### Coding of walking direction by macaque visual temporal cortical neurons

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**Introduction**

1) Human psychophysical studies on biological motion perception employed human treadmill locomotion (e.g. Cole & Giese, JVS, 2000; Orban & Tres, JVS, 2003; Thaman & Grieve, IoN, 2006;...)

2) Previous single-cell studies found selective responses in the Superior Temporal Sulcus to walkers translating across the visual field, i.e. containing translatory motion components (e.g. Giese & Perrett, JVS, 1995; Neuburger, 1994;...)

3) Goal 2: determining contribution of FORM vs. MOTION by presenting displays differing only in motion (same snapshots: forward/backward) and in both motion and form (a facing direction)

**Methods**

- Cylinder-like primitives (size 6° × 2.8°)
  - Motion capture data
  - Visual stimulation
- Fixation window: 1.3° – 1.7°
- 2 rostral rhesus monkeys
- Standard single-cell recordings
- Subjects were extensively trained in forward/backward and facing direction categorization tasks prior to the recordings, reaching proficiency in both discrimination types

**Recording Sites**

1. rostral Superior Temporal Sulcus
   - (a) Upper bank
   - (b) lower bank
2. Lateral convexity of Inferotemporal Cx

**Example Test**

**Direction Test**

- Example cells
- PWD: BWD
- **Effects**: Facing direction & forward/backward
- Mean effect: 0.59 median effect: 0.43

**Population Analyses: Support Vector Machines**

- Confusion matrix
- Linear Support Vector Machines
- 1000 permutations
  - N = 51: median rho = 0.57
- Acoustic Indices
  - Rs1 = max gross firing rate (1/7)
  - Rs2 = max gross firing rate (1/7)
  - Rs1 + Rs2 / 2
- Mean effect: 0.59 median effect: 0.43

- Acoustic Indices
  - Rs1 = max gross firing rate (1/7)
  - Rs2 = min gross firing rate (1/7)
  - Rs1 + Rs2 / 2

- Median d(FWD vs. BWD) = 0.56

**Population Analyses: Support Vector Machines**

- SVM above
  - N = 43 cells

**Comparing Statics & Action Test**

- Action Indices
  - Action Index = (Pa – max Ps) / (Pa + max Ps)
  - Pa = peak firing action
  - Pw = peak firing static (1/7)
  - SVM: d = sqrt(var(Rs1 + Rs2 / 2))

- Selectivity for static snapshots
  - Rs1 – Rs2
  - D’s for statics: n = 42 cells: median rho = 0.44

- Correlation Static – Action Frames

- Spearman’s ρ
  - static (vs. action: [frame – frame +550])
  - Significant static selectivity (1-way ANOVA)

**Conclusion**

1. Lower bank STS/IT neurons are selective for walking direction even when these are defined without translatory motion
2. Lower bank STS/IT neurons poorly distinguish locomotion directions that differ only in snapshot sequence, but nonetheless the population of such neurons is able to classify forward-backward above chance (SVM)
3. More reliable signals of forward/backward locomotion might be present in other regions than IT cortex.
4. Single neurons are selective for postures of the walking cycle, in line with form-based modules postulated in action recognition models (Grimes & Poggio, 2000; Lange & Sapiro, 2008)