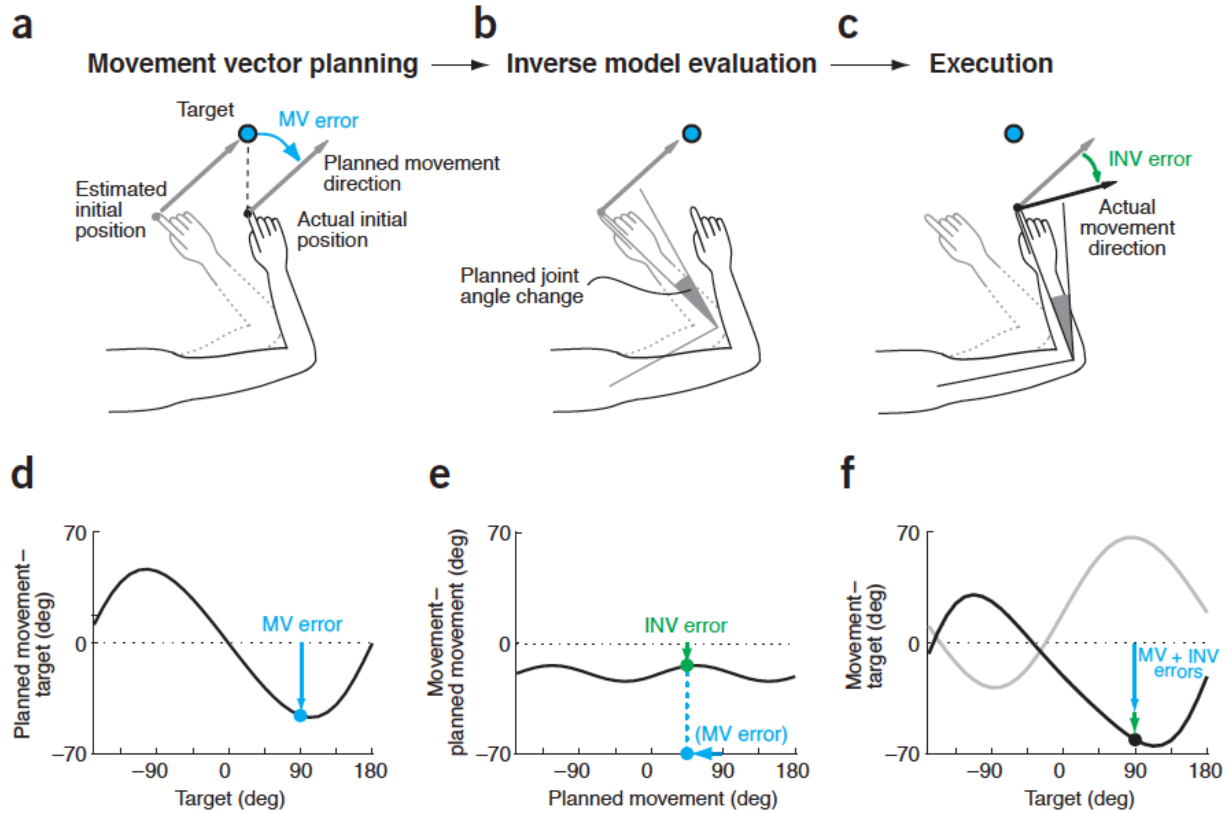
Flexible strategies for sensory integration during motor planning

Sober and Sabes, Nat. Neurosci. 2005

MV error vs. INV error

$$\hat{x} = \alpha \hat{x}_v + (1-\alpha)\hat{x}_p$$



$$\alpha_{MV} = 0.9 \qquad \alpha_{INV} = 0.3$$

Sober and Sabes, J Neurosci., 2003

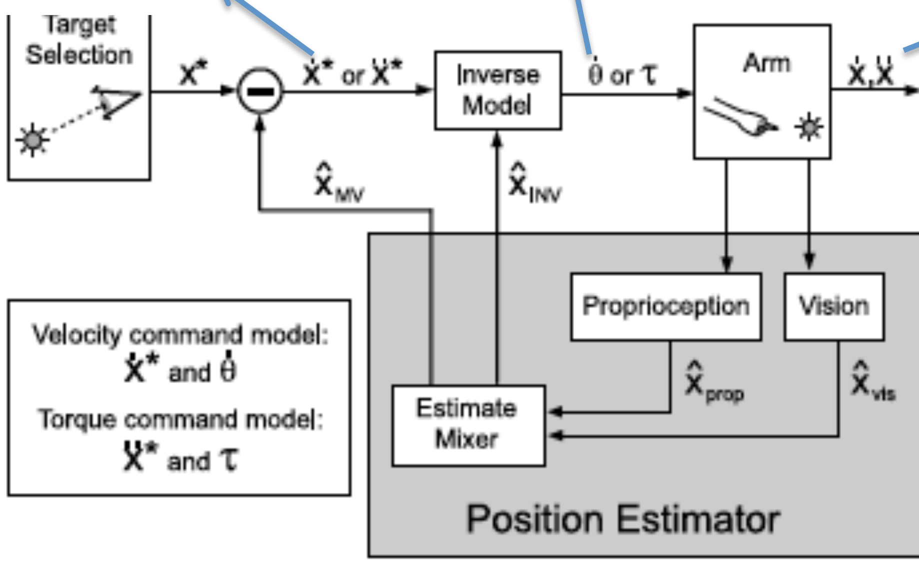
Model general structure

$$\hat{\theta}_{\mathrm{INV}} = K^{-1}(\hat{x}_{\mathrm{INV}})$$

$$\dot{\theta} = J^{-1}(\hat{\theta}_{\mathrm{INV}})\dot{x}^*$$

$$\measuredangle\, \dot{x}^* = \measuredangle\,(x_d^* - \hat{x}_{\mathrm{MV}}) + \omega_d$$

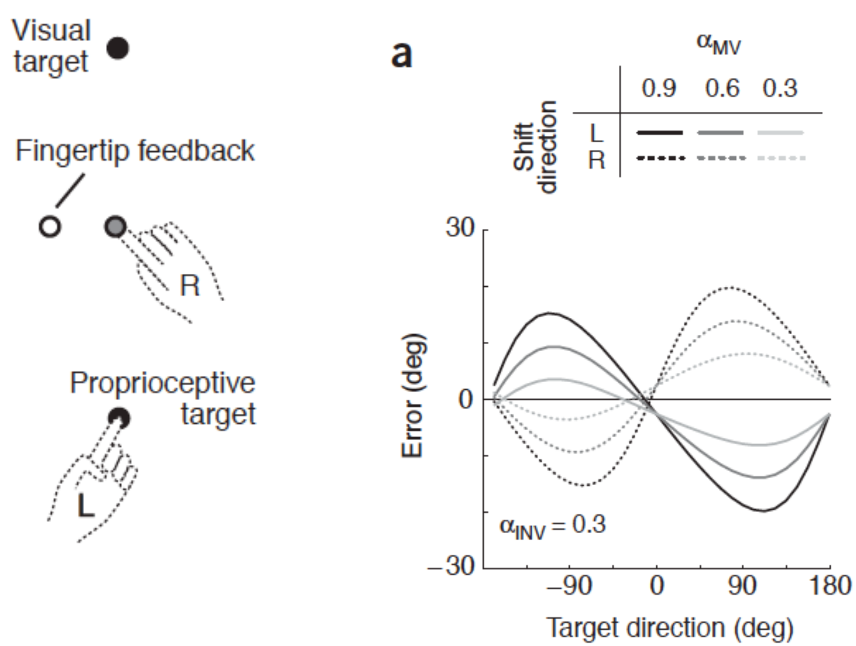
$$\dot{x} = J(\theta)\dot{\theta} = [J(\theta)J^{-1}(\hat{\theta}_{\mathrm{INV}})]\dot{x}^*$$



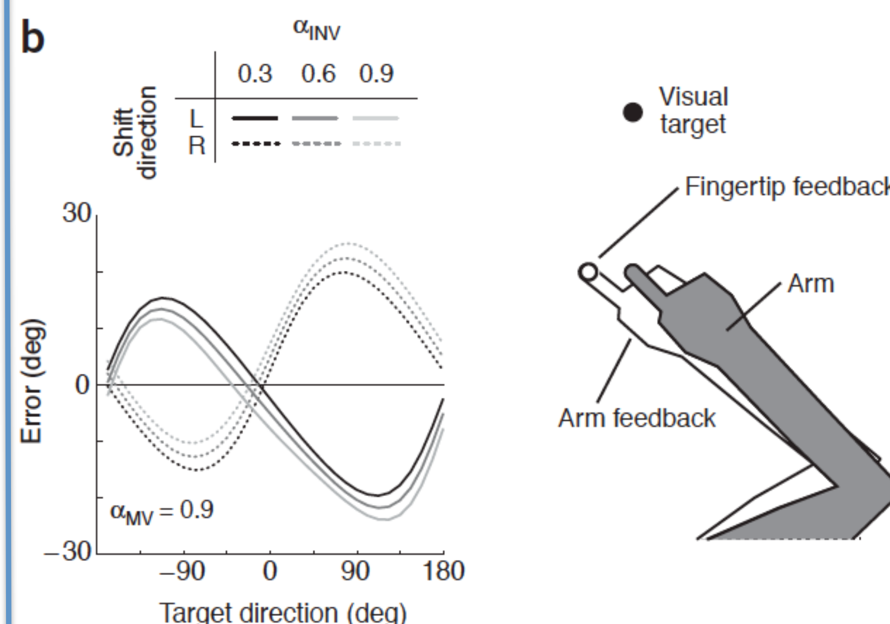
Sober and Sabes, J Neurosci., 2003

Model prediction if weights change

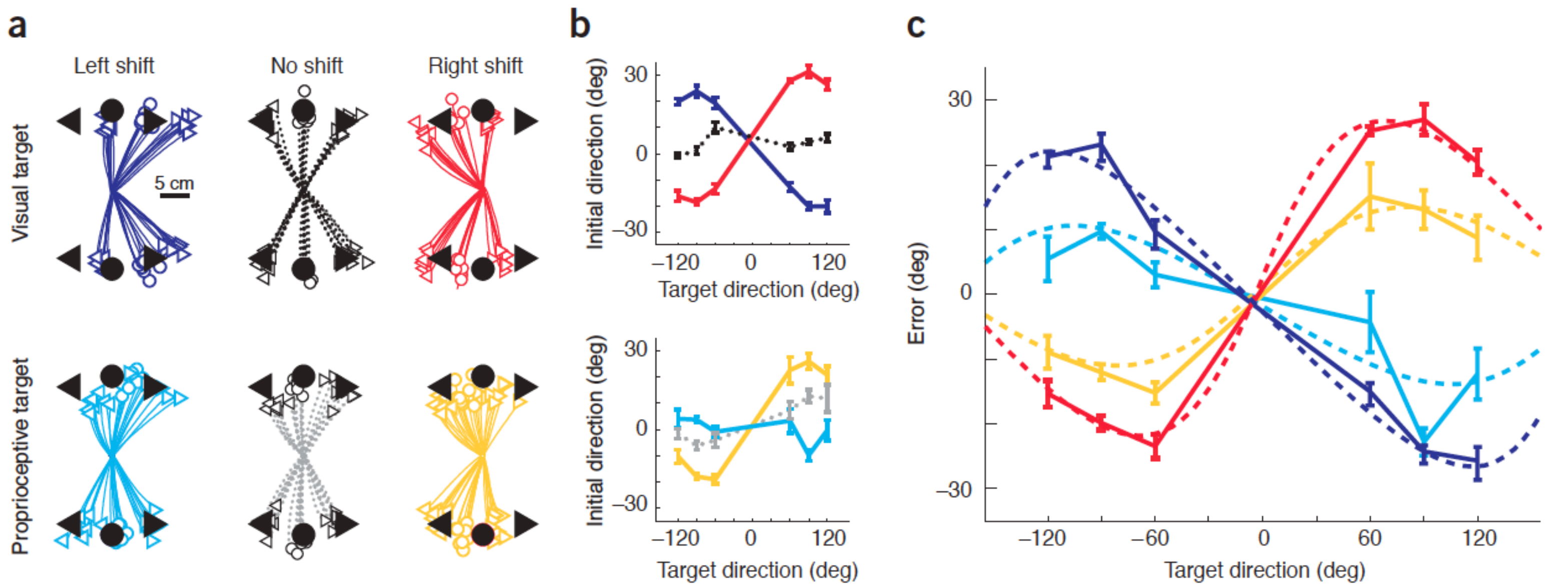
Experiment 1:
Target is proprioceptive

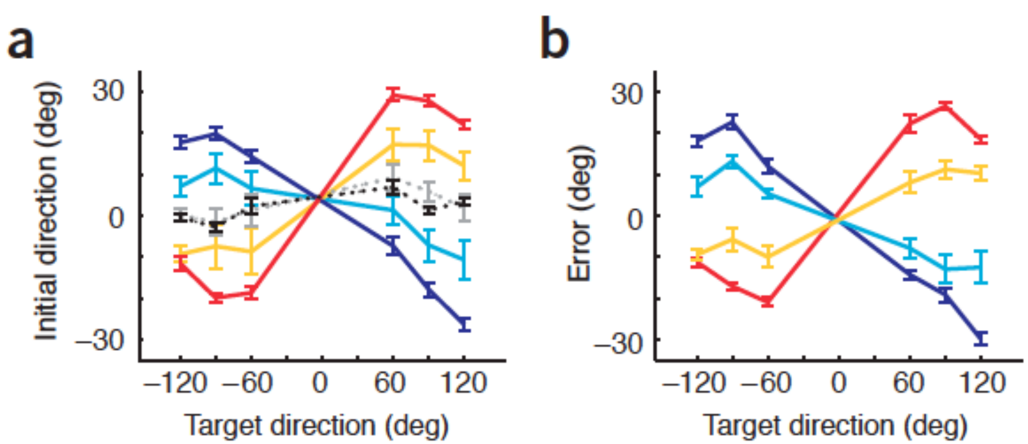


Experiment 2:
Visual feedback of all arm



Experiment 1 – proprioceptive target





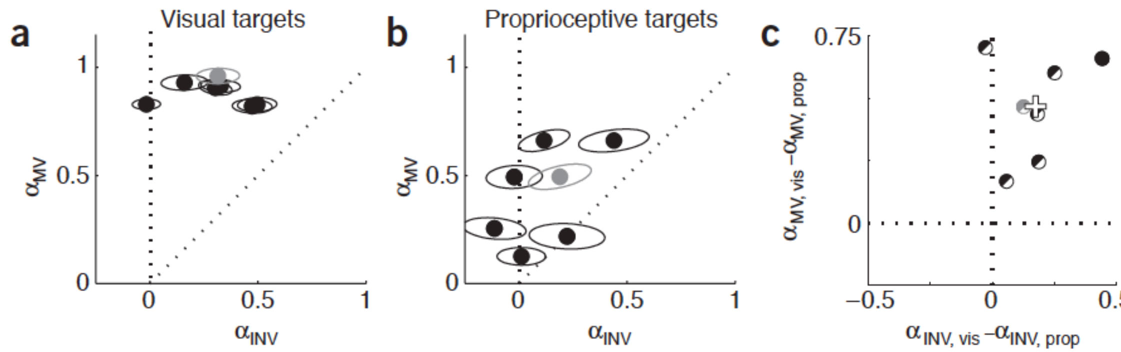
$$\alpha_{MV_{visualT}} = 0.88$$

$$\alpha_{MV_{proprioceptiveT}} = 0.42$$

Experiment 1 – proprioceptive target

$$\alpha_{MV_{visualT}} = 0.88$$

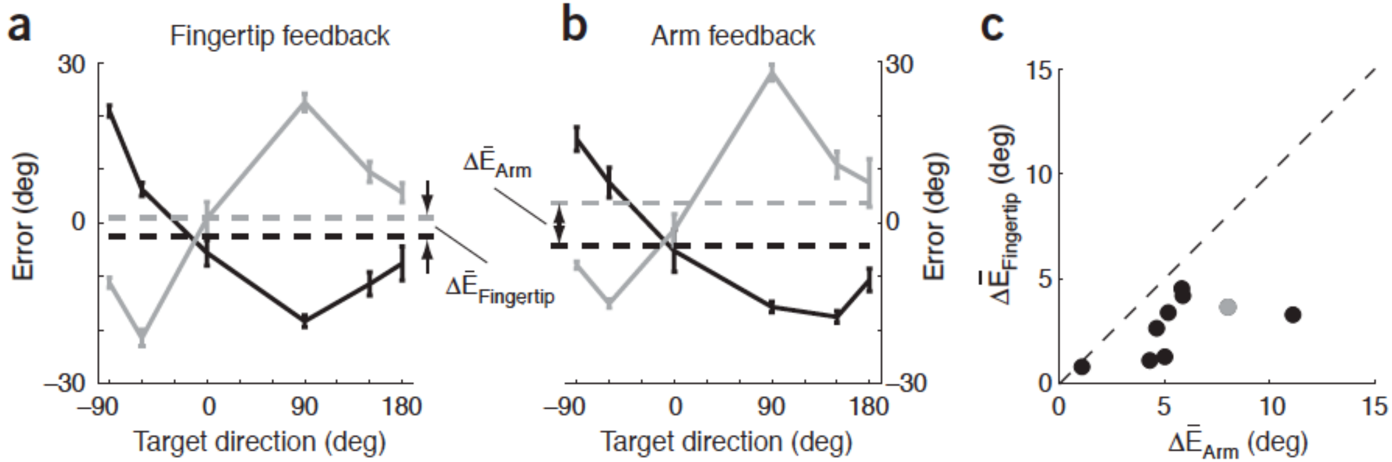
$$\alpha_{MV_{proprioceptiveT}} = 0.42$$



Controls:

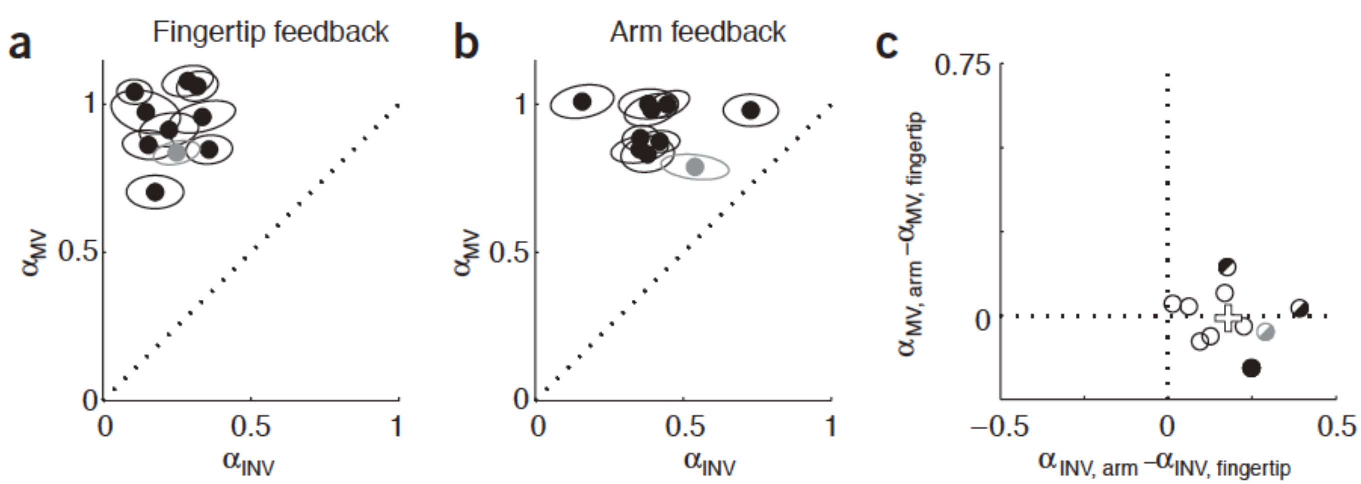
- Visual shift did not effect proprioception of left hand
- Changes in \alpha were similar regardless of gaze constraint
- Changes in \alpha were similar when left hand was moved passively

Experiment 2 – visual feedback type



$$\alpha_{INV_{tip}} = 0.24$$

$$\alpha_{INV_{arm}} = 0.42$$



Discussion

- Main contribution – the weighting of sensory signals is not dependent on input statistics alone!
- In a single experiment, weighting can be different at different stages of movement generation
  – They suggest that it minimizes transformation related noise

- Experiment 1 – unclear observations
  – Asymmetry between visual and proprioceptive conditions not clear
  – Why \alpha_inv decreased as well?
- Experiment 2 – not discussed why the values of \alpha_inv are generally so low