Honeybees flying over a mirror crash irremediably

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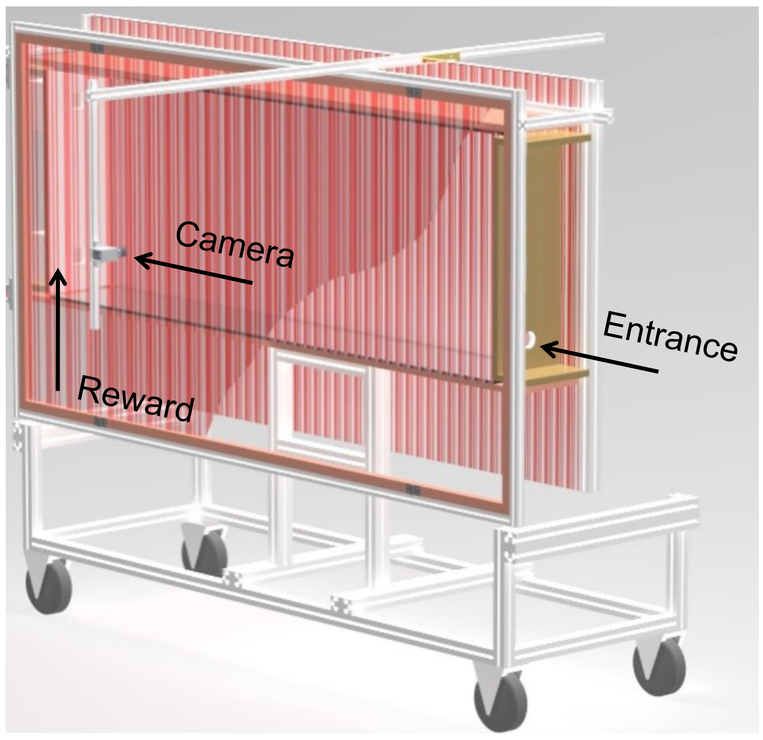
Aim: To investigate if the ventral optic flow is crucial to control honeybees' altitude (*Apis mellifera*)

Experimental set-up

- Flight tunnel: 25x71x200 cm
- 1.3 first meters recorded
- 100Hz DALSA Genie HM640
- 4 groups of honeybees
- 15 honeybees per group
- 5 distinct optical contexts

Scan me

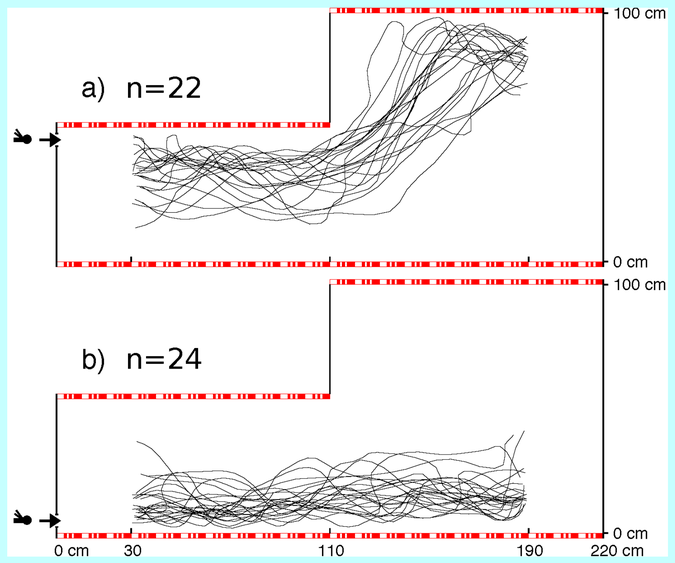


"Preferred optic flow pattern" Hypothesis

- Honeybees follow surface in tunnel, such as the floor (or the ceiling).
- Honeybees adjust their altitude to restore a ventral (or dorsal) optic flow set-point.
- A ventral (or a dorsal) optic flow pattern seems to be learned by honeybees during the training session.

See references [1-5]

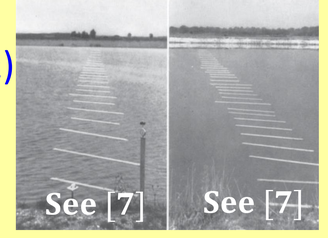
Are still honeybees able to fly without ventral optic flow?



See Portelli, Serres & Ruffier (2017) [3]

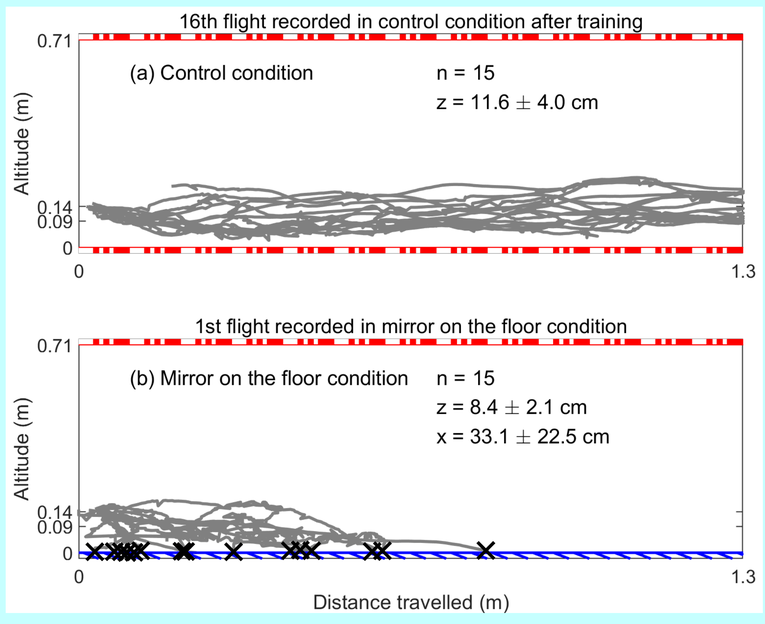
Results: Without ventral optic flow, honeybees crash irremediably on the floor

- A pair of mirrors on the floor and ceiling can be independently uncovered to suppress any ventral/dorsal optic flow.
- The double mirror condition reproduces the visual uncoupling condition in connection with the work of the Duchon & Warren (2002) [6]. The honeybee's visual informational support can be therefore uncorrelated between the horizontal and the vertical planes.
- Our study reproduces the seminal experiment of Heran & Lindauer (1963) [7]. They trained honeybees to fly above a water surface. When the water surface was provided a visual contrast, honeybees were able to cross the lake. Otherwise, they drowned.

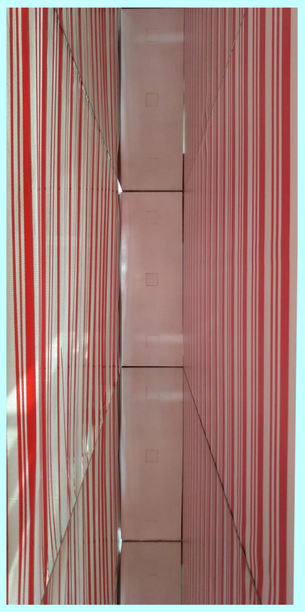


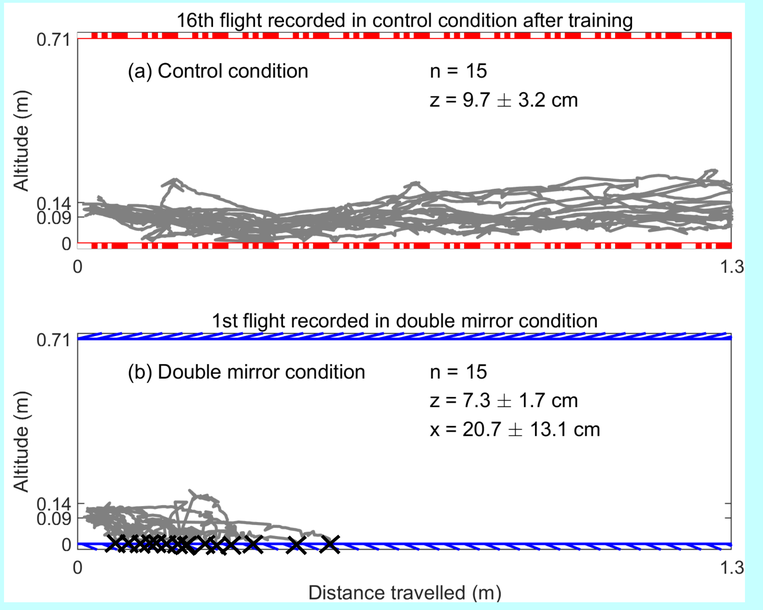
Control experiment

Mirror on the floor



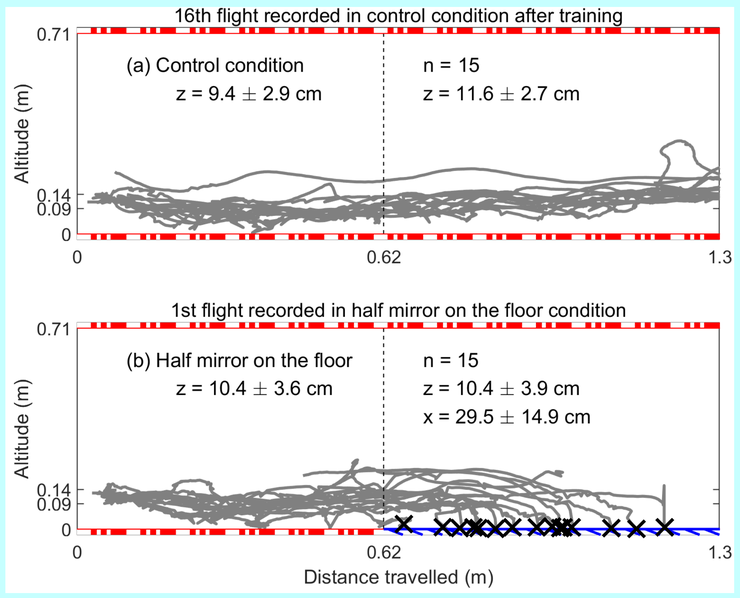
Double mirror





Control experiment

Half mirror on the floor



Mirror on the ceiling

[1] N. Franceschini, F. Ruffier, J. Serres (2007), *Current Biology* 17 (4), 329-335
[2] M.V. Srinivasan (2011), *Current Opinion in Neurobiology* (24) 4, 535-543
[3] G. Portelli, J.R. Serres and F. Ruffier (2017), *Scientific Reports* (7) 9231
[4] J.R. Serres and F. Ruffier (2017), *Arthropod Structure & Development* (46) 5, 703-717
[5] J. Lecoeur, M. Dacke, D. Floreano and E. Baird (2019), *Scientific Reports* (9) 7707
[6] A.P. Duchon and W.H. Warren (2002), *Psychological Sciences* (13) 3, 272-278
[7] H. Heran and M. Lindauer (1963), *Zeitschrift für vergleichende Physiologie*, 47(1), 39-55.

Conclusion

- Half low mirror condition reveals honeybees do not directly crash into the down mirror, but go on to fly before crashing.
- Honeybees do not rely on ventral optic flow directly at right angle to fly over the floor, but instead, rely on the overall ventral optic flow pattern.
- Lateral visual inputs alone do not allow honeybees to control their altitude. Dorsal manipulations alone do not affect honeybees' flight.