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How modulation of resting time affects collective decision making in honeybees

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Groups of young honeybees aggregate at their preferred temperature of 36 °C in a temperature arena, whereas with single bees only a few stay there. In gradients with an optimum (36 °C) and a sub-optimum (32 °C) groups choose their preferred temperature collaboratively [1]. We interfered with this decision making by confining bees in a cage in the sub-optimum as a social cue [2]. In all experiments without caged bees groups of free bees aggregated at 36 °C. With caged bees there, they selected 32 °C in 50% of the experiments .

- Material and Methods-

A temperature gradient was generated by heat lamps with an optimum at 36 °C and a sub-optimum at 32 °C in a circular arena (r = 30 cm) (Fig.1a,b). We analysed records of experiments wih and without social cues. A cage with 5 bees was situated in the sub-optimum and an empty one as a control in the optimum (Abb.1b). We investigated different group sizes (6, 24, 64 and 128 bees in experiments without and 24 bees in experiments with caged bees). We measured the resting time of randomly choosen bees in the different temperatures zones (optimum, outer zone, sub-optimum; see Fig. 1a,b – black lines) after contact with free bees, the wall, the empty cage or the cage with bees. In total 985 contacts were measured. It was found in previous studies that these resting times after contacts are modulated by the local temperature and facilitate collective decision making concerning aggregation spots [3].

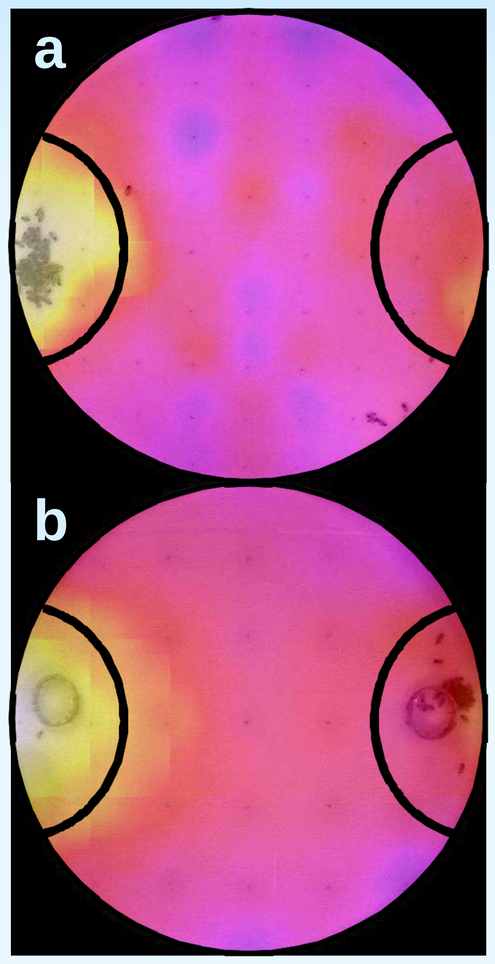

Fig. 1: Examples of experiments

Pictures of two trials after 30 min: a) without and b) with caged bees. Black lines indicate the defined temperature zones for :
Left - Optimum with 36 °C;
Right - Sub-optimum with 32 °C.

Resting-time after contact with and without social cues

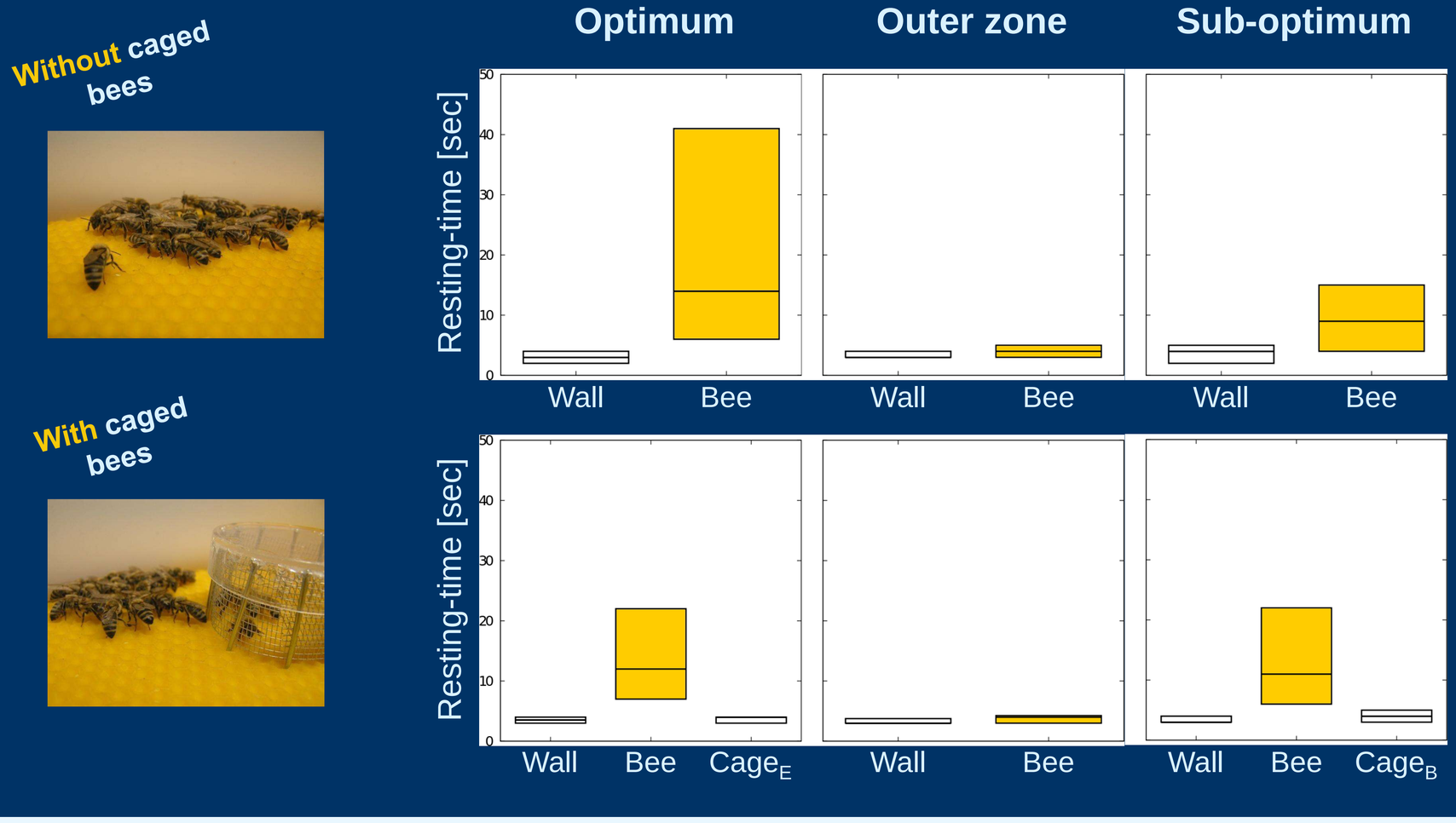

Fig. 2: Results of experiments (a) without social cue and (b) with caged bees at 32 °C.

Median and quartiles of the waiting-time (in seconds) after contact of a bee with another bee (yellow boxes), the wall, an empty cage (Cage$_E$) or a cage with bees (Cage$_B$) in the different temperature zones are shown :

Left - Optimum (36 °C);
Mid - Outer zone;
Right - Sub-optimum (32 °C).

Group sizes: a) 6, 24, 64, 128 bees;
b) 24 bees

- Results-

The resting-time of a bee after contact with another free bee at 32 °C and 36 °C is longer than after a contact with the wall, a cage or caged bees (Fig.2a,b; U-Test $p<0,05$). The bees show significant differences in the resting-time between the two optima after contact with another bee when no caged bees are present (Fig.2a; U-Test $p<0,05$). In contrast we could not find this difference in experiments with caged bees (Fig.2b; U-Test $p>0,05$). Comparison of experiments with and without caged bees and a group size of 24 bees showed no difference in the resting time after contact with another free bee in the suboptimum compared to the optimum (U-Test $p>0,05$).

- Discussion-

We showed that the resting-time of bees depends on the local temperature when a free bee meets another free bee, but not after contact with a wall or a cage. Caged bees adjust the waiting-time in the sub-optimum after contact with a free bee to the waiting time in the optimum. In doing so, the waiting-time of the free bees does not rise after contact with caged bees. This may explain why bees choose the sub-optimum in 50% of the trials when caged bees are present. However, one would expect a difference in the waiting-time in the sub-optimum between experiments with and without caged bees. Because this is not the case, the waiting-time of the bees after a bee-to-bee contact cannot be the only factor responsible for the influence of caged bees on the collective decision making. We assume that additional local cues like pheromones or vibration lead to an increasing number of bees aggregating in the sub-optimum.

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- Acknowledgements -

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