Detecting changes of evidence reliability in random-dot motion

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INTRODUCTION

Efficient sensory decision-making aims to maximize expected gain.
In natural stimuli, information reliability can vary across time:

- evidence should be weighted according to its reliability
- the decision process should terminate if current reliability drops sufficiently

→ The optimal decision-maker should track changing evidence reliability.

Question:
Are human observers able to detect consistent (Expt 1), or variable (Expt 2) changes of evidence reliability over time?

CONCLUSION

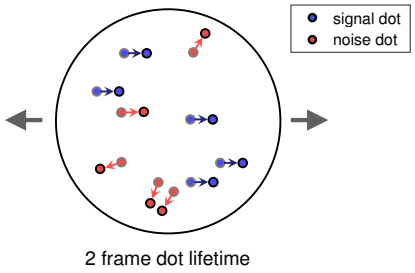
- Human observers are able to detect temporal changes of reliability over time and therefore could adjust behavior in response to changing evidence reliability.
- In some conditions, judgments are biased, which could lead to suboptimal behavior.
- Sensitivity for reliability changes is robust under conditions of volatility (i.e., variable reliability).

METHODS

Block A: Measure motion-discrimination threshold (JND) **Block B:** Measure ability to discriminate increasing from decreasing motion coherence

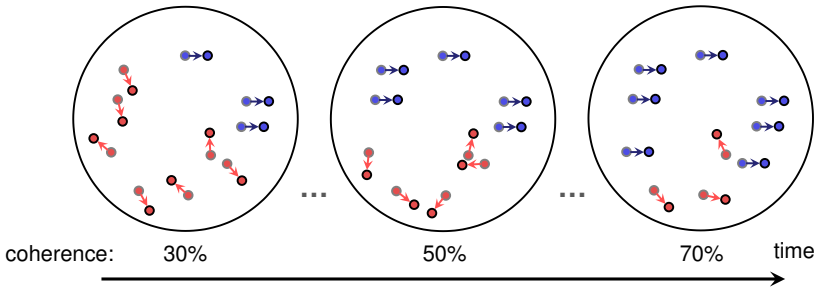
2AFC TASK: "Is motion direction left or right?"

fixed duration (2 s), constant motion coherence



2AFC TASK: "Is motion coherence increasing or decreasing?"

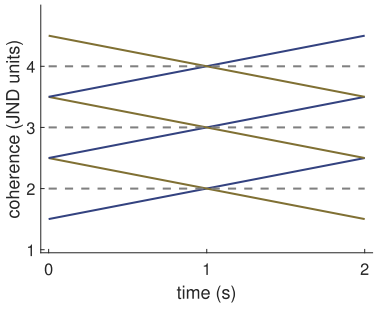
fixed duration (2 s), ramped motion coherence



Experiment 1

Does mean coherence affect threshold and bias for the direction of coherence change?

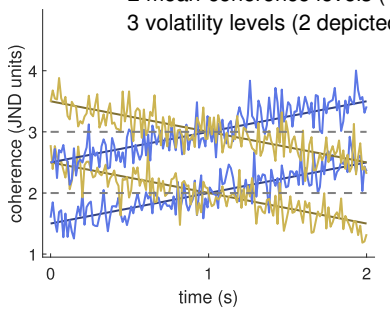
conditions: 2 directions of change (–, –)
3 mean-coherence levels (- -)



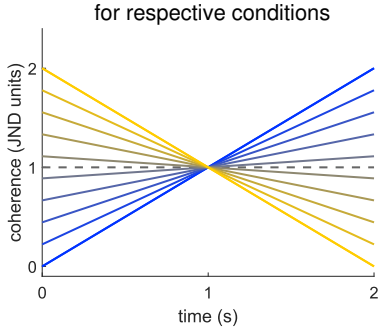
Experiment 2

Does additional variability of coherence (volatility) affect these thresholds?

conditions: 2 directions of change (–, –)
2 mean-coherence levels (- -)
3 volatility levels (2 depicted: —, ⩘)



coherence as a function of time
rate of coherence change:
controlled by interleaved staircases
for respective conditions



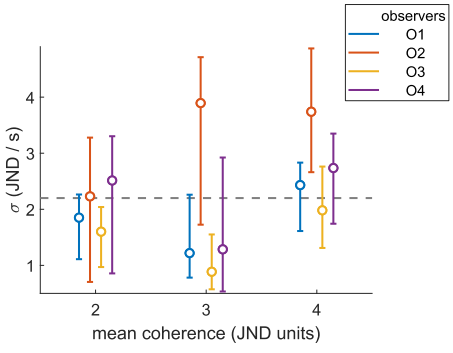
RESULTS

Analysis: Fit a cumulative normal to probability of saying "increasing" as a function of actual rate of coherence change.

Experiment 1

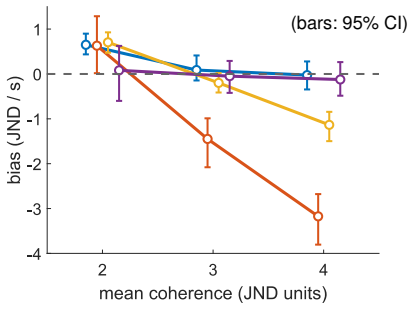
Sensitivity: Mean σ across observers: 2.2 JND/s

Observers can detect changes of stimulus reliability comparable in magnitude to the JND for motion direction discrimination.



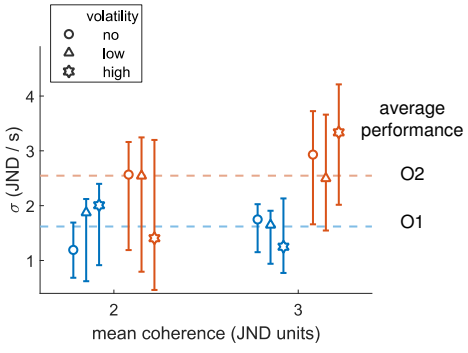
Bias: Significant for 3 of 4 observers. Decreases as mean coherence increases.

Negative bias means constant coherence appears to be increasing.



Experiment 2

Sensitivity: Does not deteriorate with the addition of overall coherence variability (volatility).



NIH EY08266, NSF-CRCNS 1420262