Convergence of a putative polarization vision pathway with PDH-immunoreactive neurons in the medulla of the honeybee

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Introduction

Honeybees are well known for their ability to navigate using a time-compensated sky compass. While sky compass orientation in honeybees has been extensively studied at the behavioral level, virtually nothing is known about the underlying neuronal mechanisms. As a first step to find possible neuronal substrates for time compensation in the sky compass system, we aimed to morphologically identify convergence sites of neurons associated with the circadian clock and neurons carrying polarization information.

Neurons of putative polarization vision pathway

The anterior optic tubercle is connected to the optic lobe via the anterior optic tract (AOT), to the lateral accessory lobe via the AOT-LAL tract (TALT), and to the contralateral anterior optic tubercle via the intertubercular tract (ITT).

Long visual fibres projected from the dorsal rim area of the eye to the dorsal area of the posterior outer medulla.

Line tangential neurons connected the projection area of long visual fibres in the dorsal medulla to the lower subunit of the anterior optic tubercle. Fibres ran in a narrow layer of the medulla.

TtAL1 neurons projected from the anterior optic tubercle to the lateral accessory lobe and had large glomeral terminations of up to 8 µm diameter.

A small number of neurons connected the lower subunits of the anterior optic tubercles of both brain hemispheres via the intertubercular tract. Ramifications of each of these neurons were restricted to certain areas within the lower AOT subunit. Neurons had large diameters of up to 4 µm as they ran through the upper subunit of the anterior optic tubercle.

Methods

Honeybees were obtained from the bee institute Kirchchain, Germany, where they were kept in a flight room.

Glass micropipettes were dipped into petroleum jelly, then into 3000 MW dextran conjugated to Texas Red. Pipettes were manually inserted into the lower subunit of the anterior optic tubercle of worker bees and animals were kept overnight in a moist chamber at 4°C to allow tracer uptake and diffusion. Brains were dissected out of the head capsule, and fixed overnight at 4°C in Zamboni’s fixative.

PDH-immunoreactive neurons were labelled with a rabbit anti serum against crustacean p-pigment dispersing hormone (kindly provided by Dr. H. Dircksen) at a dilution of 1:1000. Neurons were labelled with a monoclonal mouse antibody against the presynaptic vesicle protein synapsin I (SYNP1, kindly provided by Dr. E. Buchner).

The primary antibodies were detected with fluorophore-coupled secondary antibodies raised in goat: goat-anti-rabbit conjugated to cy2 (1:200), goat-anti-mouse conjugated to cy5 (1:200). Brains were scanned with a confocal laser scanning microscope (Leica TCS SP5). Confocal stacks were then processed with Aperio 5.4.

PDH-ir/putative polarization vision pathway

PDH-ir fibres ran in the same layer as line tangential neurons of the TtAL1 neurons in the lateral accessory lobe. No PDH-ir was detected near the terminals of TtAL1 neurons in the lateral accessory lobe.

The anterior optic tubercle was free of PDH-ir.

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Summary/Conclusions

- We traced a putative polarization vision pathway in the brain of the honeybee (Apis mellifera) by injection of dextran tracers.
- Neurons of the pathway branched in the dorsal medulla, the lower subunit of the anterior optic tubercle and the lateral accessory lobe.
- In a narrow layer of the medulla, we found neurons of the putative polarization vision pathway in close proximity to PDH-ir varicosities.
- Possibly, PDH-ir neurons feed a time signal into the polarization vision pathway for time-compensation.

See this poster again at: http://uni-marburg.de/3ITrRb