Control and Functions of Fixational Eye Movements

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**Classical view**: involuntary, uncontrolled movements; debated functions.

**Emerging view**: finely controlled; part of encoding strategies.
Recording fixational eye movements

High-resolution gaze-contingent control

Maximum delay: two frames
(10 ms at 200 Hz; typical delay 7.5 ms)

EyeRIS
A digital DPI (dDPI)
(US patent #62723169)
High-resolution gaze-contingent control
- Control of visual input

normal viewing

High-resolution gaze-contingent control
- Control of visual input

retinal stabilization

High-resolution gaze-contingent control
- Control of visual input

controlled retinal image motion
High-resolution gaze-contingent control

- Control of visual input
- Improved gaze localization


Reducing gaze localization uncertainty

Two-steps calibration procedure in which eye position is refined using a stabilized reference.

Localization improves by a factor of ~3 on each axis.

High-resolution gaze-contingent control

- Control of visual stimulation
- Improved gaze localization

1 deg


High-resolution gaze-contingent control

- Control of visual input
- Improved gaze localization
- Naturalistic tasks (no enforced fixation)
High-resolution gaze-contingent control

- Control of visual input
- Improved gaze localization
- Naturalistic tasks (no enforced fixation)

Two emerging functions

- Positioning retinal image
- Visual encoding

Microsaccades precisely shift gaze…


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Poletti, Listorti, Rucci, *Current Biology*, 2013

...to position a preferred locus
SUMMARY POINTS

1. Small eye movements, including incessant jitter (ocular drift and tremor) and occasional small saccades (microsaccades), are always present during natural visual fixation.

2. Fixational eye movements do not merely prevent the image from fading; they reformat the stimulus on the retina into a spatiotemporal signal suited for neural processing.

3. The luminance modulations that result from intersaccadic fixational eye movements enhance high spatial frequencies in the retinal input and in contrast sensitivity.

4. Luminance modulations are matched to the characteristics of the natural world. They eliminate broad correlations in natural images prior to neural processing and initiate the process of edge extraction.

5. Vision is not uniform across the fovea. Fine spatial vision is optimal within a small foveal subregion.

6. During natural execution of high-acuity tasks, microsaccades precisely move a high-acuity retinal locus within the foveola, serving similar functions to larger saccades.