Sound localisation: identifying threats and the cocktail party effect

1. Why does it matter?
   - You need two ears to localise a sound and help you understand conversation in a noisy environment – **cocktail party effect**
   - Helped our ancestors find a mate, catch prey and escape predators!

2. How do we process sound?
   Sound energy is converted to electrical impulses by hair cells in each ear, and sent through the auditory nerve to the brain.
   
   So without a brain we cannot hear!
   
   Sound localisation requires comparison of sound information from both ears, and the first place this happens is the …

3. Mechanisms of sound localisation
   The brain can determine the location of a sound source via two main mechanisms:
   1. Interaural time differences (ITDs)
   2. Interaural level differences (ILDS)

   The LSO is the first place in the brain to detect differences in sound volume (ILDS).

4. There are two neuron types in the LSO
   - **Type 1 = Principal neurons**
   - **Type 2 = Efferent neurons (LOC)**
   
   Using whole cell patch clamping I can record the different electrical impulses called action potentials

   **Single spiking principal cell**
   - 30mV
   - 0.1nA
   - 0.5nA
   - 0.9nA
   - 1.3nA

   **Multi-spiking principal cell**
   - 30mV
   - 0.2nA
   - 0.3nA
   - 0.6nA
   - 1.3nA

   **LOC Cell**
   - 30mV
   - 0.1nA
   - 0.3nA
   - 0.6nA
   - 1.3nA

5. Loud sounds can also damage our brains, as well as our ears
   LSO principal neurons locate sound by receiving impulses from both ears **at the same time.**

   **Left ear**
   - Inhibition
   - Excitation
   - -40 mV

   **Right ear**
   - Inhibition
   - Excitation
   - -70 mV

   After noise overexposure, the excitatory impulse is **slowed down,** which **disrupts sound localisation.**

Conclusion: Sound localisation is achieved by comparing differences in the sound between two ears. The part of the brain which first extracts this information is called the superior olivary complex. It requires precise timing of excitatory and inhibitory inputs from both ears, to accurately locate sounds. My lab has found that exposure to loud sound changes the brain, by slowing the excitatory component. This change disrupts sound localisation, and is a brain problem, not an ear problem. This means, for example, hearing conversation at a party becomes more difficult.