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On the utility of neural perturbation experiments for identifying the neural components of an integrated system.



Laurent Goffart, CNRS

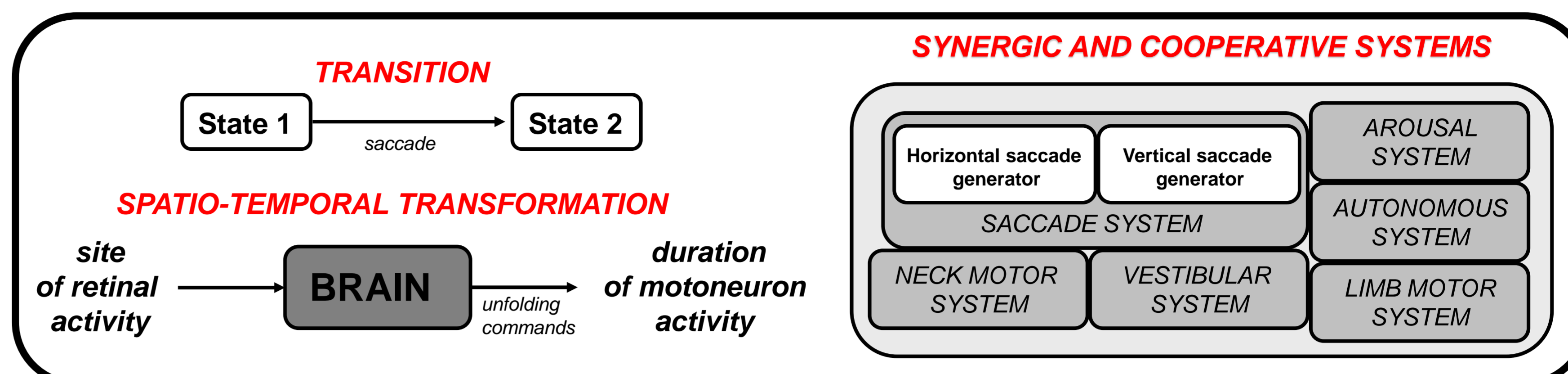
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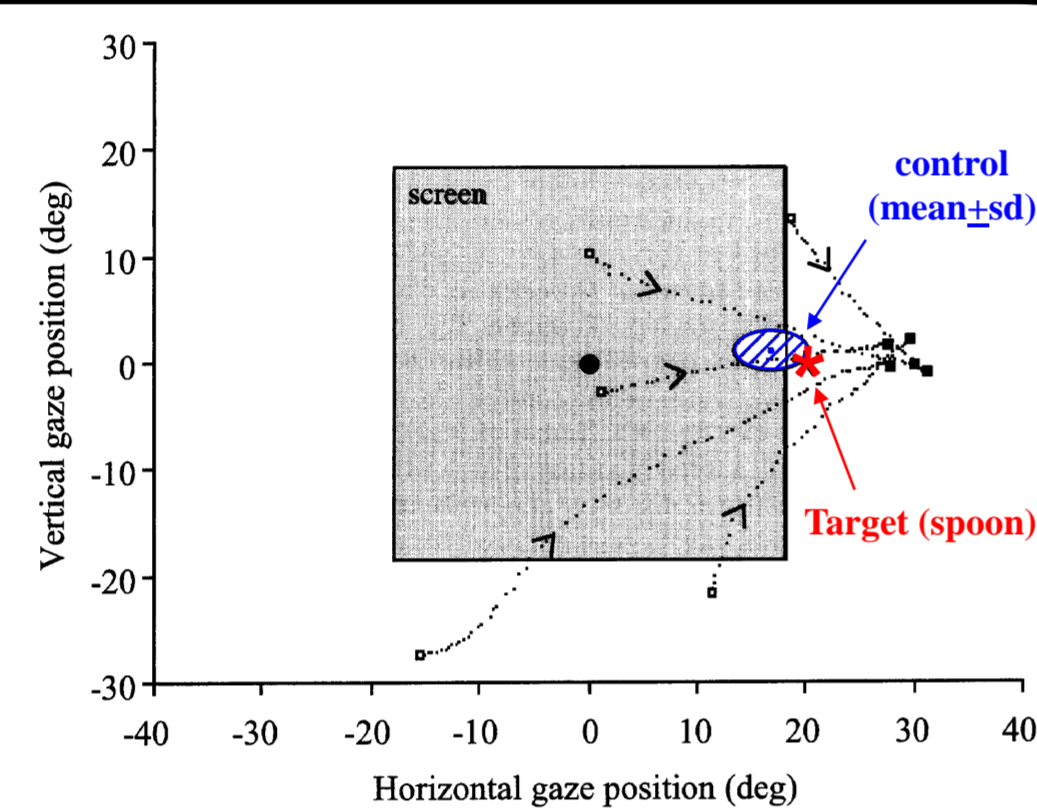
Living animals are sensorimotor systems endowed of properties that allow them to **explore** and interact with their environment. The orienting reaction is one of these systems by which animals can establish **equilibrium** between their endogen properties and the constraints imposed by the milieu. Indeed, variations in the environment (like the sudden appearance of an event) or fluctuations in the inner state (e.g., the hypovolemia) often **break** this equilibrium and lead to coordinated movements which are aimed at **restoring** it.

The orienting reaction can be viewed as a **transition**, whose detailed analysis can provide a picture of the dynamic properties of a neurobiological system, at different **time scales** (e.g., from the systematic orientation to its habituation) and **spatial scales** (e.g., from the saccade and its underlying neural network to the bistable properties of recruited neurons). Most often, this reaction consists in orienting the sensory organs toward the **source** of external events.

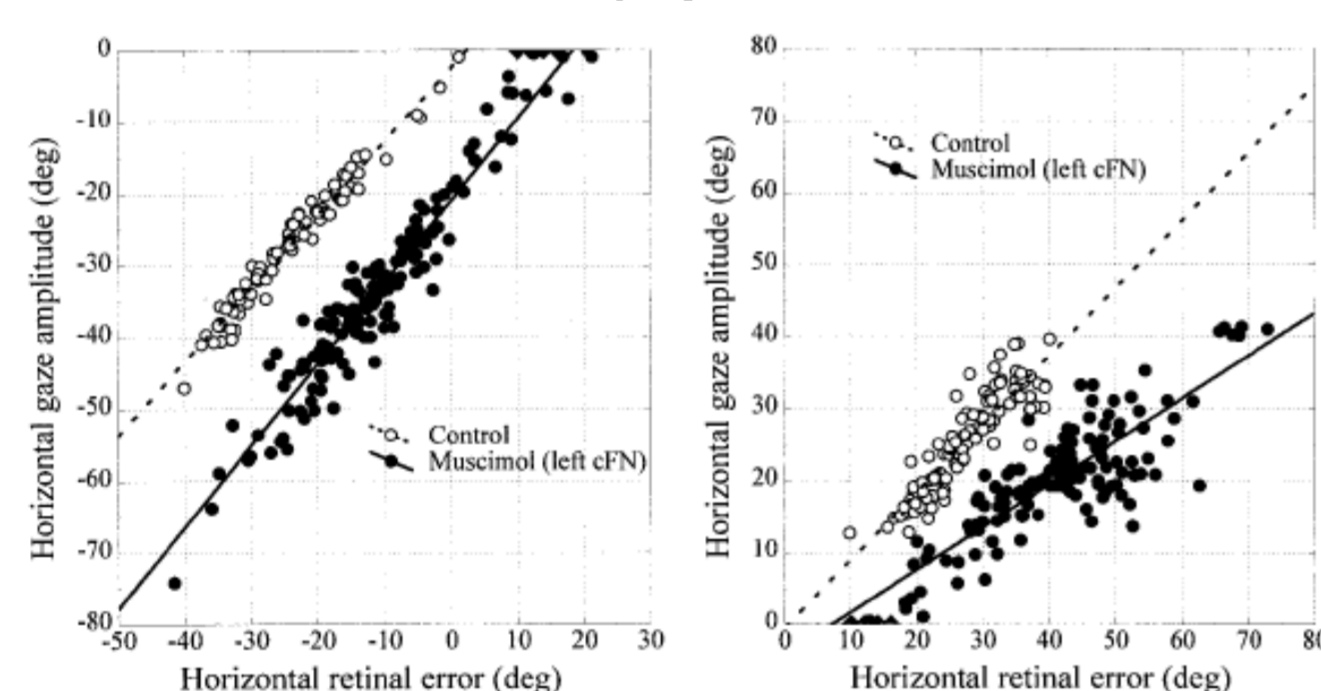
Many neuronal groups are involved in generating a reaction that **fits** with the spatiotemporal properties of targeted events. These groups are distributed in several brain regions whose interactions generate streams which are more or less **independent** or **cooperative**. Among those regions, the medio-posterior cerebellum (MPC) is known to play a major role in the **adaptability** of the orienting reaction.



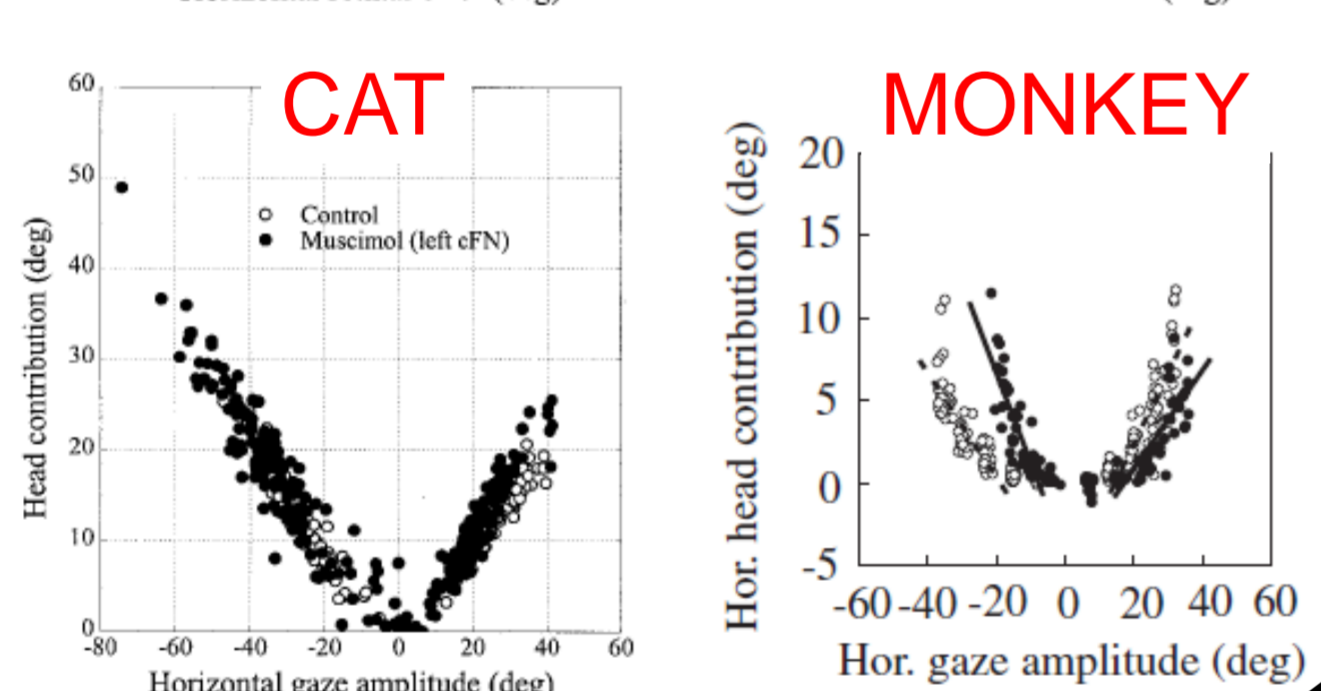
Constant error in the cat



Gaze (eye + head) dysmetria



Eye-head coupling



Cerebellar control of foveating saccades

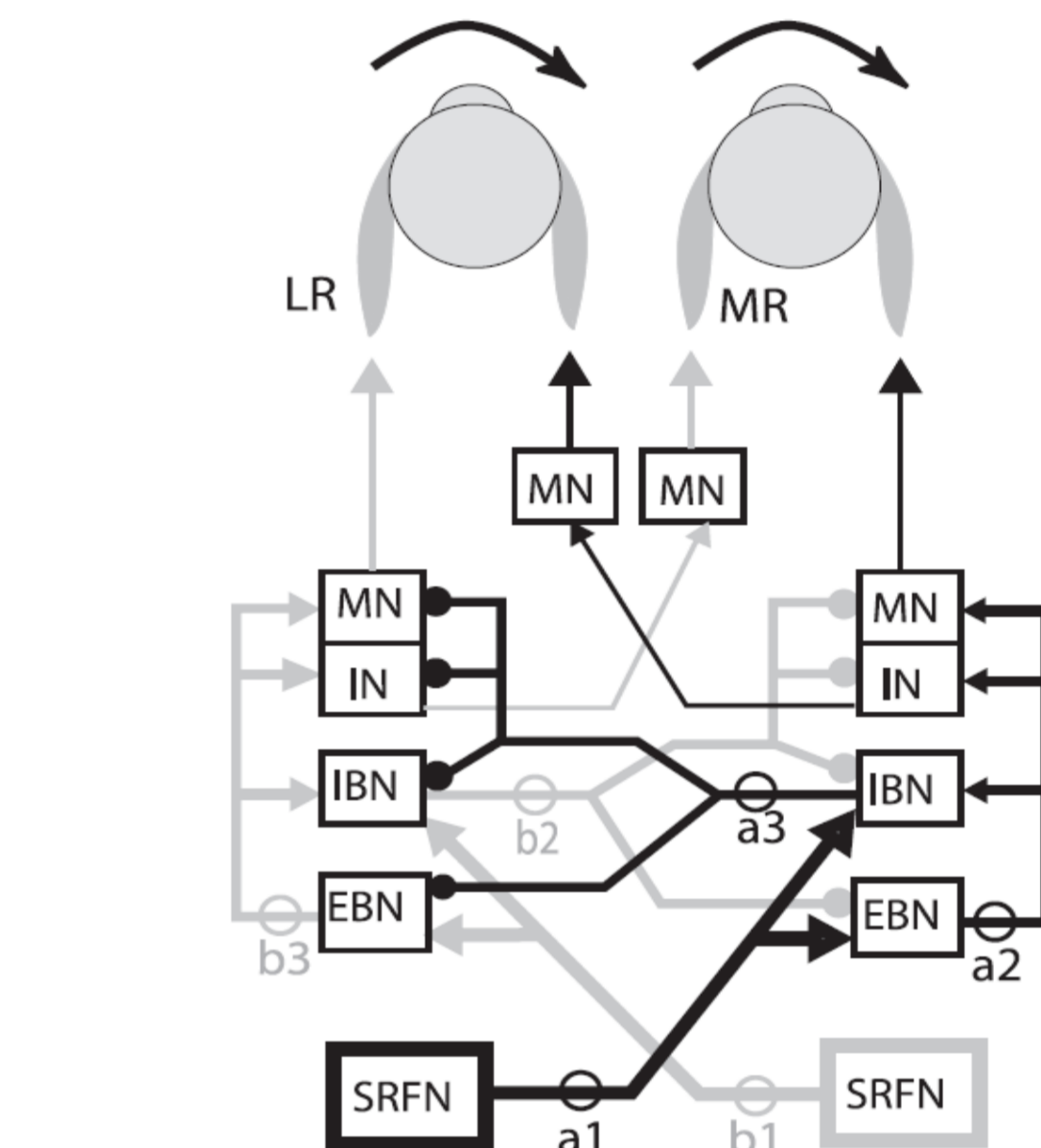
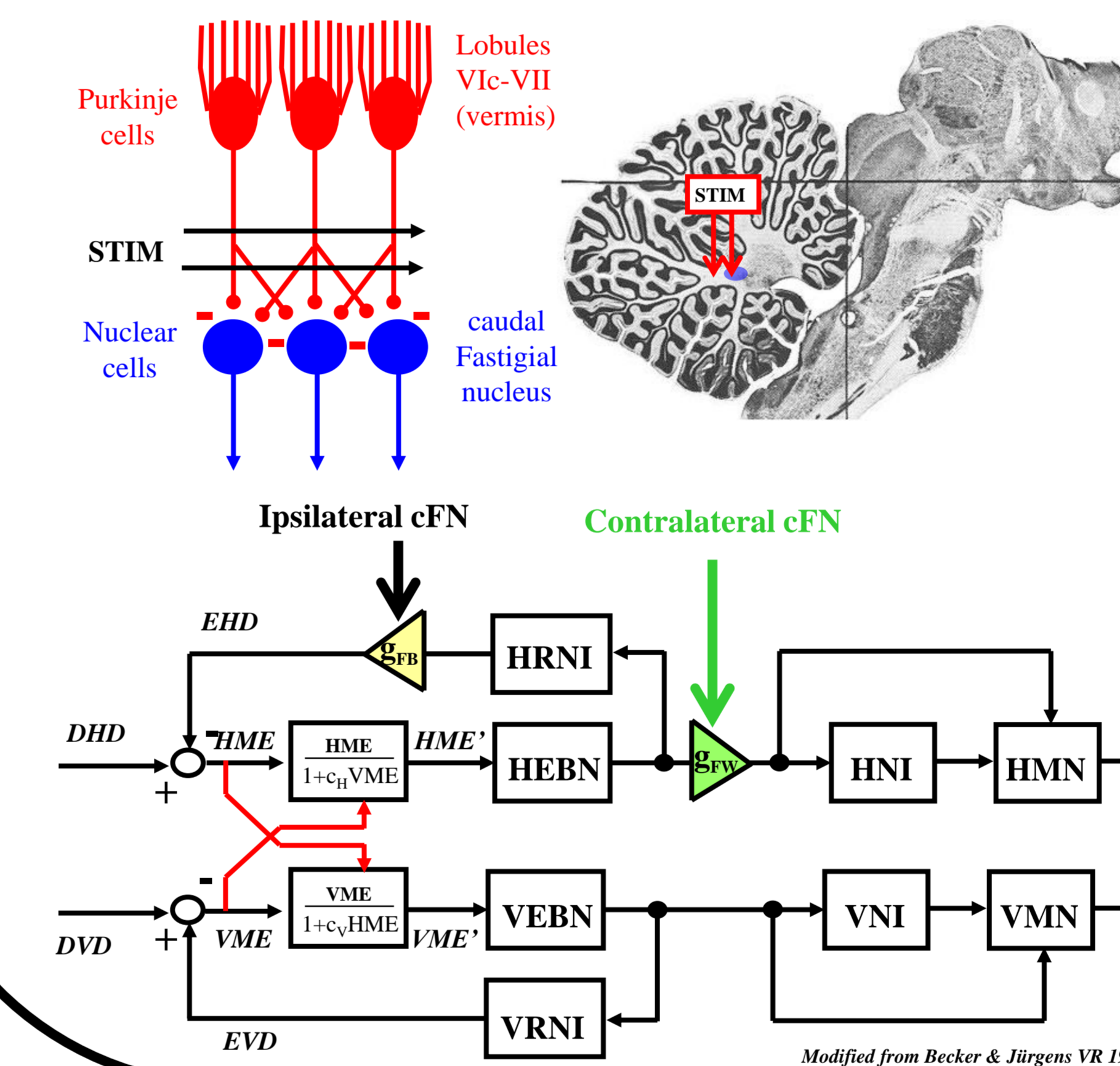
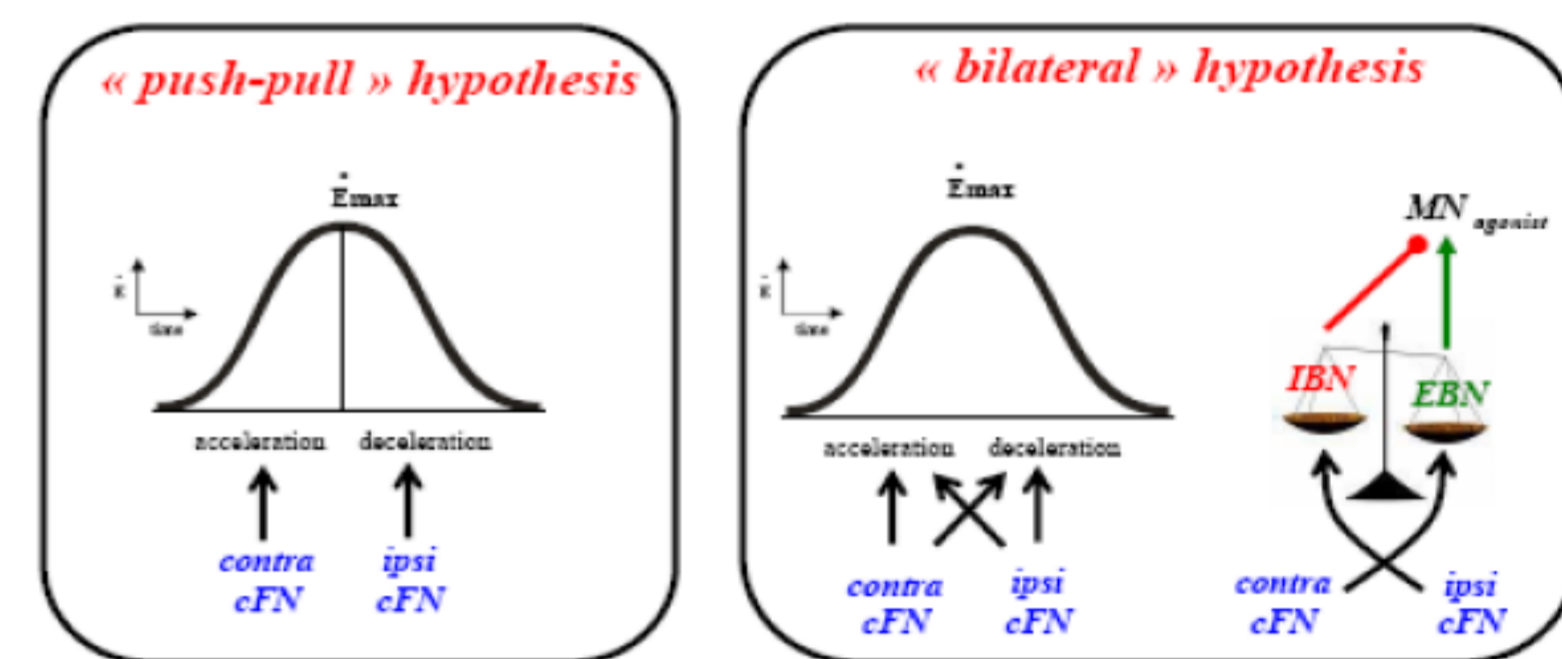
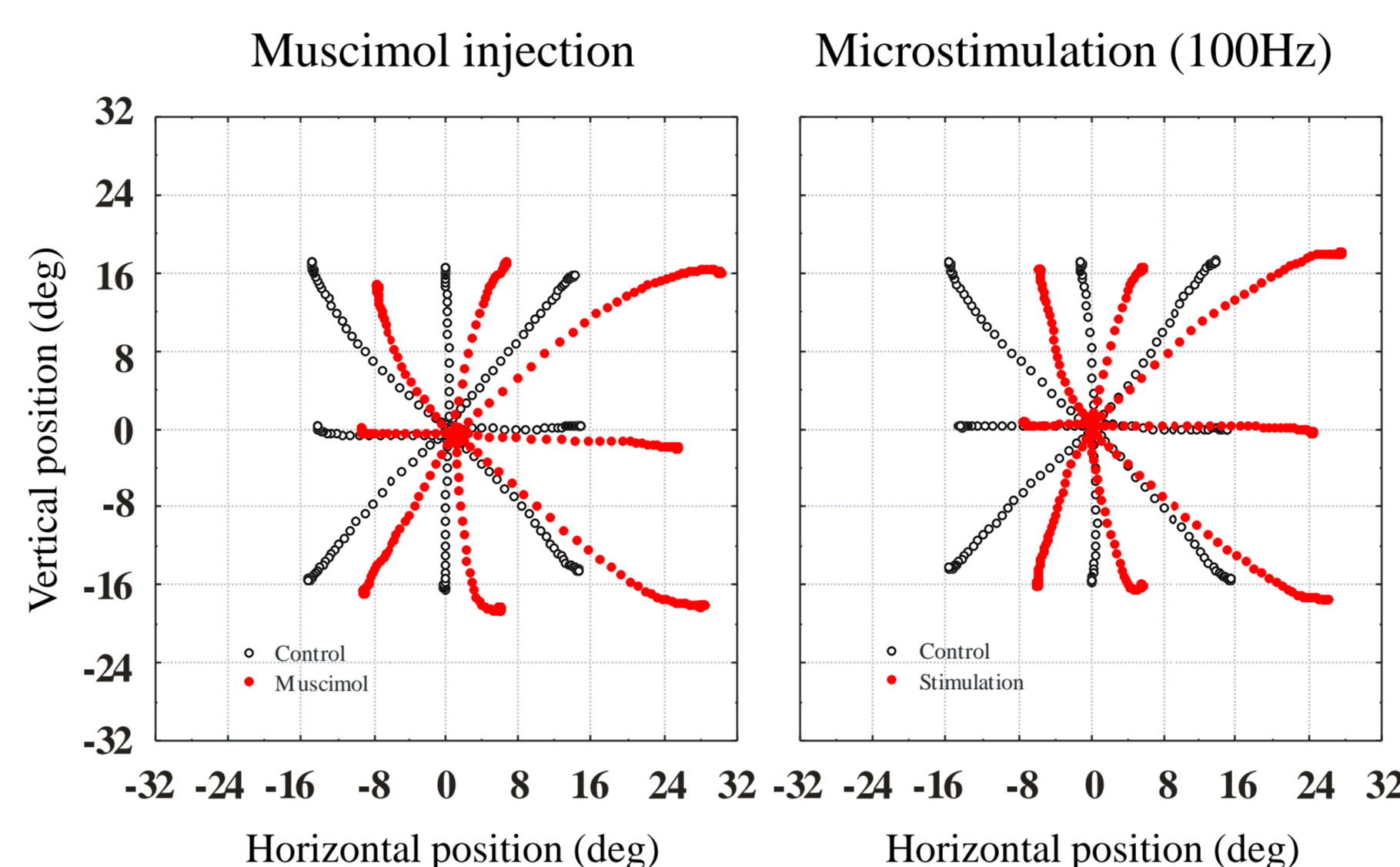
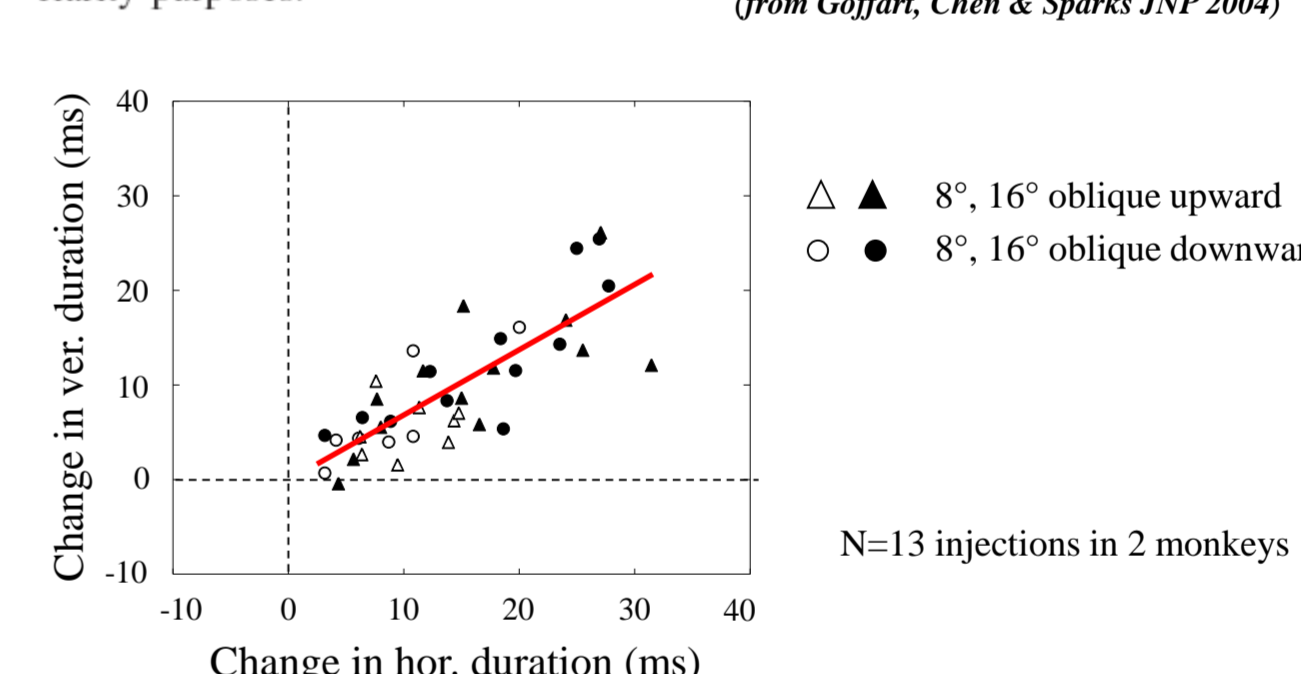
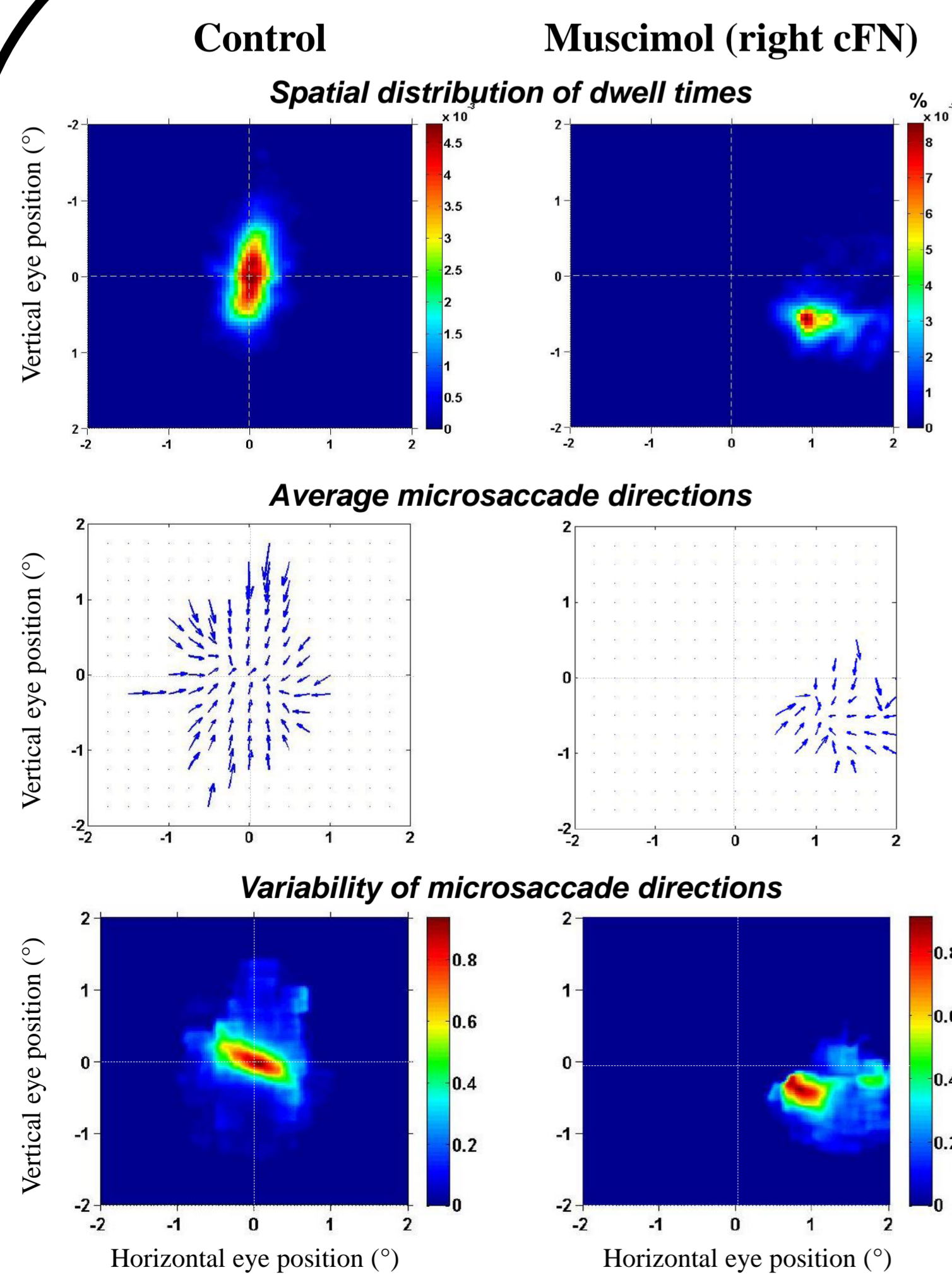


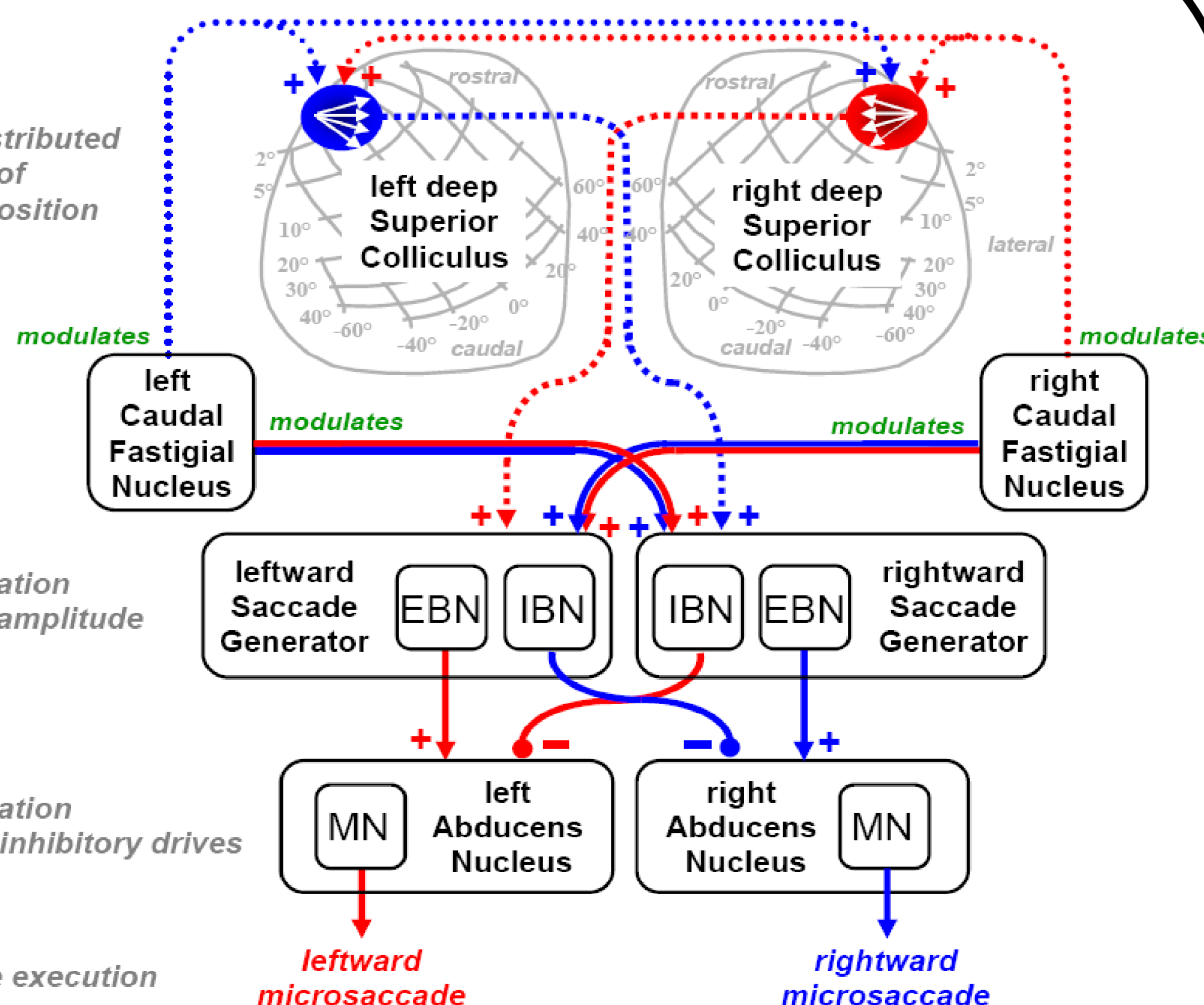
FIG. 10. Scheme by which the saccade-related neurons in the cFN (SRFN) influence the generation of the horizontal component of saccades. See text for additional details. Arrows, excitatory connections; connecting lines ended by a circle, inhibitory connections. The connecting lines have different thickness for clarity purposes.



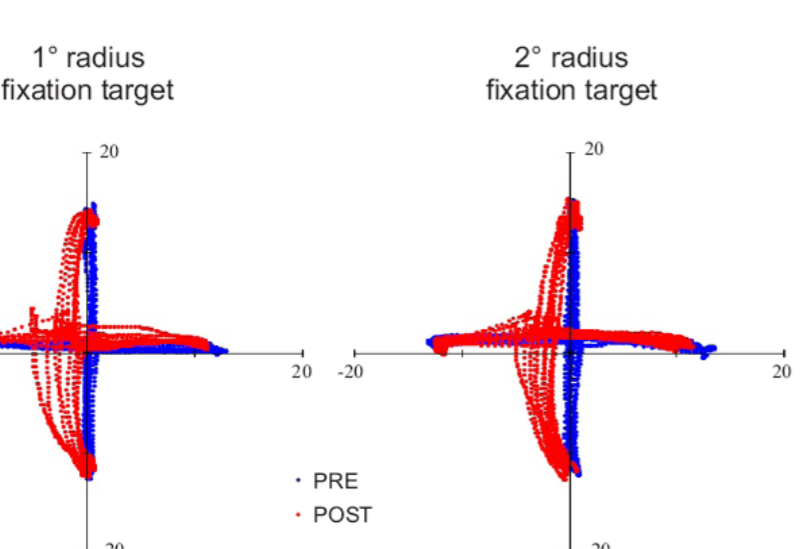
Subcortical control of foveation



Bilateral and distributed encoding of foveal target position



A small injection of muscimol in the rostral SC also causes a fixation offset



Predictions : inactivation of IBN area should lead to a **fixation offset** because of dysmetric fixational saccades (no shift)

Role of pause neurons : microstimulation of OPN region suppresses the generation of saccades (Keller 1976)
Its inactivation does not alter fixation (Kaneko 1996) → Test of H-V coupling.

On-going projects

- Subcortical control of fixational saccades in the non-human primate (NHP)** : cerebellar control : with Ulrich Büttner (Ludwig-Maximilians-University München, Germany); collicular control : with Rich Krauzlis (Salk Institute for Biological Studies, San Diego, USA).
- Control of head movements and its coupling with the saccade oculomotor control in the NHP** : cerebellar control : with Julie Quinet (Univ. Rochester, USA); head motor primitives : with Longtang Chen (Univ. Texas Medical Branch, Galveston, USA); neuro-anatomy of eye and head motor networks : with Patrice Coulon et Hélène Bras (P3M, France)
- Control of saccades toward a moving target in the NHP** : cerebellar control : with Kikuro Fukushima (Hokkaido Univ. School of Medicine, Sapporo, Japan)
- Development of an invertebrate neurobiological model (praying mantis)** : behavioral study : with Samuel Rossal (Institut für Biologie, Freiburg, Allemagne); with Yoshitomi Yamawaki (Fukuoka University, Fukuoka, Japan).

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