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Opponent motion tuning of neurons in area FST of the macaque

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The superior temporal sulcus (STS) of the macaque monkey contains several distinct motion sensitive visual areas. Neurons in these areas are typically responsive to specific kinds of motion patterns such as a direction, optic flow, or biological motion. Recent fMRI data from the monkey suggests that the fundal surface of the STS (FST) contains neurons tuned for opponent motion. However, this has not yet been confirmed electrophysiologically. Here, we present single-unit recordings confirming that a large subpopulation of neurons within area FST are tuned for opposite directions of motion and are equivalently tuned for opponent motion.

The tuning properties of this population of FST neurons are markedly different from those typically observed in MT, one of the principal input areas to FST. When tested with translating random-dot patterns, the FST neurons responded strongly to motion in two opposite directions but were weakly driven or inhibited (relative to static response) by motion in the orthogonal directions. In contrast, MT neurons are highly direction selective, responding strongly to one direction and weakly to motion in the opposite direction. Hand-mapping revealed that FST neurons have spatially homogeneous receptive fields with respect to direction selectivity. Specifically, each neuron was selective for two opposite directions of motion at all locations within the receptive field.

Further, when tested with a type of opponent motion stimulus called transparent motion, in which two random-dot patterns translate in opposite directions in the same depth plane, the FST opponent motion tuning curves were matched to the direction tuning curves in response pattern and amplitude. In MT, the response pattern is matched but the response amplitude is significantly weaker for transparent motion stimuli.

We propose that the tuning properties of the opponent motion responsive FST neurons reported here can be reproduced by performing a linear transformation followed by a static nonlinearity on the output of a population of MT neurons. In this model, an FST neuron sums the output of MT neurons that prefer two opposite directions of motion and subtracts the output of MT neurons preferring the two orthogonal directions.