EAM in Visual Perception Research

@47th ECVP 2025 Mainz

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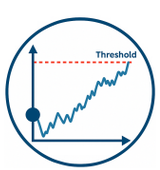
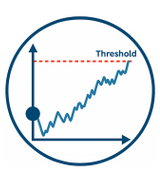
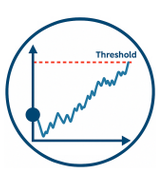


Why should we use EAM in visual perception?



Why should we use EAM in visual perception?

- accuracy



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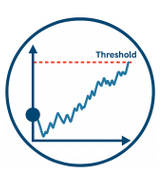
- RT



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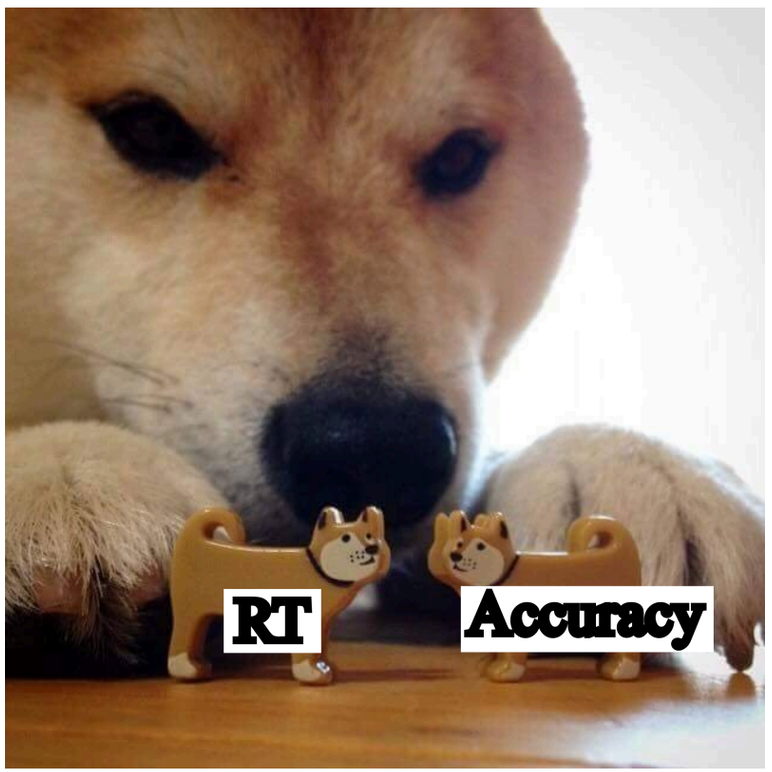

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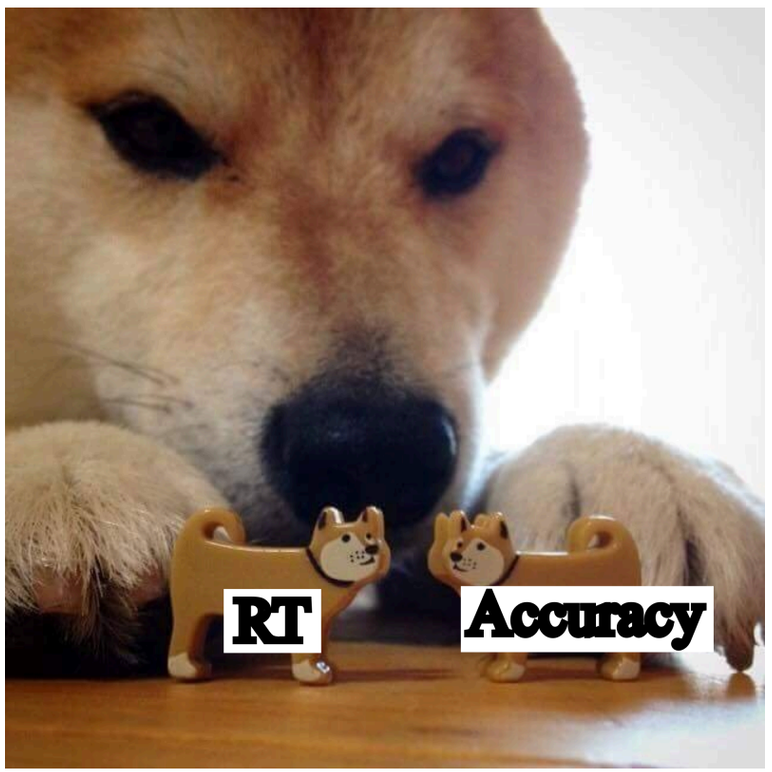
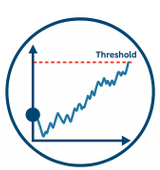
Speed-accuracy trade-off

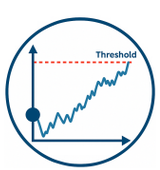


Some examples



The effect of stimulus strength on the speed and accuracy of a perceptual decision

Which is the relation between **RT** and **Accuracy** measures?



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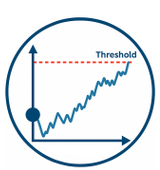
Which is the relation between **RT** and **Accuracy** measures?

Accuracy → Signal Detection Theory (SDT)
→ **Psychometric function**: d' as a function of stimulus strength



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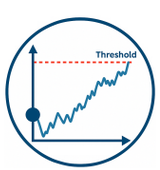

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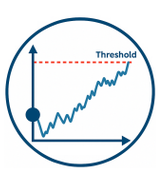
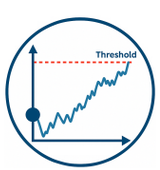
RT and Accuracy depend on the difficulty of a perceptual judgment.

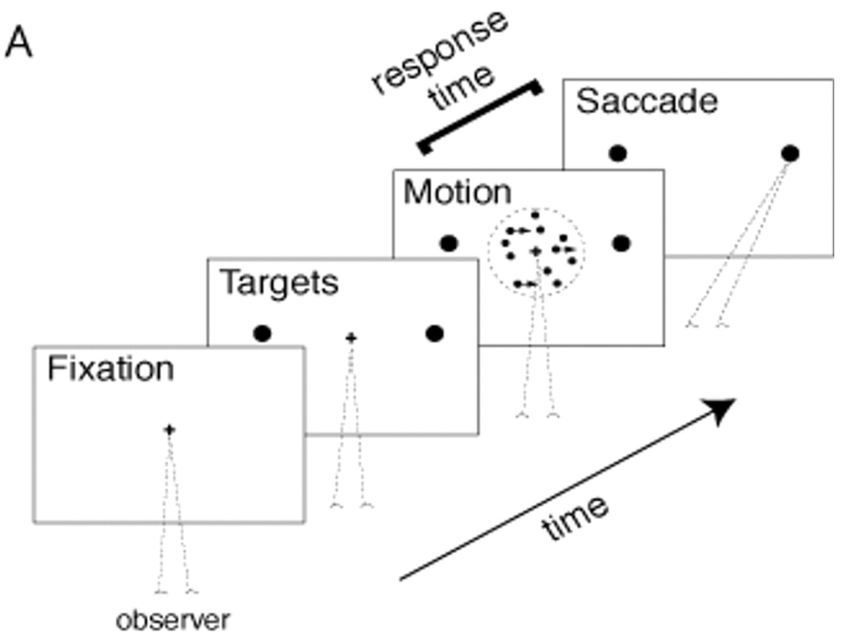


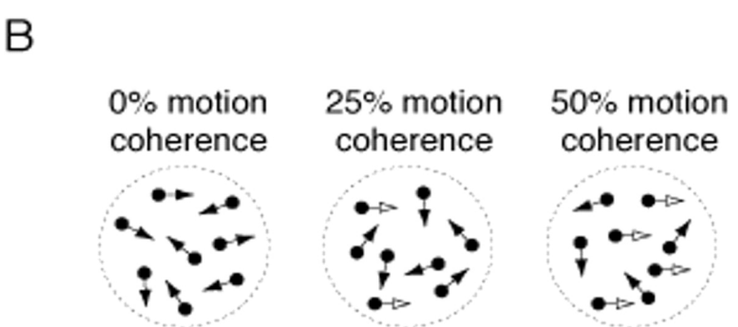
Coupling of RT and Accuracy

DDM produces a fixed relationship between RT and accuracy for a given stimulus strength

- SDT + separate RT modeling cannot capture this coupling
- RT modeling alone ignores accuracy constraints
- DDM **integrates both**, predicting how changes in stimulus strength shift RT and accuracy together
- Single generative framework → fewer parameters, more precise predictions



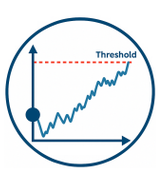


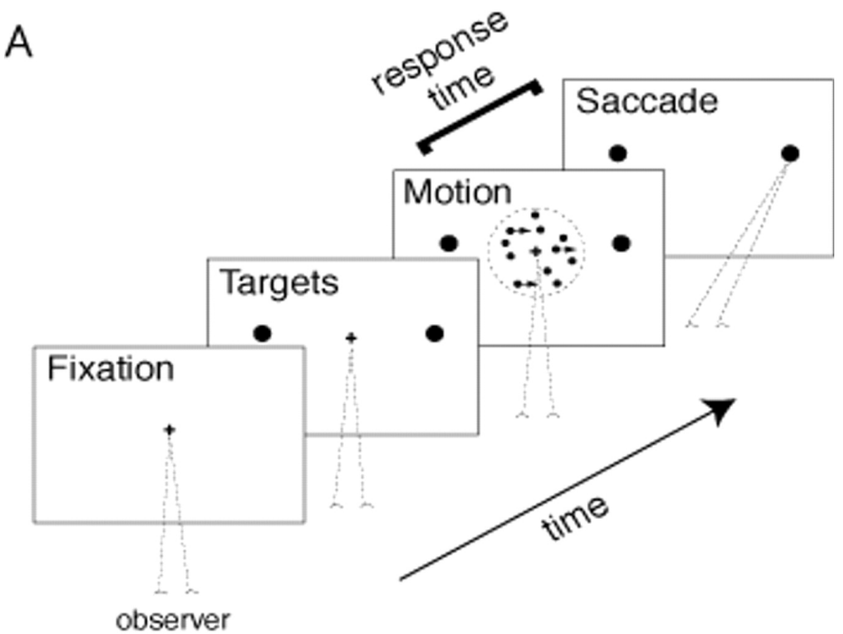


Drift rate reflects sensitivity to stimulus strength:

- Increases with stronger stimuli

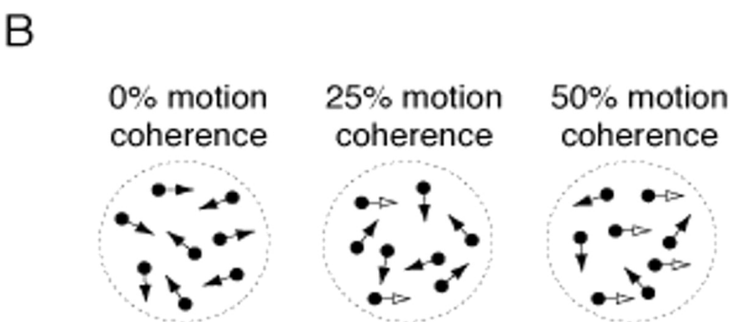
- Robust across:
  - Two **response modalities** (saccades and key pressing)
  - Three different **stimulus judgments** (motion discrimination, contrast detection, contrast discrimination)



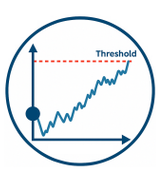


Boundary separation reflects the speed-accuracy trade-off:

- Larger boundaries produce slower but more accurate responses



- Variations in instructions or conditions that prioritize speed versus accuracy are captured primarily by adjustments in boundary, without altering drift rate

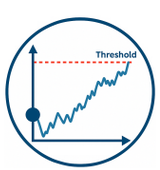


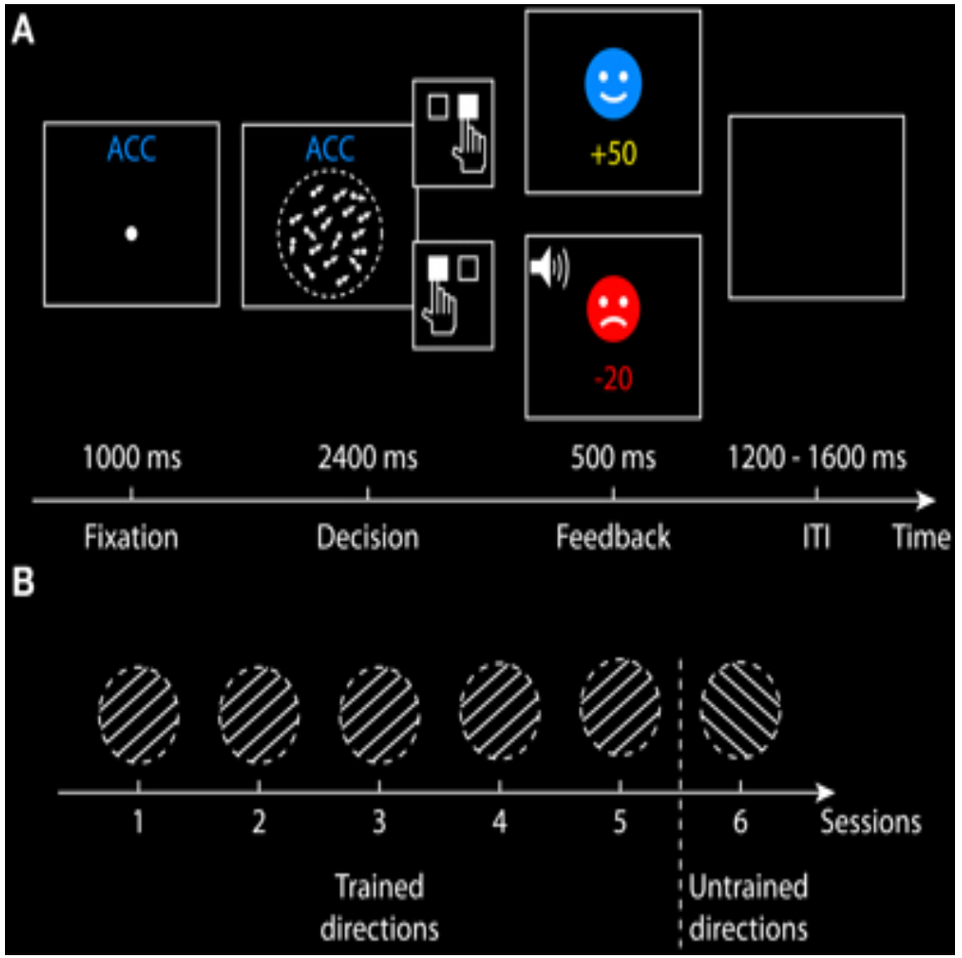
Dissociable mechanisms of speed-accuracy tradeoff during visual perceptual learning are revealed by a hierarchical drift-diffusion model

Drift-diffusion model to examine:

- the speed-accuracy trad-eoff
- perceptual learning effect

during learning of a coherent motion discrimination task across multiple training sessions.



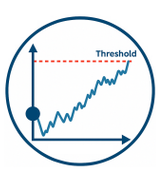


Boundary:

- Larger under accuracy vs. speed emphasis
- Decreases with training

Drift Rate:

- Not significantly affected by speed-accuracy trade-off
- Increases with training

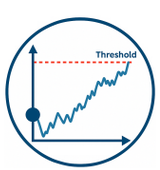


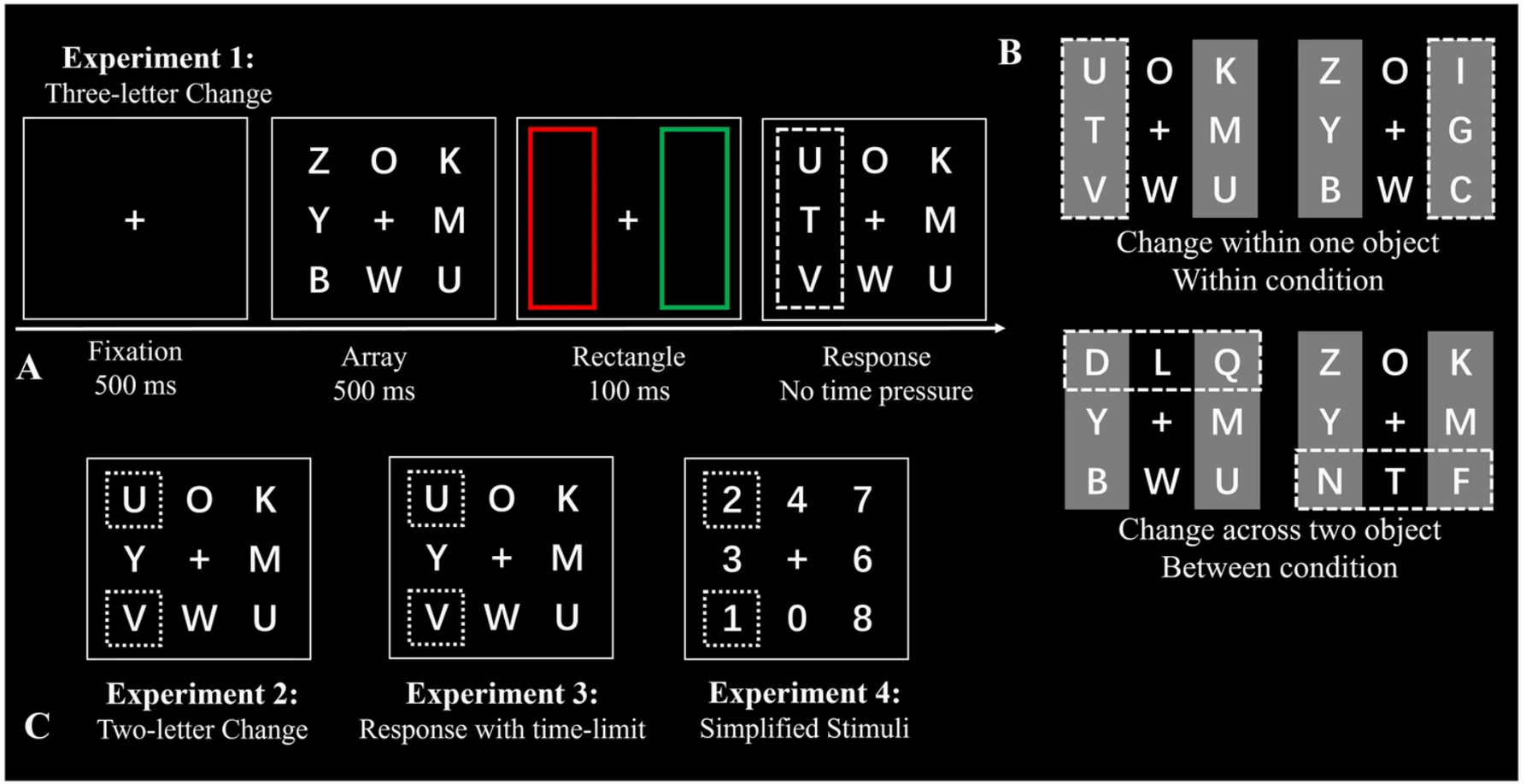
Enhancing change perception through object-based attention

In a change perception paradigm:

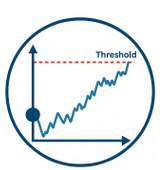
- accuracy
- RT

Is change perception facilitated by object-based attention?

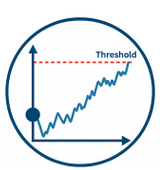




Drift rate consistently higher for within vs. between conditions → faster evidence accumulation.



The Experiment



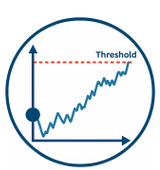
Stimuli

Manipulate difficulty to modulate:

- Drift rate
- Error rates (target: **5–35%**)

Avoid:

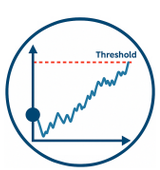
- **Floor effects** → guessing
- **Ceiling effects** → no errors to fit

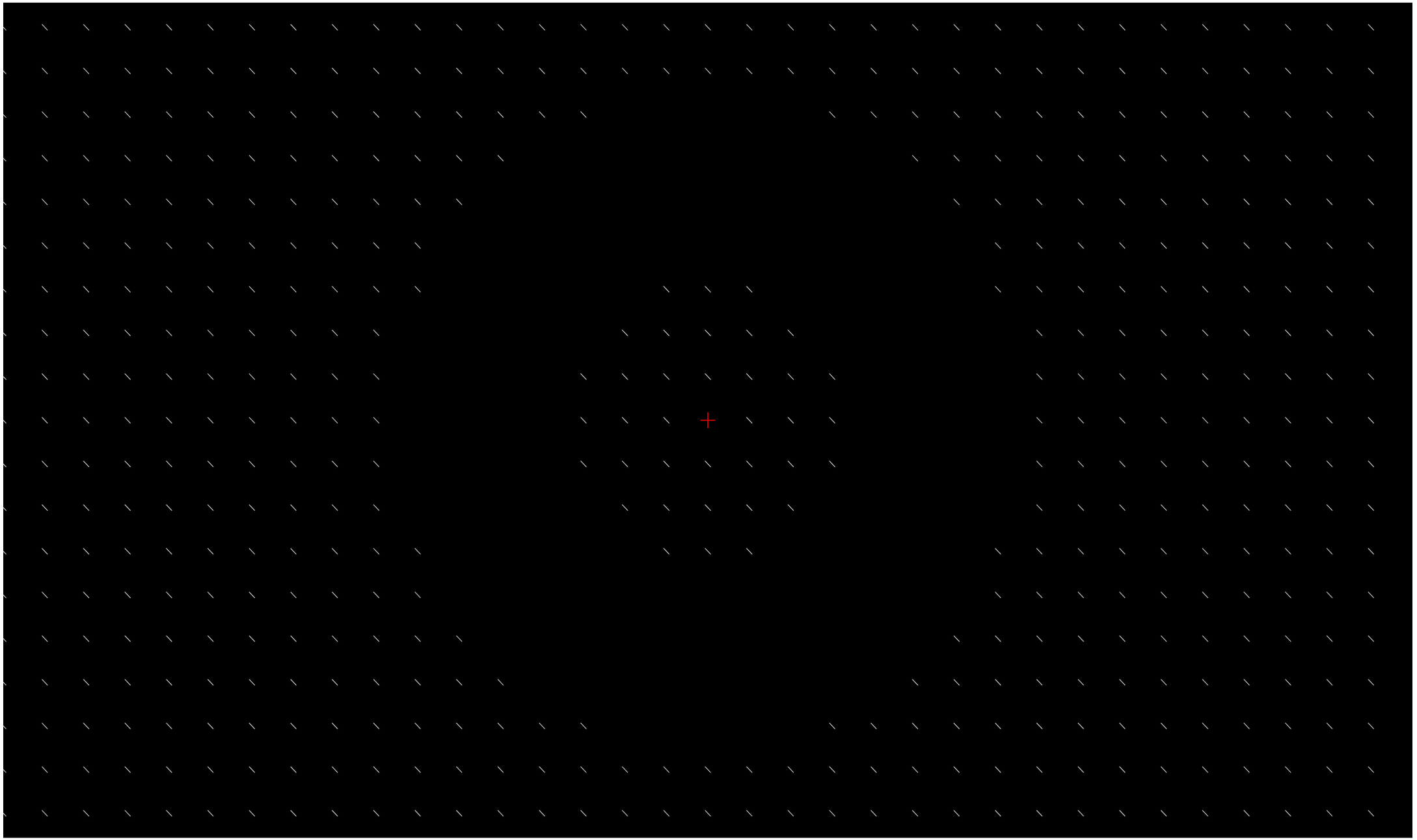


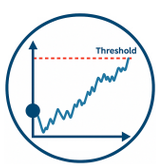
Stimuli

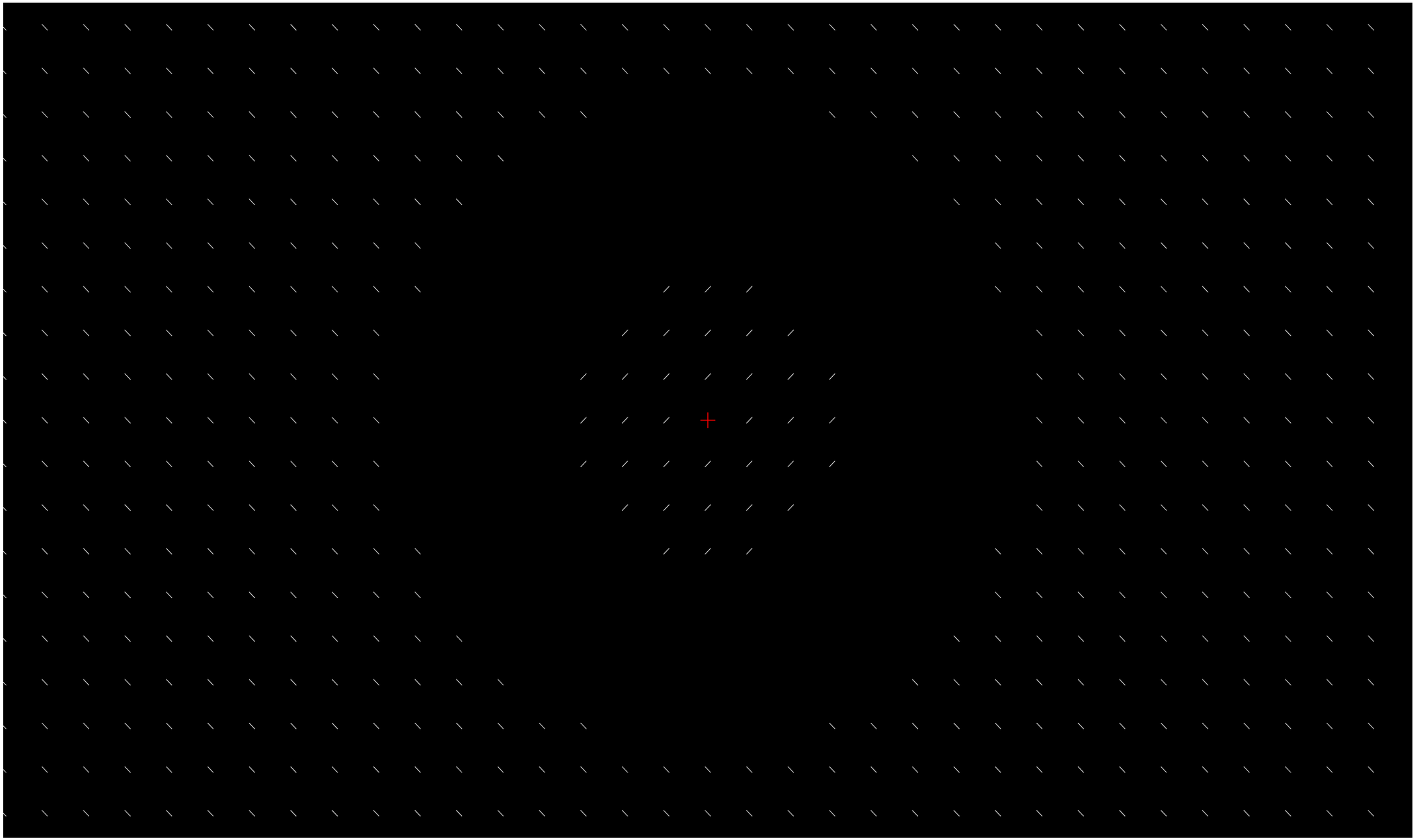
2 x 2 x 2 design:

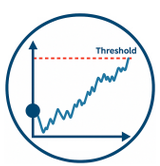
- 2 **gap sizes** (small vs large)
- 2 **conditions** (congruent vs incongruent)
- 2 peripheral orientations (left vs right)






Threshold

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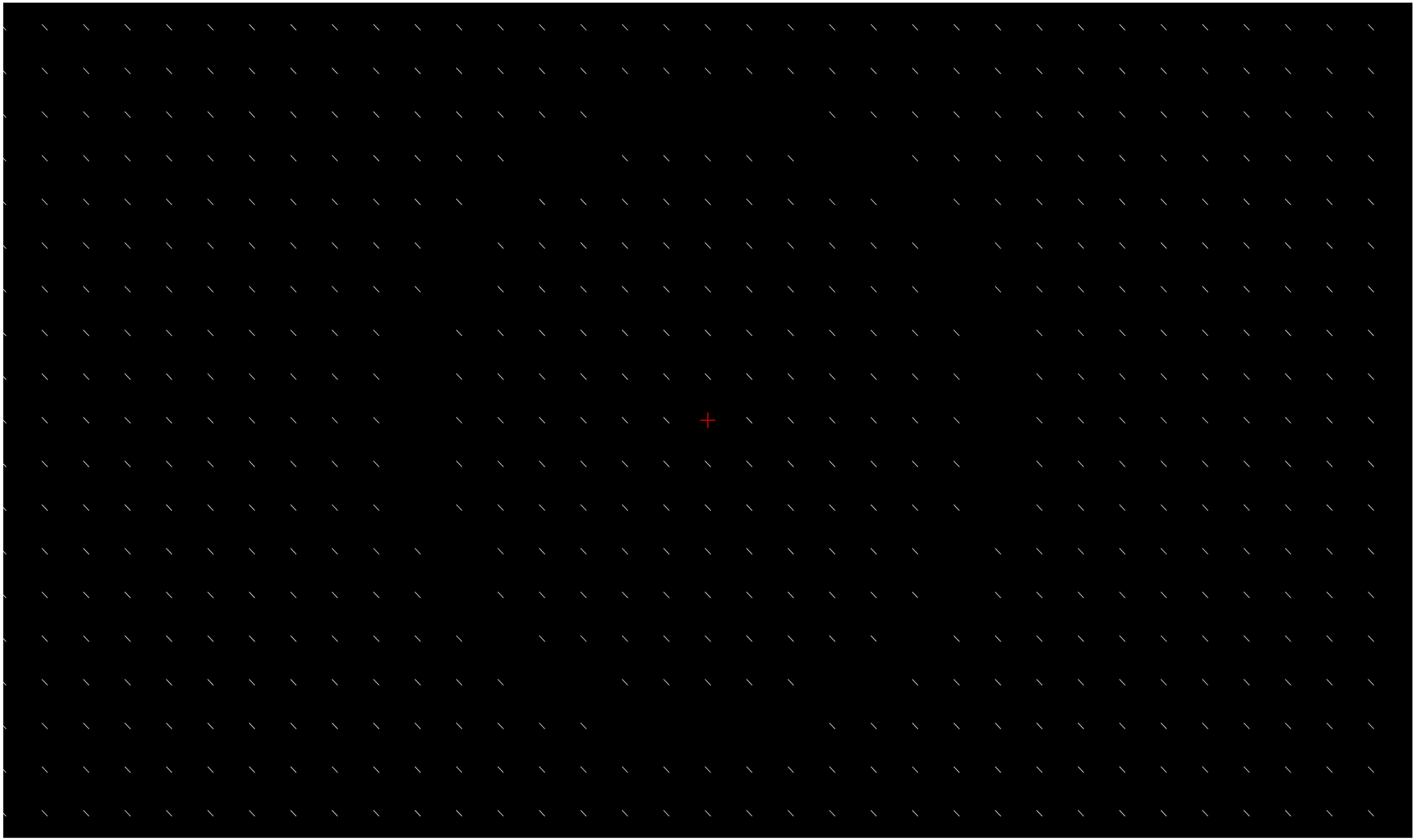

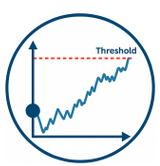
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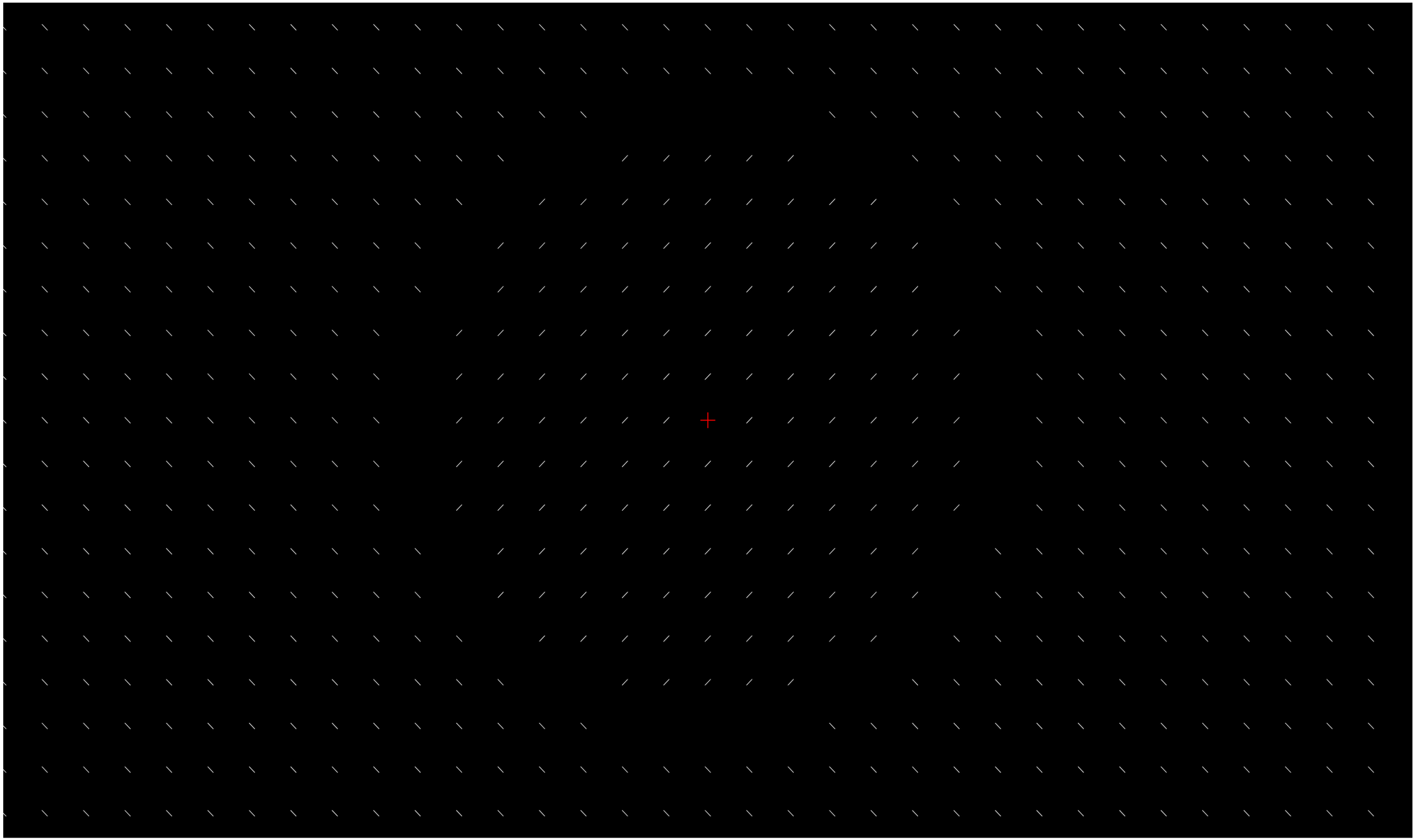
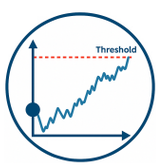



Threshold

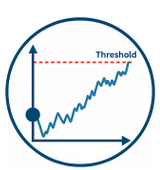
Response modality

EAMs assume the response begins **after the decision ends**.

Best modalities:

- **Manual keypresses**
- **Saccades**

Avoid imprecise, slow, or delayed responses.

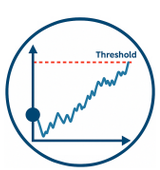


Trial structure and event timing

EAM tasks follow a structured sequence of events:

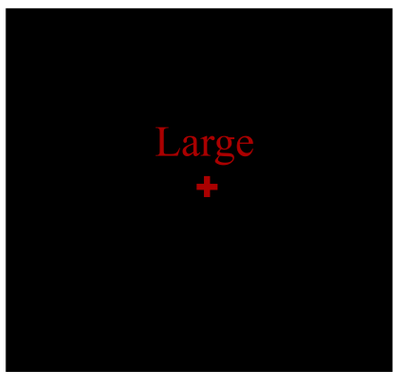
1. **Cue** (optional)
2. **Fixation**
3. **Stimulus onset**
4. **Response window**
5. **Intertrial interval**

Each component affects the integrity of evidence accumulation.

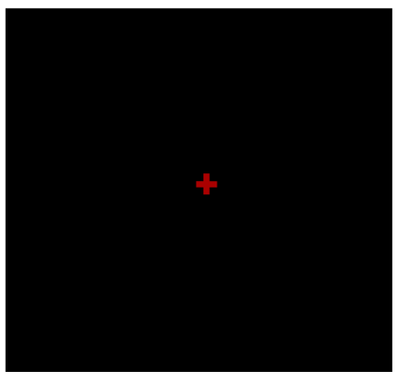


Procedure

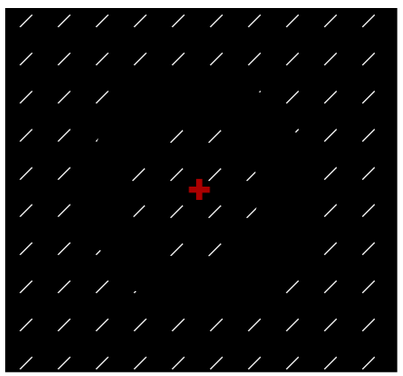
ISI (500-1000 ms)



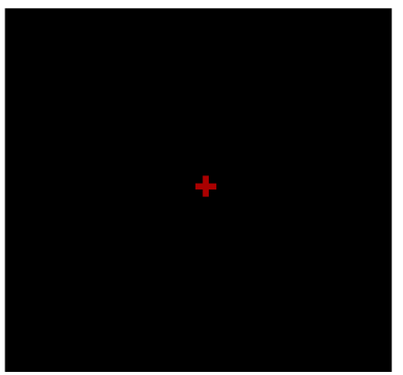
Cue (300 ms)



Fixation (300-500 ms)

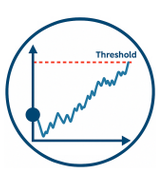


Stimulus (until response)



ISI (500-1000 ms)

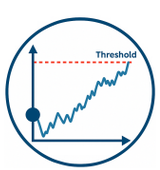
Task: targets (peripheral) lines **orientation judgement** left vs right.



Cue

Optional cue presented **before** stimulus onset.

Informs participants **how** to respond (e.g., emphasis on speed or accuracy).



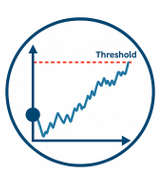
Cue

May set cognitive control parameters:

- **Thresholds**
- **Biases**

Can direct **gaze or attention** to a spatial location.

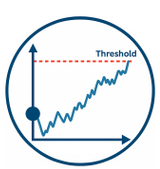
> Must occur **before** evidence accumulation begins.



Fixation interval

- Ensures eyes and attention are centered.
- Allows previous trial's processes to return to **baseline**.
- Reduces overlap across trials.

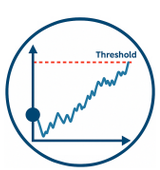
💡 **Best practice:** Use **variable durations**



Stimulus onset

- Marks the **start** of evidence accumulation.
- Assumes **constant signal strength** from onset to response.

> Any variability or delay in onset weakens the assumption of continuous accumulation.



Response window

Starts with stimulus onset.

Ends with:

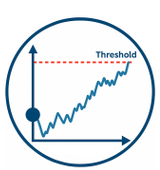
- A **response**
- Or a **deadline**

Typical EAM use: **mean RT < 1.5 s**

💡 Calibrate response window:

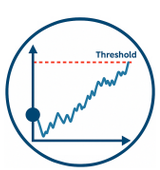
Long enough to allow natural responding

Short enough to avoid strategy shifts



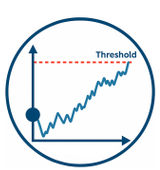
Intertrial interval

- Allow participant to **reset**
- Prevent **proactive interference**
- Avoid **sequential effects**



Collecting data

- Participant ID
- Condition
- Stimulus presented
- Response submitted
- RT
- Session/trial number
- Event timings: cue, stimulus, response, feedback, intertrial interval



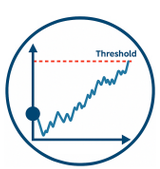
Hypotheses

1. Smaller gap enhances central interference (same-feature suppression)

Gap effect: **small gap** higher accuracy but slower RT (**higher threshold**)

2. Incongruent lines enhance central-peripheral segmentation

Congruency effect: **incongruent conditions** have higher accuracy and faster RT (**higher drift rate**)



Your turn now!