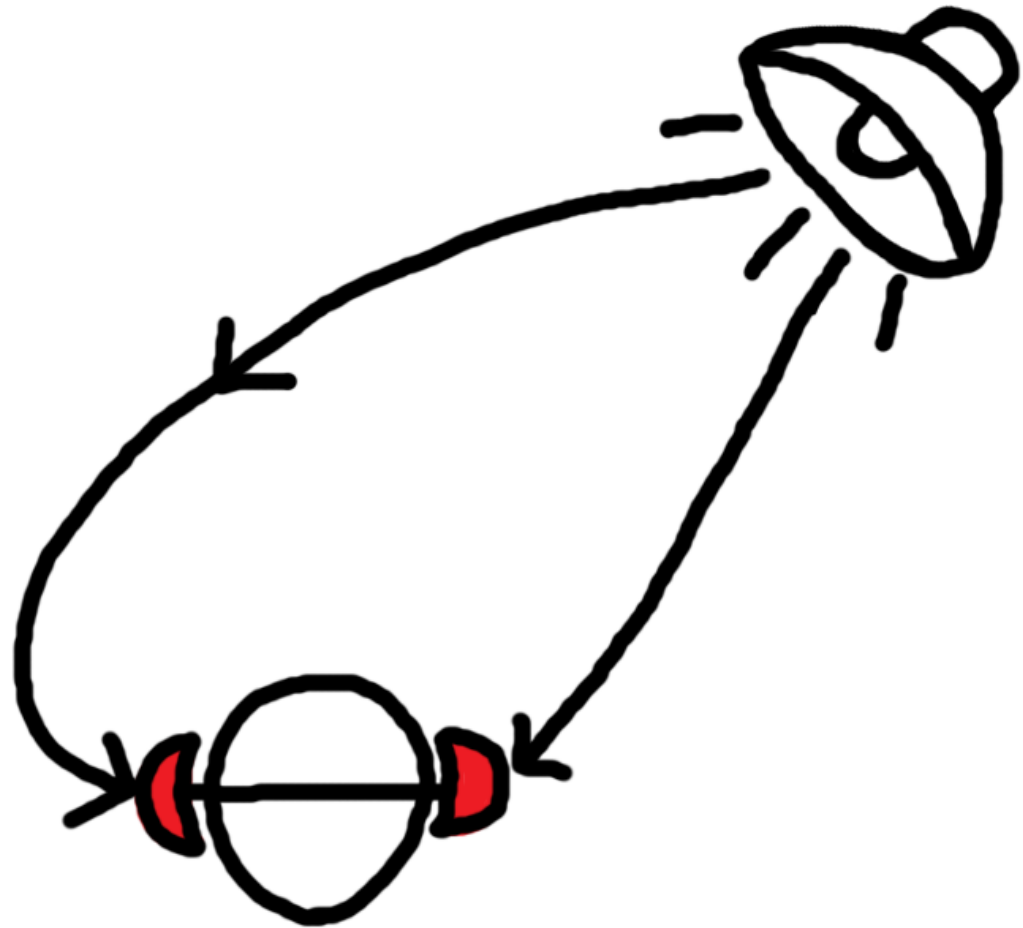


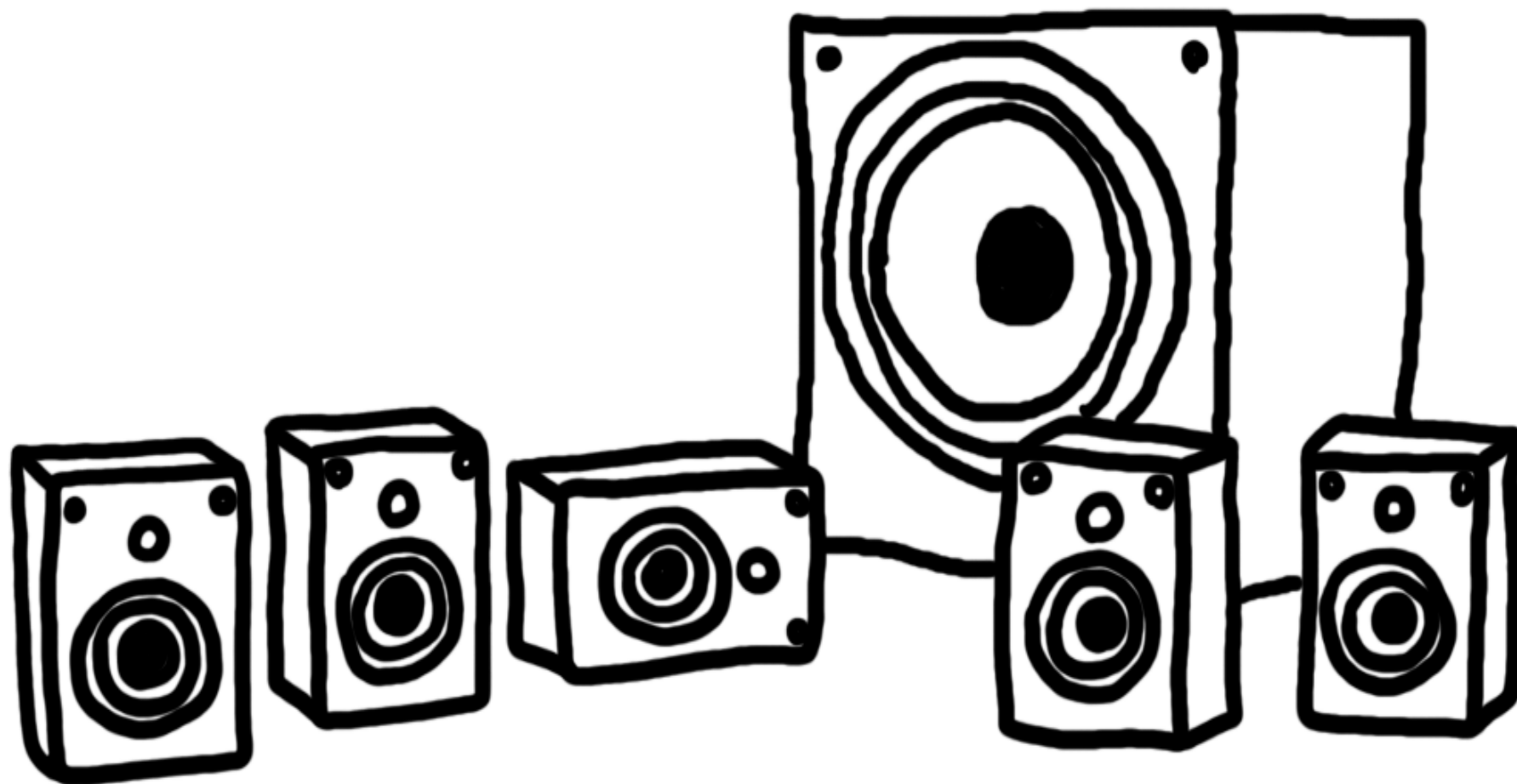
# Chapter 4

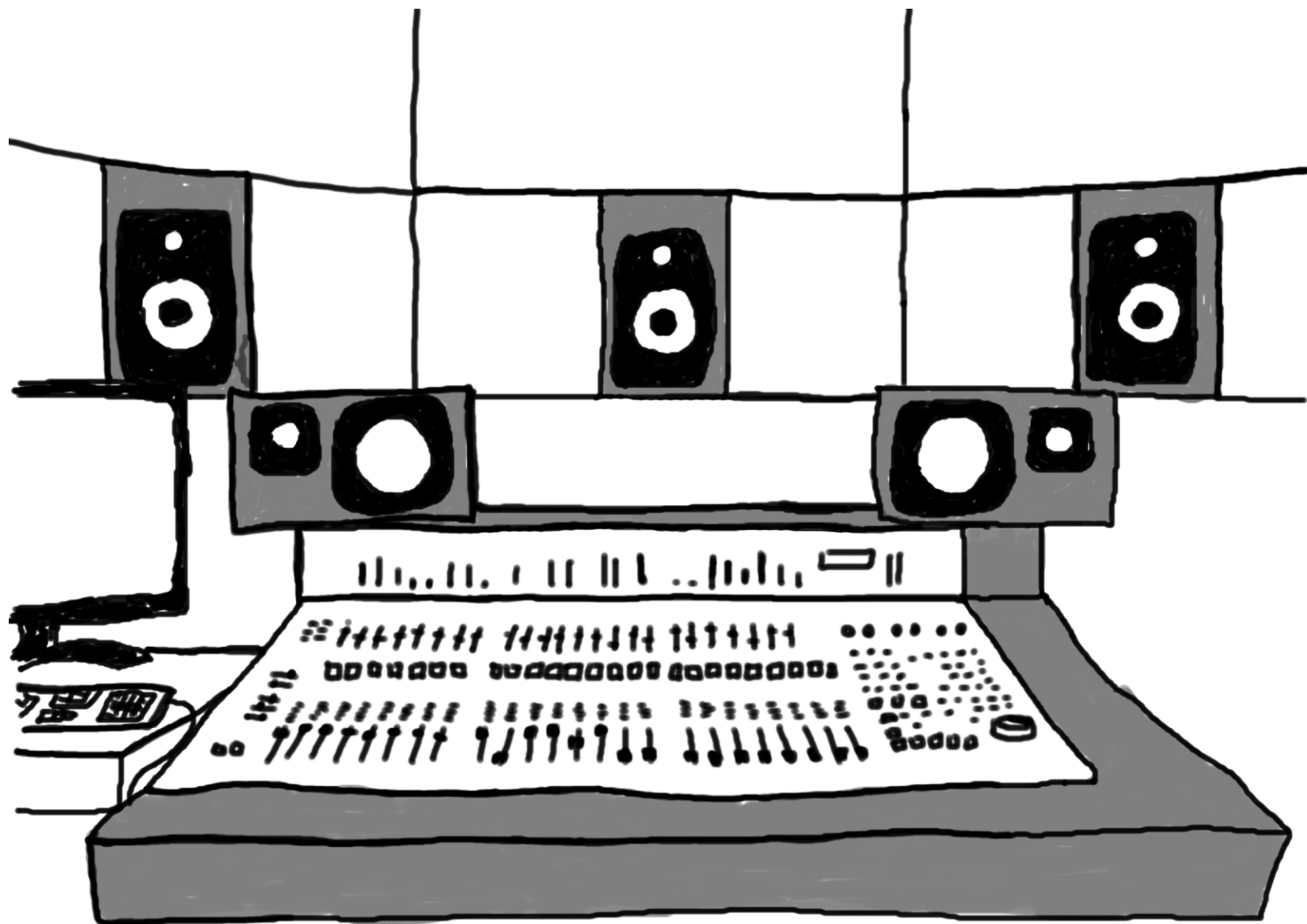
## *Positional Sounds*

# Head-Related Transfer Functions

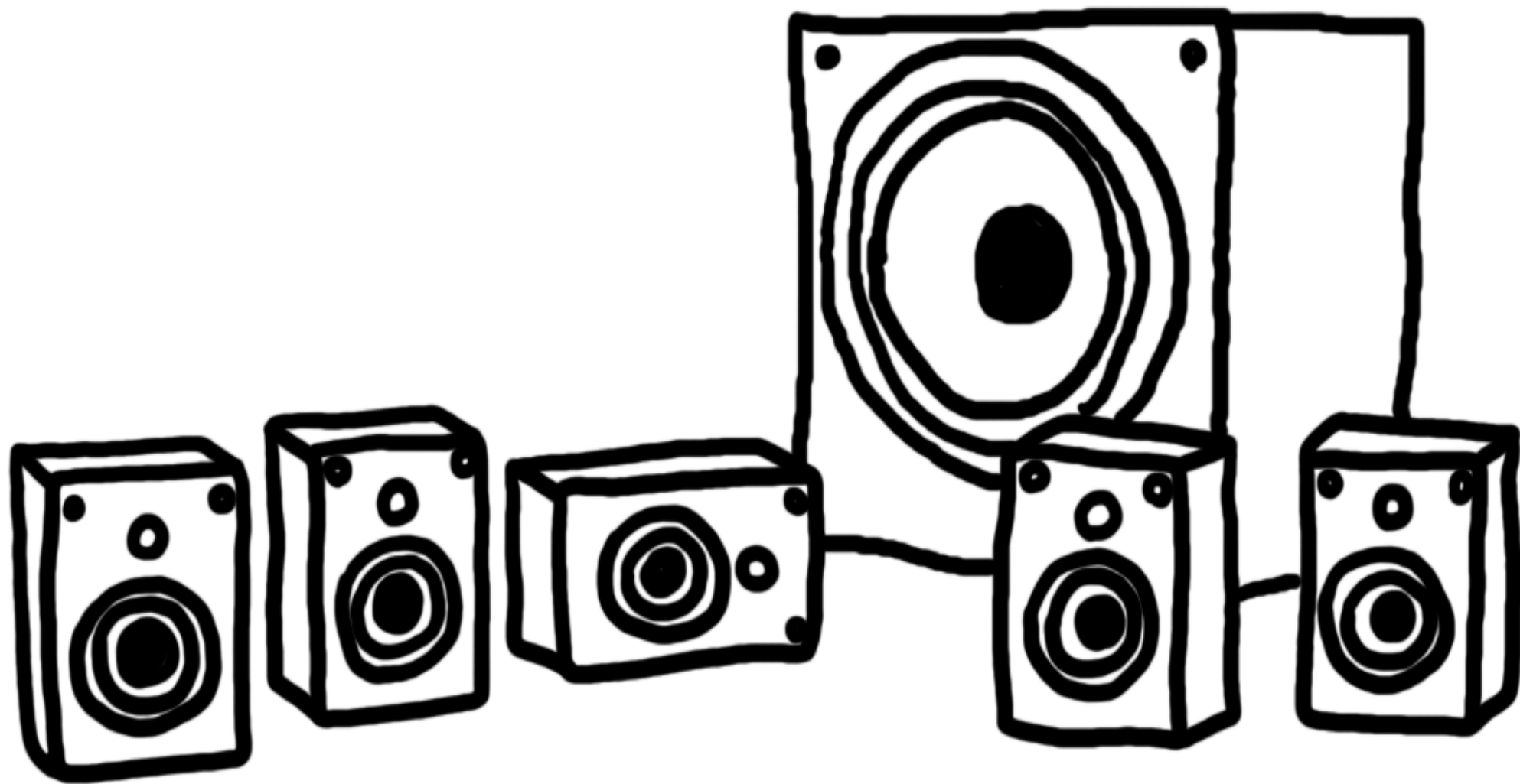
...will  
require  
headphones

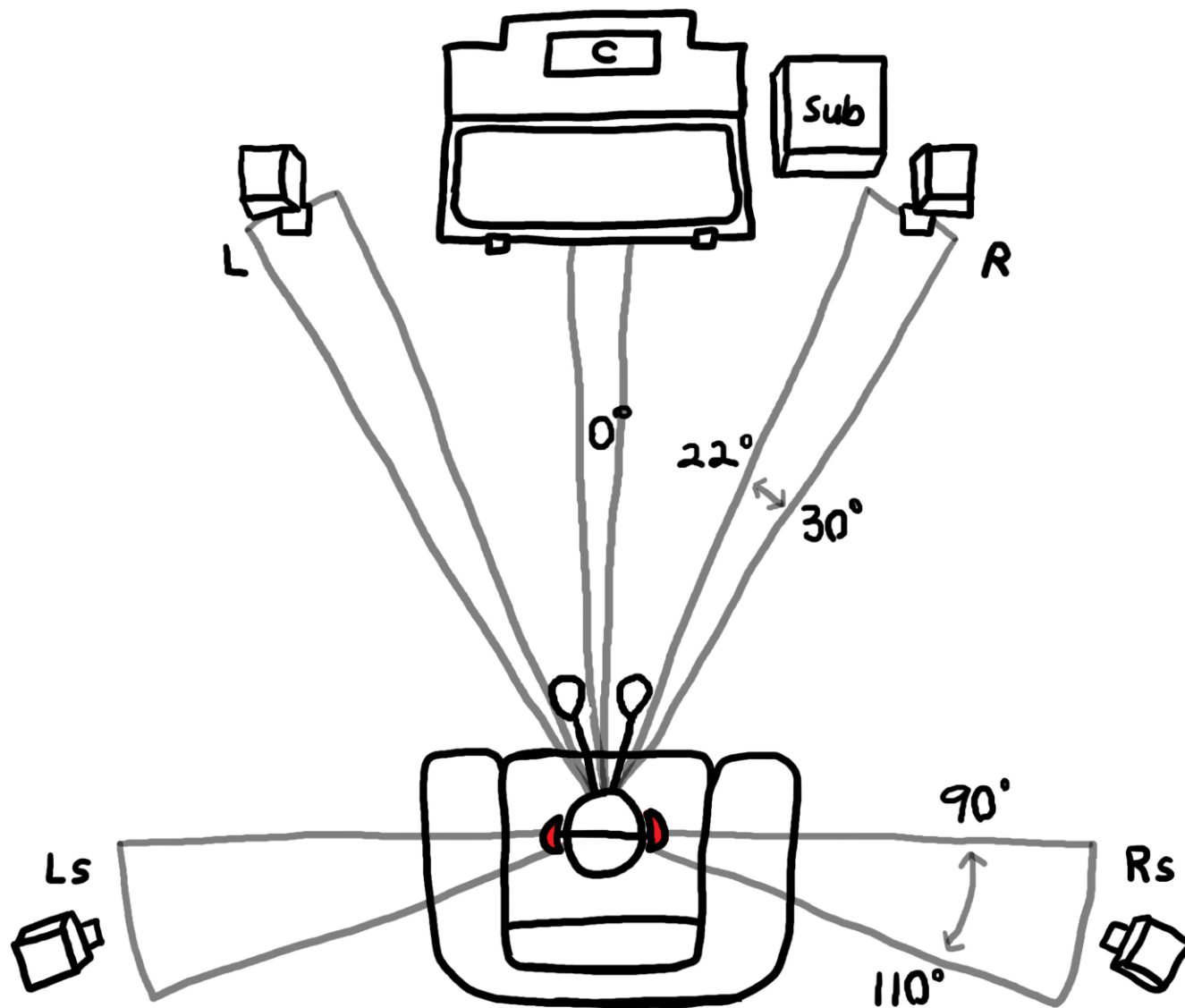




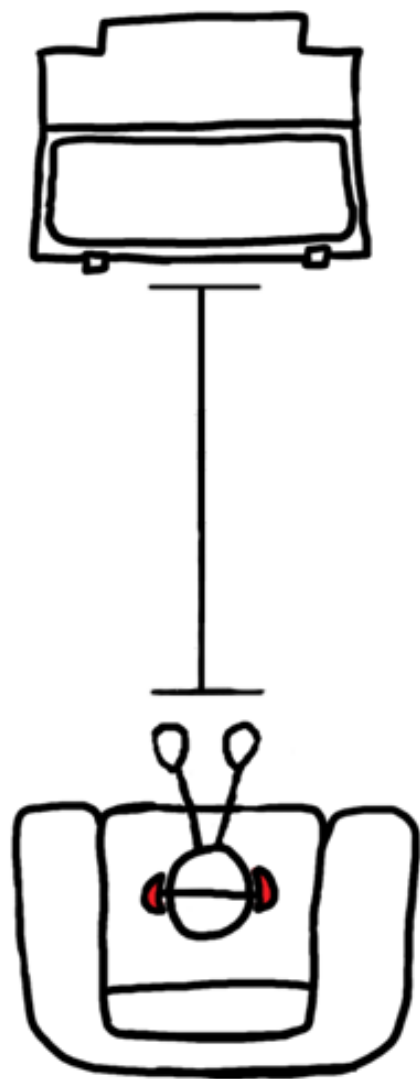




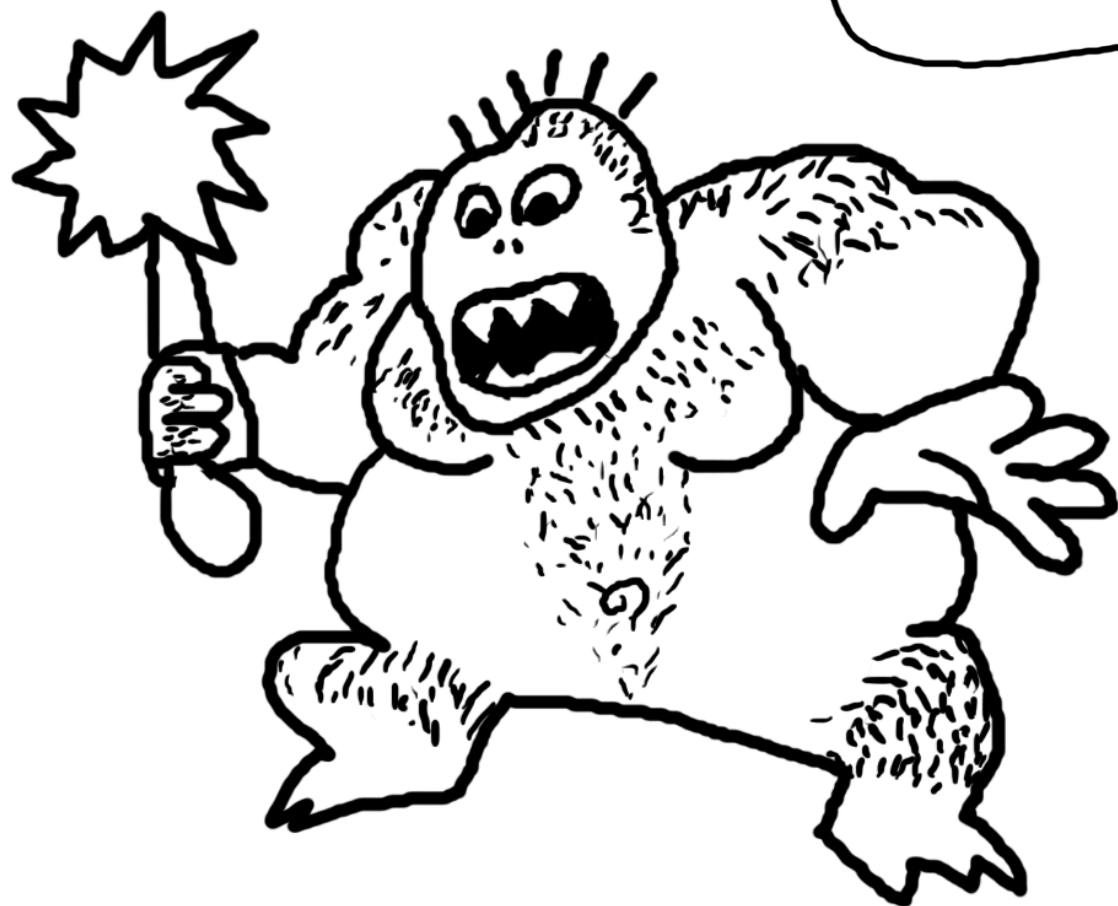










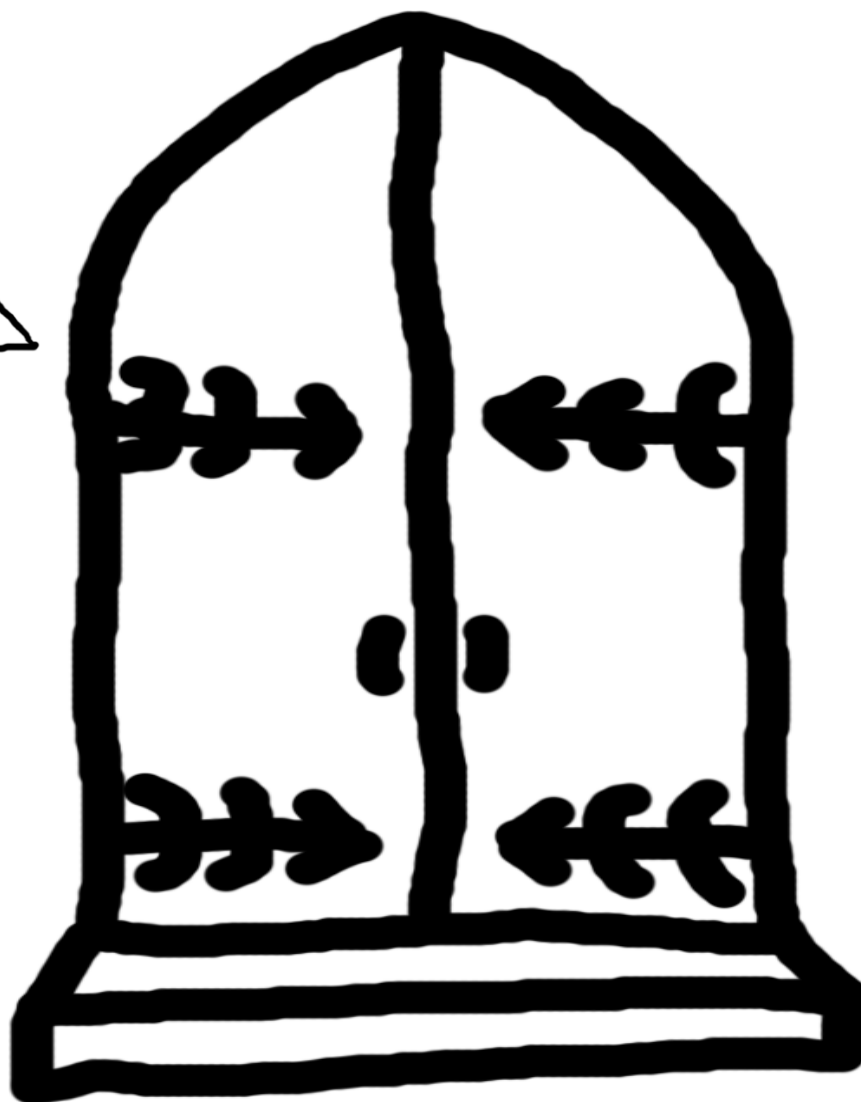


RAWR!



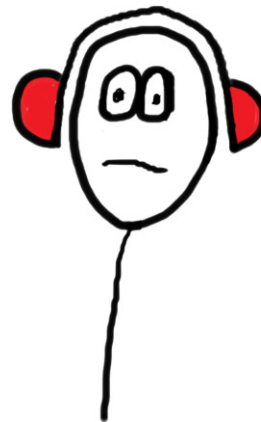
RAWR!

RAWR!





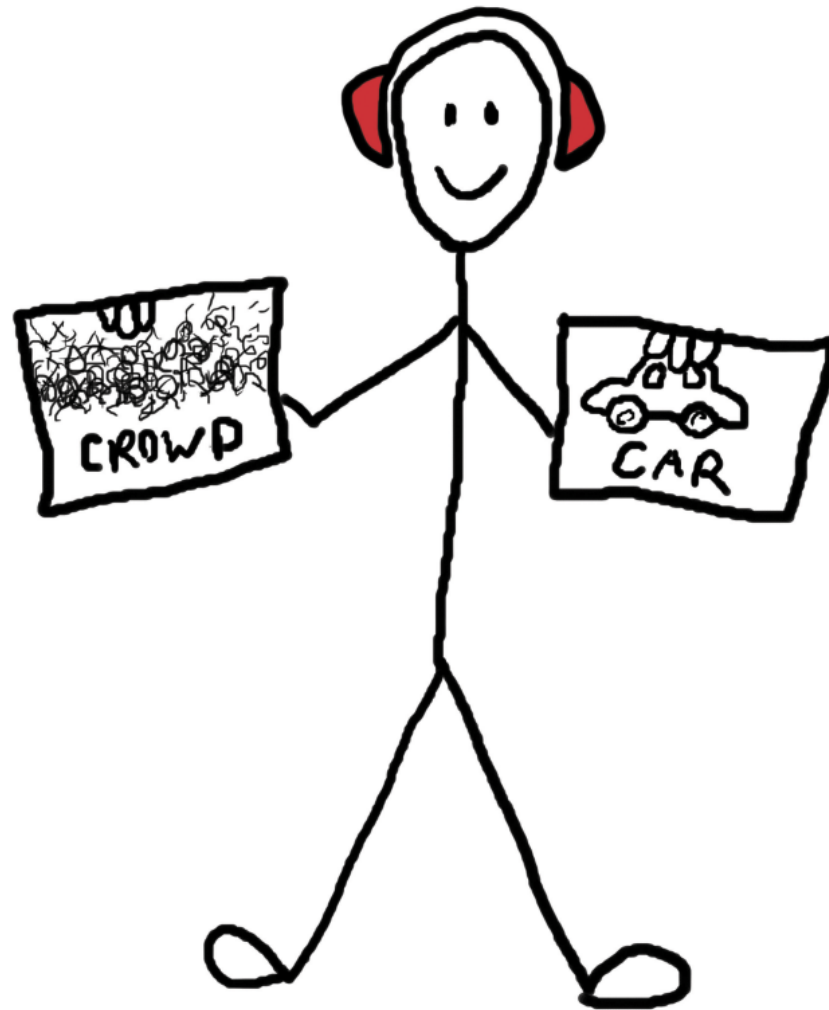
# *Sonic Expectations*



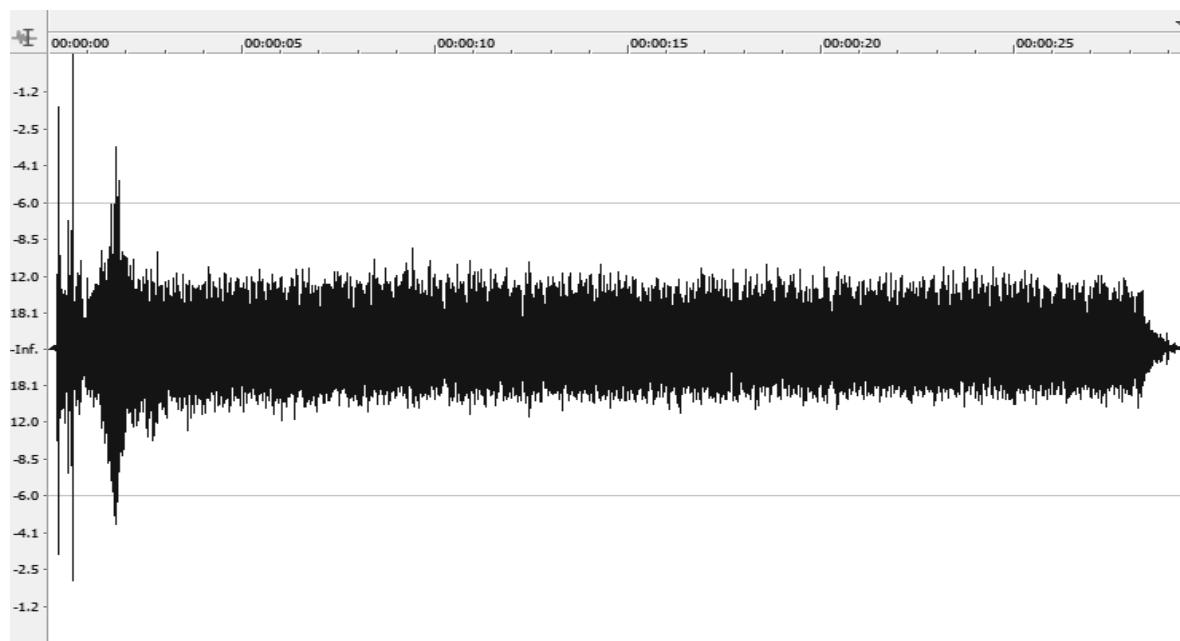
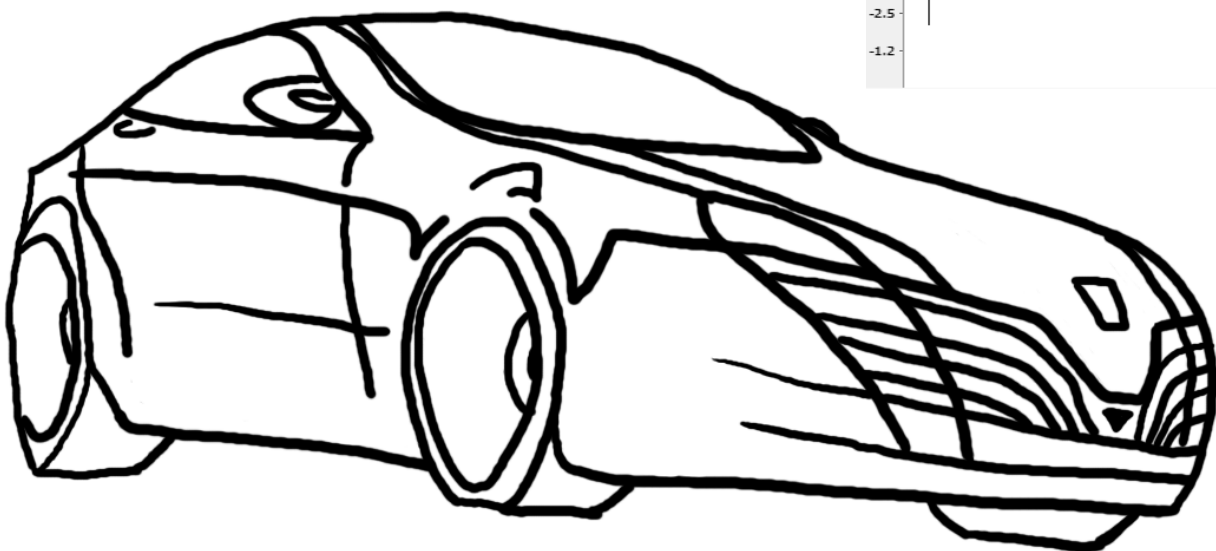
5

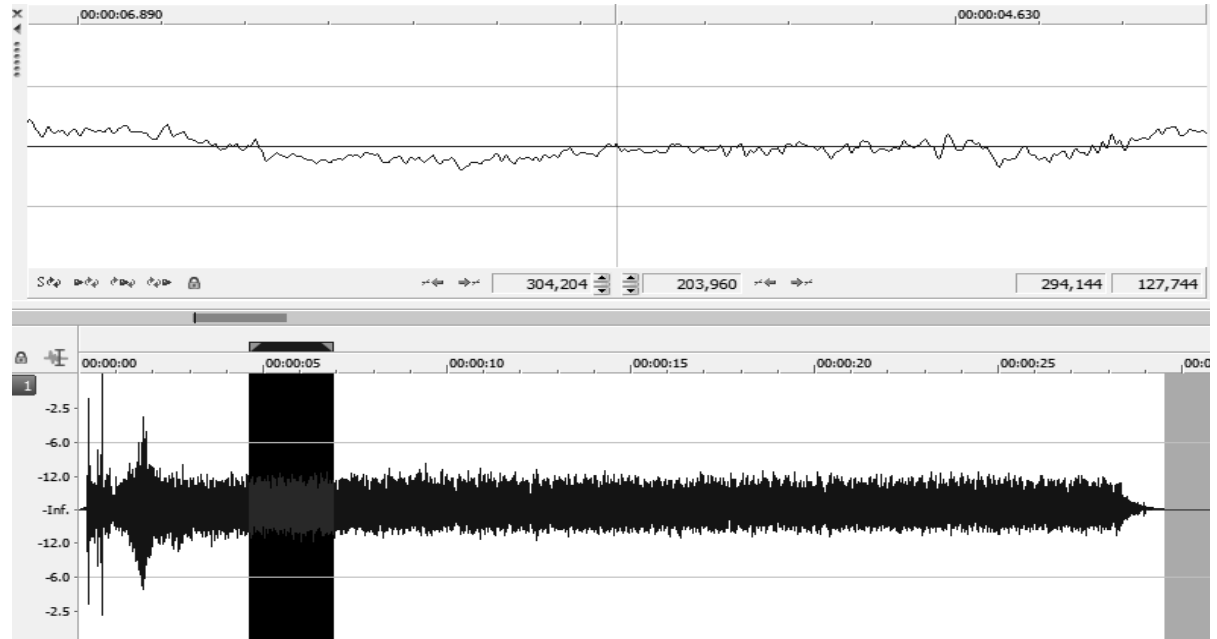
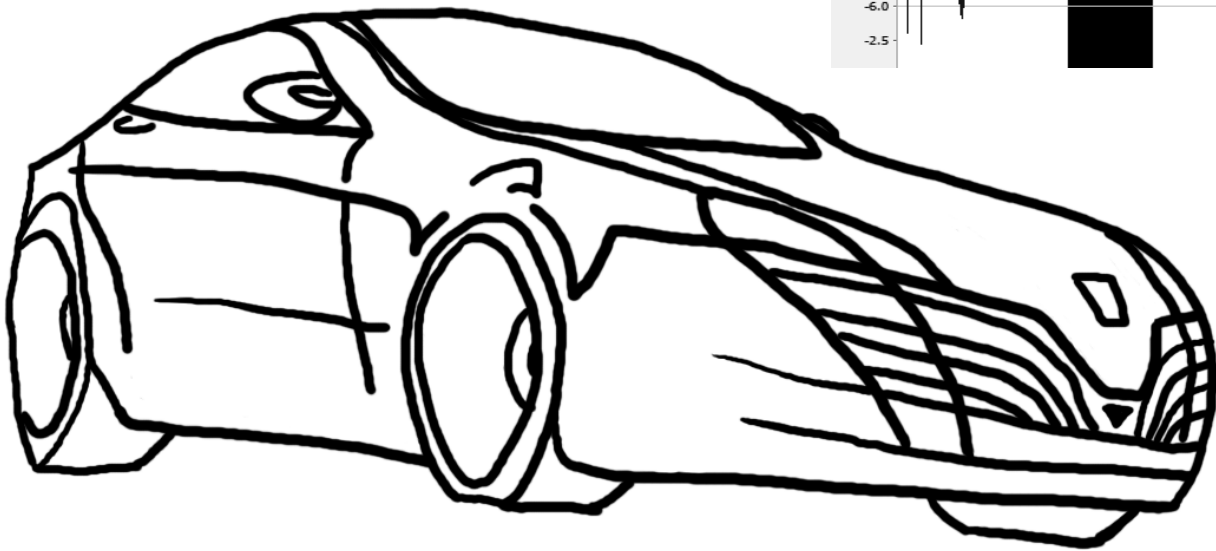
# Chapter 5

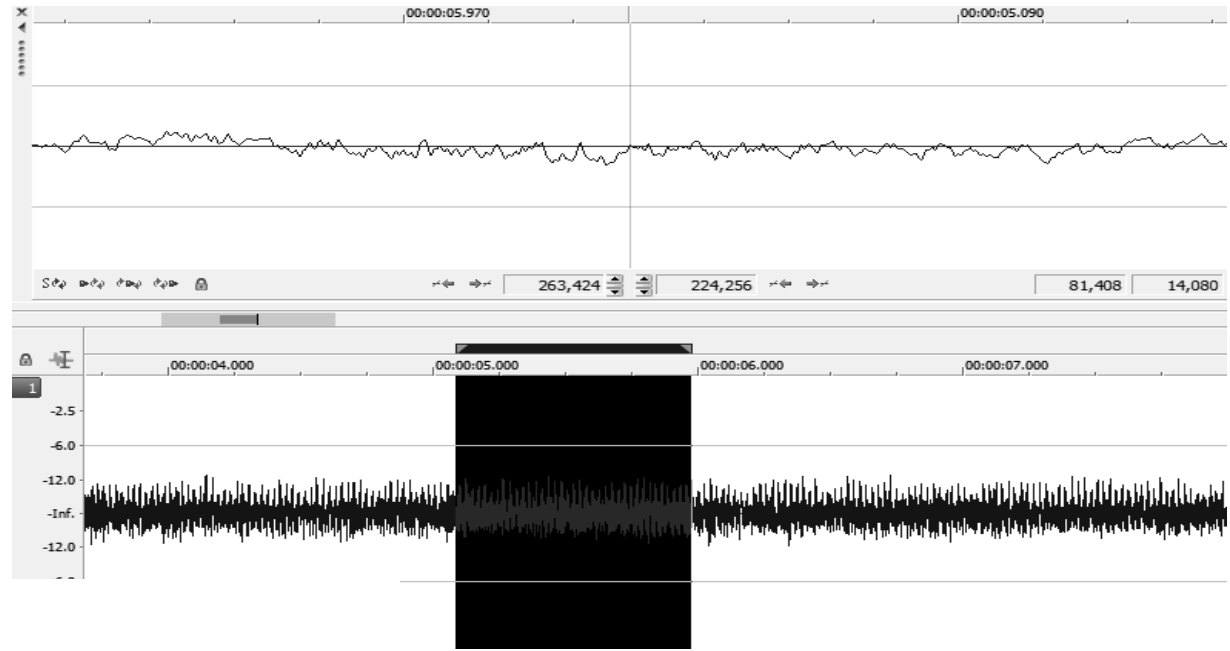
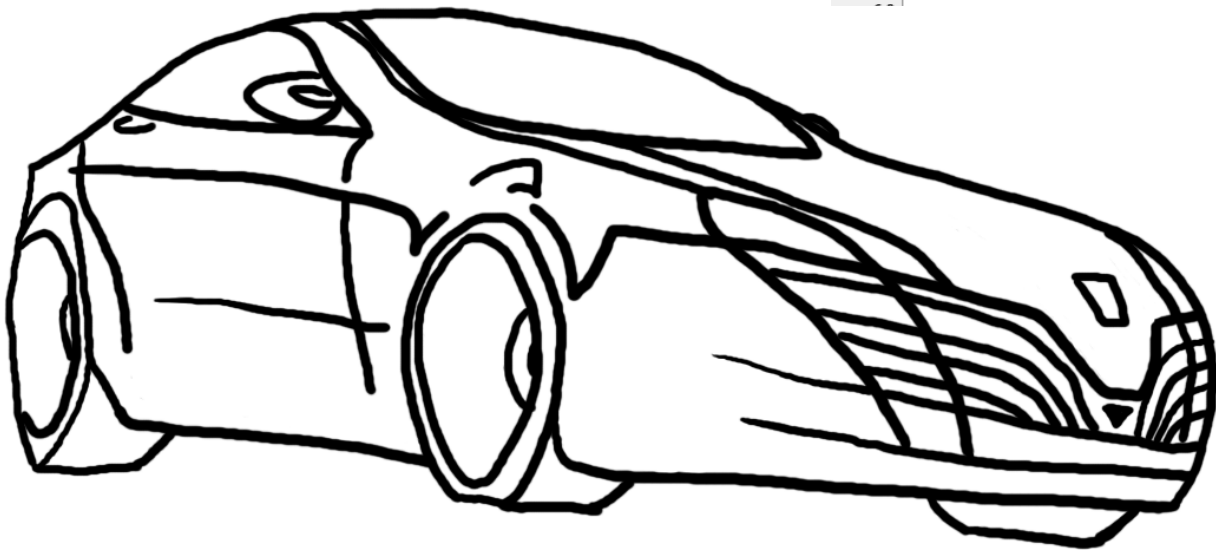
*Looped Sounds*

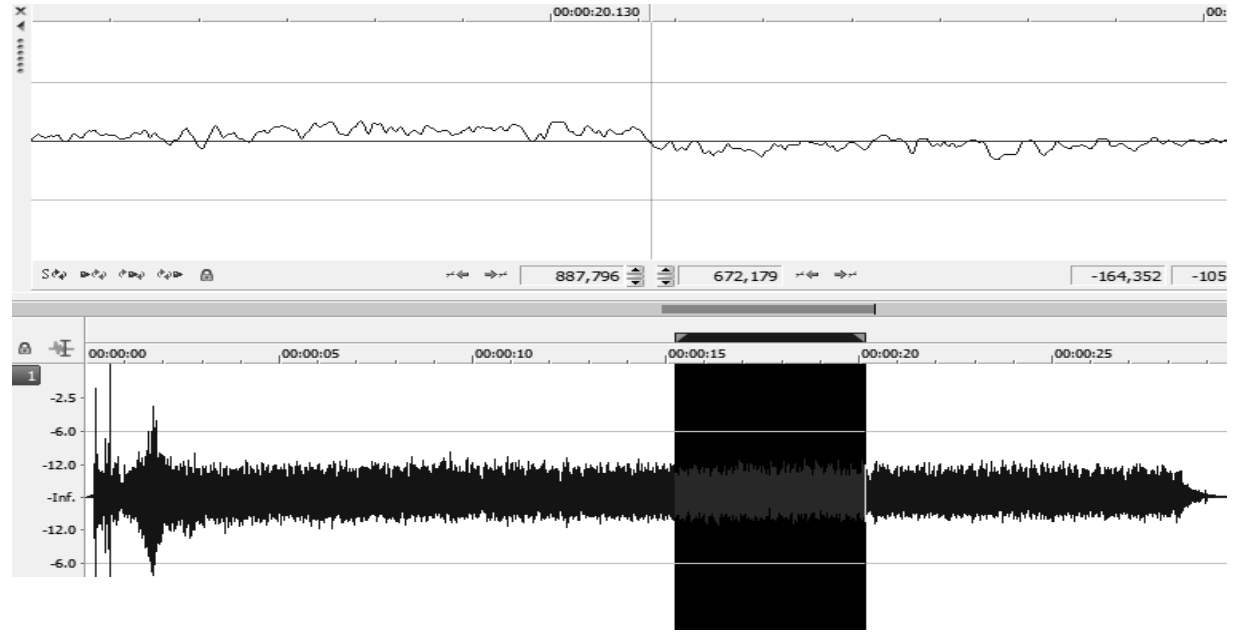
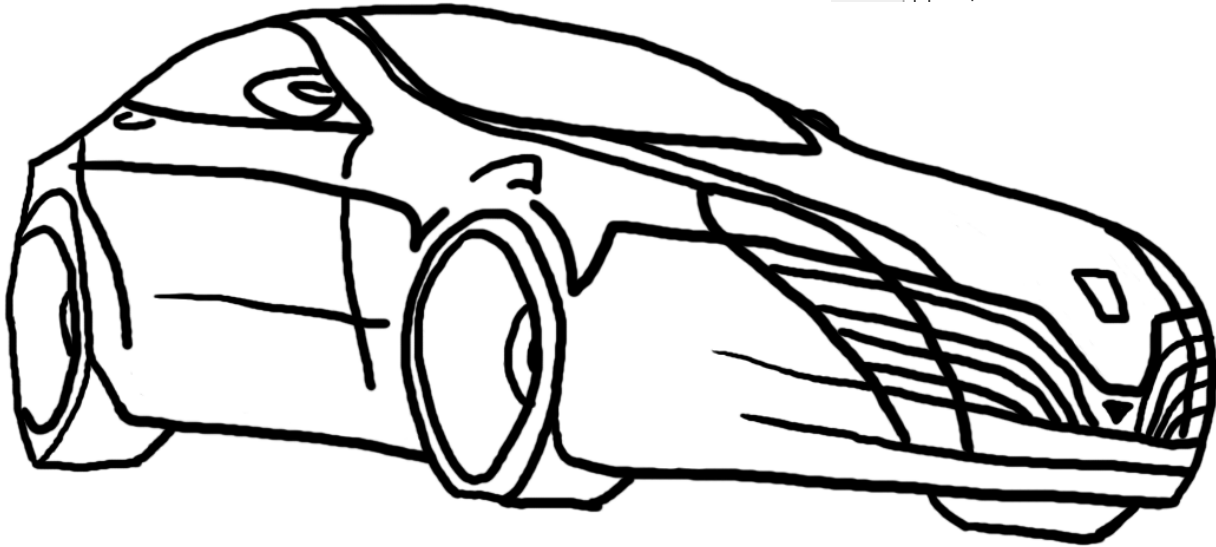


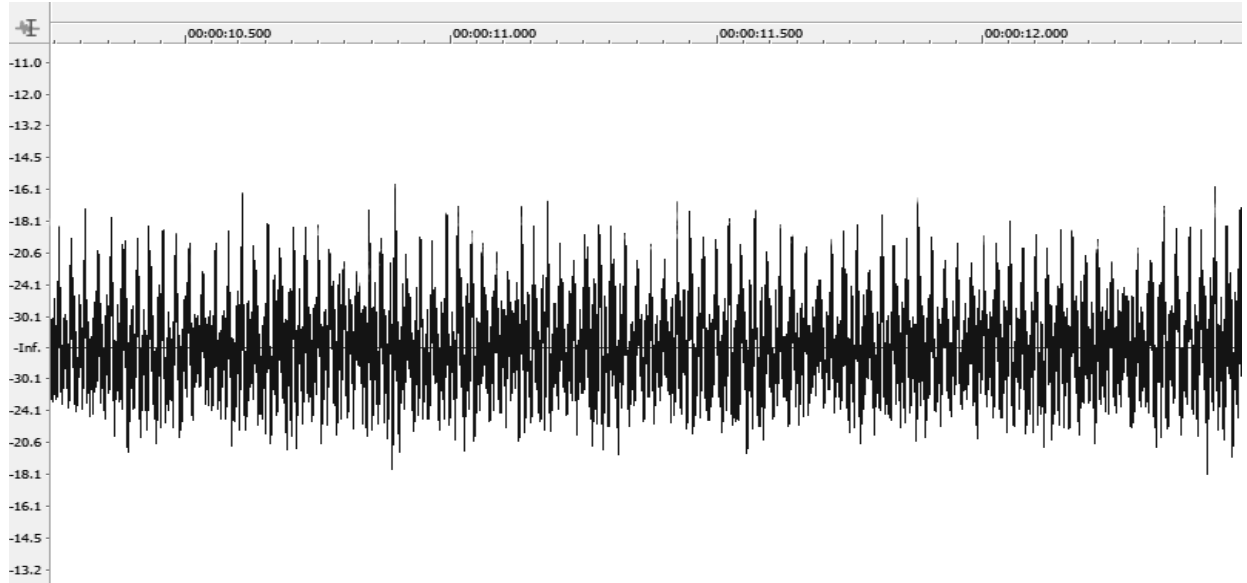
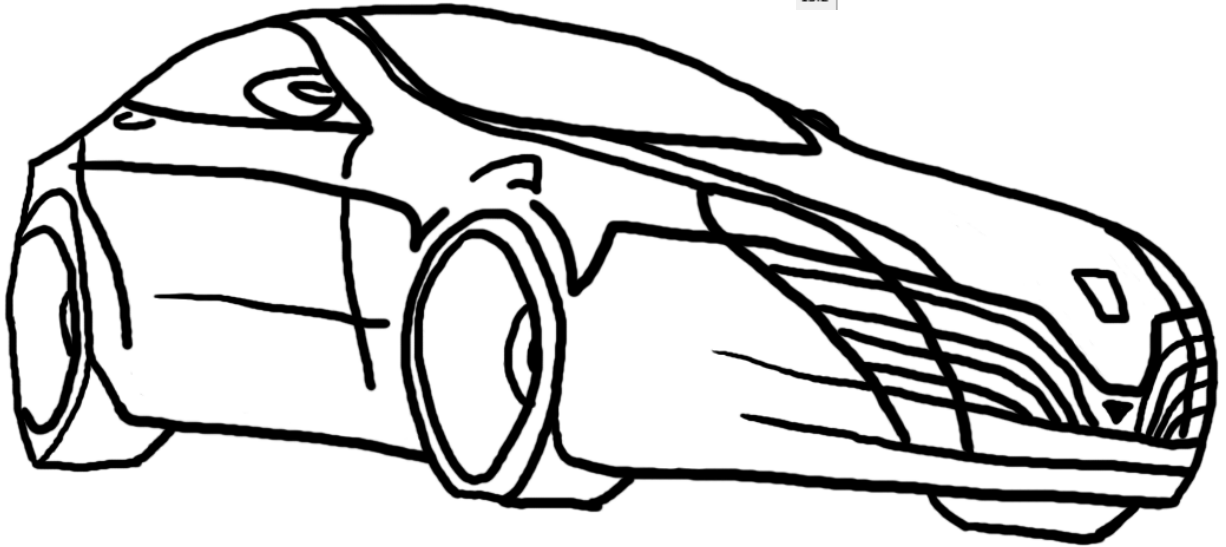


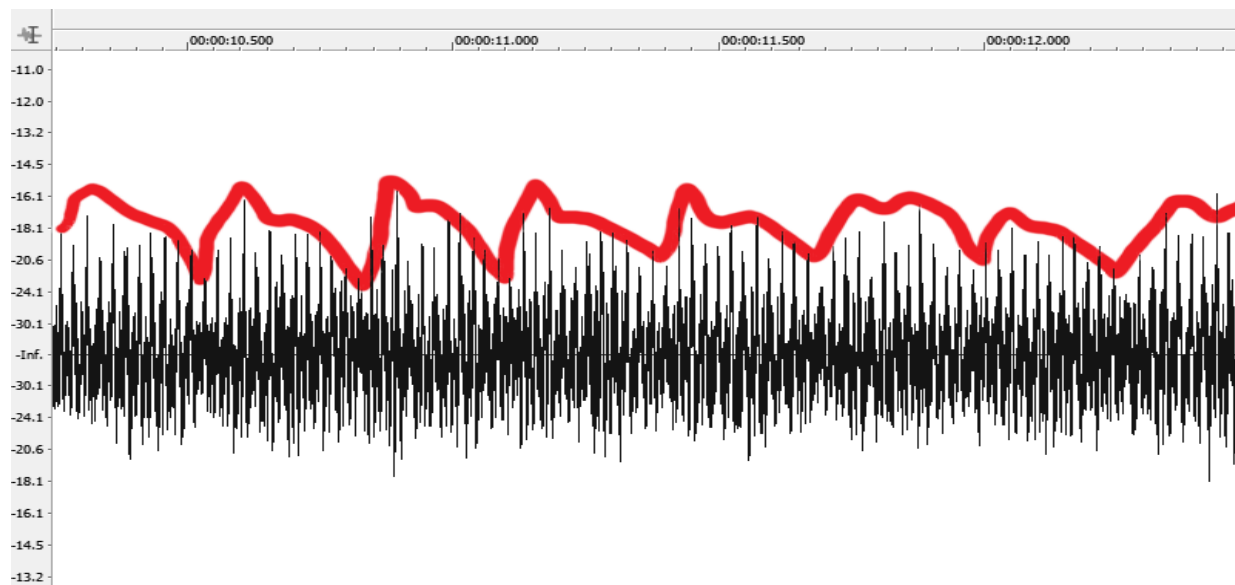
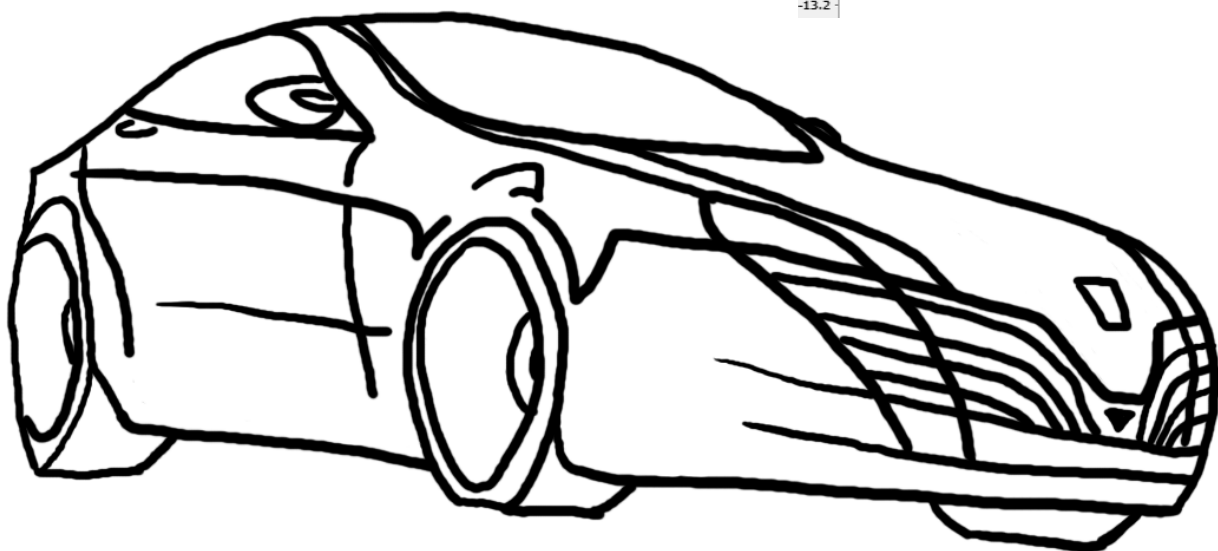


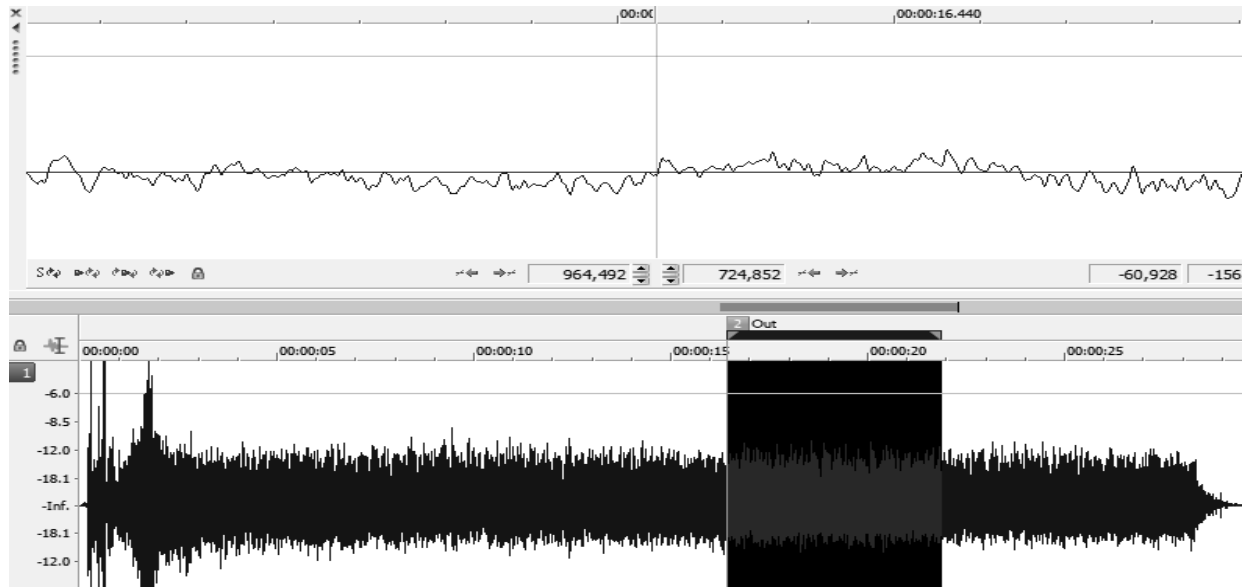
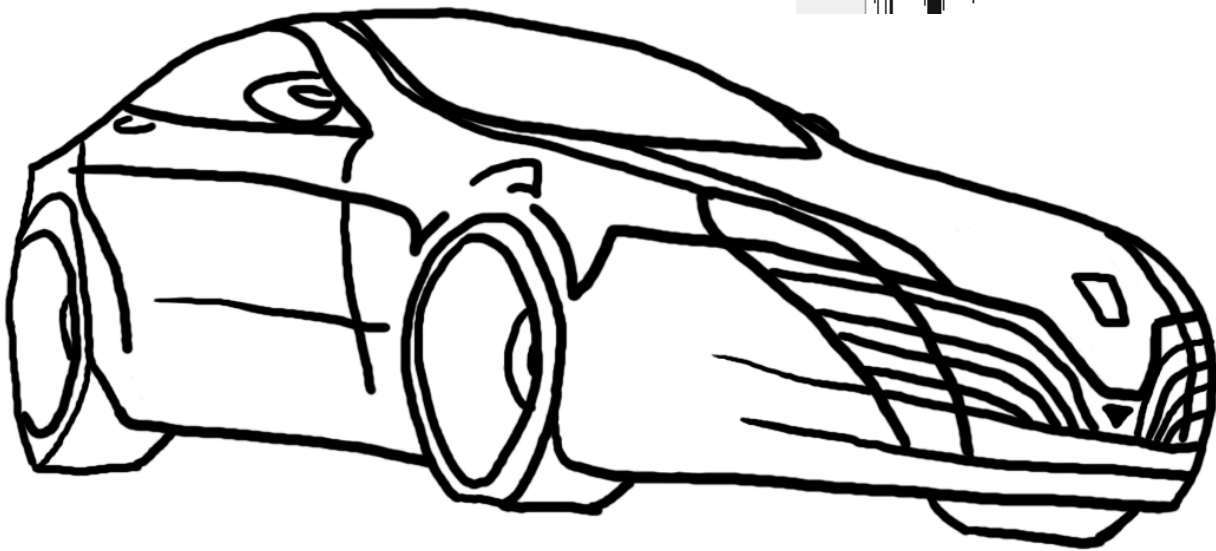








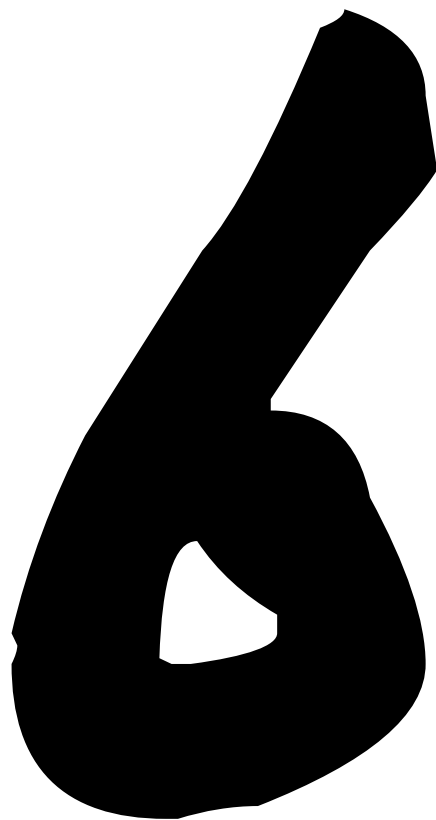




# Good Loops

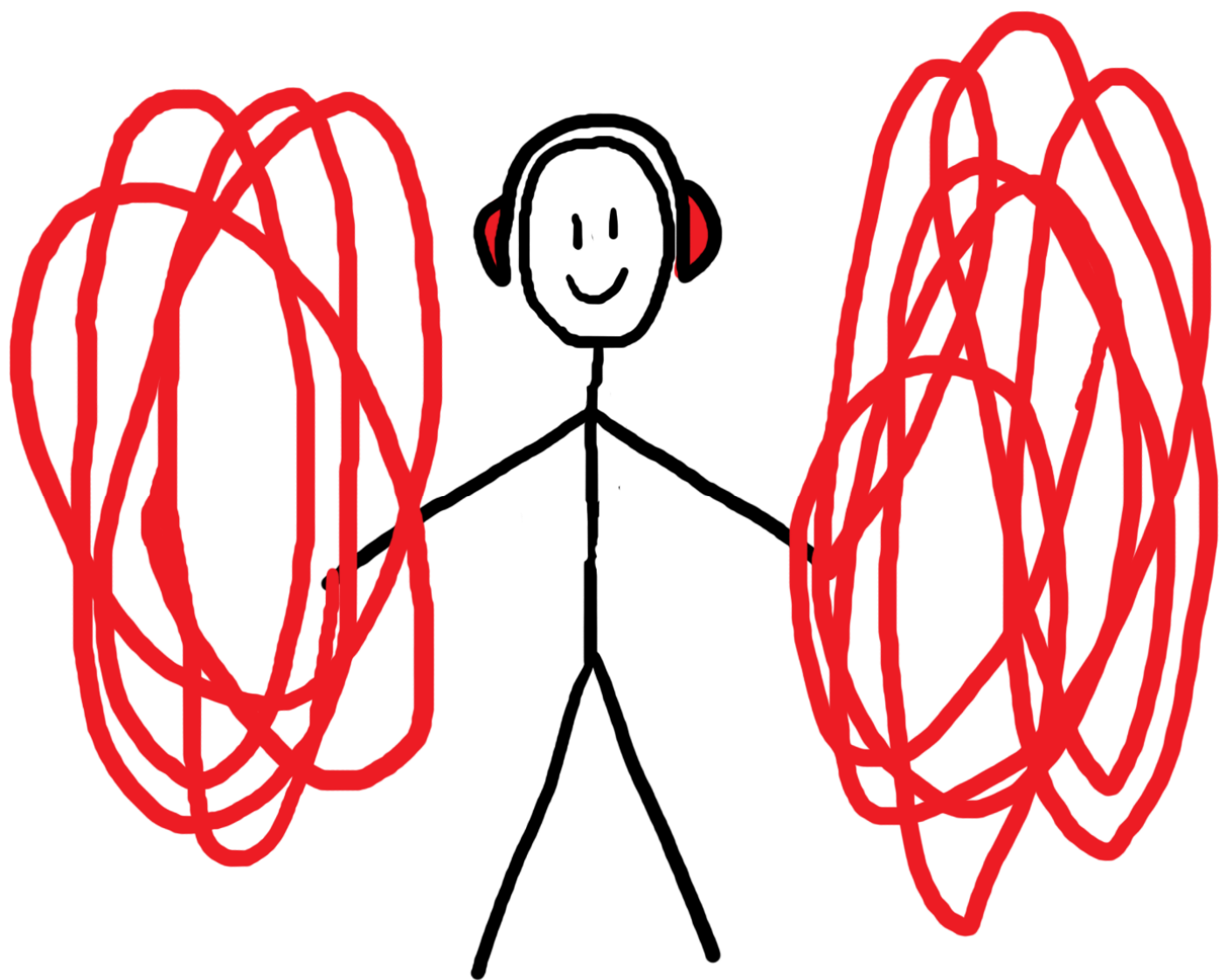
1. No identifiable events
2. Get all variation
3. Consider natural periodicity



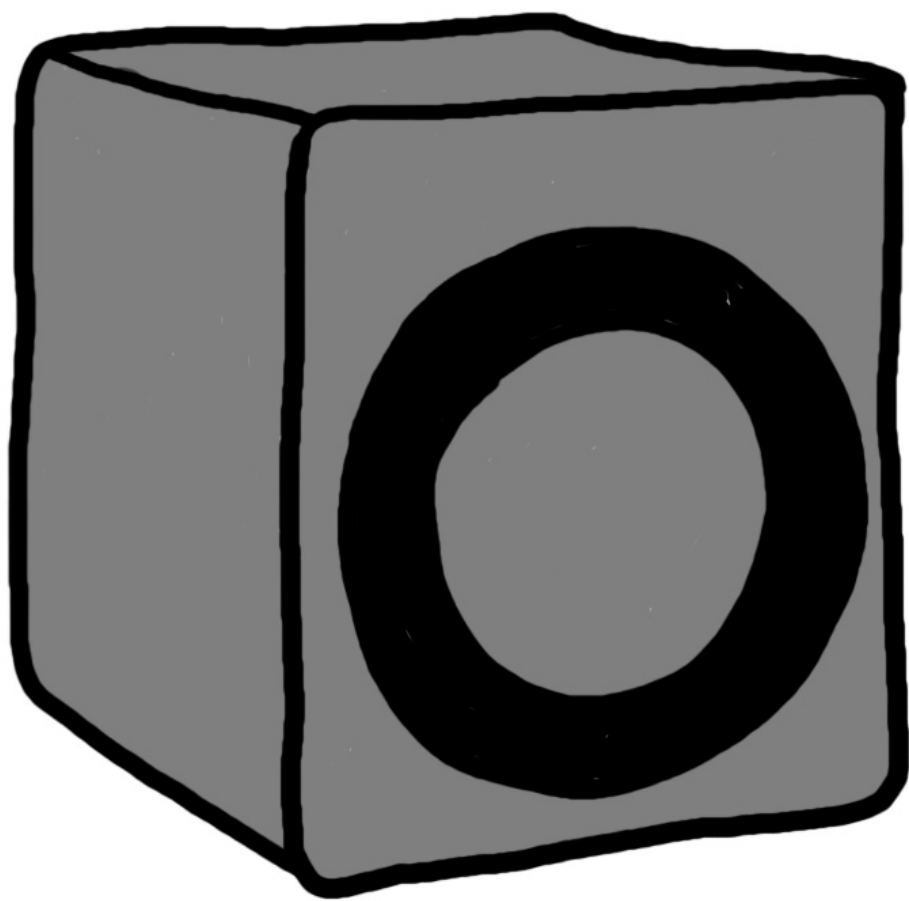


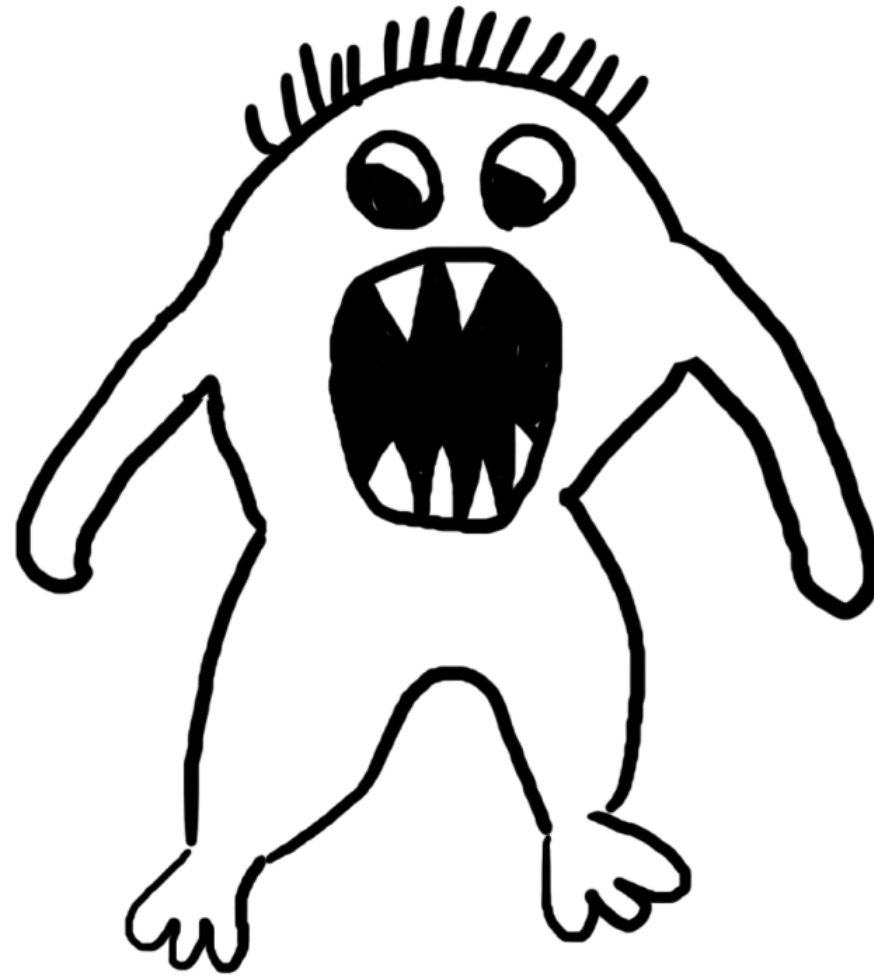
# Chapter 6

*Low Frequency Effects*









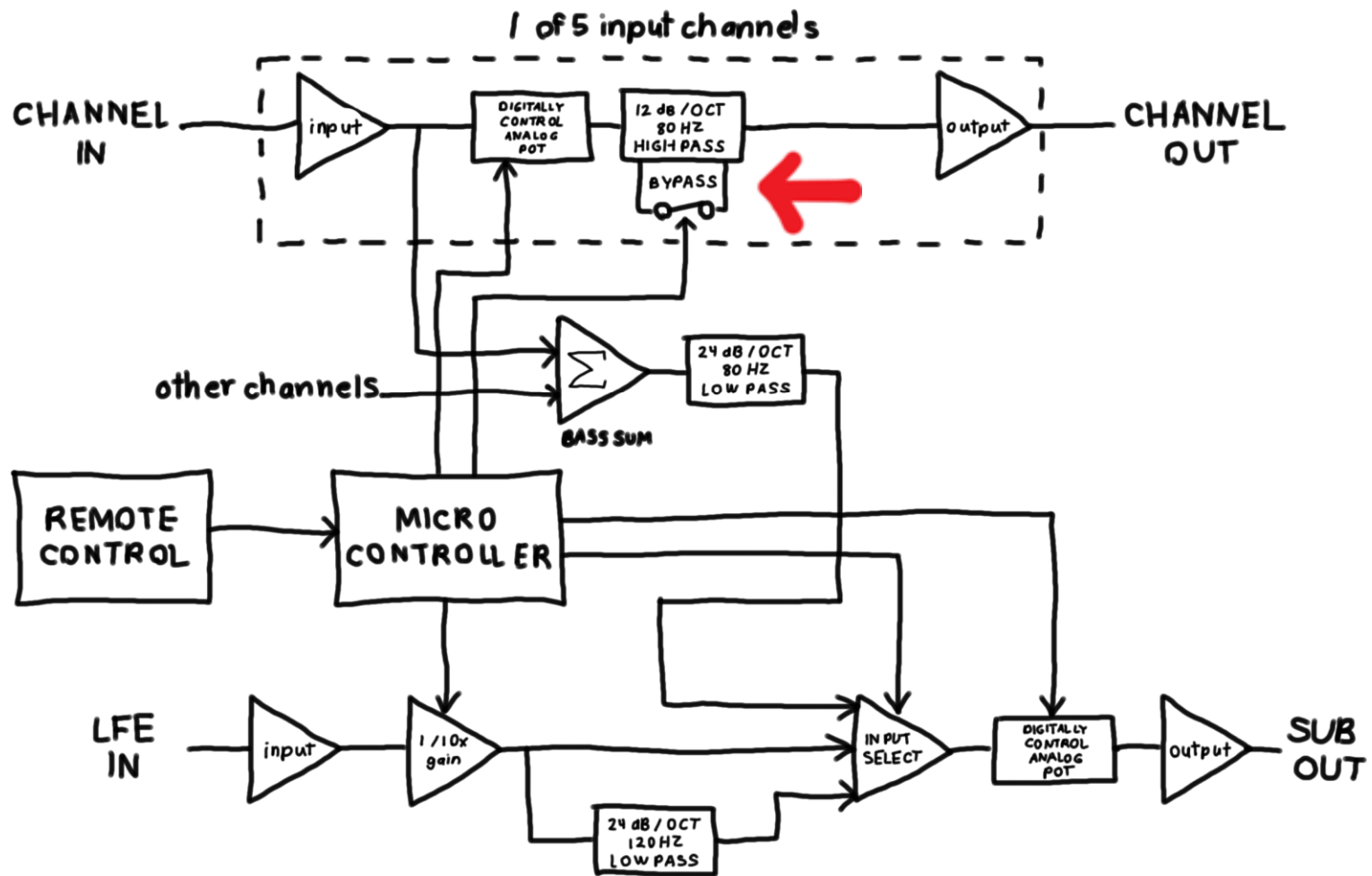




**THE  
HISTORY** of the LFE  
**CHANNEL**



# BMC BLOCK DIAGRAM



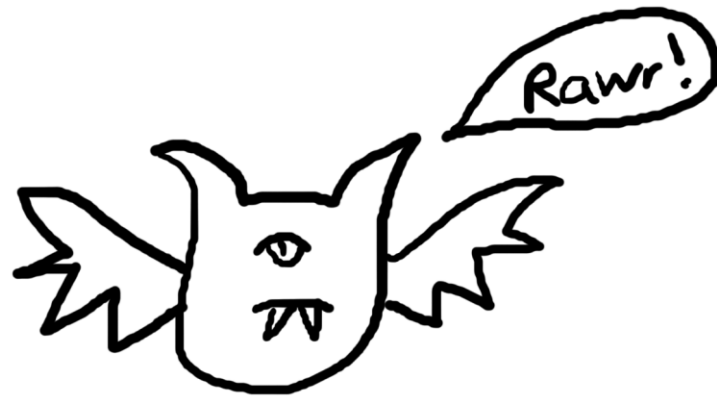




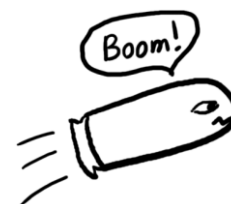
# Chapter 7

## Cinematic Mixing





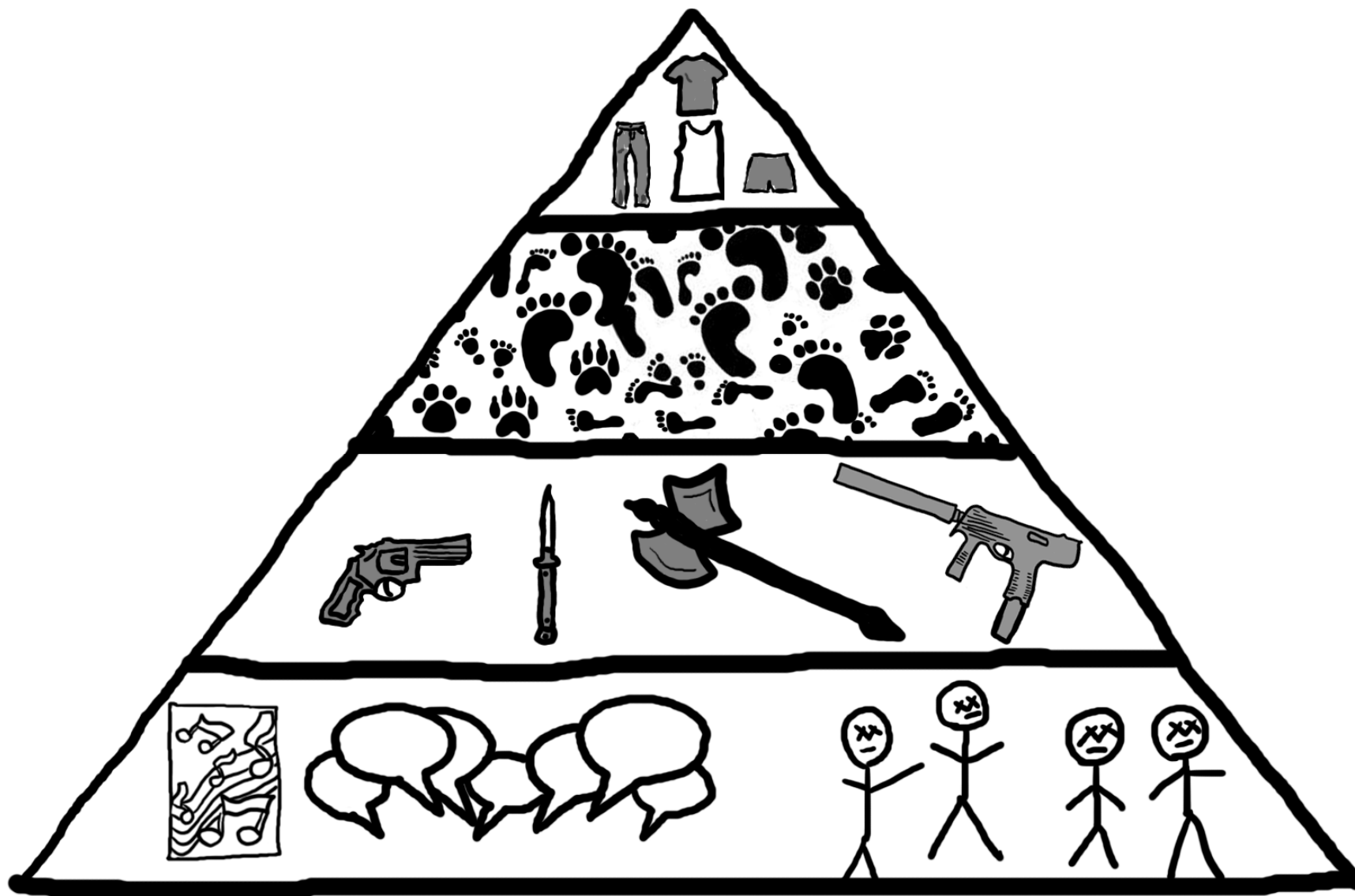




HA HA! Silent  
sneak attack  
bullet!



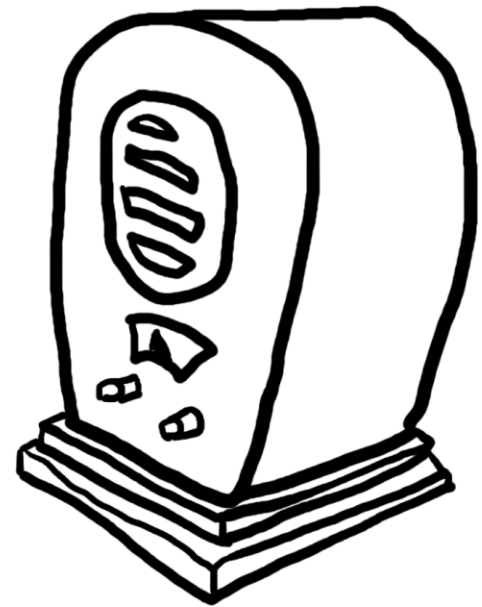




? ?

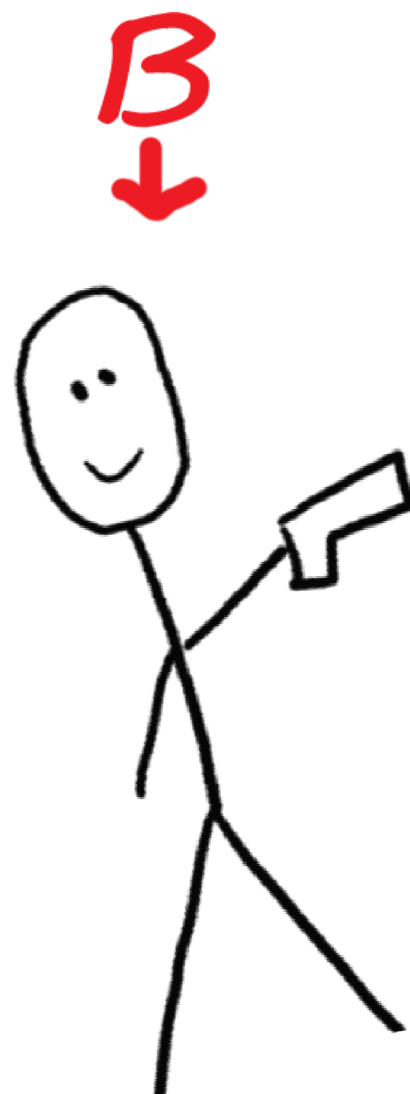
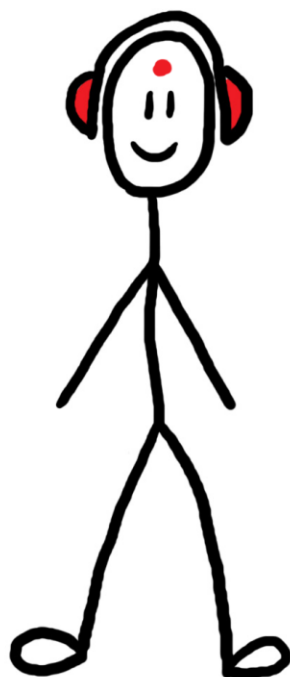


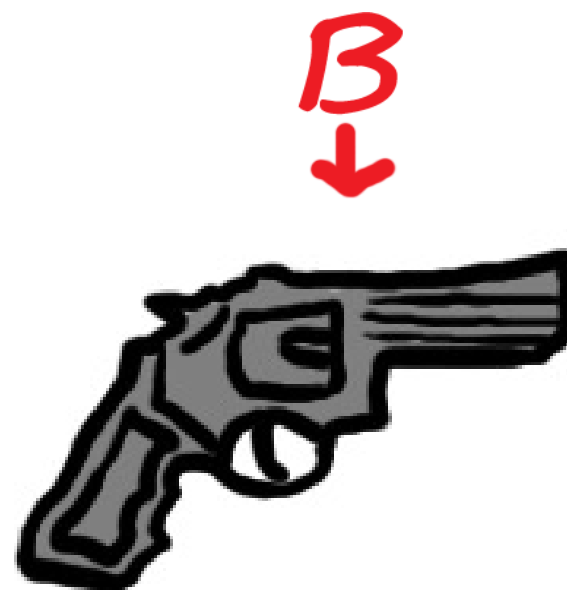
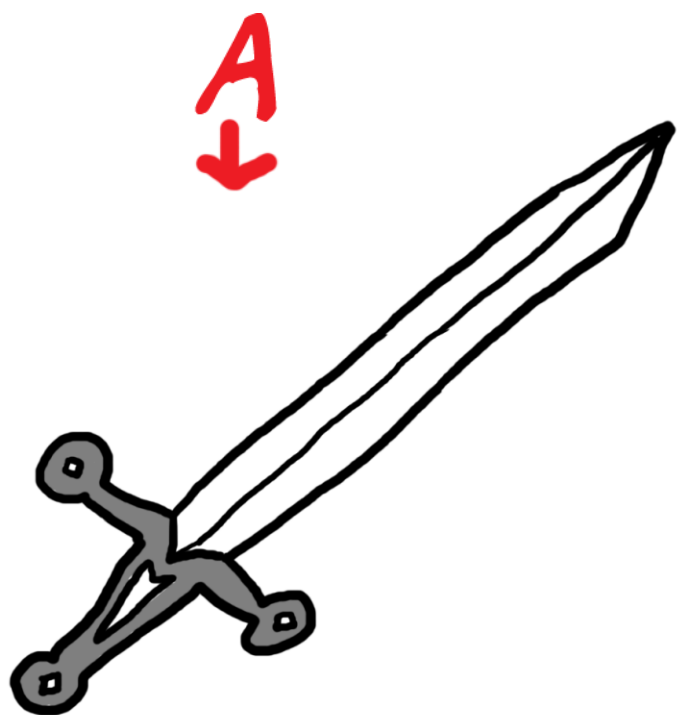
Television characters have  
magic radios!



WHICH SOUND IS MORE  
INTERESTING?









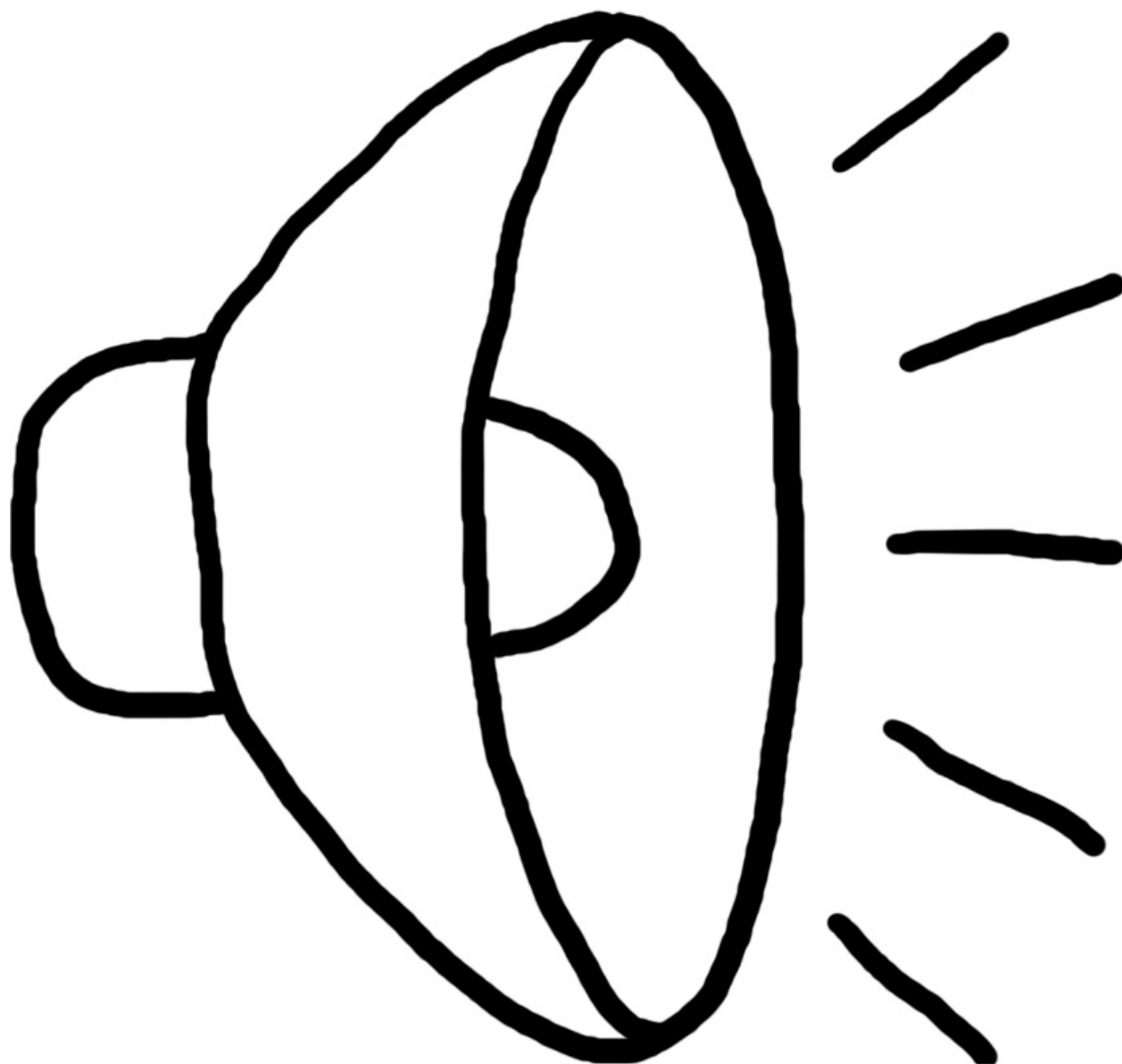


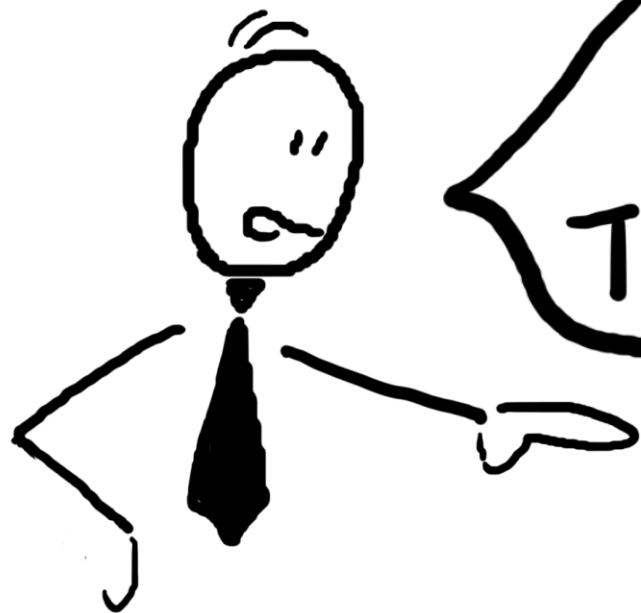
1. Simultaneous Voice Masking
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- 8.



Chapter  $\infty$





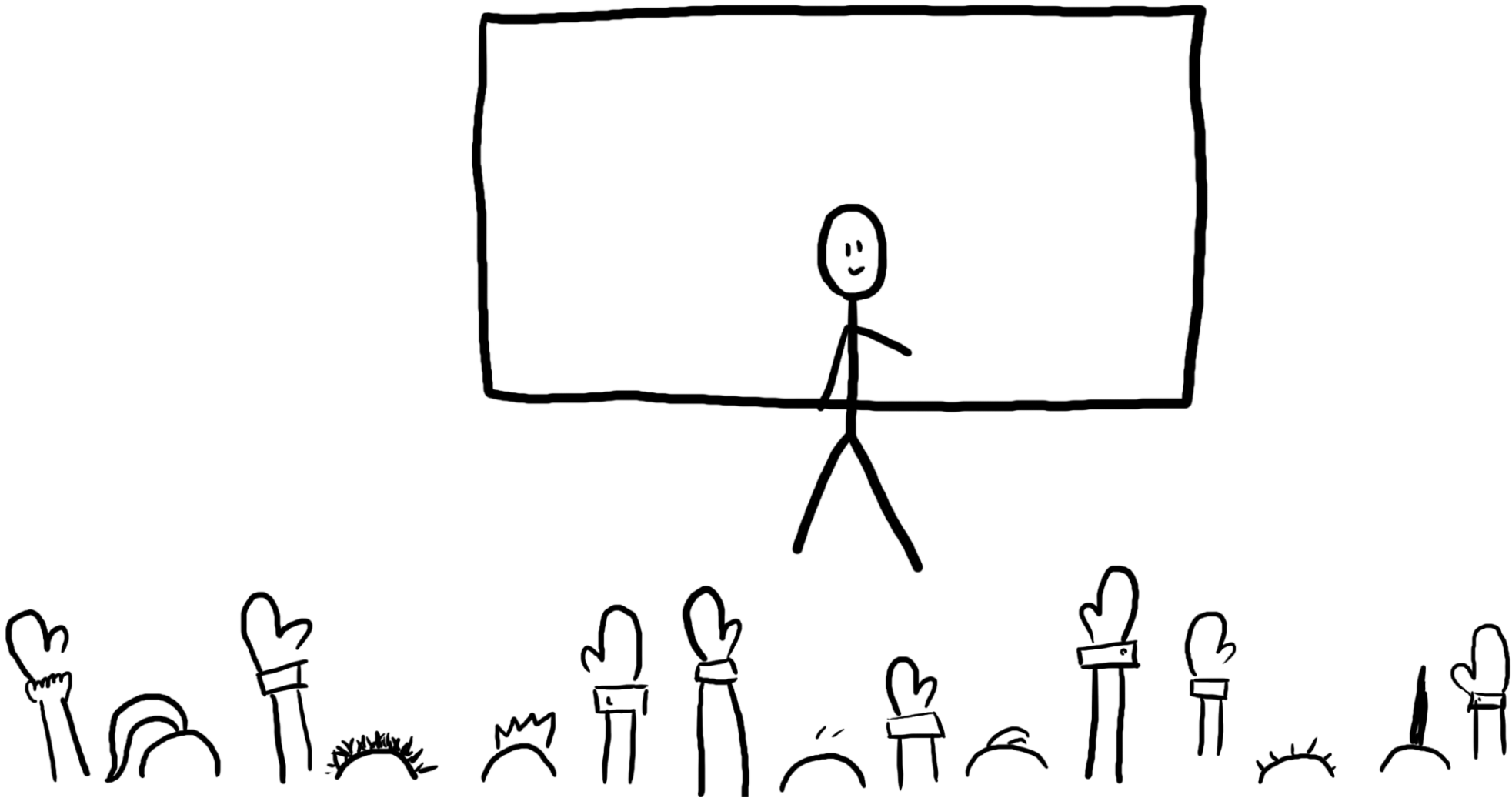


WHY CAN'T  
I HEAR ANYTHING?  
TURN EVERYTHING UP!

Turn

everything

down





[www.giganticsoftware.com](http://www.giganticsoftware.com)