Robustness of group decisions in honeybees

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Introduction

Freshly emerged honeybees show thermotaxis. Their temperature optimum is near 36°C [1]. The mean temperature in the broadest area is 36°C (Fig.1b). To test the robustness of group decisions as described in [2] we investigated the behaviour of single bees and groups of bees with different thermotactic abilities.

Material and Methods

Experiments were performed in a temperature arena [2]. The radius of the arena was 15 cm. We fixed the bees and then we amputated one or both antennae (Fig.2), to be sure that no temperature sensors were left [1]. With these bees we wanted to investigate the robustness of the cooperative thermotaxis as described in [2]. We defined a target area below the heating lamp (36°C). The size of the target area was 25% of the arena surface. The experiments lasted 30 minutes. We conducted experiments with single bees (either not manipulated or manipulated; N=8) homogenous groups of bees (either 15 AA or 15 AA': A-A bees; N=6; see Tab. 1) and heterogenous groups of bees (not manipulated bees and an amount of 33%, 53% and 80% manipulated bees; N=6).

Results

Single bees (AA, AA': A-A): about 70% of the AA-bees and AA’-bees are able to reach the target area. Only 30% of the A-A’-bees reached the target area. This proportion is not different to the predicted proportion for spatially uniform distributions of bees in the arena (Fig.3). Our results show that more of the AA-bees and the AA' - bees found the target area than the A-A’-bees (Chi-Square-Test: p<0.001).

Homogenous groups: more than 90% of the not manipulated and more than 70% of the AA’-bees reached the target area. Only 10% of the A-A reached the target area (Fig.4). AA-groups have a higher success rate to find the target area, than AA’-groups. AA’-groups have a higher success rate than A-A’-bees. (Mann-Whitney U-Test: p>0.05).

Heterogenous groups (consisting of not manipulated and manipulated bees, which show a considerably different thermal and social behaviour): In presence of manipulated bees, groups of not manipulated bees are able to reach the target area. The amount of manipulated bees has no significant influence on the success rate of the not manipulated bees. More than 70% of the not manipulated bees reach the target area even if the amount of manipulated bees increases (Fig.5: Kruskal-Wallis-Test p=0.48; n.s.).

Discussion

In a temperature gradient of 30°C to 36°C and an arena size of r=15 cm, single bees have a high success rate to reach the target area. Groups of bees have a higher success rate to reach the target area than single bees. Single AA’-bees and groups of AA’-bees are able to reach the target area. It is possible that the receptors of the one remaining antenna are enough to perform this behaviour. In heterogeneous groups of bees consisting of manipulated and not manipulated bees, the not manipulated bees show a robust group behaviour. They are able to find the target area and stay there. This is an important adaptation because young honeybees should quickly be taken to the broodarea to take over the cell cleaning task and to build clusters to isolate the brood against cooling. They should not let themselves be disturbed by other bees engaged in other jobs within the broodarea, like pollenster or nurses. With our experimental set-up we were able to investigate the robustness of group decisions under varying disturbance conditions.

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