Collision Avoidance in Flying Locusts

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Introduction:

For many insects flight is essential for survival. Important components of survival that rely on flight include mating strategies, dispersal, and foraging. For example successful flight requires the ability to avoid collisions with looming obstacles in the flight path i.e. stationary objects, conspecifics and potential predators. Earlier studies described putative behavioural strategies that underlie collision avoidance (Gray *et al.* 2001) as well as the neural mechanisms of collision detection (Gabbiani *et al.* 1999). Neurons exist which are maximally sensitive to the types of visual stimuli produced by looming objects yet there is no direct evidence linking neural activity to flight manoeuvres. A better understanding of the importance of insect flight will come from investigating how insects: A) distinguish between threatening and non-threatening objects and B) produce adaptive behaviours in response to each type of object.

Objective:

To examine the underlying neural mechanism(s) of visually-evoked obstacle avoidance behaviour in flying locusts.

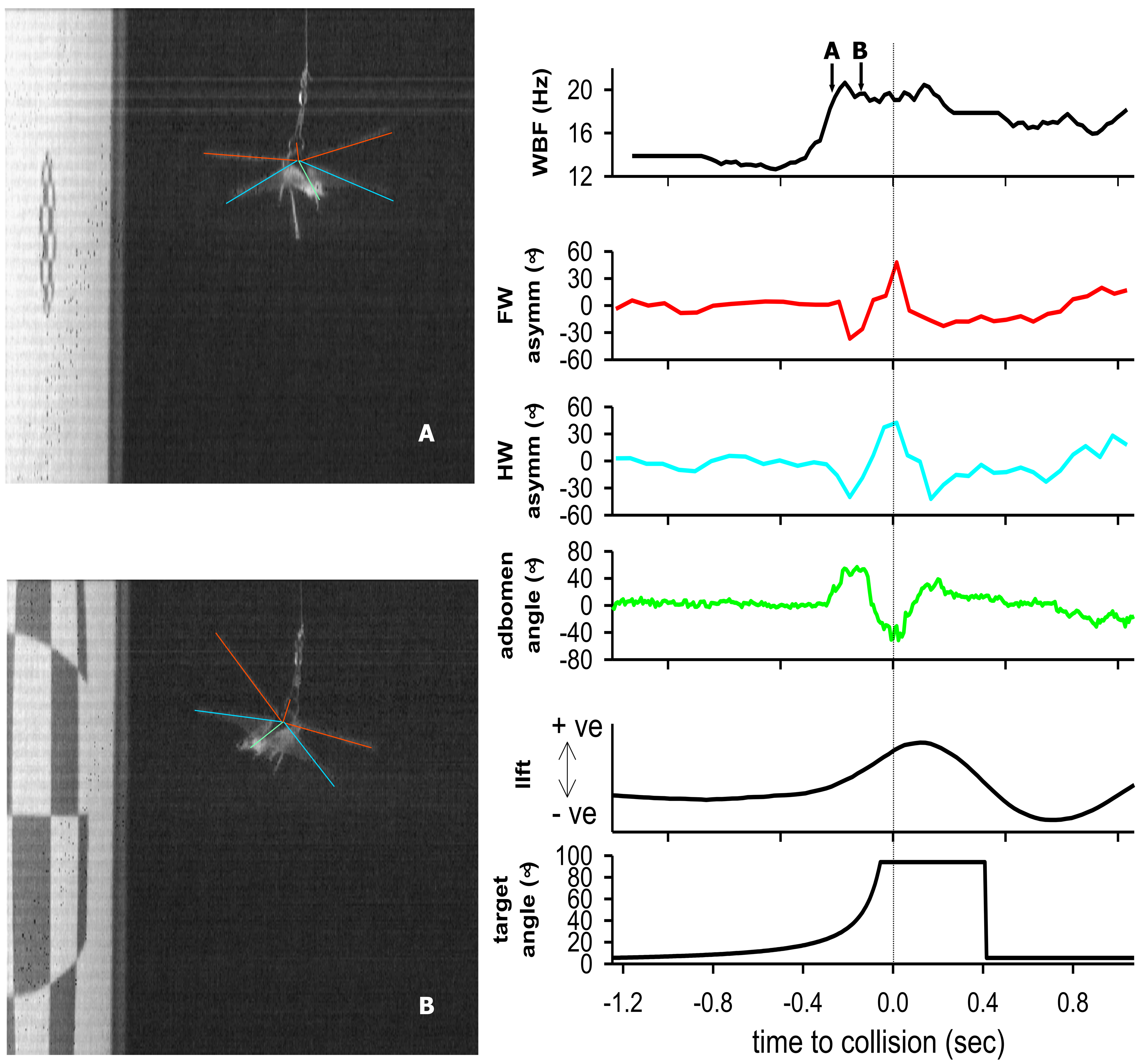


Figure. 1 Two frames from a video clip (125 fps) taken of the same animal showing two distinct responses to a projected looming stimuli as it approaches (times A and B) . This animal is on a loose tether which provides for a greater range of motion than experiments using locusts on a rigid tether. WBF = Wing beat frequency; FW = Forewing; HW = Hindwing; The dotted line is indicative of the actual time of collision were this an actual object.

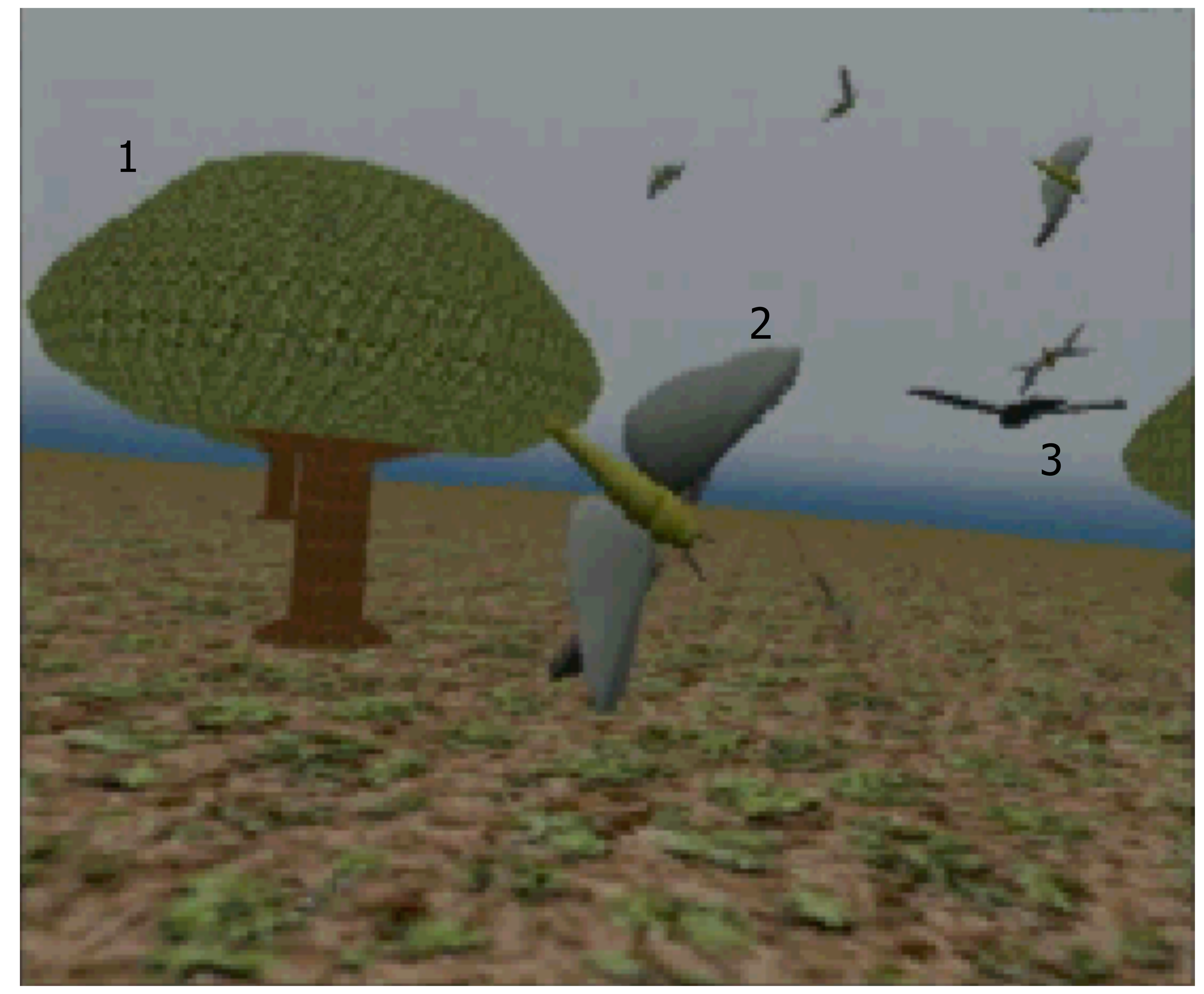
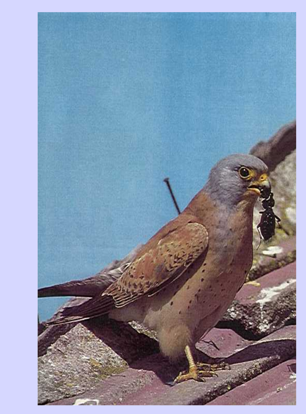


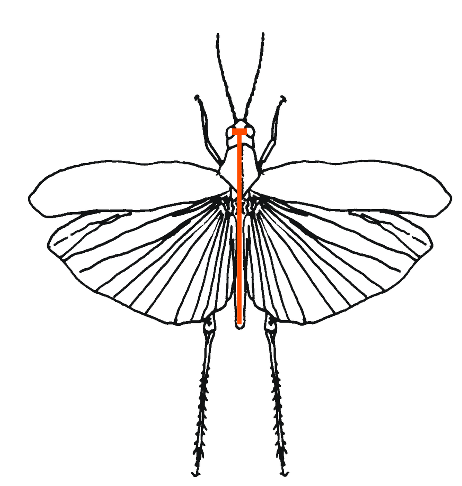
Figure 2. Locusts will be presented with three visual stimuli in all experimental paradigms.

1. **Stationary object, i.e. tree**
2. **Moving, non-threatening objects, i.e. conspecifics**
3. **Moving, threatening object, i.e. predator (lesser kestrel *Falco naumanni,* rose-coloured starling *Pastor roseus*)**

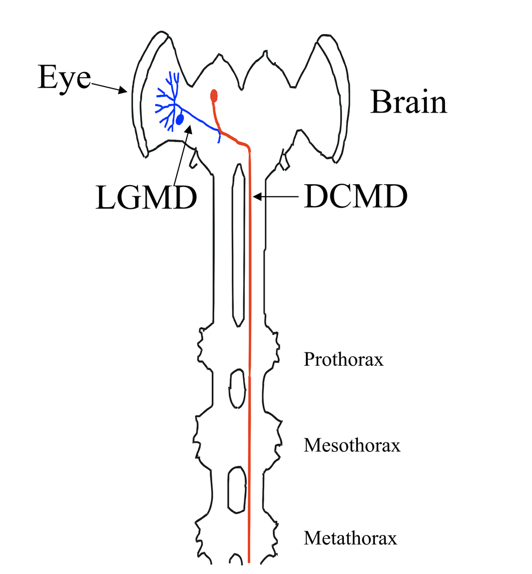


Methods:

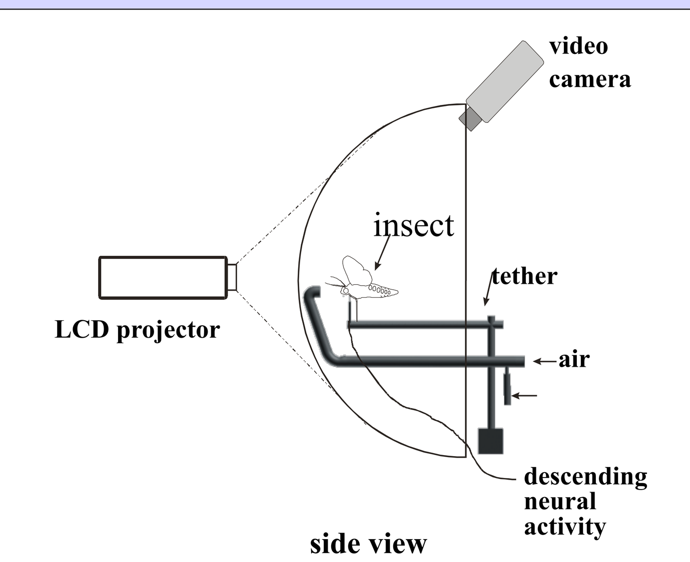
1. **Behavioural experiments: examine behavioural response(s) to computer generated visual obstacles (Wind tunnel, High Speed Camera 125-250 frames per second)**
2. **Flight muscle activity experiments: examine flight muscle activity (EMG) in response to computer generated visual obstacles. Since locusts are neurogenic fliers EMGs will correlate with neural activity (Wind tunnel, Virtual Environment, EMG recording equipment)**
3. **Neural response experiments: examine the response of the DCMD to computer generated visual obstacles to determine their putative role in collision avoidance (Virtual Environment, neural recording equipment)**



Location of the nervous system in the locust



Location of visual neurons, the LGMD and the DCMD



Schematic of the virtual environment

Significance:

1. **Discover how integrative mechanisms link sensory processing to adaptive flight behaviour.**
2. **The organization of certain systems is remarkably conserved across species (Marder 2002). Therefore, understanding neural mechanisms underlying obstacle avoidance in locusts could provide insights into general mechanisms of adaptive insect flight strategies.**

References:

- **Gabbiani, F., H.G. Krapp and G. Laurent 1999. Computation of object approach by a wide-field, motion-sensitive neuron. J. Neurosci. 19: 1122-1141.**
- **Gray, J.R., J.K. Lee, R.M. Robertson 2001. Activity of descending contralateral movement detecting neurons and collision avoidance behaviour in response to head-on visual stimuli in locusts. J. Comp. Physiol. A. 187:115-129**
- **Marder, E. 2002. Non-mammalian models for studying neural development and function. Nature 417:115-129**

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