Dynamics of heading-encoding in macaque area VIP

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Self-motion through an environment induces optic flow on the retina. In a previous study [1] we showed that neurons in the macaque ventral intraparietal area (VIP) respond selectively to such optic flow stimuli. By introducing a population code termed '*isofrequency encoding'* we showed that an ensemble of VIP neurons is capable of representing the direction of heading. This computation, however, was based on response times of up to 2000 ms. Yet, such an integration time obviously would be too long for navigational processes within everyday life. Accordingly, we were interested in the question, how fast the recorded neuronal responses would allow a reliable estimate of the current heading direction.

The present results are based on a previous study on two macaque monkeys. A complete description of the materials and methods for the recordings can be found in [1]. Data relevant for our present study stem from recordings of a subset of 54 cells while optic flow stimuli (expansion and contraction) were presented. The singularities of either expansion or contraction stimuli were positioned at one of nine different locations. We applied the previously introduced population code termed '*isofrequency encoding'* to calculate the heading direction at different temporal intervals. To do so, the mean firing activity was calculated from stimulus onset up to time t' (with t' a multiple of 50 ms). We then computed the mean neuronal responses $z(t')$ at the nine SOF locations and approximated them by the a two-dimensional regression function. The regression parameters were determined and served as input values for the isofrequency encoding.

For monotonically increasing response intervals the decoding error decreased continuously. By employing a threshold criterion we estimated a heading processing time of about 250 ms. Our results are well in line with psychophysical studies on heading perception in humans.

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References: *[1] Bremmer et al.: Eur.J.Neurosci., 16(8): 1569 - 1586 (2002)*