**Neurodynamical Model for the Multi-stable Perception of Biological Motion**

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**Introduction**

- **Bistable perception:** sometimes 2 alternative perceptions can be caused by the same stimulus
- **Biological motion perception:** Perception of body motion, induced also by impoverished visual stimuli such as point-light walkers (Johansson, 1973).
- **Body motion perception can be bistable** (Vannie et al. 2004; 2006; Vangeneugden et al. 2012)
- The perception of body motion has been modelled using physiologically plausible architectures (Giese & Poggio, 2003; Lange & Lappe, 2006). These models cannot deal with perceptual multi-stability.

**Bistable body motion stimulus**

- No disparity cues.
- Upper and lower body consistent with motion in different directions.
- Two movement directions are perceived in alternation; perceptual switching (Vannie et al. 2006)
- Similar perceptual multi-stability observed for other perceptual phenomena (reviews e.g. Blake 2001, Leopold 1999).

**Goals**

- Accounting for multi-stable perception of body motion by physiologically-inspired dynamical neural models.
- Replication of neurophysiological data of switching times

**Neural model for body motion perception**

**Overview**

- **Form pathway:** Contour feature detectors, Complex cell receptive fields.
- **Motion pathway:** Local OF detectors, Complex cell receptive fields.

**Two Pathways**

- **Form pathway:** Extracted features: Bars, Body shapes, Sequence of elementary shapes.
  - Area: V1/2, MT, MST.KD, F5.
- **Motion pathway:** Extracted features: Local OF patterns, Sequence of complex OF patterns.
  - Area: STS, F5, FST.

**Template detectors for ‘snapshots’ (radial basis function units)**

- **Form pathway:** “Snapshot neurons” trained on different views.
- **Motion pathway:** “Motion pattern neurons” trained on different views.

**Response statistics**

- **Snapshot neurons:** $u_i(t) = -u_i(t) + x_i(t)$
  - Respond to keyframes.
  - Sequence selectivity emerging from asymmetric lateral connections.
  - Dynamic neural field with stable travelling pulse solution.
- **Motion pattern neuron:** $y(t) = -y(t) + \sum f(u_i(t))$
  - Sums responses from snapshot neurons.
  - Low-pass characteristics.
  - Signals presence of walking with specific viewpoint.

**Extension: addition of inhibition and noise!**

- **Three alternative views.**
- **Decision dynamics:** top-down inhibition between networks for different views.
- **Addition of Gaussian white noise:** $(a, b > 0; f: param. pattern no.)$

**Results**

**Responses of snapshot neurons and motion pattern neurons to unambiguous training stimuli**

- **Walking 45°**
- **Walking 45°**
- **Walking 180°**
- **Inhibition**

**Test with ambiguous stimulus (derived by morphing)**

**Activation of motion pattern neurons**

- Ambiguous stimulus generated by morphing 45° and 45°.
- Responses of motion pattern neurons encoding 45° switch spontaneously over time.
- MP neuron for third view not activated.

**Neural activity dynamics reproduces perceptual switching between the different views over time.**

**Conclusions**

- Experimentally observed multi-stability of body motion perception can be accounted for by simple extension of Giese-Poggio model.
- More detailed quantitative simulations in progress; different types of decision dynamics being tested.
- Further extension: Addition of adaptation dynamics to produce switching by adaptation.
- More accurate account for the phenomenon likely requires implementation of additional pathways for 3D or disparity cues.

**References**


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