EYH 2014
The Science of Sound workshop protocol

While girls are walking in, have live spectrogram playing on projector **(http://www.tomyumcorp.com/scope/)**
Put ambient music on through horizontal speaker

Introduction [15 -20 min]:

Jenélle

- Welcome, introductions
    - We introduce ourselves and say a sentence about our research
    - Girls say name, which is their favorite animal or subject in school
    - Explain that we'll go through introductions then they will switch between 3 modules.
- Ask girls what they think sound is
- Define sound as pressure waves/vibrations propagating through some medium such as air or water.

Matt/Cameron

- **Wave properties:** use slinky and stick to demonstrate wave properties such as frequency and amplitude
    - Ask volunteers to hold the stick with the slinky on it, try to move it back and forth fast and slow and talk about what each would sound like (low or high)
    - Show the slow motion video of violin string (Cameron has video)

Jenny

- **Marbles on wooden track demo**: demonstrate that the particles of the medium do not travel with the sound wave; the vibrations of particles in the transport the vibrations, while the average position of the particles over time does not change. This concept is intuitive with solids, less with gas and liquids. **Sound is faster than wind!**
- Place marbles tightly or loosely to represent states of matter, ask girls what will happen.
- [optional] bring their attention to horizontal speaker and ask how sound is going from speaker to their ears.
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Joel

- **Tuning fork demo:**
    - Girls will play with tuning forks
    - Ask girls which part of tuning fork is making the sound & how that part makes sound
    - Have girls describe differences between lengths of tuning forks
    - Have girls describe relationship between pitch, frequency, and length/thickness of forks.
    - Ask them to guess what the numbers on the tuning forks mean (frequency)

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Cedar

- Explain this is how scientists record and analyze sounds
- Explain spectrograms or ask girls to explain axes
- Draw reverse spectrograms
  - Need to download this software: http://www.uisoftware.com/SUPPORT/cust_support/download_form.php?demoBlurb=MSDEMO
- Have volunteers to show low and high frequency tuning fork on spectrogram [optional if out of time]
- Break girls into 3 groups.

Station 1 [15min, Jenélle and Cedar]: Sound production
Order of events: Explain sound production mechanisms, ask girls if they can think of an animal that does this, show animal video, ask girls to mimic production mechanism by using materials in front of them

- **Percussion**: Woodpeckers; toy drum
- **Strigilation:** Crickets; rhythmic frog, combs
- **Vocalization:** Birds; whoopee cushion
- **Pulsation:** Midshipman; provide midshipman with swim bladder exposed in jar; any speaker
- **Buckling:** Cicadas; sheets of metal, different sizes of mason jars with lids
- **Tremulation:** Spiders, elephants; putting tuning forks on table
- **Fanning:** Wings

Station 2 [15min; Cameron and Matt]: Sound perception

- **Speed of sound demo:** set up 2 microphones at a known distance apart, have girls snap into one microphone and display the time it took the sound to travel to the other. Ask girls what to do to get speed with this info.
  - **https://www.tomyumcorp.com/triggered-scope/**
- **Sound localization demo:** girls point while one person claps and moves around.
  - Are we better at telling azimuth or altitude?
  - How does our brain do this?
  - [Optional] use headphones to demonstrate computers can use time difference and amplitude to simulate sound coming from different locations.
- **Hearing range demo:** How high can you hear?
  - Have everyone raise their hands until they cannot hear the sound anymore, sweep from low to high frequency. Humans have a higher hearing range of ~20kHz.
  - Discuss sex and age differences in hearing range
- **Echolocation [optional]**
  - Could show slowed down version of bat echolocating call

  - Bats can compensate for the Doppler shift while they are flying by changing the frequency of their calls as well as determine the direction their prey is moving based on the prey's Doppler shift
    - **http://c21.phas.ubc.ca/article/bats-and-doppler-shift**
    - **http://science.howstuffworks.com/zoology/mammals/bat2.htm**

Station 3 [15min; Jenny and Joel]: Sound propagation and reverberation
Joel & Jenny

- **Tuning fork demo:** Put tuning forks on a variety of media and observe how sound travels. Best comparison is distance traveled between air and solids
  - Wooden stick, table, bottle with water, arm bone, cup with string

Jenny

- **Walk to reverberant stairway,** ask girls why they think music sounds different in different environments, such as in a church vs. shower vs. bedroom vs. hallway
- **In stairway,** discuss what is happening to sound in this environment: reflection, refraction, attenuation
  - Discuss what is happening to the sound, why hall way is so good for echoes (low attenuation, lots of smooth surfaces to reflect sound)
  - Pop a balloon, record on spectrogram. Can you see the echo? What has changed from the original sound?

Joel

- **Anechoic chamber demo:**
  - What is happening to the sound in the chamber? Little reflection of sound
  - Record balloon popping on spectrogram, compare to echo hallway recording, discuss differences

Video/Audio:

- Midshipman vocalizations (Jenny has)
- Spider tremulation (Jenélle has)
- Woodpeckers (Jenélle has)
- Crickets (Jenélle has)
- Cicadas (Jenélle has)
- Human vocal chord (optional)
- Bat echolocating sounds (optional)
- slow motion video of violin string (Cameron has)

Materials we have ready access to:

- Vacuum jar + sound source (Intro; Cameron)
- Midshipman in jar (Production station; Bass lab)
- Mason jars (Production station; Joel)

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- 2 microphones (Perception station; Bass lab)
- Headphones (Perception station)
- Horizontal and regular speakers
- Combs
- Meter stick or tape measure

Materials bought:

- Whoopee cushion
- Vacuum pump
- Toy drum
- Balloons