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Abstract: Many animal species, including humans, rely on eye movements to explore their visual environment. For vision to be useful, however, retinal inputs must be combined with signals related to the ongoing positions of the eyes, head, and body. In the macaque brain, many visually-responsive neurons exhibit systematic changes in their firing rates as a function of eye position, even in darkness. These 'eye position fields' are thought to provide a link between visual positions on the retina and positions in the world. Despite their theoretical importance, little is known about the spatial characteristics of eye position fields of single units and across cell populations. A common observation is that the firing rates of single units tend to increase monotonically as the eye moves further along a preferred axis in 2D oculomotor space. Accordingly, most investigators have summarized the eye position fields of single units by fitting a planar function to the spike data. However, theoretical work indicates that there may be computational advantages for eye position fields to include non-linear components. We investigated the shape of eye position fields by recording neural activity in four dorsal cortical areas (LIP, VIP, MT, and MST) in two awake macaques during maintained fixation at thirteen different oculomotor positions. The structure of eye position fields was examined by fitting the spike data for single-units with regression functions that included rotatable planar and quadratic components. Several notable characteristics of eye position fields were observed across the population, including: a) linear and non-linear components that were distributed around all gaze directions; and b) for cells with opposite-signed quadratic terms (i.e. "saddle" components), an alignment of the positive saddle axis to the planar component such that the neurons could be described as having broad parabolic tuning for the plane direction as well as non-linear modulation along its steepest gradient. These functional properties may provide an efficient and flexible means of representing spatial variables in the brain for perception and action.