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Motion integration for tracking eye movements: the fast and the slow of it

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The perceived direction of motion of a sinusoidal grating viewed through an elongated aperture is biased towards the long axis of the aperture. This 'barber-pole' illusion is a consequence of integrating ambiguous 1-D and nonambiguous 2-D local motion signals (line-endings) over the visual field. We probed the temporal dynamics of such motion integration by recording, using a scleral search coil, tracking eye movements driven by large (>50 deg^2) horizontal or vertical moving gratings (0.3 cycle deg^{-1}, 10 Hz) seen through a diagonal rectangular aperture. The initiation of ocular following responses is first driven at ultrashort latencies (80 ms) by 1-D motion signals, and 2-D motion signals start biasing the tracking direction only 15 - 20 ms later. Such latency shift is not changed when an elongated foveal mask is superimposed at the centre of the stimulus. The response magnitude in the bias direction is dependent upon the aperture aspect ratio and dramatically reduced by either reducing the contrast of end-lines or indenting the aperture. These results support current models, suggesting that feedforward processing of 1-D and 2-D motion signals have different temporal dynamics, but converge onto a single stage very early in the visual motion stream.