McMASTER INSTITUTE FOR MUSIC & THE MIND

Signals, Sensors, Sounds
WORKSHOP

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- Neuroscience

LIVELab
2024

LIVELab

Your instructors for today

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Maya Flannery

Joshua Schlichting

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Overview

What are signals, sensors, & sounds?

- Signals
- Sensors
- Sounds
- Music?

Why should we care about signals, sensors, and sounds?

- Understanding psychological and physiological responses to music
- Creating more immersive music

Practical skills

- Working with musical signals
- Cardiac signals
- Eye-tracking signals

What is a signal?

Signal refers to both the process and the result of transmission of data over some media, accomplished by embedding some variation.

Signals often convey information

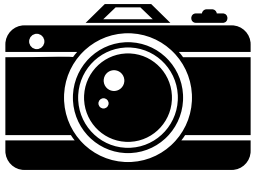
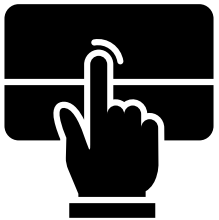
Signaling occurs in all organisms, even at cellular levels

Examples:
- Speech
- Video
- Action potential of a neuron

What is a sensor?

A device which detects or measures a physical property and records, indicates, or otherwise responds to it. Often a sensor detects one type of signal and outputs another type of signal!

Can you think of some examples of a sensor?

What might the limitations of a sensor be?

What is sound?

Sound is a vibration that propagates as an acoustic wave through a transmission medium such as a gas, liquid or solid.

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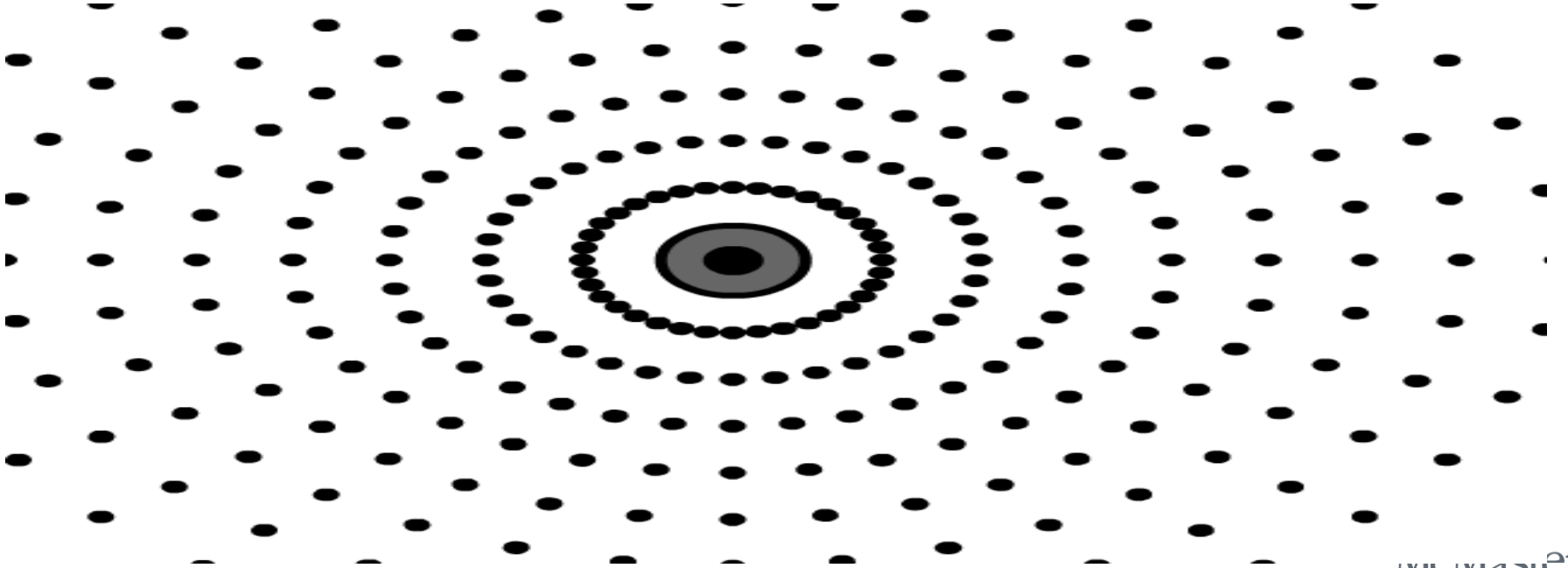

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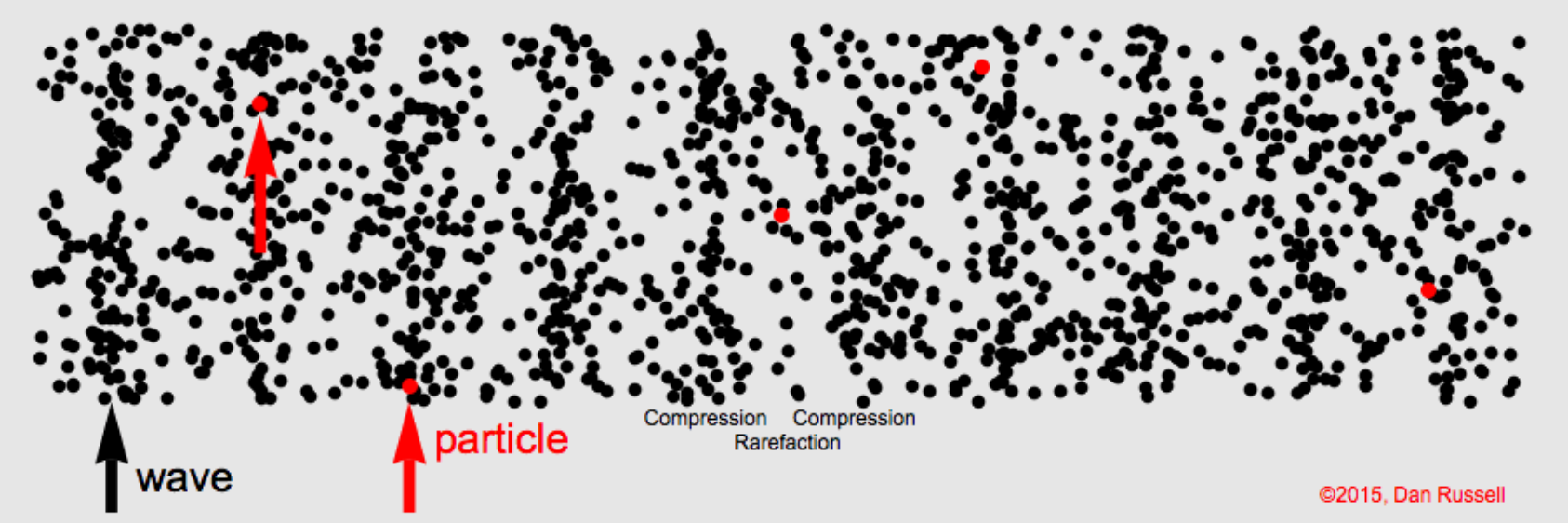
wave
particle
Compression
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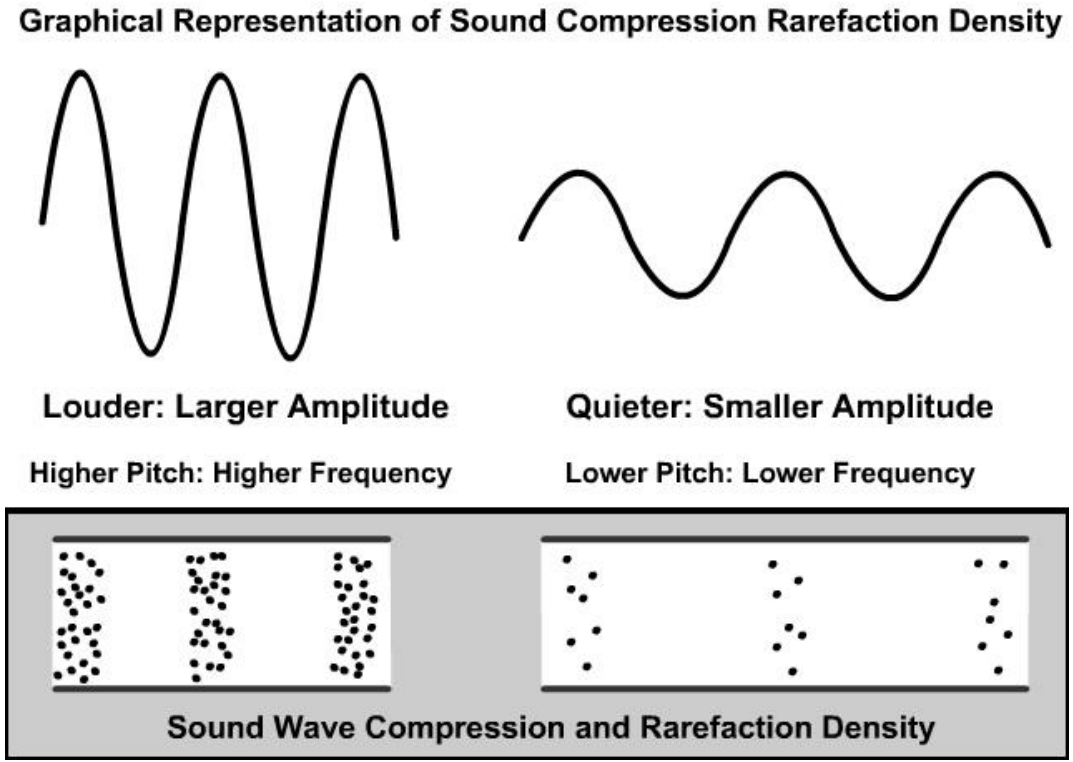
Compression
©2015, Dan Russell

What is sound?

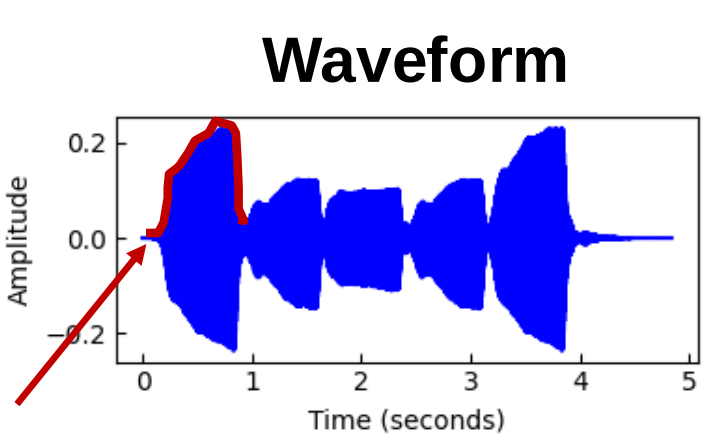


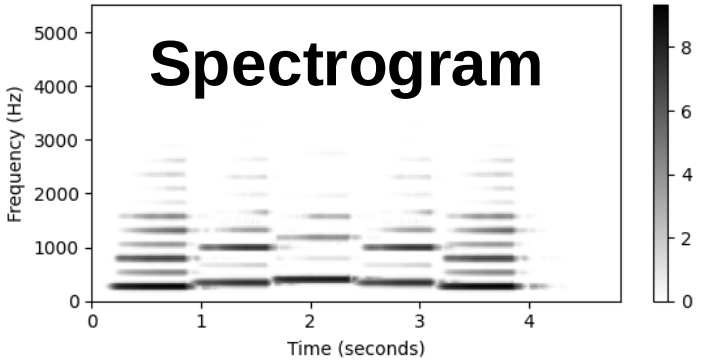
https://stickmanphysics.com/stickman-physics-home/unit-10-waves/sound-waves/

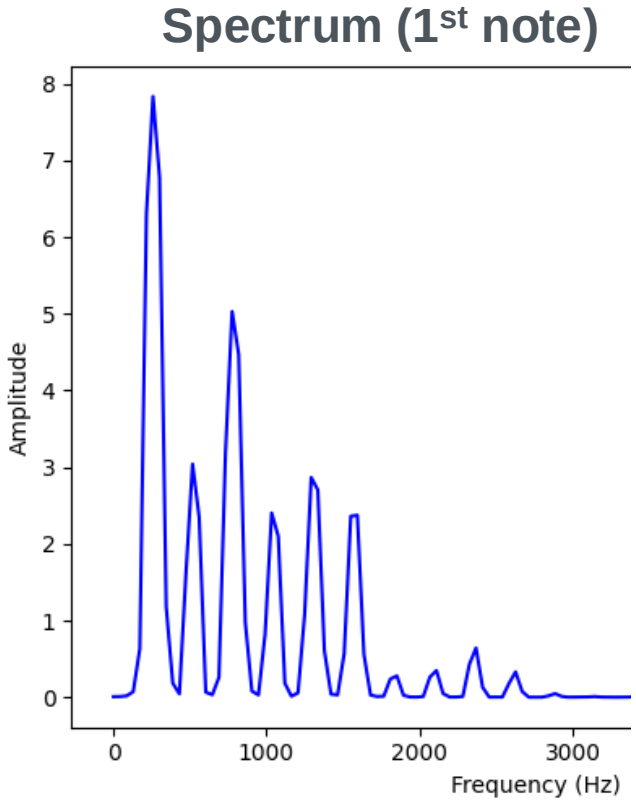
What is sound?

https://pudding.cool/2018/02/waveforms/

Many different ways to represent sound

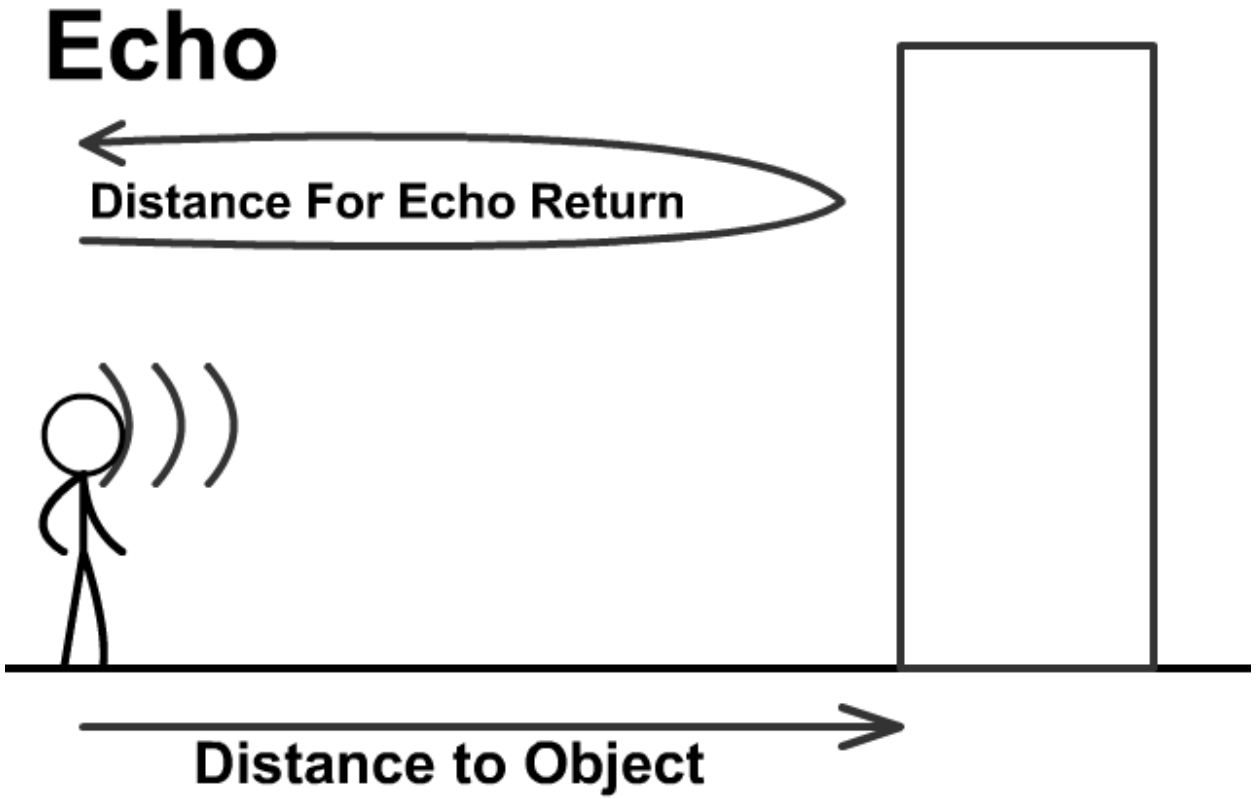






Many different ways to represent sound

https://musiclab.chromeexperiments.com/Spectrogram/



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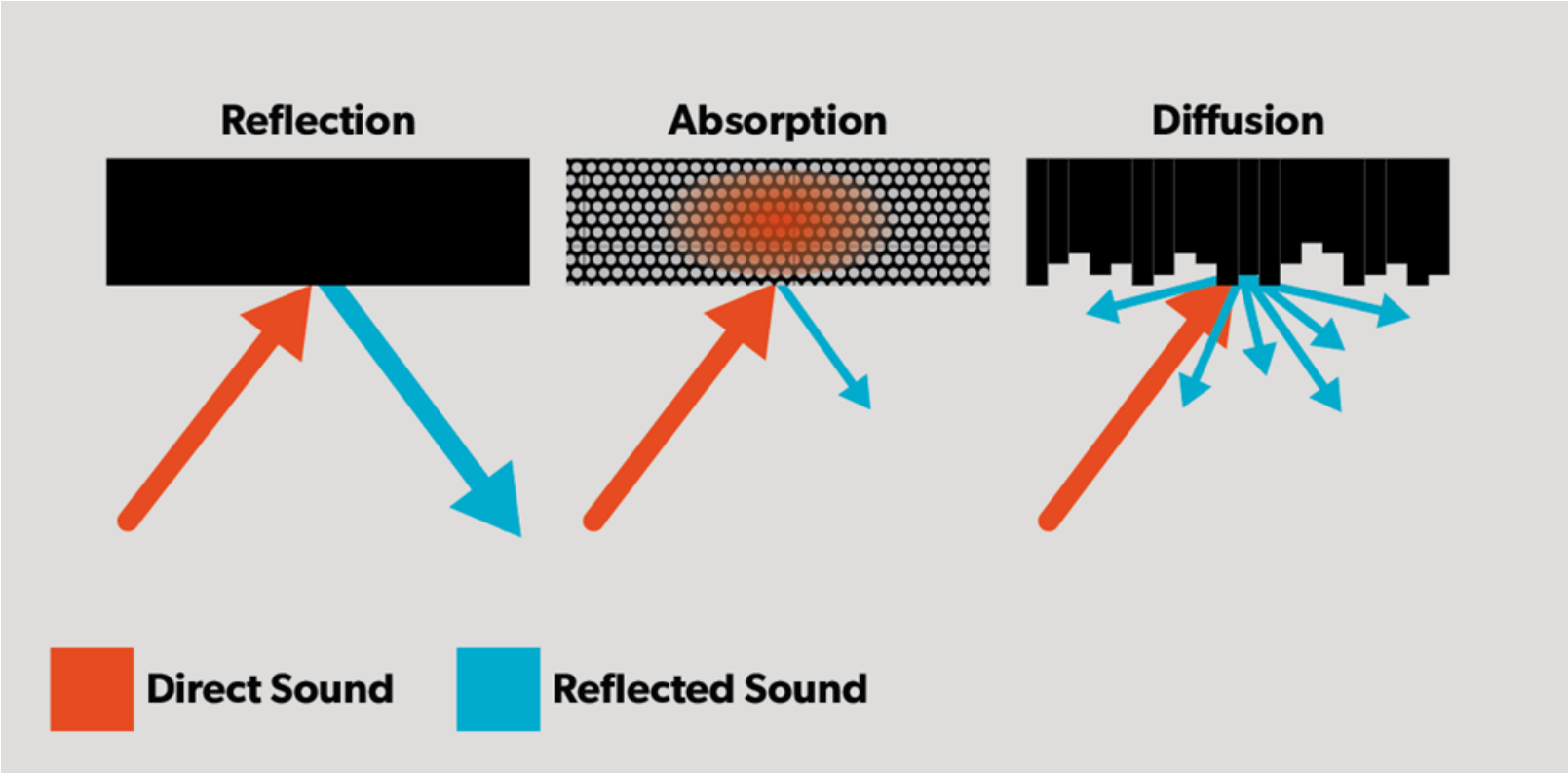


https://www.crutchfield.ca/S-HKoUfUFroVq/learn/room-acoustics-home-audio.html

LIVELab acoustics DEMO!!

What type of room do you think would be best for a music recording?

What about a performance?

But what is music…?

Oxford:

- vocal or instrumental sounds (or both) combined in such a way as to produce beauty of form, harmony, and expression of emotion.
- the written or printed signs representing vocal or instrumental sound.

Definition often incorporates cultural and psychological factors, making it subjective

What biological sensors are involved in our processing of music?

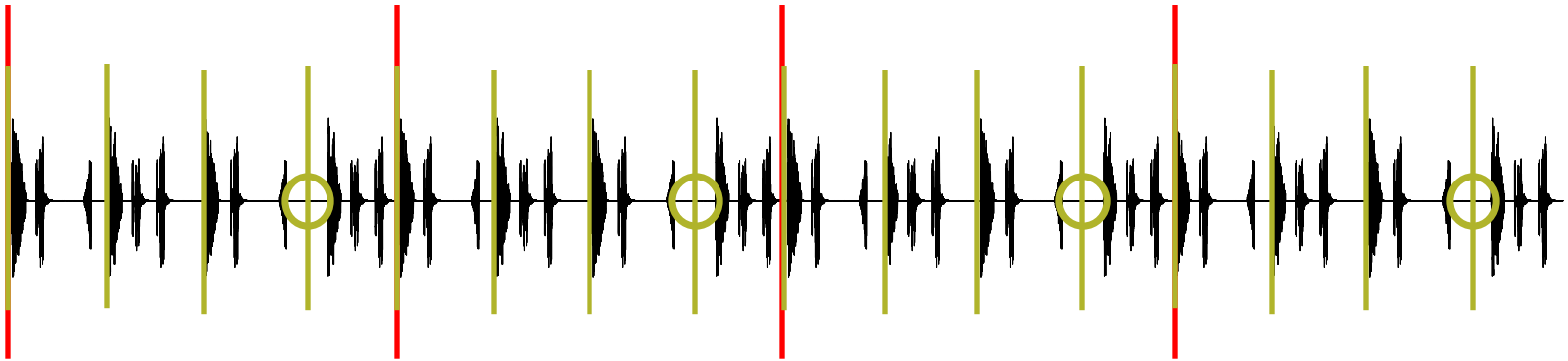
Does a signal recorded from a microphone represent what humans will perceive?

Clap along to the beat

Rhythm (acoustic): the pattern of timing and stress in the amplitude envelope of an acoustic sequence

Beat (psychological): most salient temporal periodicity

Meter (psychological): grouping(s) of perceived salient periodicities



Music != Sound

Amplitude (acoustic) != Loudness (psychological)

Frequency (acoustic) != Pitch (psychological)

https://www.youtube.com/watch?v=LVWTQcZbLgY&ab_channel=Vox

How can we understand the psychological effects of music?

ChatGPT 4o

- Self-report:
  - Questionnaires,
  - Interviews,
  - Experience Sampling
- Behavioural tests
- Observations of behaviours
- Physiological measures
  - Cardiac, gaze, brain, etc.

Why might we want to better understand connections between physiology and musical experience?

- To create more immersive music or musical experiences
- To develop new forms of musical expression, or opportunities for performer-audience interactions

Why might we want to better understand connections between physiology and musical experience?

To advocate for social change, justice, or solidarity

Why might we want to better understand connections between physiology and musical experience?

To sell things to people

- Music is multi-billion dollar industry.
  - Canada's music industry currently outpacing US

Why might we want to better understand connections between physiology and musical experience?

To foster social connection




To regulate emotion, attention, arousal



More generally..

Studies on music have the potential to change or influence existing theories on:

- Emotions
- Memory
- Creativity
- Time perception
- Auditory perception
- Motor control
- Nonverbal communication
- Social bonding

Plan for the rest of the day

Hands-on demo on how to analyze music signals
- Gentle introduction to Python

LUNCH

Lecture & Hands-on demo of Cardiac Monitoring

Lecture & Hands-on demo of Eye Tracking

Wrap Up & Final Discussion

Thank you!

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