Active Neural Field model of goal directed eye-movements

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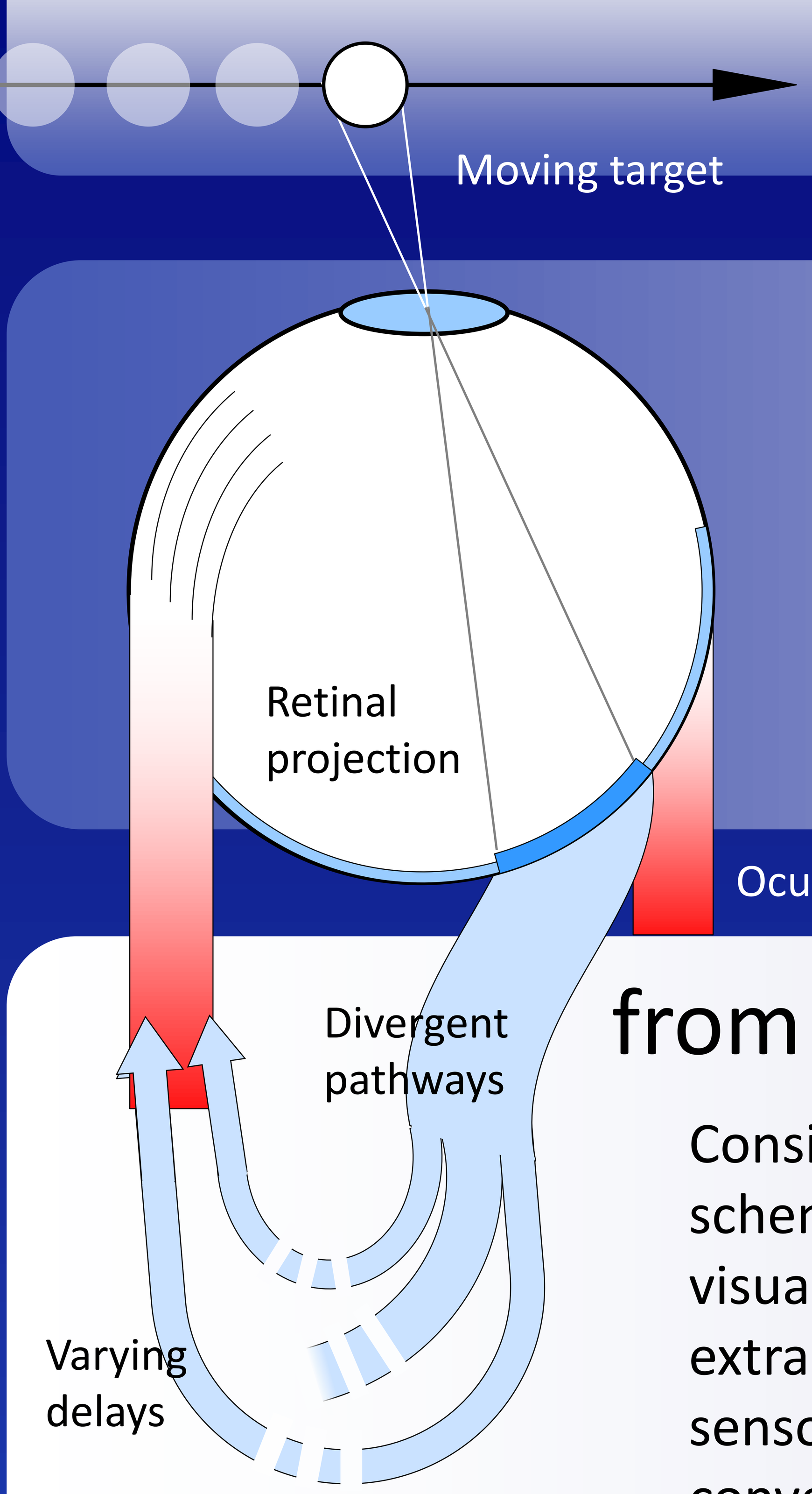


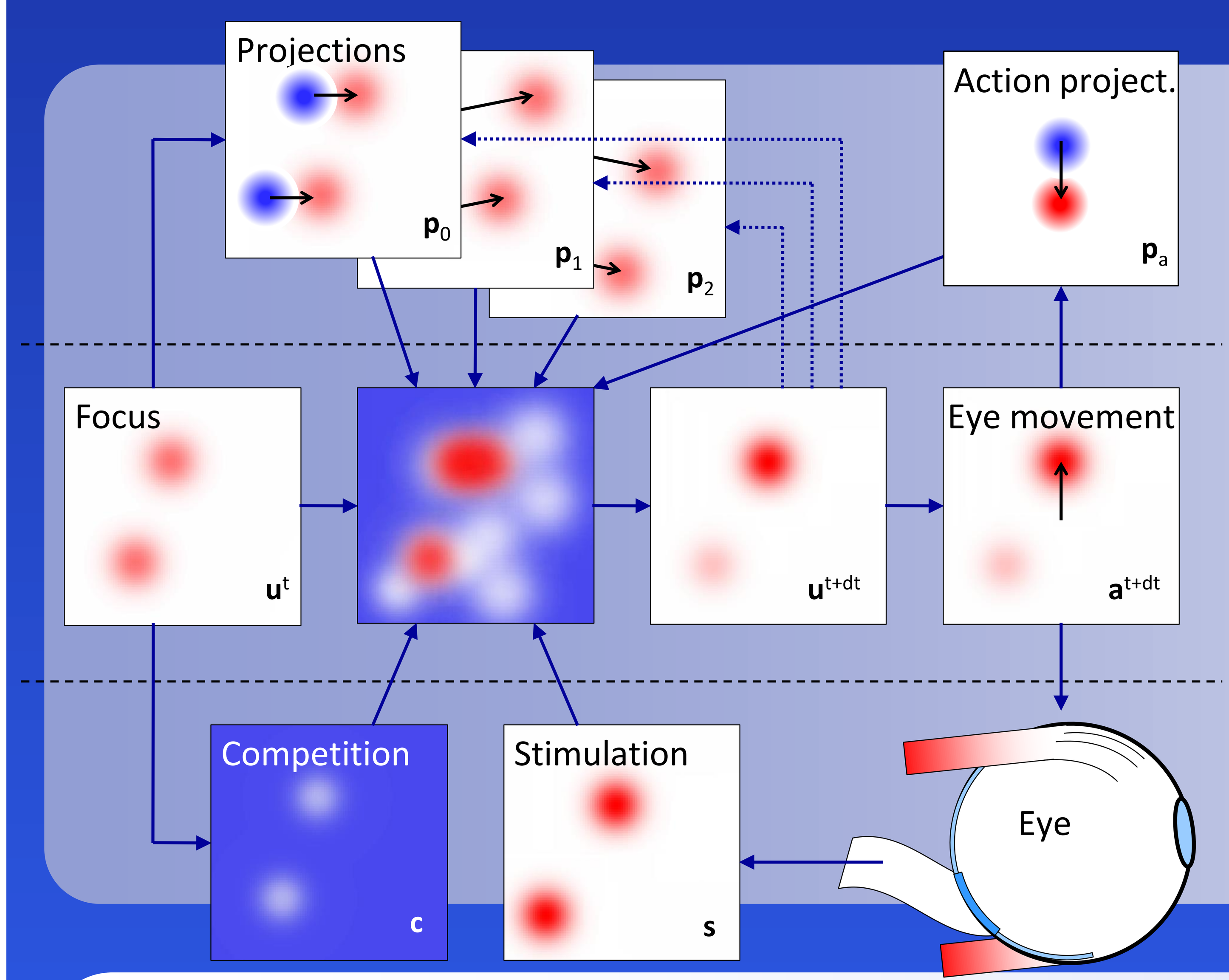
Introduction

For primates (including humans), interacting with objects of interest in the environment often involves their foveation, many of them not being static (e.g. other animals, relative motion due to self-induced movement). Eye movements allow the active and continuous sampling of local information, exploiting the graded precision of visual signals (e.g., types and distributions of photoreceptors). **Foveating and tracking targets thus requires adapting to their motion**.

from sensory…

Considering the delays involved in the transmission of retinal signals to the eye muscles, a purely reactive schema could not account for the smooth pursuit movements which maintain the target within the central visual field. Internal models have been posited to represent the future position of the target (for instance extrapolating from past observations), in order to compensate for these delays. Yet, adaptation of the sensorimotor and neural activity may be sufficient to **synchronize with the movement of the target**, converging to encoding its location here-and-now, **without explicitly resorting to any frame of reference** (Goffart et al., 2017).

…to motor ?

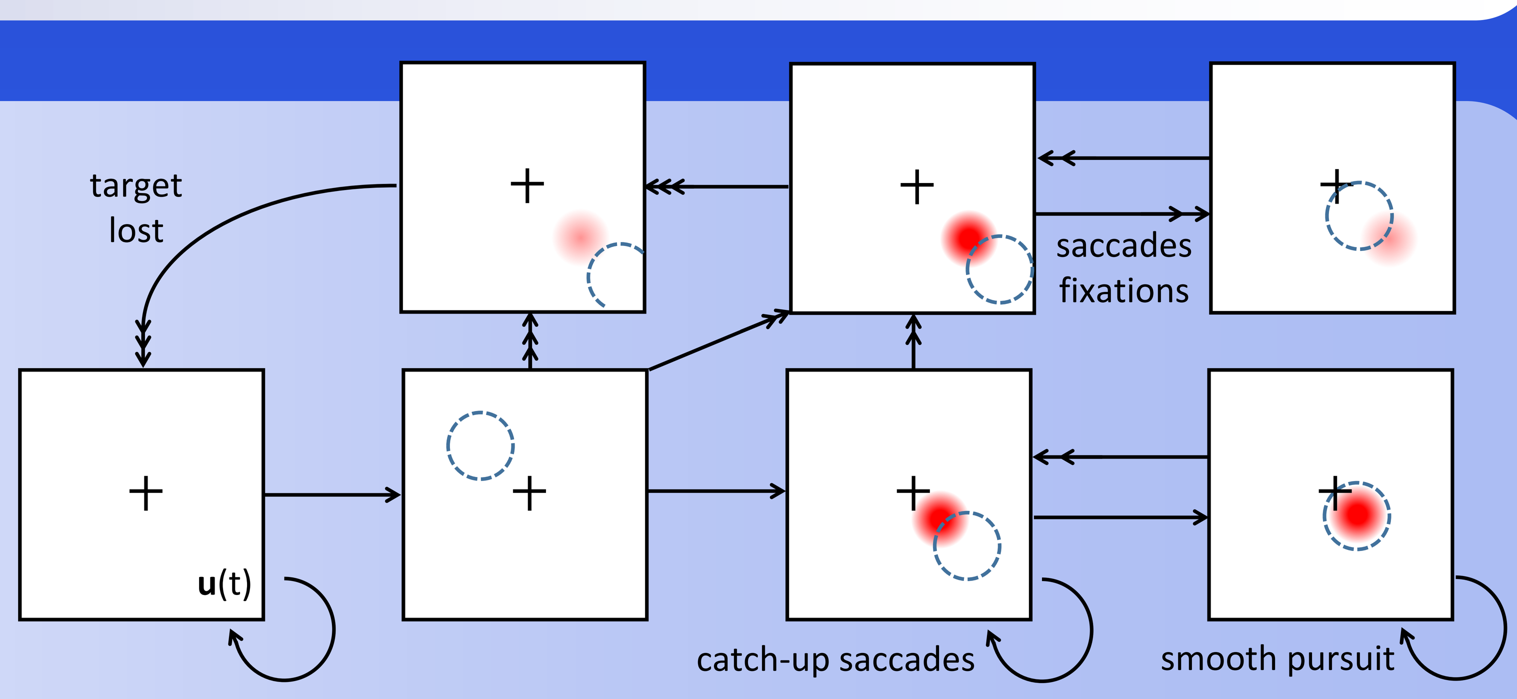


Active Neural Field model

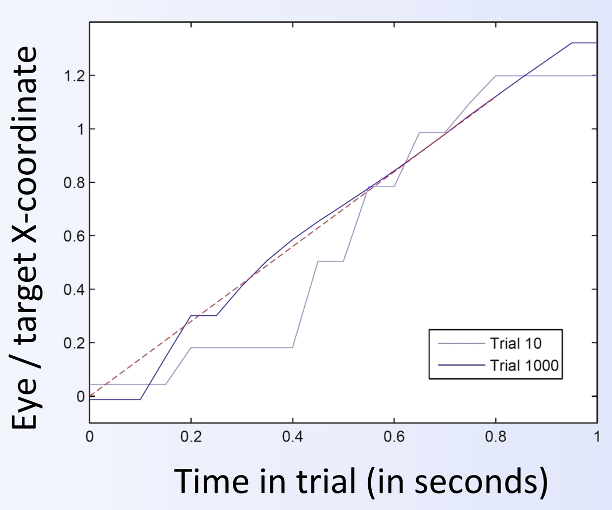
Committing to a distributed dynamical systems approach, we relied on a computational implementation of neural fields to model an adaptation mechanism sufficient to select, focus and track rapidly moving targets. By **coupling the generation of eye-movements with dynamic neural field** models and a simple learning rule, we demonstrated how different eye-movements and the synchronization with rapidly moving targets could be generated from a **single dynamical system without explicit encoding of the target location** (Quinton & Goffart, 2018). Qualitatively different behaviors corresponded to attractors (e.g., smooth pursuit as a fixed point attractor).

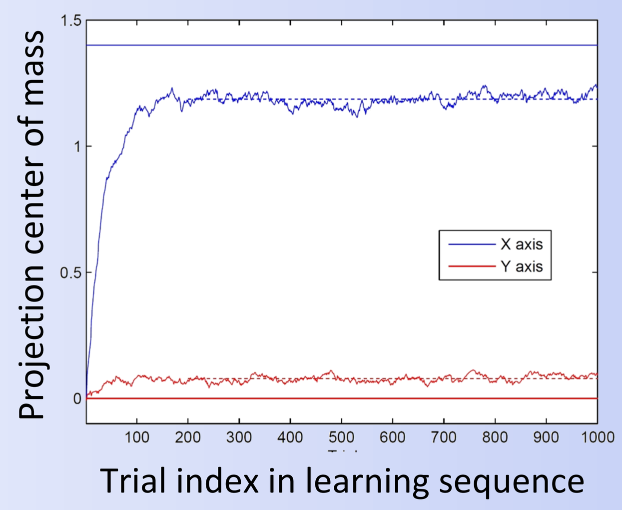
Simulation Results (vs. experimental)

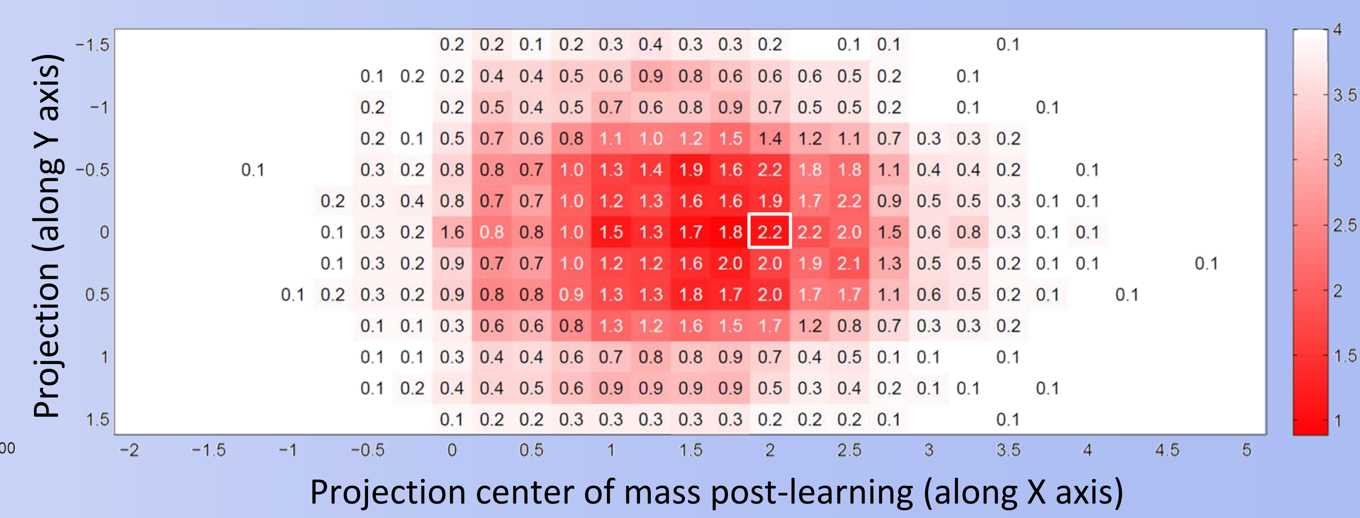
We here relied on a simplistic learning rule (the center of mass of the neural activity during the trial drives the adaptation of the projection eccentricity) and oculomotor commands (neural field to motor map). The computational model made it possible to **replicate neurophysiological findings in presence of rapidly moving targets** (Bourrelly et al., 2016).



- Distributed neuro-inspired model
- Catch-up saccades reduced and smooth pursuit velocity increased
- No encoding of future locations of the target (here-and-now at best)
- Neural projections not matching the target frame of reference







References

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