脳科学入門

メンフクロウー
デンキウオー顔細胞

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Knudsen EI, Konishi M, Pettigrew JD (1977)
Auditory Space Map in the Inferior Colliculus: a Centrally Synthesized Map

Knudsen EI, Konishi M (1978)

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Owls Use ITD for Localizing the Azimuth and IID (ILD) for Localizing Elevation of Sound

- **Interaural Time Difference (ITD)** 両耳間時差
  - Transient Cues (Onset/Offset Difference)
  - Continuous Cues (Phase Difference)
- **Interaural Intensity (Level) Difference (IID or ILD)** 両耳間強度差
- **Spectral Cues** 周波数差がかり

<table>
<thead>
<tr>
<th>位置</th>
<th>両耳間時差 (ITD)</th>
<th>両耳間強度差 (IID)</th>
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<tbody>
<tr>
<td>フクロウ</td>
<td>ITD</td>
<td>IID</td>
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<tr>
<td>ヒト</td>
<td>ITD (低周波)</td>
<td>IID (高周波)</td>
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水平位置 垂直位置

水平位置 垂直位置
Jeffress’s Model (1948)
1. Delay Line
2. Coincidence Detection


Structure of Nucleus Magnocellularis and Nucleus Laminaris


Memo: Winding route
Axonal caliber
Internodal distance
Neural Algorithm and Hardware Implementation for Computation of Sound Location in Barn Owls

Brain Areas

- External nucleus interior colliculus
- Lateral shell of central nucleus interior colliculus
- Core of central nucleus interior colliculus
- VN
- Nucleus laminaris
- Nucleus magnocellularis
- Inner ear

Neural Algorithm

- Formation of a map of auditory space
- Emergence of phase antecity
- Convergence of different frequency channels
- Convergence of time and intensity pathways
- Emergence of neural tuning to intensity differences
- Sharpening of ITD selectivity
- GABAergic Inhibition
- First stage in encoding interaural intensity differences (H V.L)

- Detection and encoding of interaural time differences
- Delay Line of NM Fibers and Coincidence Detection by NL Cells
- Bombardment by Converging NM Fibers
- Separation of time and intensity
- Terminal Structures of 8th Nerve
- Biophysical Membrane Properties of NM and NA
- Encoding of frequency, intensity, and time
- Biophysics of Hair Cells, Structure of Basilar Membrane


情報処理機械を理解するのに必要な三つの水準

計算理論（computational theory）
計算の目的は何か、なぜそれが適切なのか、そしてその実行可能な方略の論理は何か。

表現とアルゴリズム（representation and algorithm）
この計算理論はどのようにして実現することができるか、とくに入力と出力の表現は何か、そして変換のためのアルゴリズムは何か。

ハードウェアによる実現（hardware implementation）
表現とアルゴリズムがいかに物理的に実現されるか。

Weakly Electric Fish vs Barn Owl

Weakly Electric Fish Produces an Electric Field to Locate Objects

\[ Df = f_{\text{neighbor}} - f_{\text{own}} \]

(Jamming avoidance response, JAR)

Fish uses no internal reference

Jammed Electric Signals Accompany Modulation in Amplitude and Phase
The Neural Pathway for JAR

- torus semicircularis
- electrosensory lateral line lobe
- nucleus electrosensorius
- prepacemaker nucleus
- sublemniscal prepacemaker nucleus
- from electroreceptors to electric organ
- to pacemaker nucleus


Konorski’s “Gnostic Unit” 認識細胞仮説
In order to help you process faces efficiently, your brain stores lots of information about faces. Even babies are born knowing basic information about faces:
Prosopagnosia

Other species

• Do these sheep all look the same to you?
average East Asian male
average European male
East Asian morphing... European

caricature caricature

Visual cortex

human

monkey
Some neurons in the monkey brain respond preferentially to face images. They are often called “Face neurons” or “Face responsive neurons”.

Face-responsive neurons are found in the temporal visual cortex and the amygdala. Some neurons in the temporal cortex and the amygdala are selective for facial expression (Sugase et al., 1999; Gothard et al., 2006).
“Sydney Opera House” cell in the left anterior hippocampus

“Jennifer Aniston” cell in the left posterior hippocampus

(Quian Quiroga et al., Nature, 2005)
Do face responsive neurons contribute to face perception and recognition?

How can address this question experimentally?
Evidence for a role of face responsive neurons in perception of face

Binocular flash experiment

David Scheinberg, Nikos Logothetis
Recording from medial temporal lobe in a patient

Sample stimuli

(Kreiman et al., Nat Neurosci, 2000)

Some face-responsive neurons appear to be selective for a particular face: "President Clinton cell"

(Kreiman et al., Nat Neurosci, 2000)
Binocular rivalry test for face-responsive neuron in the human amygdala

(Kreiman et al., PNAS, 2002)