SAND2020-2413PE

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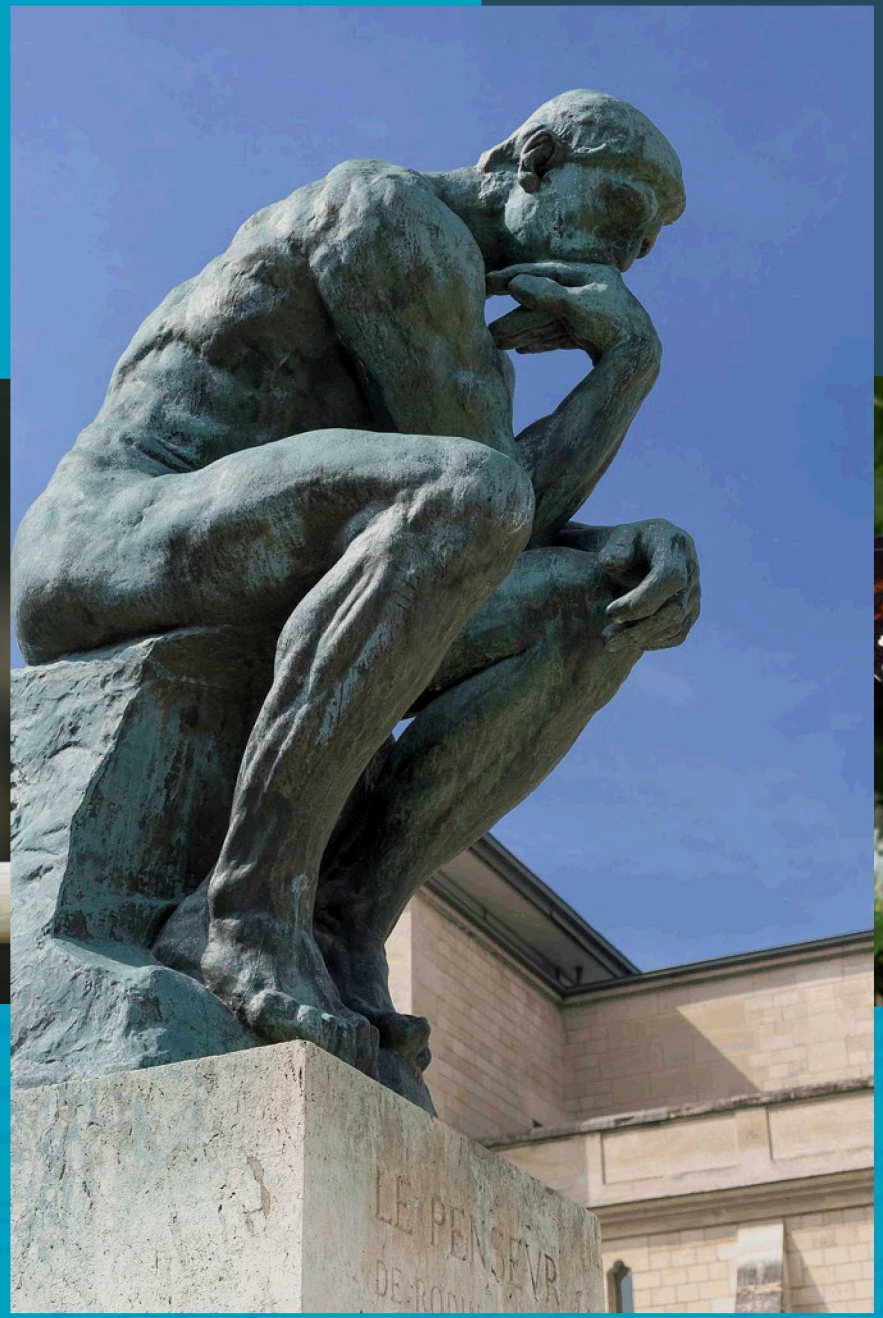
SANDIA TALKS

Frances S. Chance

Dragonflies

A Lesson in Missile Defense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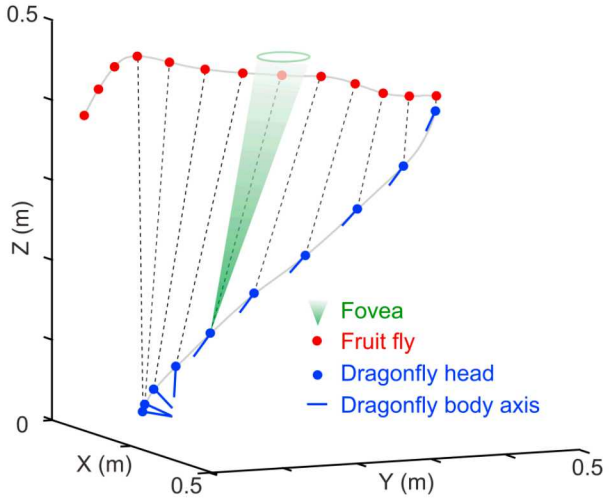
Why dragonflies?

Good at hunting (90-95% capture rate)

When hunting, dragonflies use interception strategies similar to modern defense systems



from Lin & Leonardo 2017

The underlying neural circuitry is relatively simple

Dragonflies are fast

Why dragonflies?

Time scales of dragonfly interception computation

Latency to react to prey maneuver: 50 ms

Time scales of a neurobiological system

Synaptic transmission: 1-5 ms

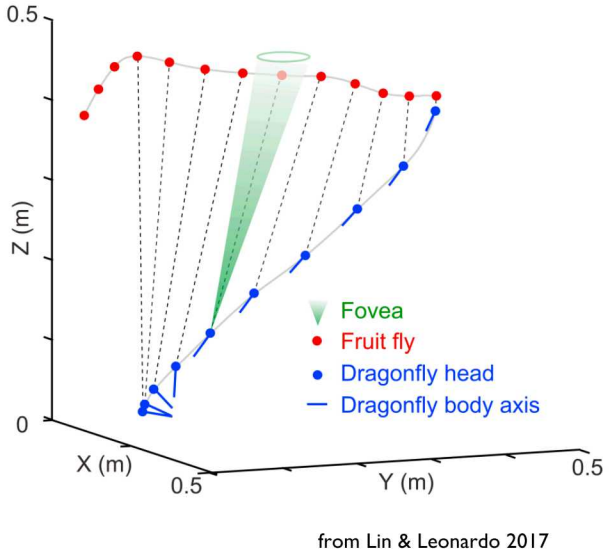
Neuronal integration: 10-50 ms

Muscle contraction: 5 ms to produce force

Why dragonflies?

Good at it (90-95% capture rate)

When hunting, dragonflies use interception strategies similar to modern defense systems



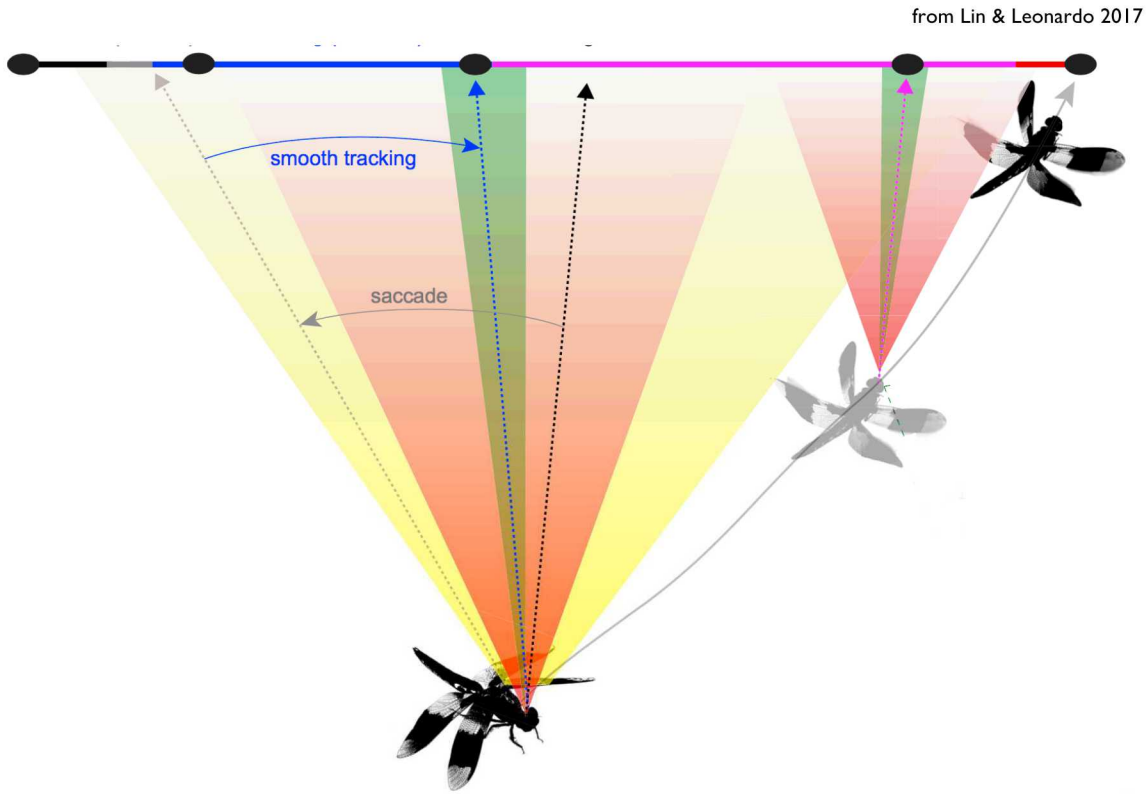
from Lin & Leonardo 2017

The underlying neural circuitry is relatively simple

Dragonflies are *really* fast

Can we learn from them to compute things faster?

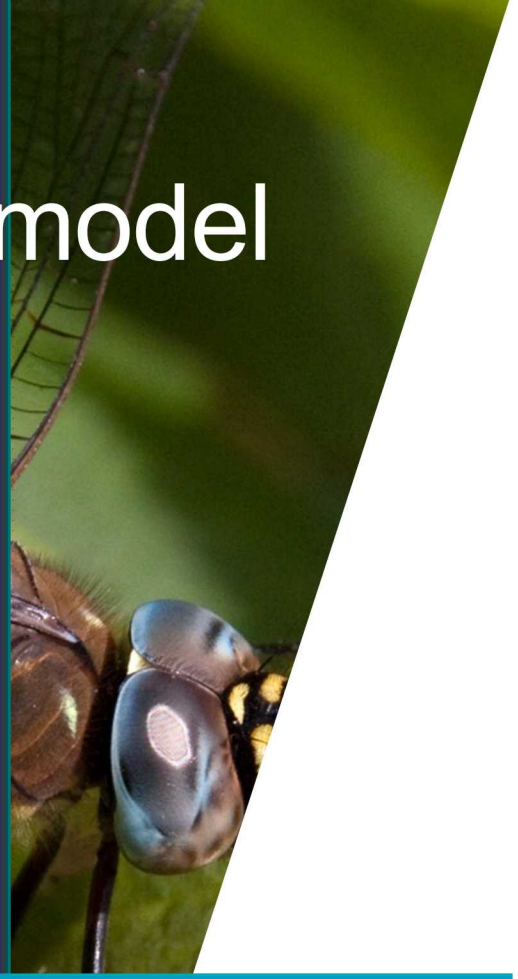
The dragonfly model

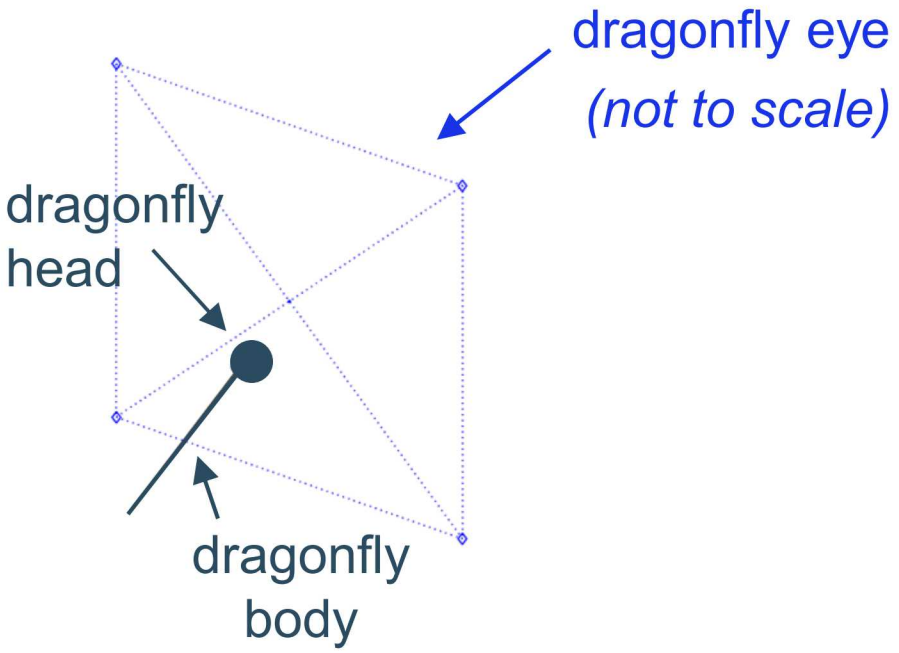


We know dragonflies keep the prey-image on a specific location on the eye…

Does dragonfly interception equal holding target-image on a fixation spot?

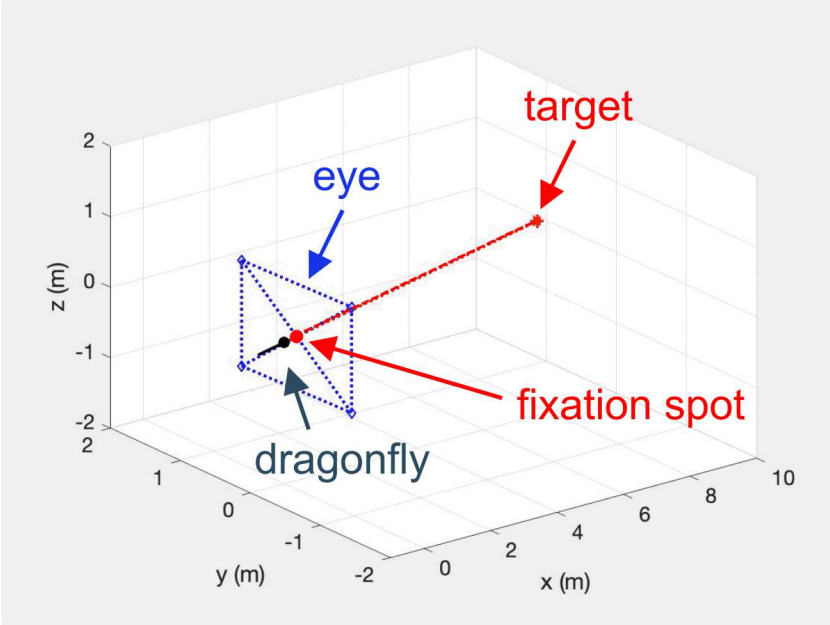
The dragonfly model





The dragonfly model

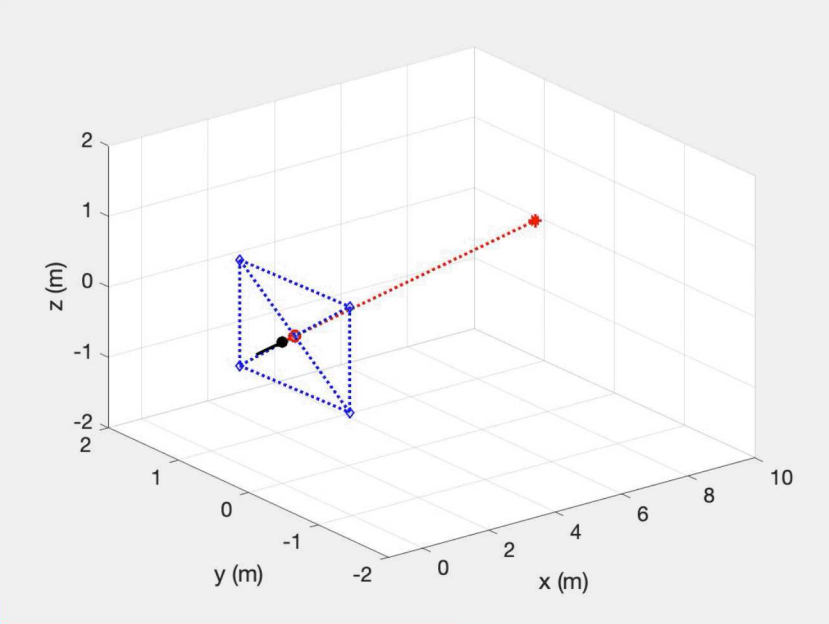
Model dragonfly turns to keep prey-image at fixation spot



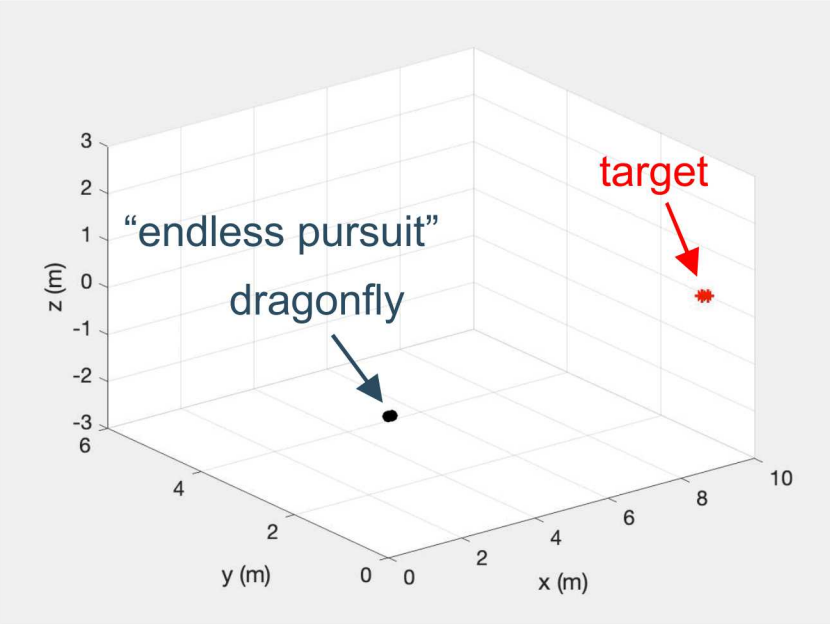
dragonfly-centered reference frame

The dragonfly model

Model dragonfly turns to keep prey-image at eye-center



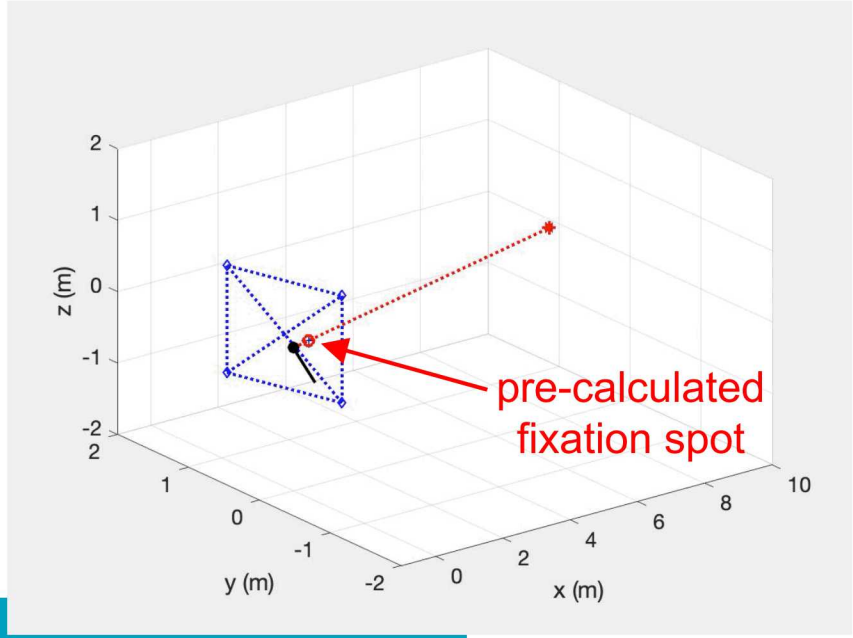
dragonfly-centered reference frame



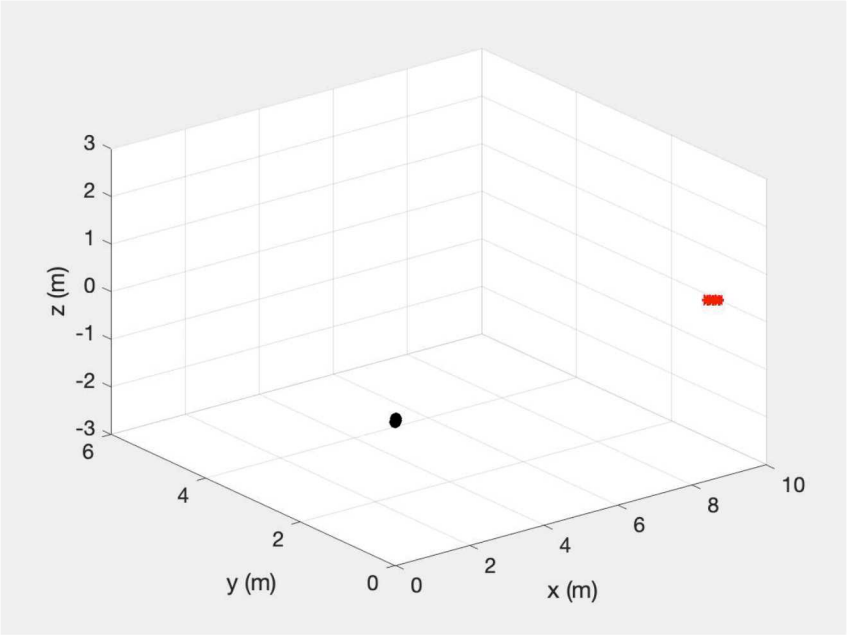
physical-space reference frame

The dragonfly model

“ideal” interception



dragonfly-centered reference frame

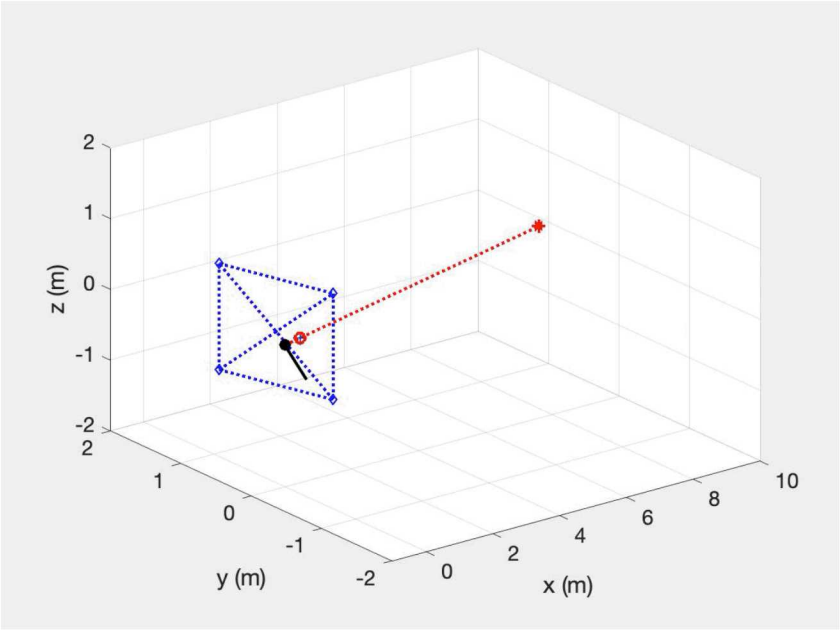


physical-space reference frame

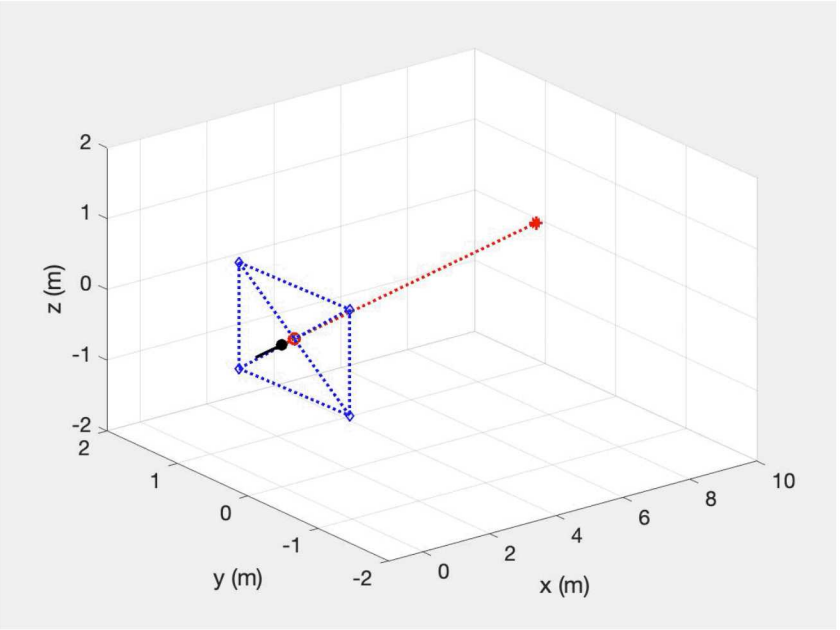
The dragonfly “knows” when it is not on the ideal interception trajectory

The dragonfly model

How could the model dragonfly know?

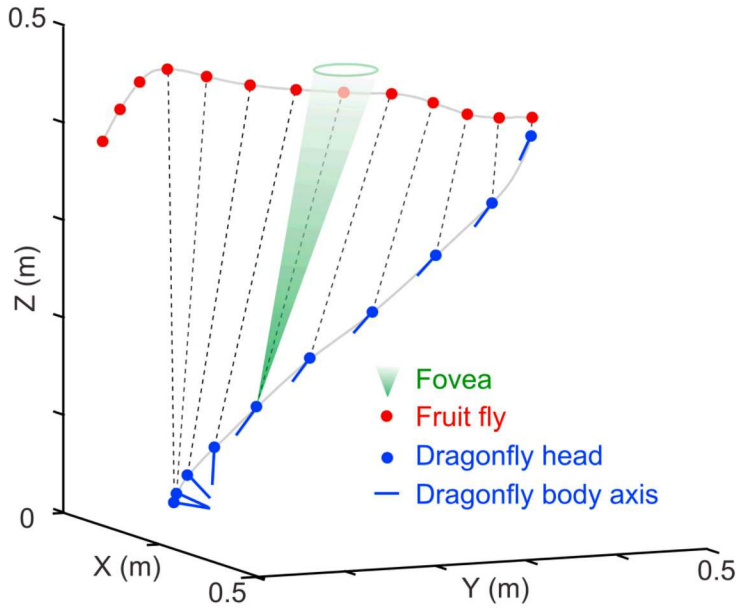


ed fixation spot
otion trajectory)

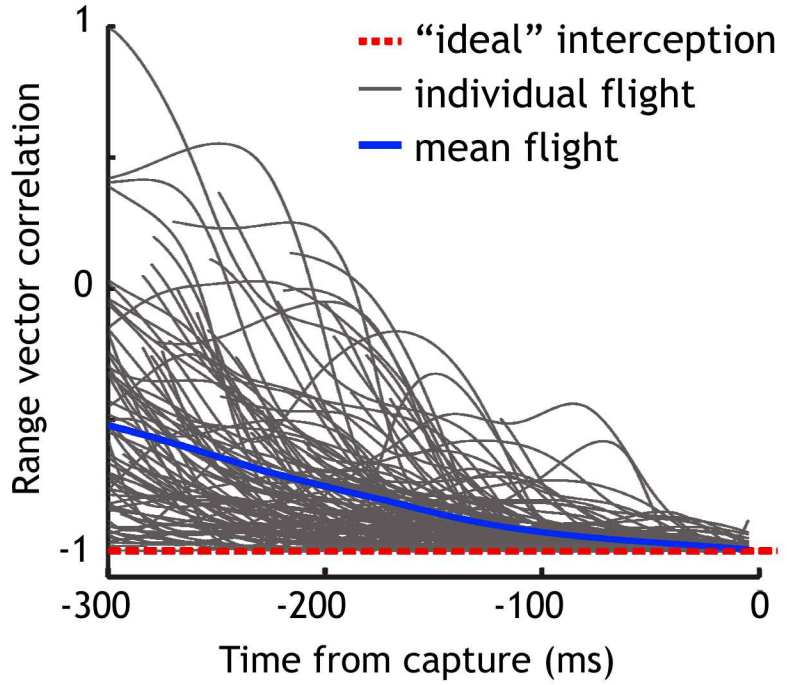


fixation spot at eye-center

Back to the dragonfly…



from Lin & Leonardo 2017

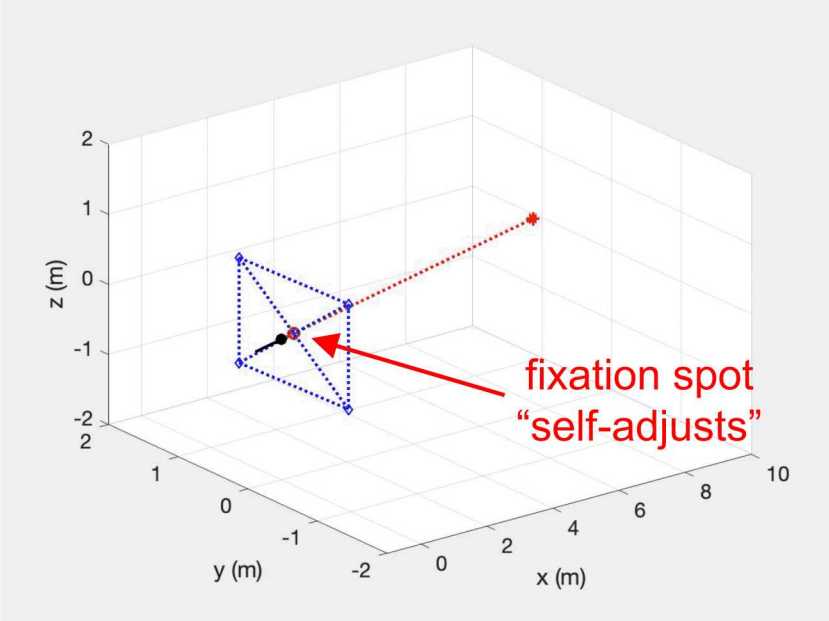


from Mischiati et al 2015

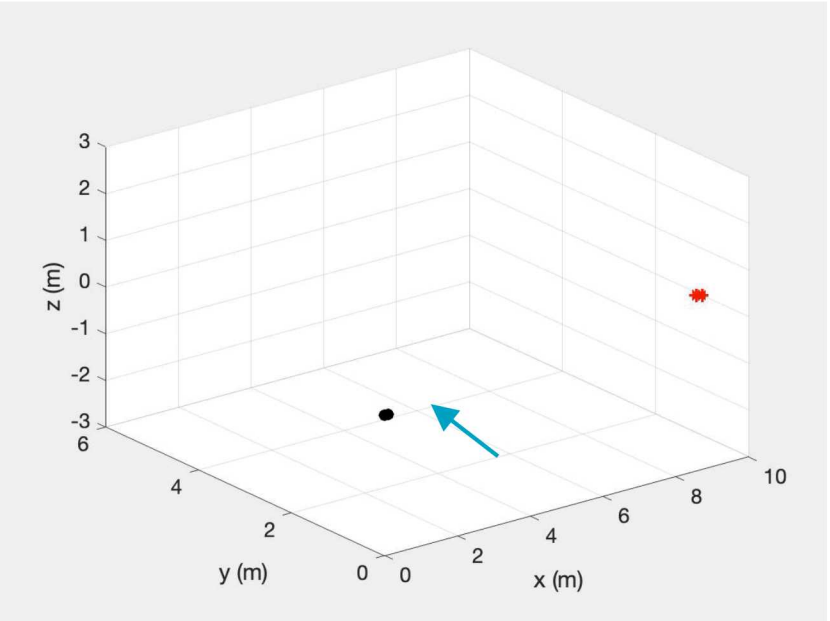
The dragonfly model
(with error correction)

Dragonfly maneuvers provide “error” signal

(initial condition: fixation spot at eye-center with dragonfly flying straight at target)

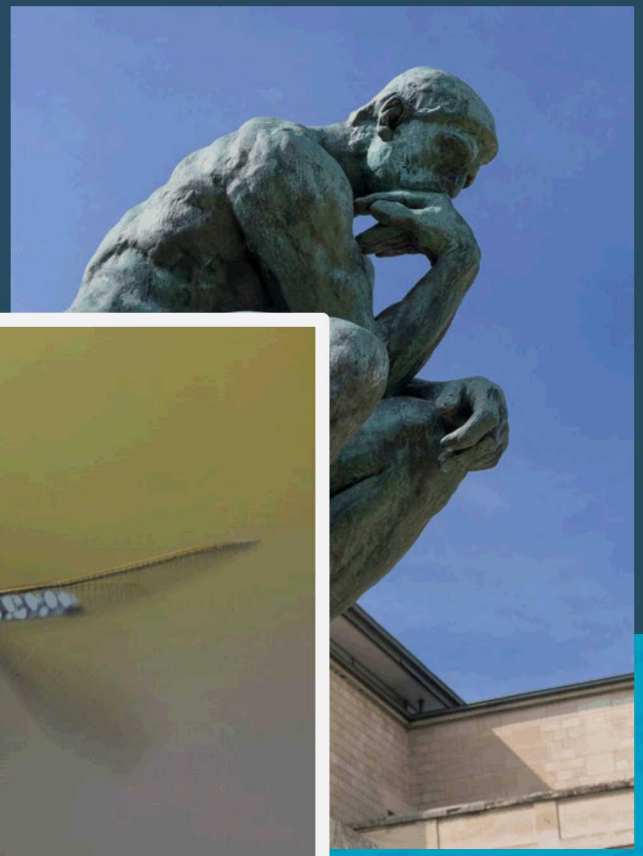


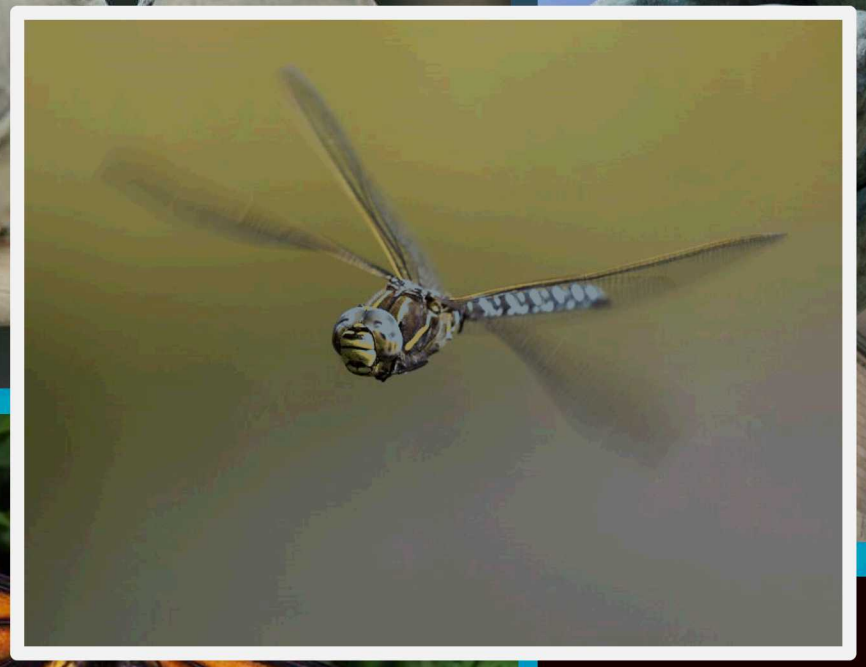
dragonfly-centered reference frame

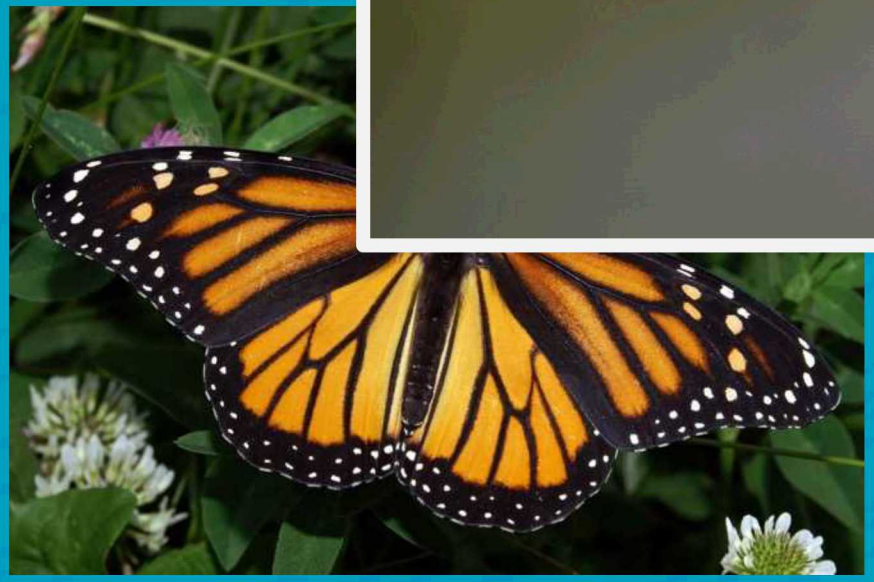


physical-space reference frame

Yes! Holding target-image on a fixation spot is a viable path to robust interception.







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Thank You

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