

Visual Motion

Alan Yuille

Barber Pole Illusion

- Barberpole:
- <http://www.youtube.com/watch?v=Hs-Tkqbwgd4>
- Rotating ellipse: occluders.
- <http://www.youtube.com/watch?v=A14vrl9gY7Y>
- Akiyoshi's illusion page:
- <http://www.ritsumei.ac.jp/~akitaoka/index-e.html>

Barlow and Tripathy: Ideal Observer

- N dots – C move coherently, Correspondence Problem.

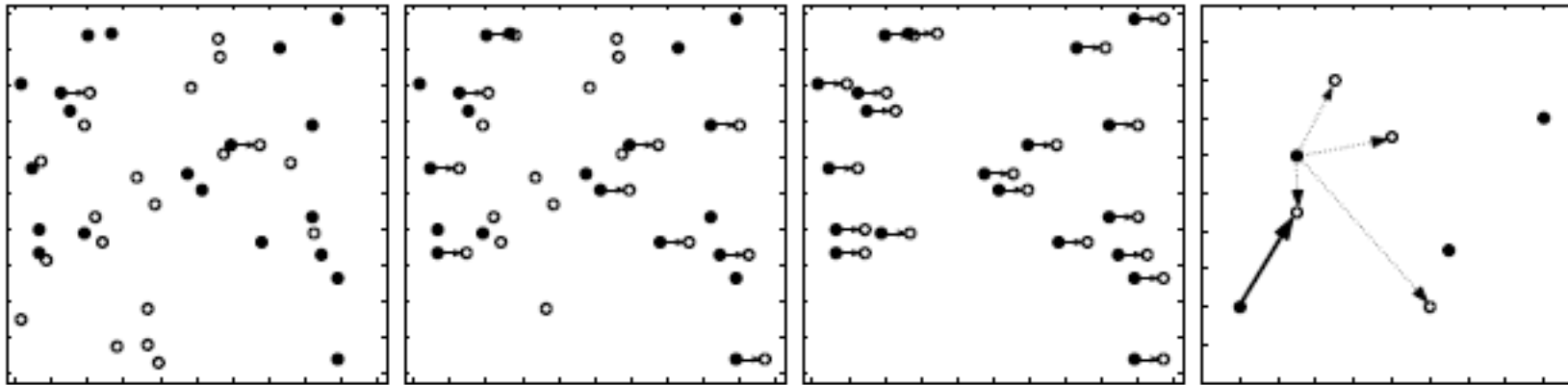


Figure 1: The left three panels show coherent stimuli with $N = 20, C = 0.1$, $N = 20, C = 0.5$ and $N = 20, C = 1.0$ respectively. The closed and open circles denote dots in the first and second frame respectively. The arrows show the motion of those dots which are moving coherently. Correspondence noise is illustrated by the far right panel showing that a dot in the first frame has many candidate matches in the second frame.

Ideal Observer: Barlow and Tripathy, Lu and Yuille

- Psi is the number of matches for translation T – include false matches,

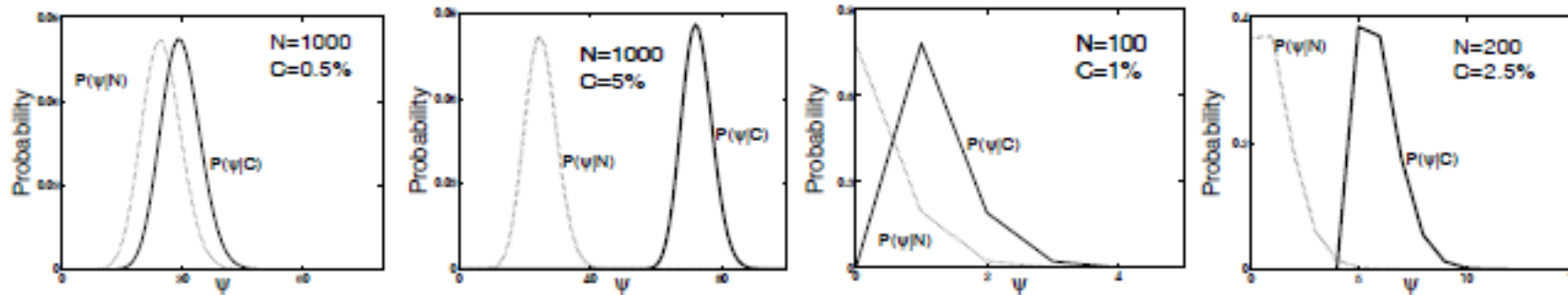


Figure 2: We plot $P(\Psi|\text{Coh}, T)$ and $P(\Psi|\text{Incoh})$, shown as $P(\Psi|C)$ and $P(\Psi|N)$ respectively, for a range of N and C . One of Barlow and Tripathy's two approximations are justified if the distributions are Gaussian with the same variance. This is true for large N (left two panels) but fails for small N (right two panels). Note that human thresholds are roughly 30 times higher than for BIO (the scales on graphs differ).

Comparison to Human Performance

- Humans do much worse than the models – threshold C is much higher.

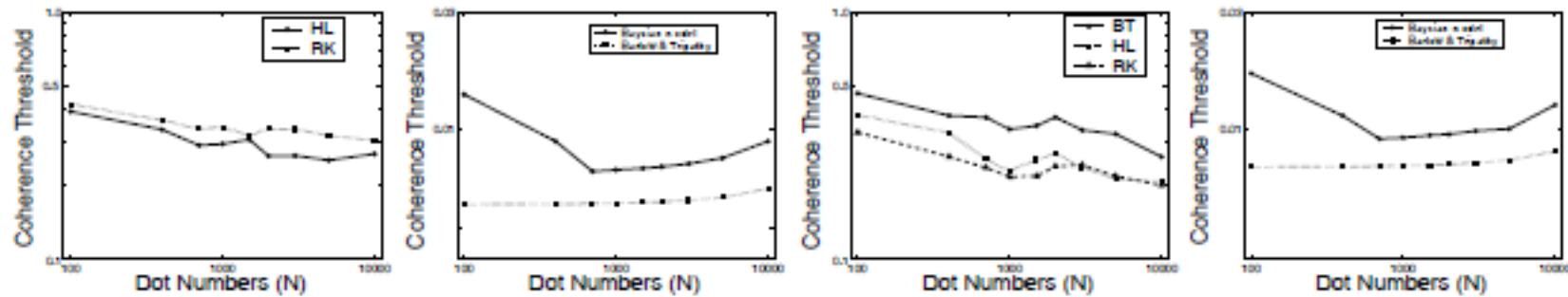


Figure 3: The left two panels show detection thresholds – human subjects (far left) and BIO and BT thresholds (left). The right two panels show discrimination thresholds – human subjects (right) and BIO and BT (far right).

How badly must you degrade model to get human performance?

- A lot!

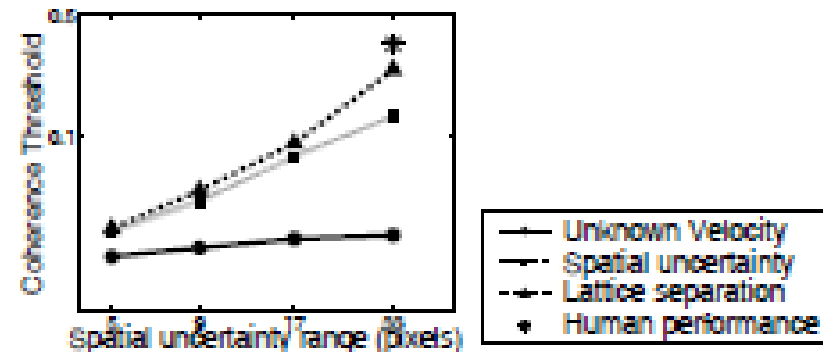


Figure 4: Comparing the degraded models to human performance. We use a log-log plot because the differences between humans and model thresholds is very large.

Predictions of the Ideal Observer Models

- Human performance is relatively independent of the number N of dots and the size of the translation T . Unlike the ideal observer models.

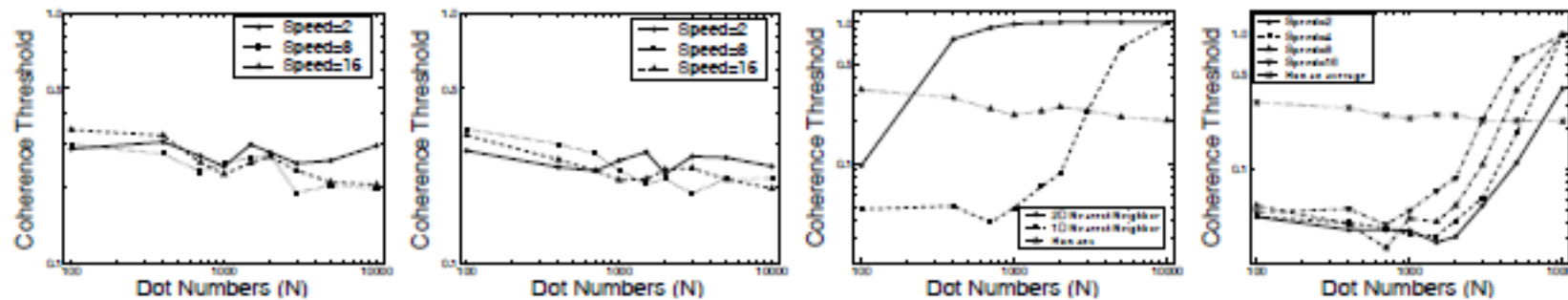
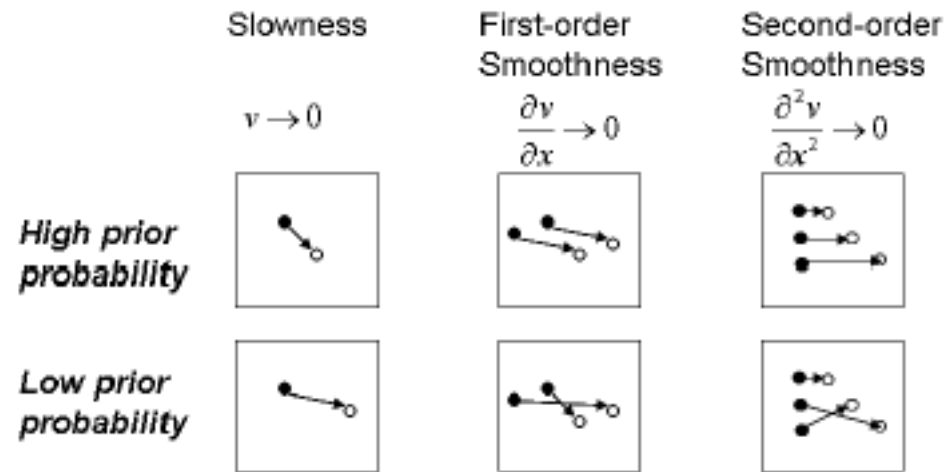


Figure 5: The coherence threshold as a function of N for different translation motions T . From left to right, human subject (HL), human subject (RK), 2DNN (shown for $T = 16$ only), and 1DNN. In the two right panels we have drawn the average human performance for comparison.

Alternative: Slow and Smooth

- Maybe humans are not ideal for the experiments specified in laboratories. Maybe humans are better adapted to real world stimuli.



Effects of Slow-And-Smooth

- Some results

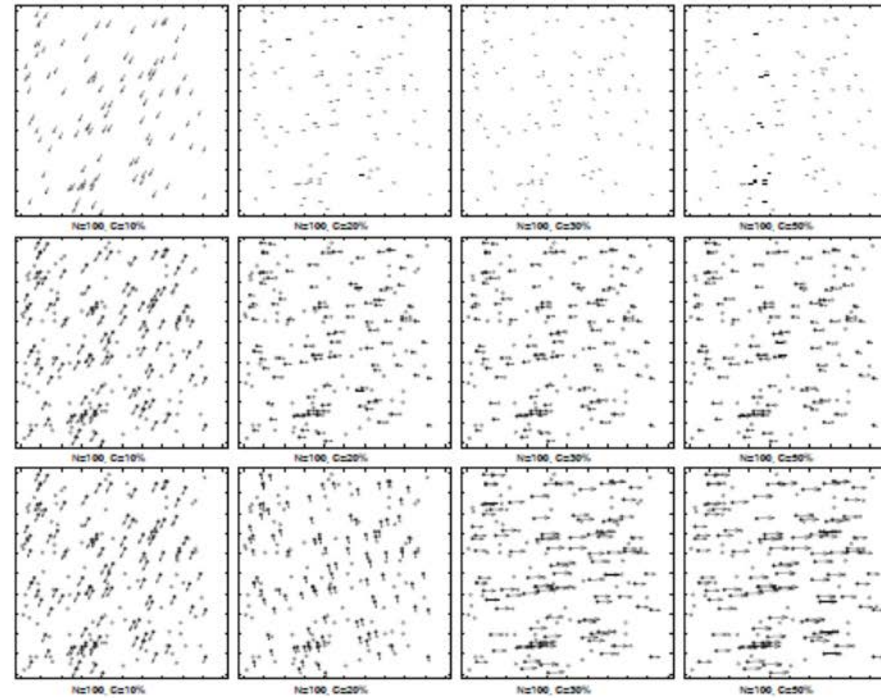


Figure 6: The motion flows from Slow-and-Smooth for $N = 100$ as functions of C and T . From left to right, $C = 0.1, C = 0.2, C = 0.3, C = 0.5$. From top to bottom, $T = 4, T = 8, T = 16$. The closed and open circles denote dots in the first and second frame respectively. The arrows indicate the motion flow specified by the Slow-and-Smooth model.

Motion Flows: Slow and Smooth

- Predictions of slow-and-smooth model fit human data fairly well.

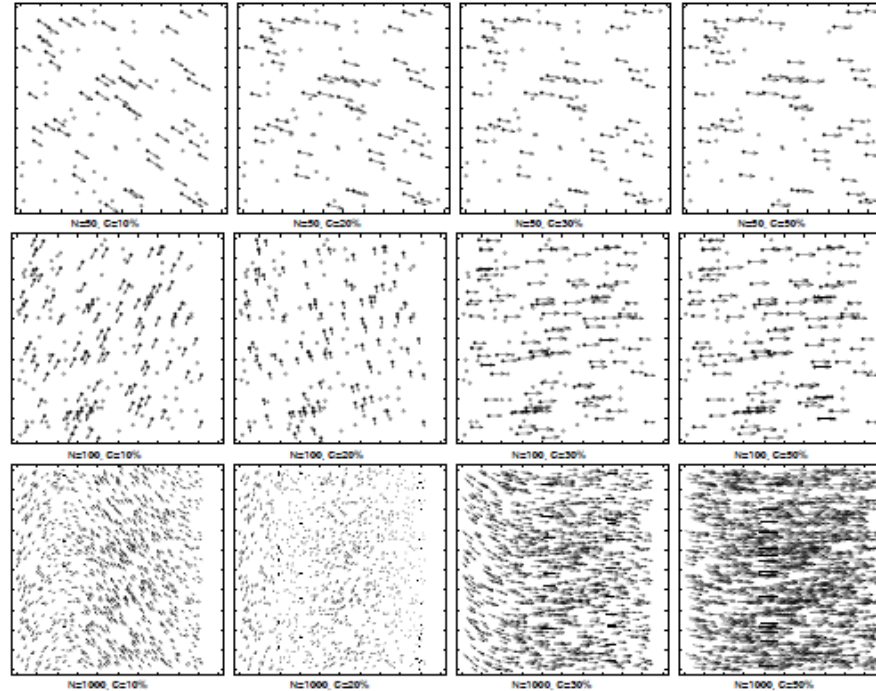


Figure 7: The motion fields of Slow-and-Smooth for $T = 16$ as a function of c and N . From left to right, $C = 0.1, C = 0.2, C = 0.3, C = 0.5$. From top to bottom, $N = 50, N = 100, N = 1000$. Same conventions as for previous figure.

Other Effects

- Competitive Priors – expansion, rotation, translation.
- Layered Surfaces.
- Motion over time.
- Perception of Structure from Motion.