Frontal eye field microstimulation modulates the pupil light reflex

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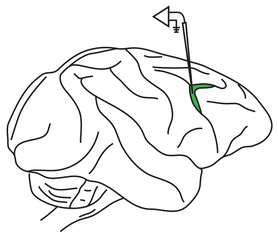
1. Is prefrontal microstimulation sufficient to modulate a brainstem reflex circuit?

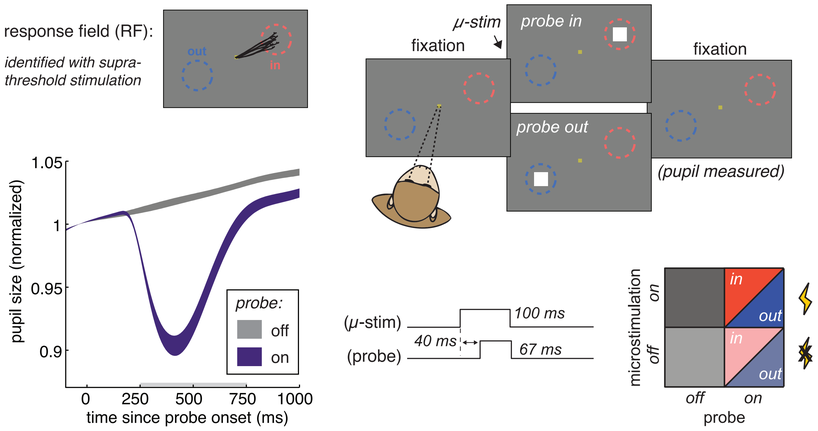
The pupil light reflex is the reflexive constriction of the pupil in response to luminance increments. The PLR depends on a simple, evolutionarily conserved, brainstem circuit: luminance information from the retina is relayed to the pretectum, and then to the Edinger-Westfall nucleus, which in turn commands the pupillary sphincter to contract. Although it is mediated by this simple circuit, the magnitude of the pupil light reflex can also be modulated by attention. Critically, **the neural basis of these modulations remains unknown.**



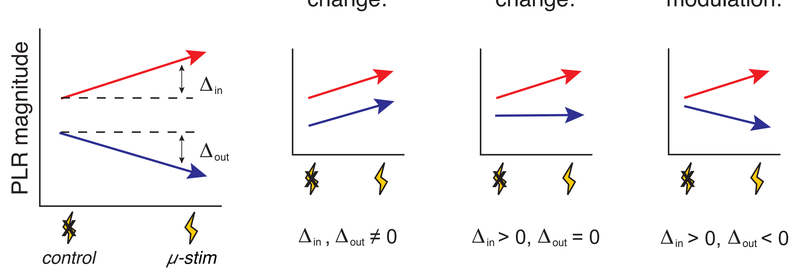
One possible source is the frontal eye field (FEF). The FEF is a prefrontal oculomotor structure with an established role in visual spatial attention. In addition, to its organized projections to posterior visual cortex and to brainstem oculomotor nuclei, the FEF projects to the pretectum, a critical node in the PLR circuit. However, whether input from prefrontal cortex can modulate this, or any, brainstem reflex is not known.

Here we show that low-current microstimulation within the FEF exerts spatially-specific modulations of this cannonical brainstem reflex.

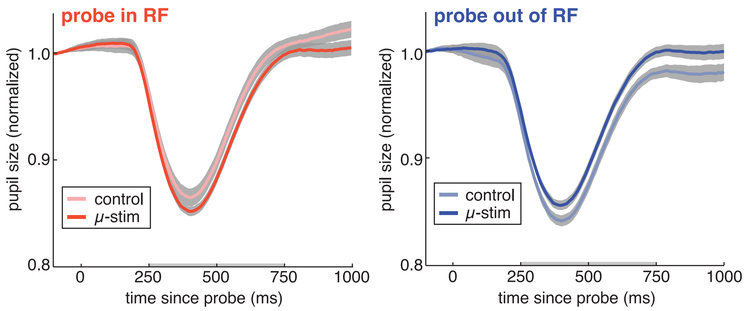
2. Method: Task and pupil light responses:



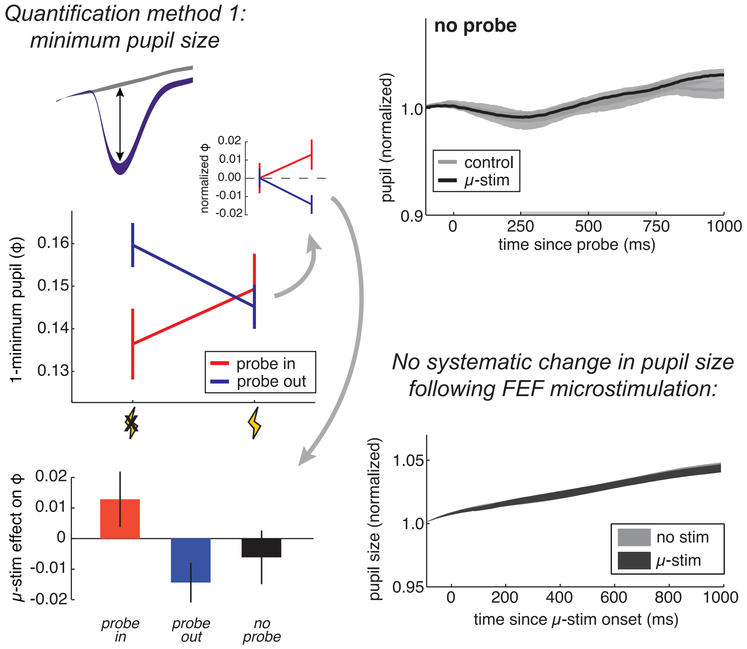
Hypotheses:



3. Results from an example session:

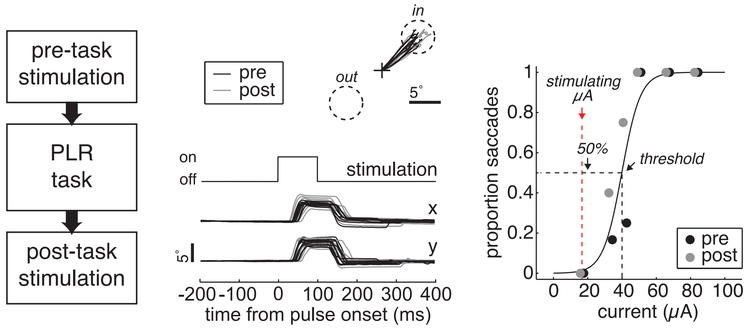


Quantification method 1: minimum pupil size

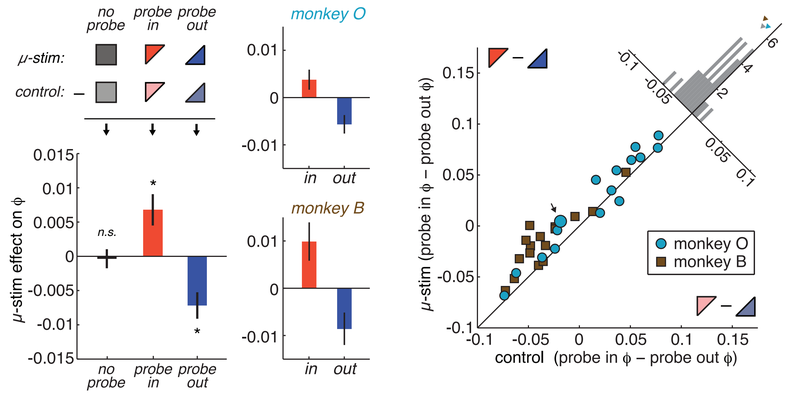


No systematic change in pupil size following FEF microstimulation:

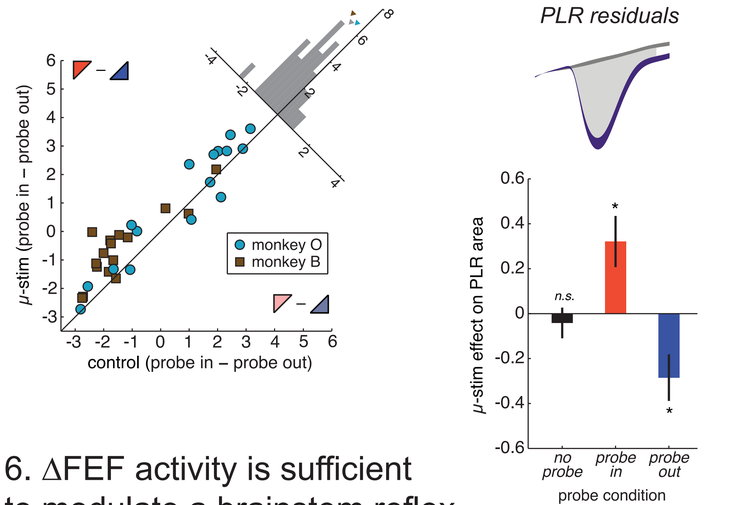
Site characterization, current levels:



4. Gain is increased across both monkeys and the population of sessions:



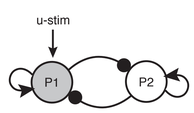
5. An alternative metric of the PLR produces an identical result:



6. ΔFEF activity is sufficient to modulate a brainstem reflex.

- μ-stimulation **does not affect** pupil size independent of visual stimuli
- μ-stimulation **increases** the PLR for probes in the response field
- μ-stimulation **decreases** the PLR for other probes

These observations suggest that the FEF exerts a spatially-specific effect on the PLR: it modulates its gain. The FEF may be one source of the cognitive modulations of the PLR and thereby contribute to anticipatory light adaptation during saccades in natural vision.



Support provided by the National Eye Institute (R01-EY014924), and a NEI T32 posdoctoral training grant and a NIMH NRSA (F32-MH102049) to RBE.