Stimulus history effects on the activity of MT neurons

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In natural environments the velocity of moving objects continually changes. Successful interaction with such objects requires not only an up-to-date estimate of the current motion direction and speed, but also of the ongoing changes of these parameters. We investigated whether area MT - the main motion area in the primate brain - also carries information on recent stimulus history.

We recorded from MT neurons during visual stimulation with moving random dot patterns whose motion direction or speed changed continuously over time. For each condition (direction and speed) stimuli were constructed in mirrored pairs, so that the same motion states (directions or speeds, respectively) were present in each pair member. However, for each motion state the stimulus history, i.e. the preceding directions or speeds, differed between the pair members.

We found influences of stimulus history on the tuning of nearly 70% of neurons. The change in direction tuning carried information that could be used to encode the curvature of the recent motion path. In the case of the speed tuning, the history effect mainly consisted of a change in tuning width. The speed tuning was narrower when the stimulus was accelerating than when it was decelerating.

This suggests that the system is less sensitive to speed changes when the stimulus smoothly accelerates than when it decelerates. We investigated this in a psychophysical experiment with human subjects. We determined detection thresholds to speed changes in a smoothly accelerating or decelerating stimulus. The results confirmed the prediction: during smooth deceleration, sensitivity was much lower than during smooth acceleration.

Overall, our results demonstrate that MT cells do not solely represent snapshots of the ongoing motion. They also carry information on preceding motion features. At least in the case of speed history, the effects in MT correlate with a perceptual effect. More generally, the observed effect of stimulus history in MT responses may be used to predict motion paths and thus enables successful interaction with moving objects.