MiCRAM

Midbrain Computational and Robotic Auditory Model for focussed hearing

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Aims

This research involves the collaborative development of a biologically plausible model of auditory processing at the level of the inferior colliculus (IC) and its implementation on a biomimetic robot

This approach potentially clarifies the roles of the multiple spectral and temporal representations that are present at the level of the IC

We will investigate how representations of sounds interact with auditory processing at that level to focus attention and select sound sources

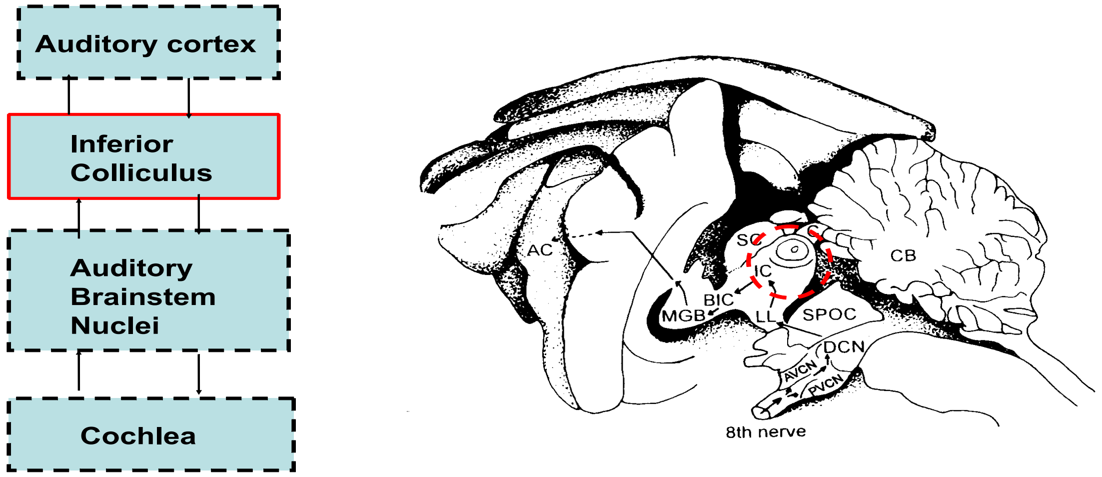

Fig 1 Basic input /output architecture and midbrain anatomy of IC

The Role of the IC

The IC is the main midbrain nucleus in the auditory pathway located at the head of the brainstem

It is a centre of convergence for parallel pathways that diverge from the cochlear nucleus.

The IC plays a strategic role in the processing of auditory information.

Information necessary for fundamental aspects of auditory processing (localization, spectral and temporal structure) are extracted by the IC before the thalamo-cortical level.

Approach

The physiological and anatomical data exist to simulate the auditory midbrain using computational modeling techniques.

The project involves an interdisciplinary collaboration between experimental neuroscientists, computational modelers and robotics scientists.

We will use GENESIS (GEneral NEural SImulation System) to model the structural and biophysical properties of IC neurons as defined by anatomy (Fig 2) and intracellular recordings (Fig 3).

Biologically realistic simulations in the form of spiking compartmental models will be used to develop a systems- level representation of the IC as a set of modules centered on different frequency bands.

These modules will be combined in parallel across the frequency range of hearing.

The outputs of the model will be used as inputs to the behaviour of a biomimetic robot.

Object-oriented databases will be used to store and access data from experimental studies

We will document our findings on the web (in the form of a wiki and databases), and provide visualization software to make the anatomical and physiological data mined from the literature publicly available as a resource.

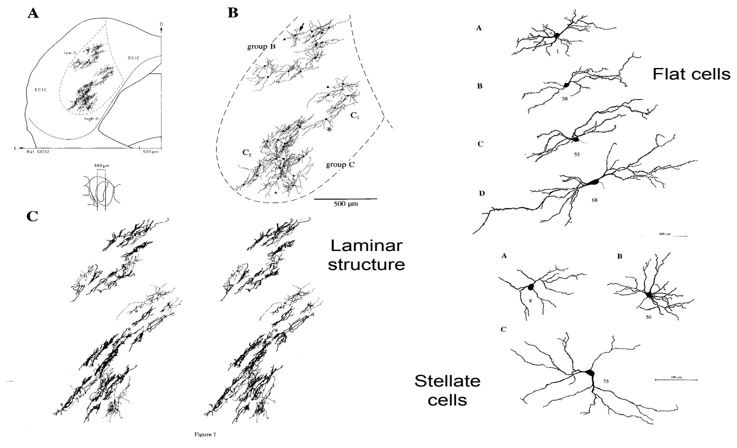

Fig 2 Laminar organisation of IC (left) and examples of flat and stellate neurons of which the laminae are composed (right). (Malmierca et al 1993)

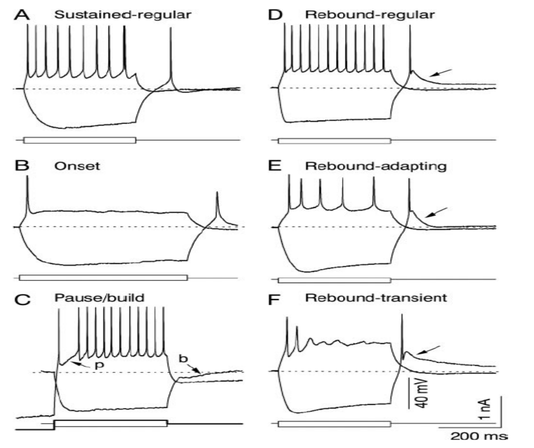

Fig 3 Firing patterns and voltage responses of IC neurons recorded intracellularly to depolarising and hyperpolarising current injection (Shivaramakrishnan and Oliver 2001)

Where does the robot fit in?

The IC modelling will provide representations of the auditory scene, and the robot will use those to maintain an environmental model to support behavioural choices.

The robot is *situated*—it experiences much the same environmental constraints as an animal would, and so provides insight into the roles of specific sensory cues as represented at the IC.

In particular, this application of robotics in a real environment will allow us to understood how separate sound sources might be distinguished, assigned to sound streams, and localized.

It will also allow us to gain insight into the role of attention in selecting and disambiguating sound sources.

Robotics allows us to test neuroscience - based models by implementing and grounding them in a real world platform to test current theories associated with the IC

Fig 4 Example robot platform for implementing and testing the computational model

We will be grateful for data contributions to the model

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