Detecting top-down influences and predicting upcoming choice from neural activity in sensory area MT in a working memory task

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**Introduction**

- MT neurons show direction selective (DS) activity in response to contralateral visual motion.
- During memory-guided direction comparison tasks, neurons in the lateral prefrontal cortex (LPFC) also show DS responses to motion, most likely supplied by MT.
- These parallels in activity between MT and LPFC suggest a possibility of reciprocal exchange of signals between the two areas.
- During such tasks, MT feeding bottom-up signals to LPFC and LPFC providing top-down influences to MT.
- We tested the presence of potential top-down influences on activity in MT while monkeys compared two directions of motion separated by a delay.

**Methods**

**Memory-guided direction comparison task**

*Fixation* → *S1* → *Delay* → *S2* → *Post-S2* → *Session*

**MT Recordings**

- Two monkeys, 16 / 6 sessions
- 16-channel V-probe (Plexon)
- Receptive field of channels mapped before task recording
- Each channel was manually spike sorted offline

**Direction selectivity during direction task**

- Mean preferred / anti-preferred (null) response
- Full response / partial / null
- Mean tuning curve during S1 and S2

**Tuning parameters during S1 and S2**

- All units
- Mean / tuning width / directional selectivity

**Effect of task demand: task vs passive fixation**

- Decoding accuracy is equally high in task and passive fixation when simultaneously decoding across all 8 stimulus directions.
- Also when decoding two directions only.

**Decision / response signal**

- Upcoming decision of animal is decodable from population activity.
- In most sessions, the effect increases in strength towards the end of the trial.

**Effect of preceding stimulus and task demand**

- Slightly reduction of gain during S2 in “same” trials.
- Slight reduction in direction selectivity in every parameter, e.g. increased tuning width.
- Task demand / context have an effect on the direction selectivity of MT neurons.

**Effect of task demand: task vs passive fixation**

- Increased tuning width.
- Slight reduction in direction selectivity in every parameter, e.g. increased tuning width.
- Task demand / context have an effect on the direction selectivity of MT neurons.

**Summary & Conclusions**

- Direction selectivity of neurons in MT depends both on
  - bottom-up factors, such as stimulus repetition, and
  - top-down influences, such as task demand / context.
- Population decoding results suggests that slight reduction of direction selectivity at the level of individual neurons may be compensated at the network level.
- Similarly to neurons in PFC, MT neurons exhibit ramping activity during the delay period in preparation to second stimulus, a likely top-down effect.
- MT neurons carry information about the decision / upcoming response more than 1000 ms before the actual response occurs.
- Lateralized nature of effect suggests decision signal may reflect preparation for motor response.