Serial Dependence in visual perception

Jason Fischer, David Whitney (NN2014)

Gatsby Tea Talk

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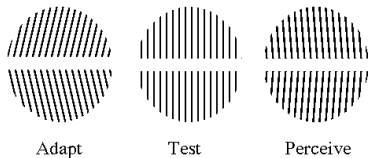
Background

Two potentially *competing goals* of sensory systems

Background

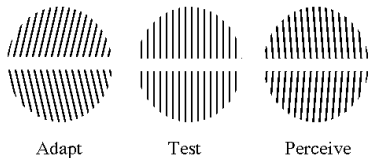Two potentially *competing goals* of sensory systems

- maximize change sensitivity: neural/sensory adaptation:
  - Negative Aftereffects (repulsion)

Adapt   Test   Perceive

Background

Two potentially *competing goals* of sensory systems

- maximize change sensitivity: neural/sensory adaptation:
  - Negative Aftereffects (repulsion)
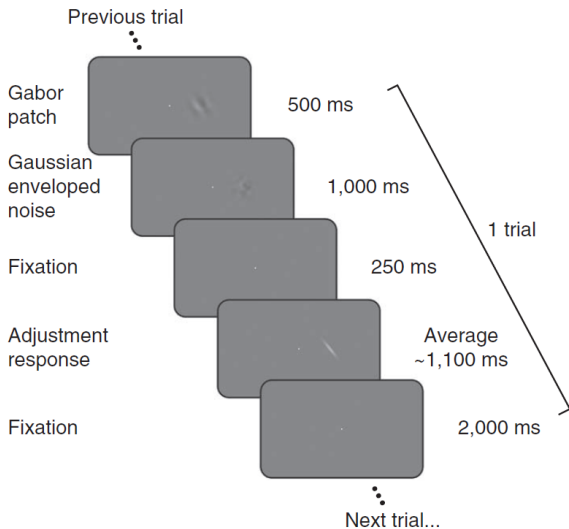

Adapt   Test   Perceive

- capitalize on temporal continuity: serial dependence
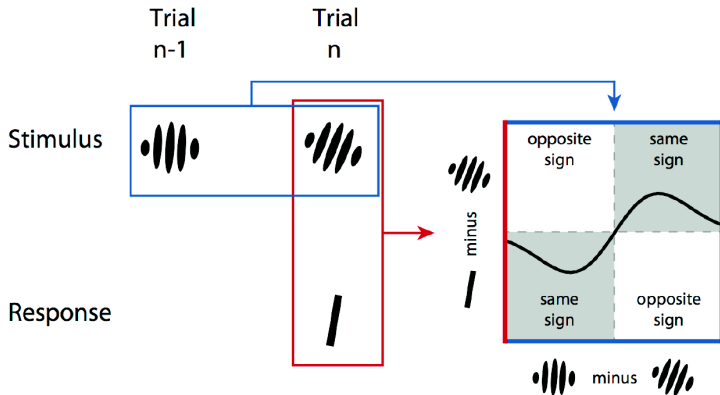 - Positive Aftereffects (attraction)

Content

Five Experiments on Serial dependence

- ▶ Exp1: Serial dependence in visual task
- ▶ Exp2: Controlling for hysteresis in motor responses
- ▶ Exp3: Controlling for decision processes
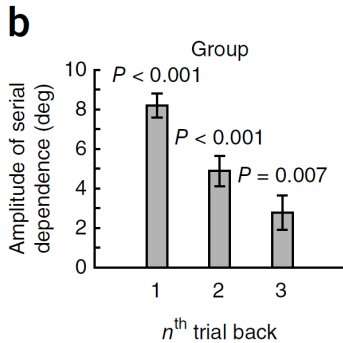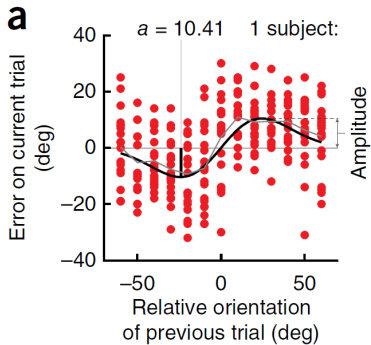- ▶ Exp4: Attention modulation
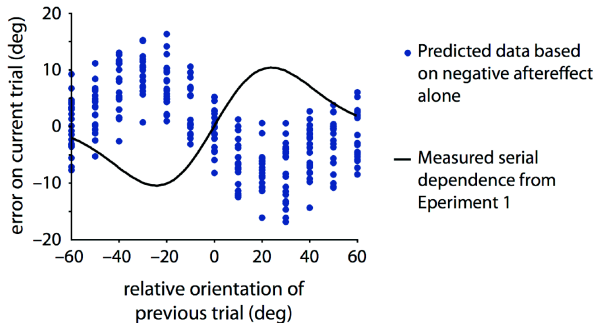- ▶ Exp5: Spatial tuning
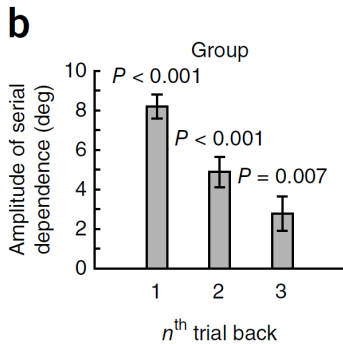
Exp1

Serial Dependence

Exp1: Results

Exp1: Simulating adaptation

- Predicted data based on negative aftereffect alone

— Measured serial dependence from Eperiment 1
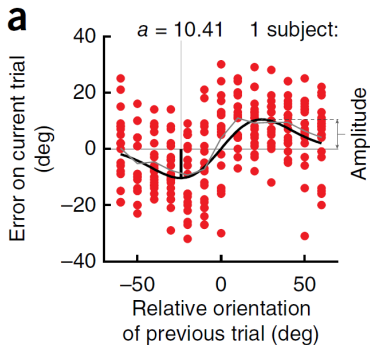
Exp1: Results & Controls
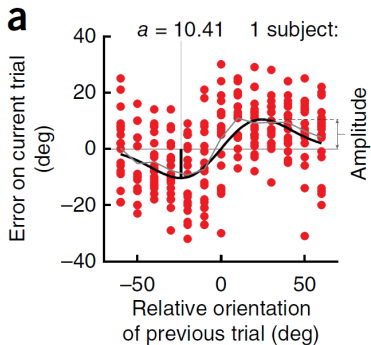
Exp1: Results & Controls
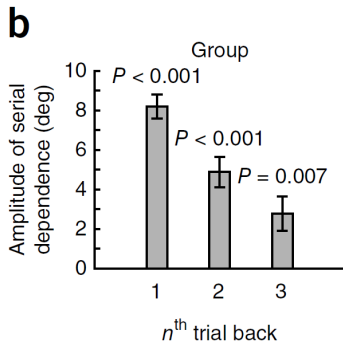
Needs controls:

- motor execution? -> 25% trials with no action, no change in results

Exp1: Results & Controls

a

Error on current trial (deg) vs Relative orientation of previous trial (deg)

$a = 10.41$ 1 subject:

Amplitude

b

Group

Amplitude of serial dependence (deg) vs n^{th} trial back

$P < 0.001$

$P < 0.001$

$P = 0.007$
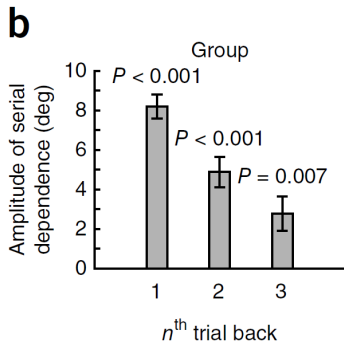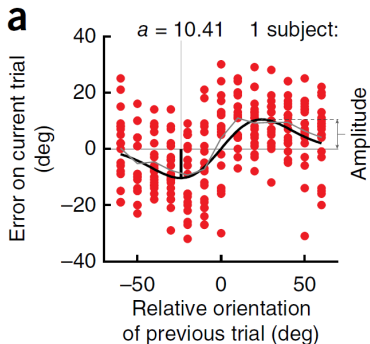
Needs controls:

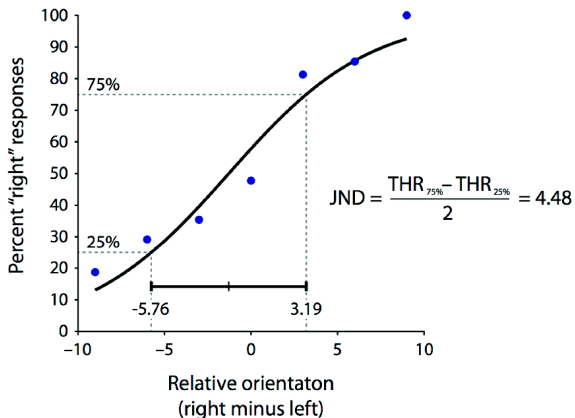▶ motor execution? -> 25% trials with no action, no change in results

▶ explicity memory? -> 25% trial question about past stim (left/right) : chance level, still serial dependence

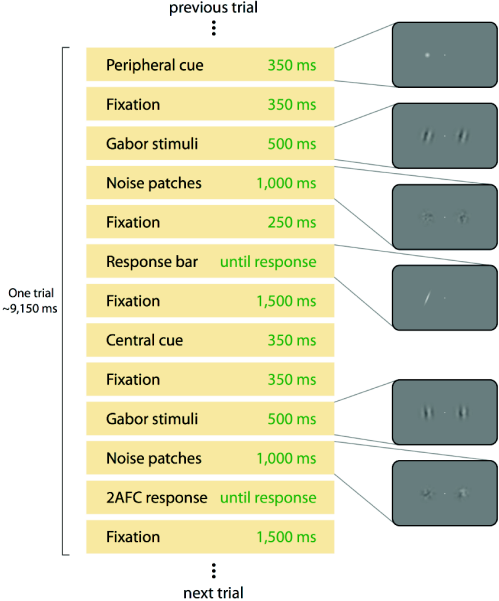# Illusion (altering perception)

Can serial dependence induce an illusion?

Illusion (altering perception)

Can serial dependence induce an illusion?
Discrimination task (2AFC)

$$JND = \frac{THR_{75\%} - THR_{25\%}}{2} = 4.48$$

Exp3: Illusion

Discrimination task (2AFC) +adjustment

previous trial

One trial ~9,150 ms	Peripheral cue	350 ms
	Fixation	350 ms
	Gabor stimuli	500 ms
	Noise patches	1,000 ms
	Fixation	250 ms
	Response bar	until response
	Fixation	1,500 ms
	Central cue	350 ms
	Fixation	350 ms
	Gabor stimuli	500 ms
	Noise patches	1,000 ms
	2AFC response	until response
	Fixation	1,500 ms

next trial

Illusion

Adjustment task + Discrimination task (2AFC)

Illusion

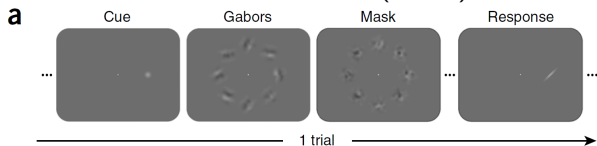Adjustment task + Discrimination task (2AFC)

c ΔPSE $P < 0.001$
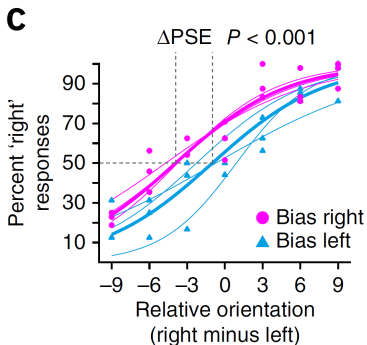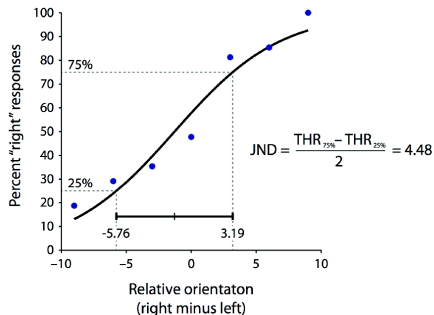
Serial dependence based on cued inducer (adjusted)

Exp4: Effect of Attention (gating)
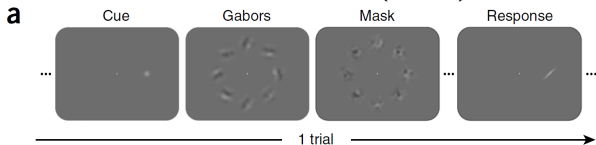
Adjustment task + Discrimination task (2AFC)

Exp4: Effect of Attention (gating)

Adjustment task + Discrimination task (2AFC)
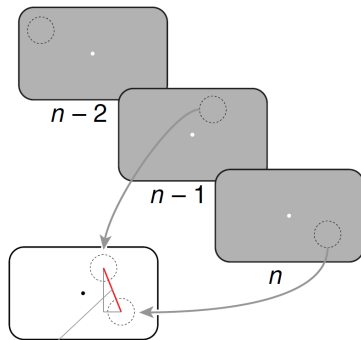
a

Cue   Gabors   Mask   Response

1 trial

Exp4: Effect of Attention (gating)

Adjustment task + Discrimination task (2AFC)

Exp5: spatial tuning of perceptual serial dependence

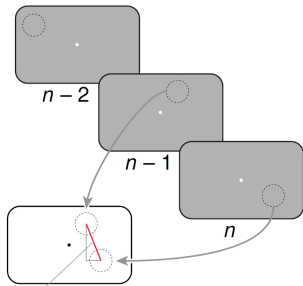**a**

$n - 2$

$n - 1$

n
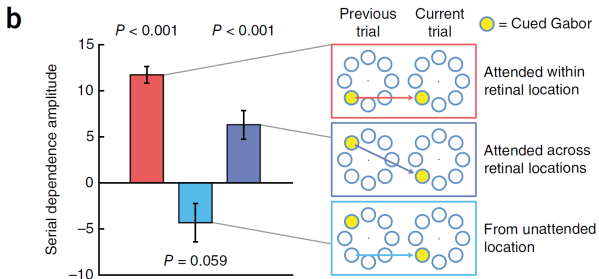
Distance between stimuli n and $n - 1$

Exp5: spatial tuning of perceptual serial dependence

a

$n - 2$

$n - 1$

n

Distance between stimuli n and $n - 1$

b

Serial dependence binned by distance:

- 1-back ±1 s.d.
- 2-back ±1 s.d.

Amplitude of serial dependence

Distance of previous trial from current (deg. visual angle)
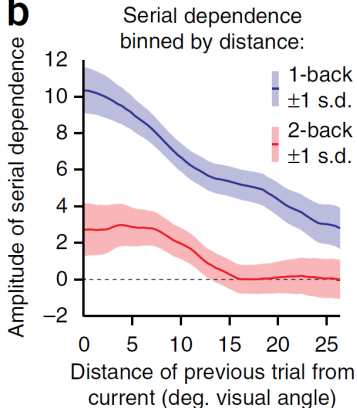
Supplementary info shows that Serial dependence is

- 'Spatiotopic' (isotropic), head centered (same task with multiple fixation centers)

Adaptation VS Serial Dependence

Serial Dependence is

- is not retinally specific
- is modulated by attention
- do not require long exposure time
- has a spatiotopic component

Adaptation VS Serial Dependence

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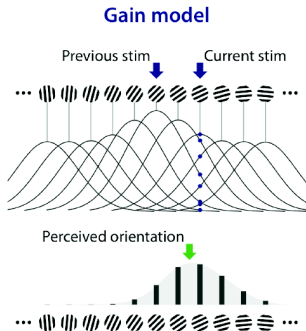
- is not retinally specific
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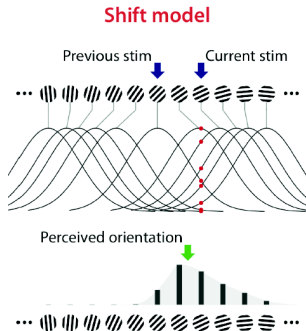- has a spatiotopic component

Serial Dependence could be underlying
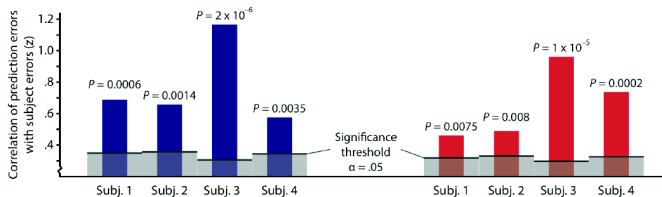
- general tracking abilities?

Mechanism?

a Gain model

Previous stim   Current stim

Perceived orientation

b Shift model

Previous stim   Current stim

Perceived orientation

c

Correlation of prediction errors with subject errors (z)

$P = 0.0006$ $P = 0.0014$ $P = 2 \times 10^{-6}$ $P = 0.0035$

$P = 0.0075$ $P = 0.008$ $P = 1 \times 10^{-5}$ $P = 0.0002$

Significance threshold $\alpha = .05$

Subj. 1   Subj. 2   Subj. 3   Subj. 4   Subj. 1   Subj. 2   Subj. 3   Subj. 4

Thank you!