HST 722
Descending Systems
Chris Brown

Ascending System: Solid
Descending System: Dashed

From Slama, unpublished
Huge Cortico-Thalamic Projection

Injection of HRP in MGB (thalamus)

Cortical Labeling:

Terminals of thalamo-cortical axons in layer IV (Ascending System)

Cell bodies of cortico-thalamic neurons in layers VI and Vb (Descending System)

From Peterson and Winer, 1993
Cortical Descending Projections to cochlear nucleus neurons that project to inferior colliculus - studied with multiple tracers

**Injection Site**

- Cortex (to label axons & terminals of descending system)
- Inferior Colliculus (to label cell bodies of the ascending system)

**Tracer**

- contra: Fast Blue
- ipsi: fluorescein dextran (green)

From Schofield and Coomes (2005)
Descending Projections of Auditory Cortex

From Winer, 2006
Methods for studying descending systems:

1. Anatomical tracings
2. Activate - electrical stimulation, sound
3. Inactivation - lesion, temporary block (cooling), gene deletion
4. Record responses
Electrical Stimulation of Cortex changes frequency responses of neurons in the Inferior Colliculus
Olivocochlear (OC) Neurons are a Descending System that Projects from the Olive (superior olivary complex) to the Cochlea

<table>
<thead>
<tr>
<th>Origin</th>
<th>Lateral (L) OC Neurons</th>
<th>Medial (M)OC neurons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axon caliber</td>
<td>lateral regions near LSO thin</td>
<td>medial regions near MSO thick</td>
</tr>
<tr>
<td>Peripheral Target</td>
<td>auditory-nerve dendrites</td>
<td>outer hair cells</td>
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</table>
MOC Efferent Fibers Terminate on Outer Hair Cells

MOC Efferent Fibers usually decrease OAEs and increase Cochlear Microphonic (CM). Afferent Fiber Responses are usually decreased (including compound action potential, CAP). Alpha 9/10 cholinergic receptors are present on OHCs.
Activation of MOC Neurons Shifts Rate-Level Functions

This shift adjusts the dynamic range of nerve fibers, enabling better signaling at higher levels

Other MOC Functions:
1) Reduce Masking
2) Protection from overstimulation
3) Selective Attention
Noise Masking Demonstration

“You will hear a 2000-Hz tone in 10 decreasing steps of 5 decibels. Count how many steps you can hear.”

“Now the signal is masked with broadband noise.”

audio demonstration from Houtsma et al., 1987
OC Activation Reduces Masking in Auditory-Nerve Response

A. Noise Off

Auditory-Nerve Response

Acoustic Stimuli

Tone Burst

B. Noise On

C. Noise On + OC Activation
Behavioral experiments suggest tones in noisy backgrounds become harder to detect after lesion of the OC system

From May and McQuone, 1995
Recordings from single MOC neurons:
Ipsi vs. Contra Response and locations of Neurons
Recordings from single MOC Neurons: Sharp Frequency Tuning Tonotopic Cochlear Frequency Map

Brown, unpublished
What is the pathway of the MOC Reflex?
PVCN Lesions Interrupt the MOC Reflex

From Brown et al., 2003
Interneurons are probably PVCN Choppers
Plasticity of OC System?
MOC Postsynaptic Target in Cochlear Nucleus

From Benson & Brown, 1990
Auditory Brainstem Reflexes

1. MOC Reflex
2. Middle Ear Muscle Reflex
3. Acoustic Startle Reflex

(all are under descending control of higher centers)