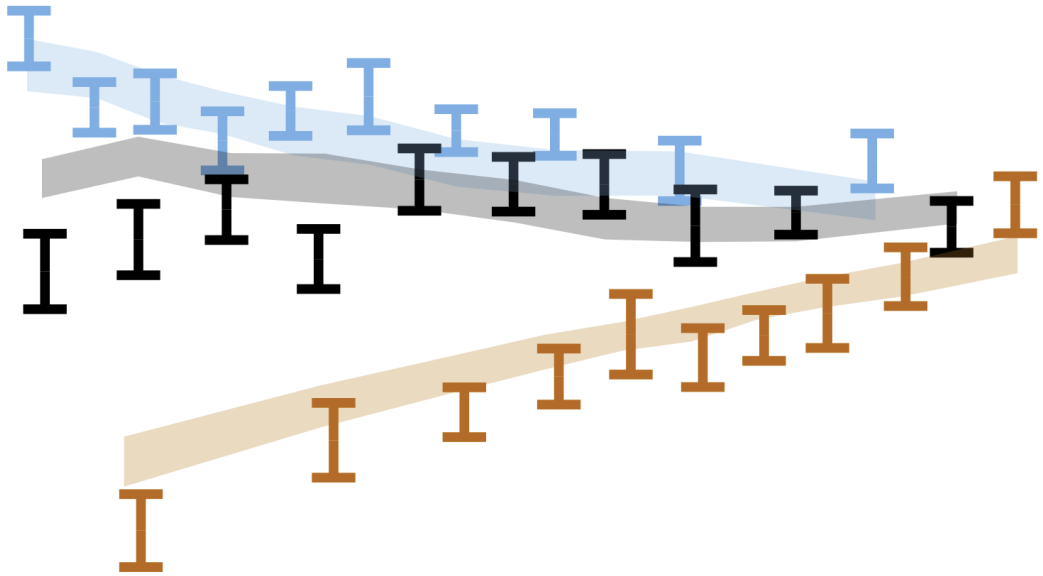
# Visual search with heterogeneous distractors

*Andra Mihali, Joshua Calder-Travis and Wei Ji Ma*

Nov 2020



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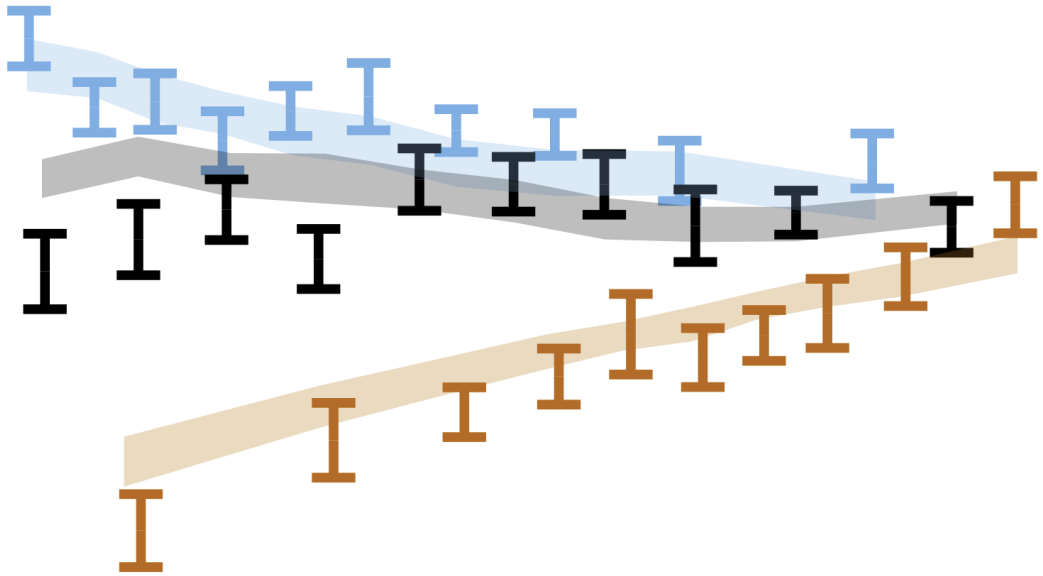
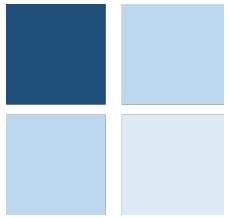


Explaining the effects of distractor statistics in visual search

# Outline

4. The task

5. More on Duncan & Humphreys (1989)



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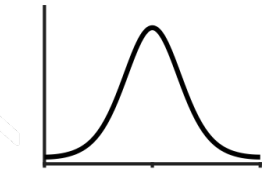

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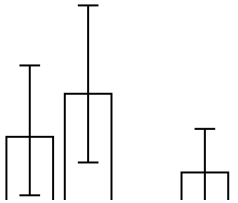
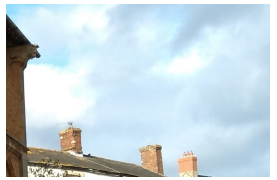


8. Limitations



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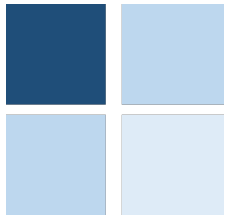

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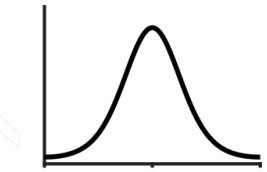

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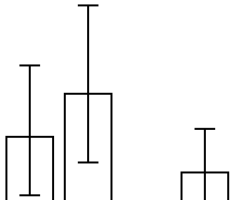

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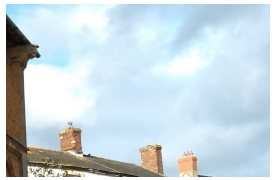

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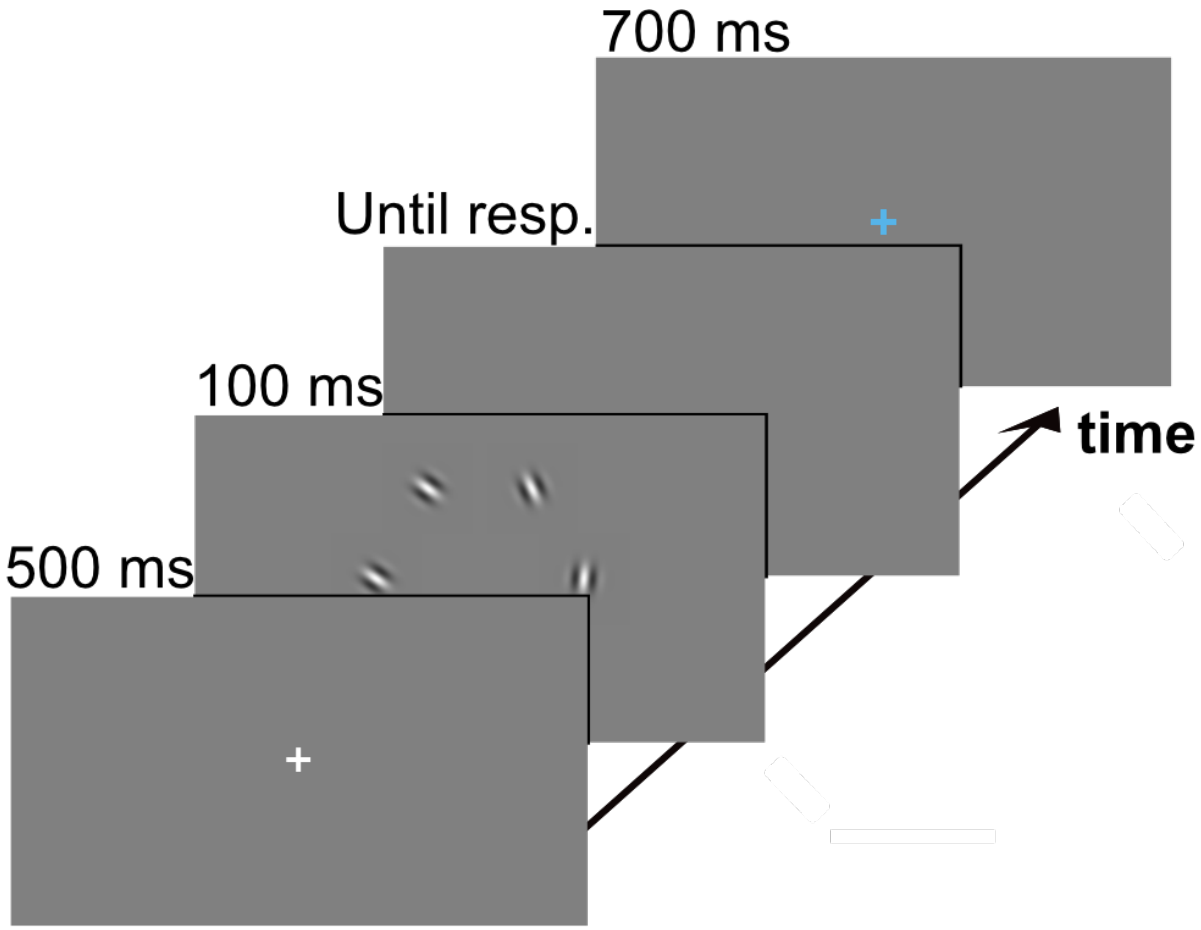
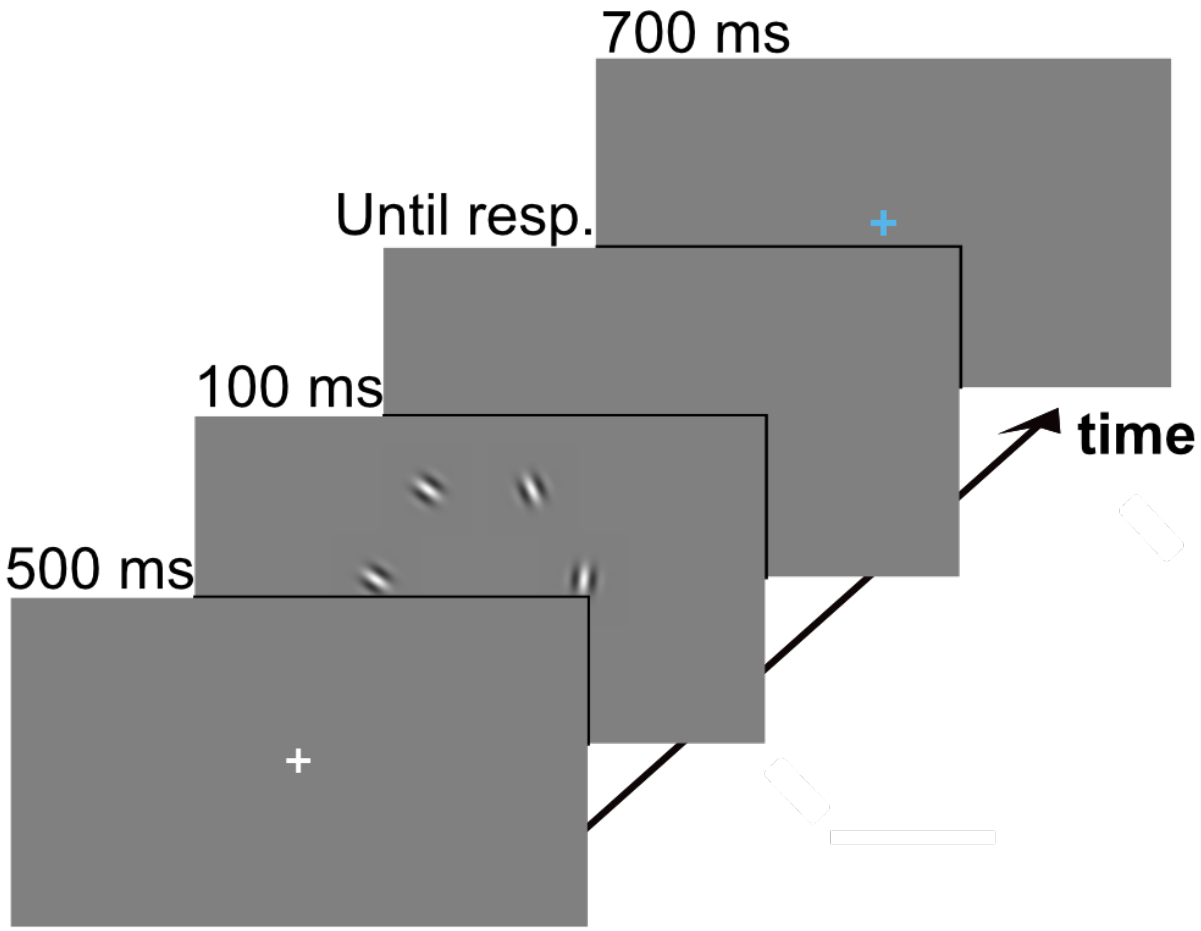




**Detection only**

Fig. from Calder-Travis & Ma (2020)

# Task



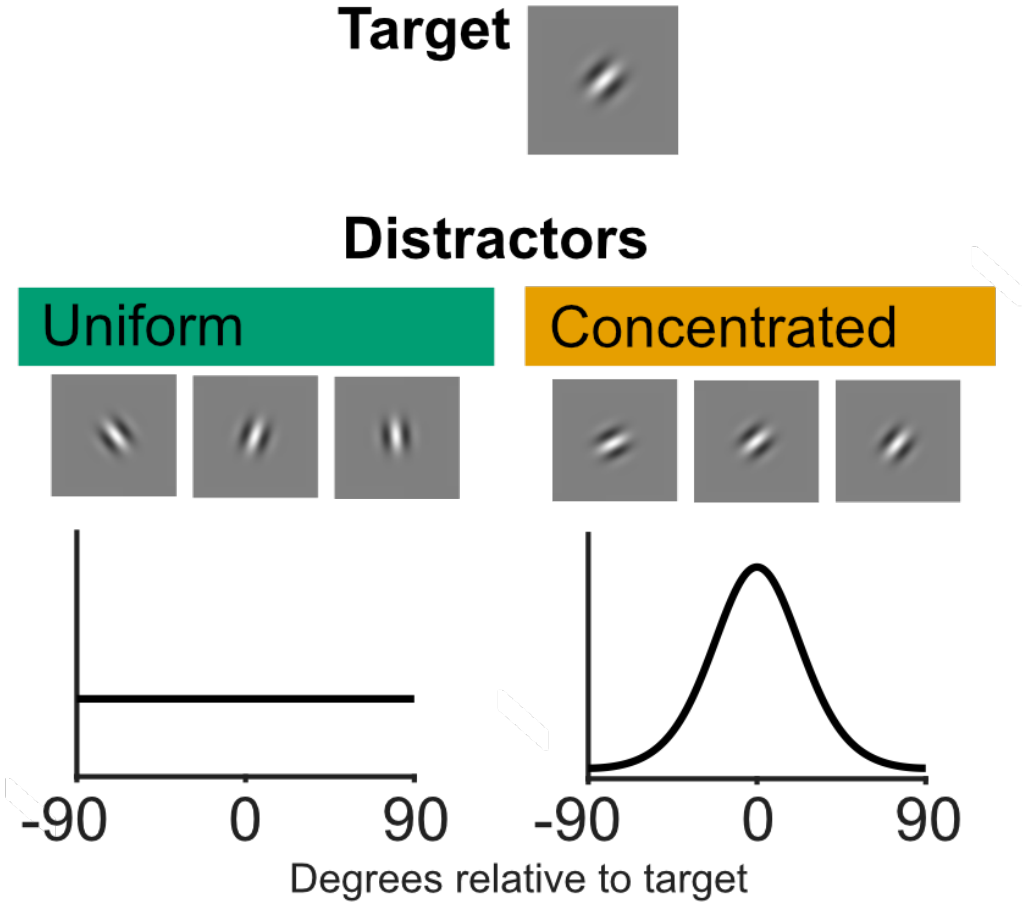




Fig. from Calder-Travis & Ma (2020)

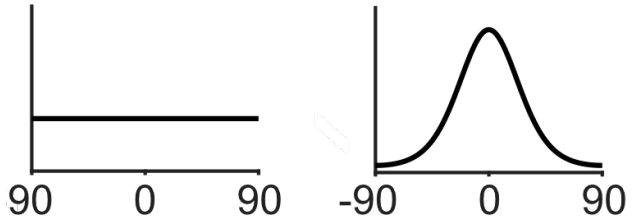
# Distractor statistics

Target-distractor mean difference (T-D mean)

Distractor variance

Minimum target-distractor difference (min T-D difference)

**Sample** vs. **Population**




Duncan & Humphreys (1989)

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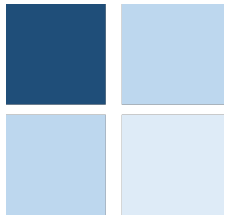

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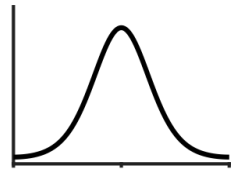

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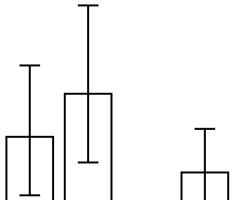

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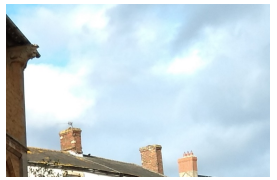
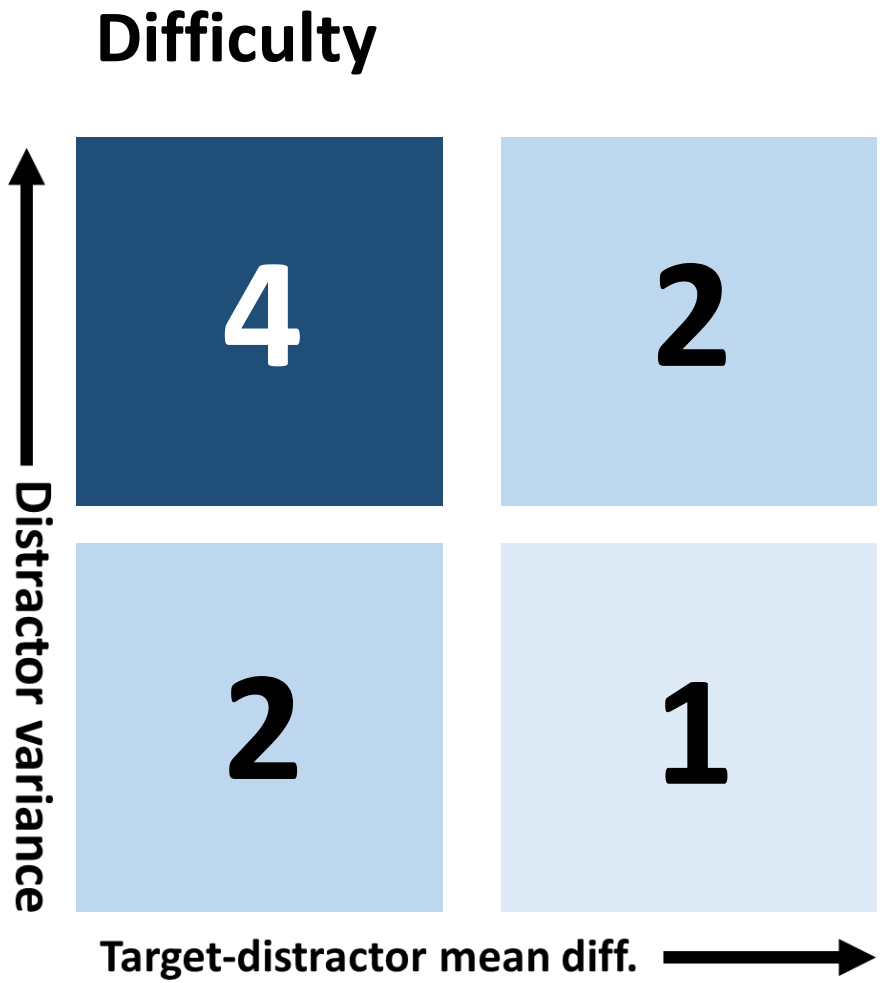


# Duncan & Humphreys' pattern




Duncan & Humphreys (1989)

# Experimental results

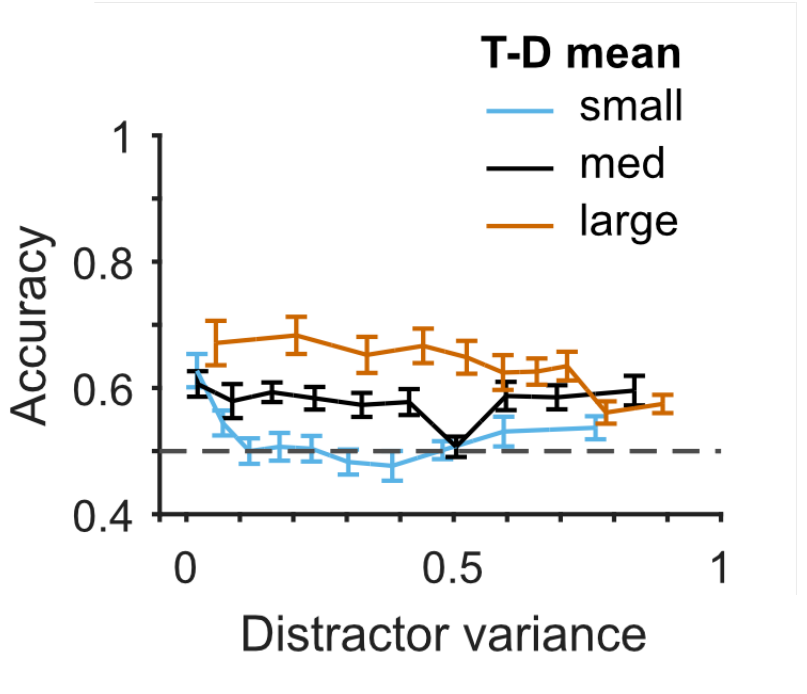



Fig. from Calder-Travis & Ma (2020)

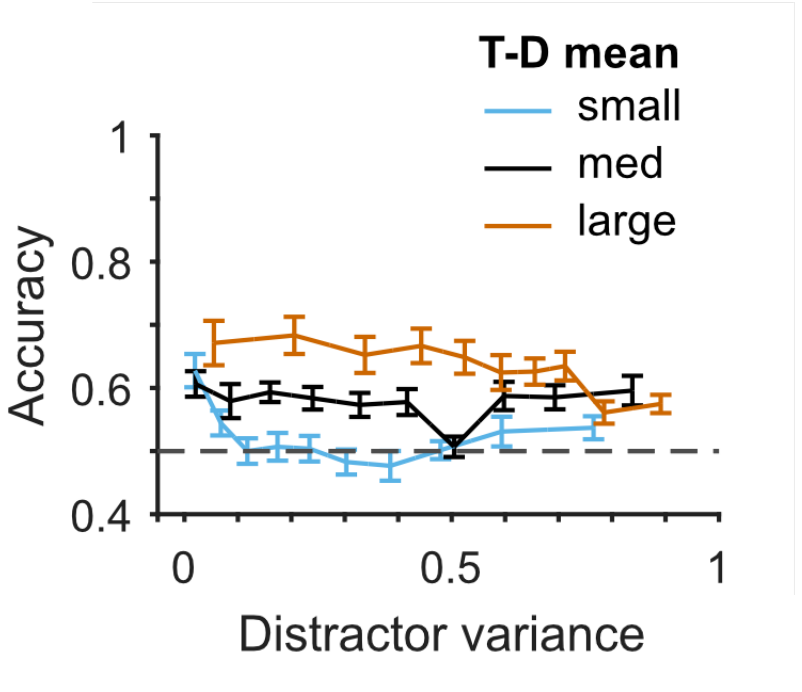
# Experimental results

**Accuracy**

T-D mean ⬆

Distractor variance ⬇

Interaction ⬇

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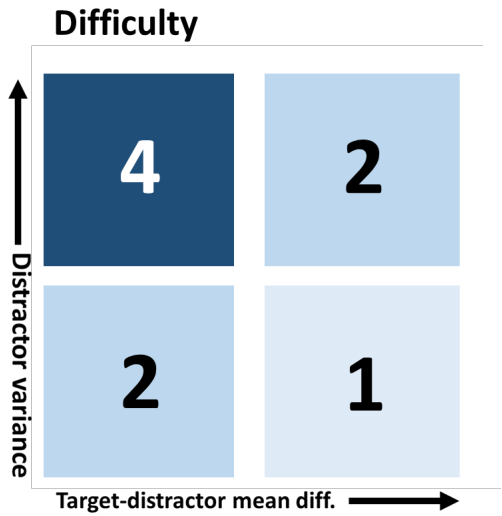


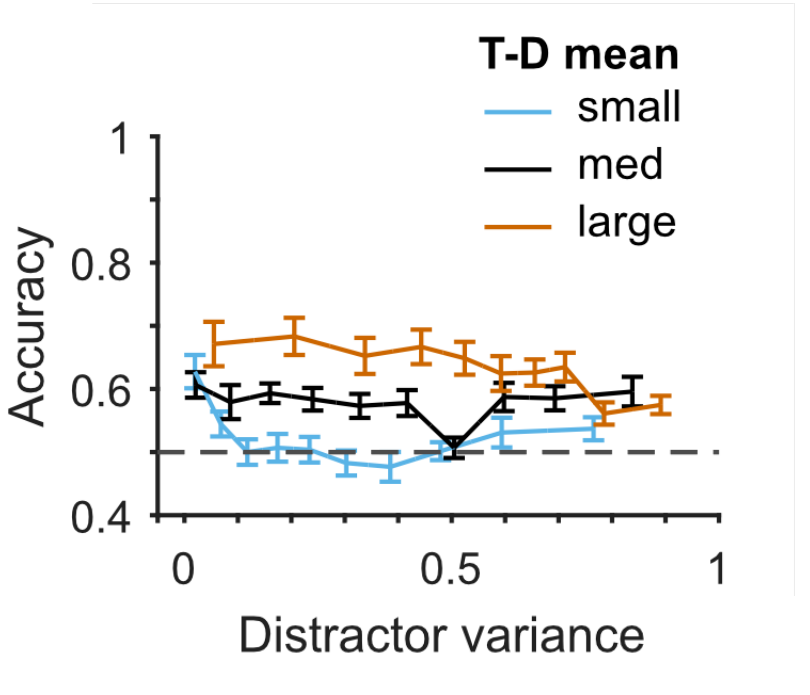
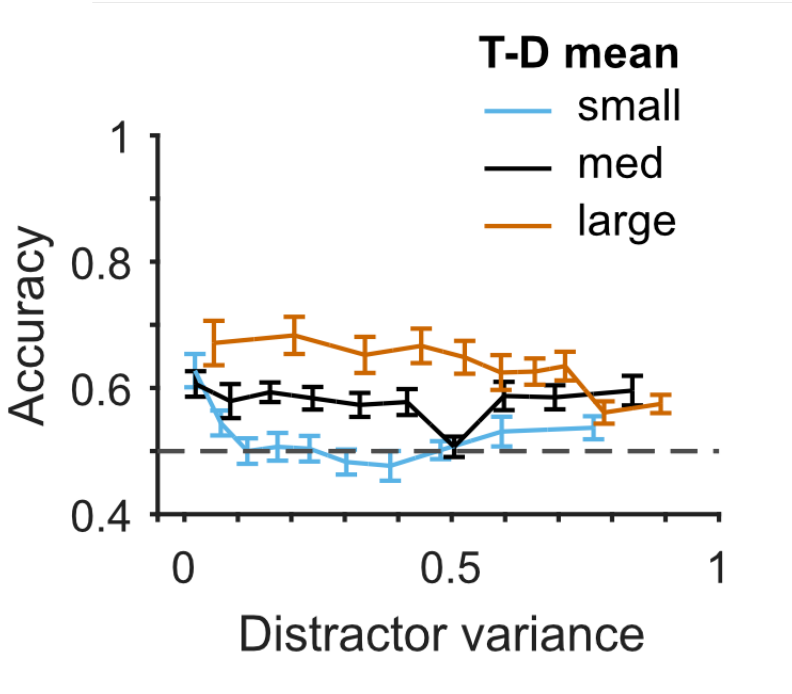




Fig. from Calder-Travis & Ma (2020)

# Experimental results

**Accuracy**

| | | |
|---|---|---|
| T-D mean | ↑ | ↑ |
| Distractor variance | ↓ | ↓ |
| Interaction | ↓ | ↓ |
| Min T-D difference | | ↑ |
| Number of stimuli | | ↓ |



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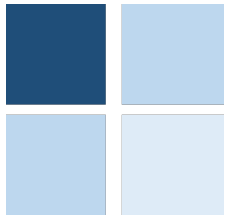

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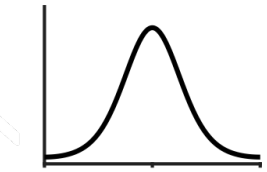

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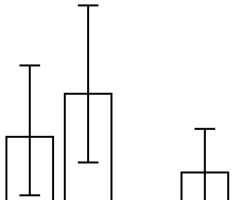

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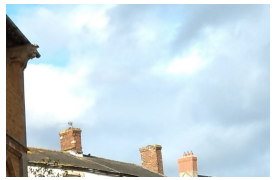
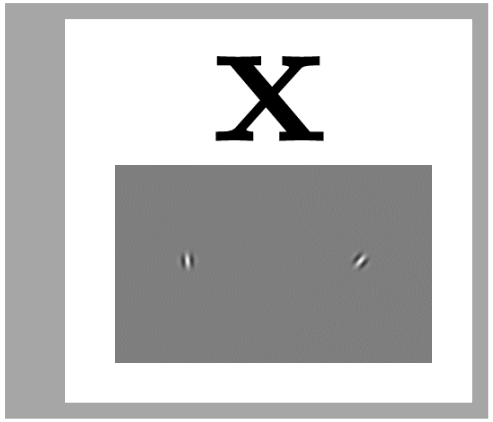


# Modelling




$$\frac{p(C=1|\mathbf{x})}{p(C=0|\mathbf{x})}$$

Green & Swets, 1966; Rosenholtz, 2001; Palmer et al., 2000; Ma et al., 2011

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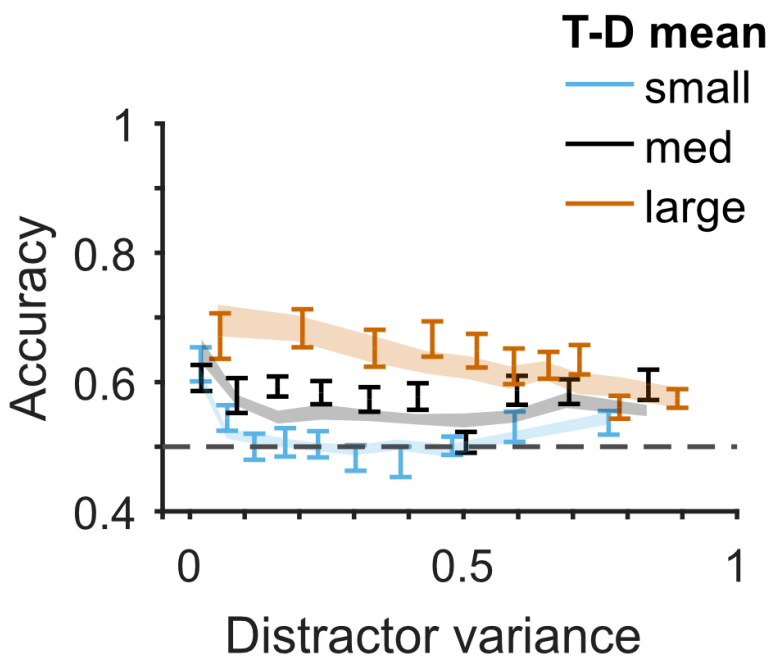


Fig. from Calder-Travis & Ma (2020)

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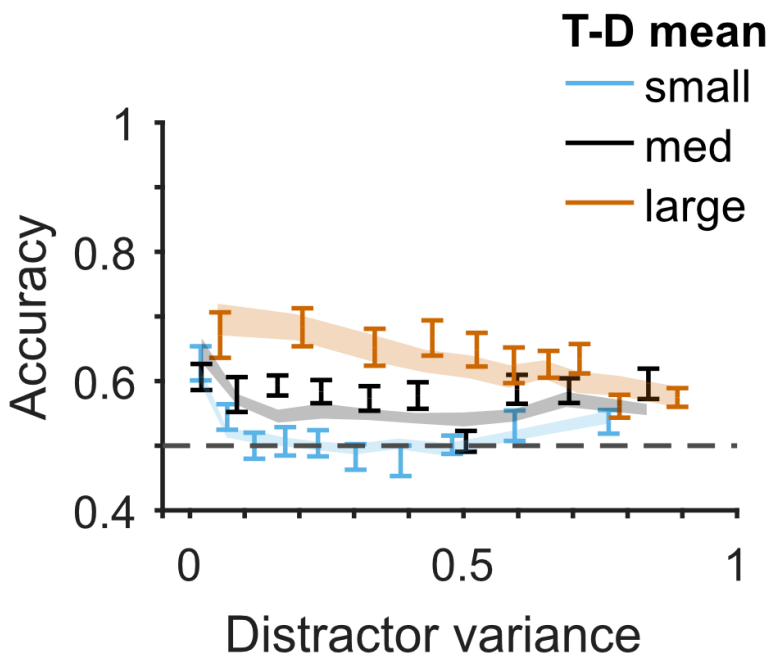


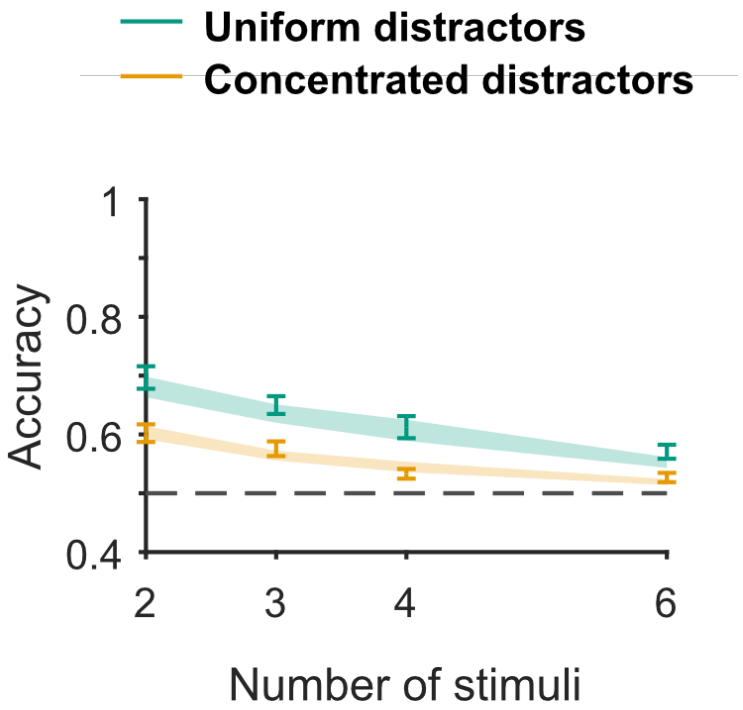


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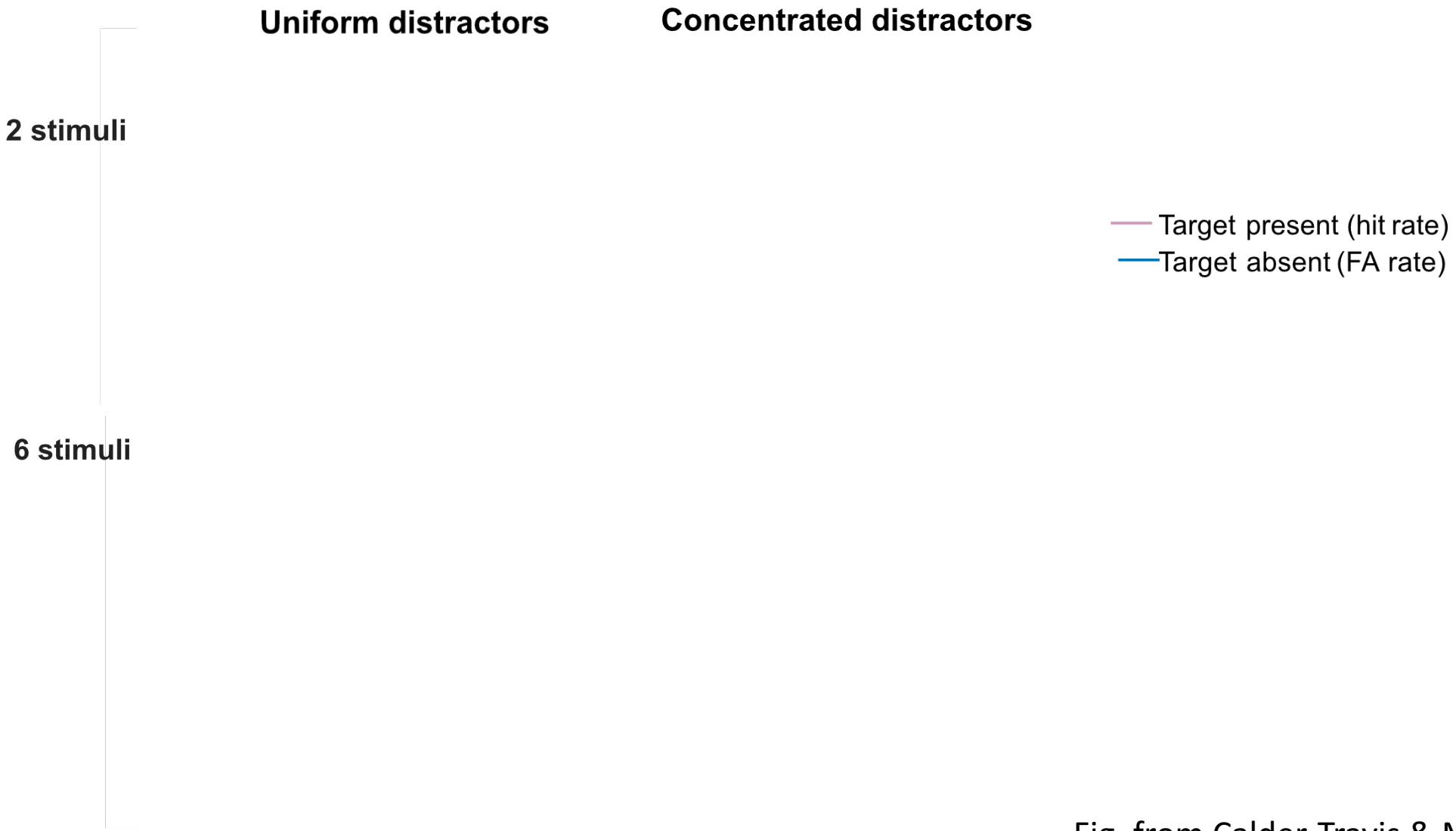


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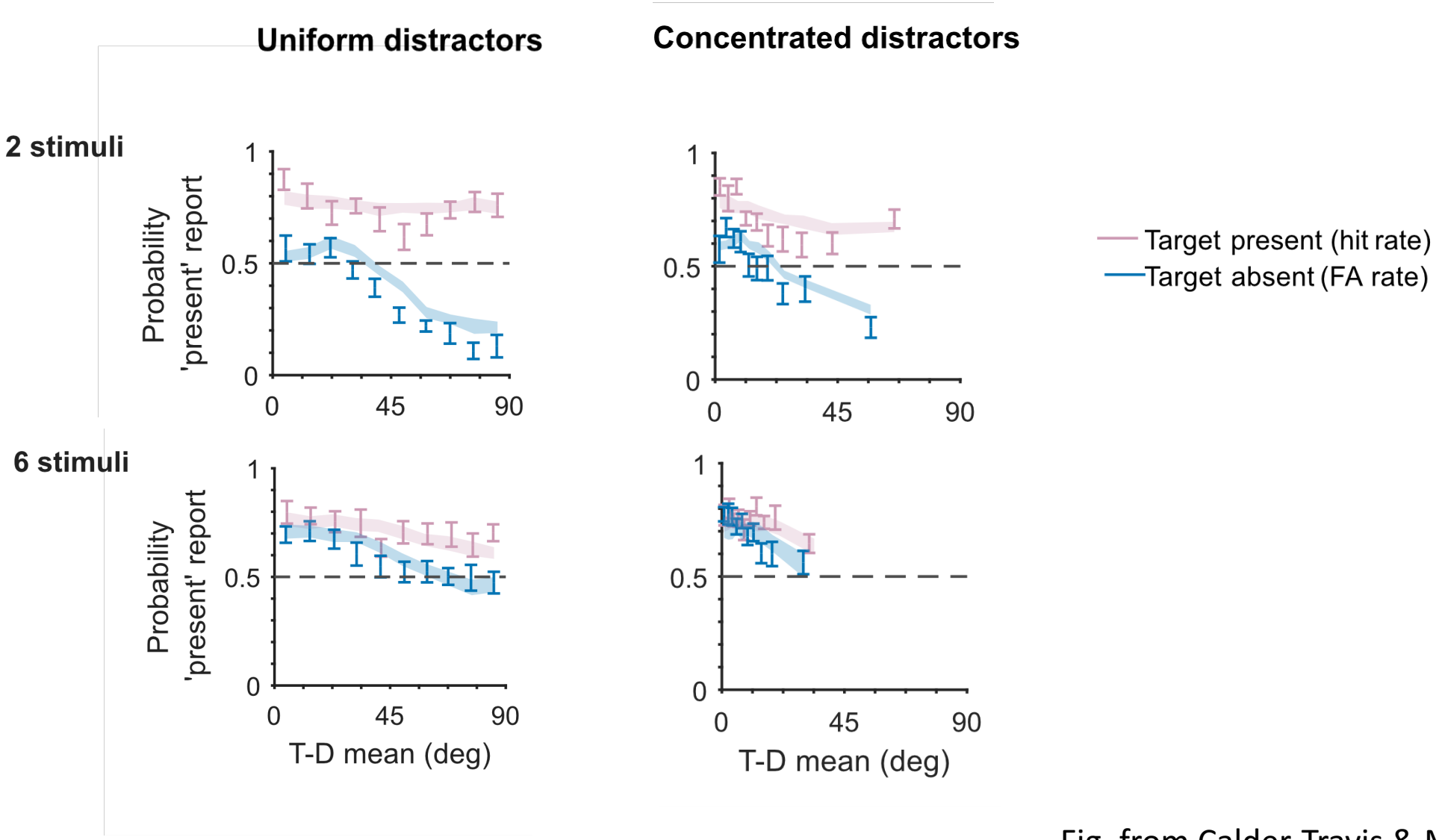


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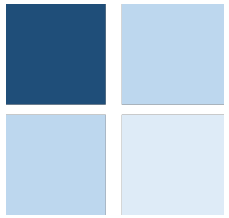

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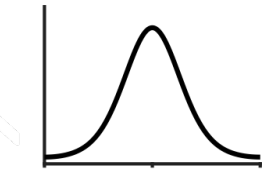

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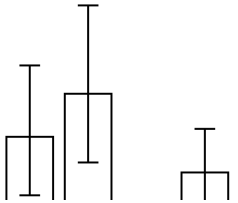

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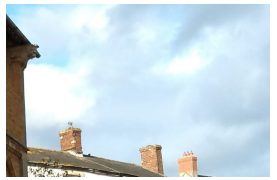

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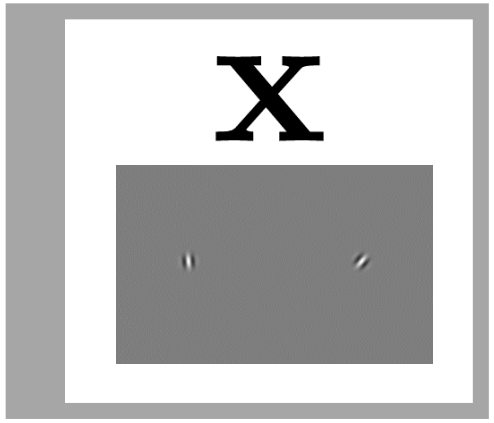


Ma, Shen, Dziugaite & van den Berg, 2015; Palmer et al., 2000; Palmer et al., 1993

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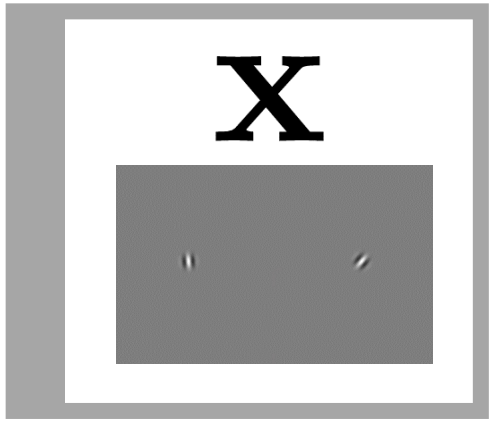
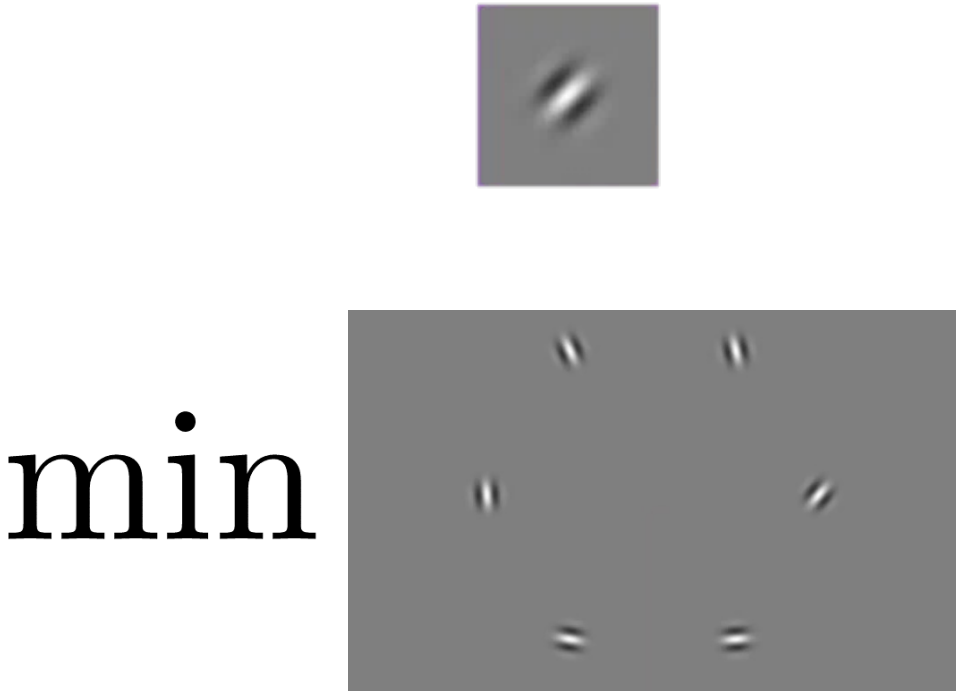



Ma, Shen, Dziugaite & van den Berg, 2015; Palmer et al., 2000; Palmer et al., 1993

# Model comparison

**Bayes**

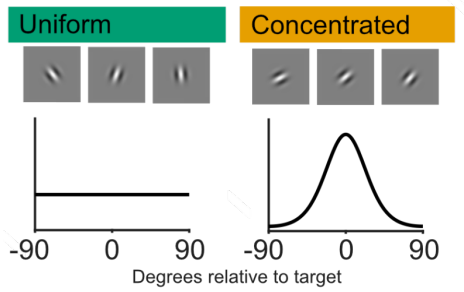
$$\log \frac{p(C=1|\mathbf{x})}{p(C=0|\mathbf{x})} > 0$$

VS.

**Heuristic**

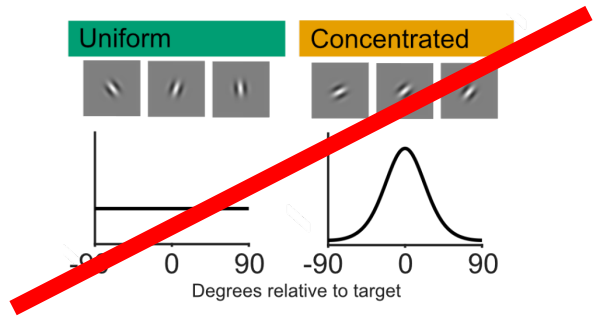
$$\min \mathbf{x} < \rho$$

**Use env.**



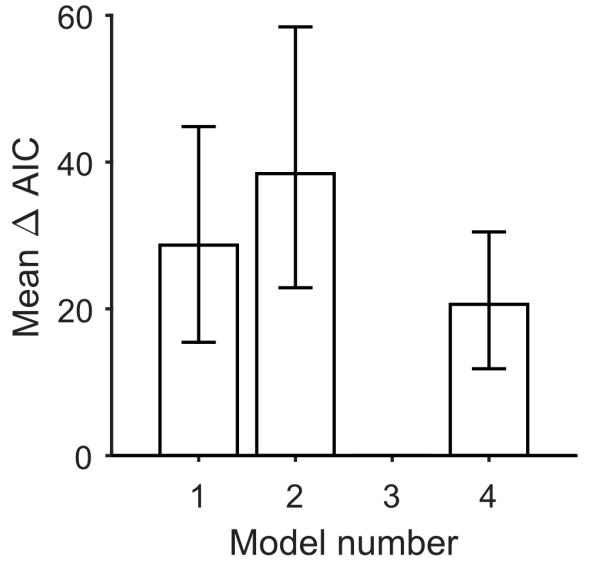

VS.

**Ignore env.**



# Model comparison

| | | |
|---|---|---|
| 1 | Bayes | Use env. |
| 2 | Bayes | Ignore env. |
| 3 | Heuristic | Use env. |
| 4 | Heuristic | Ignore env. |



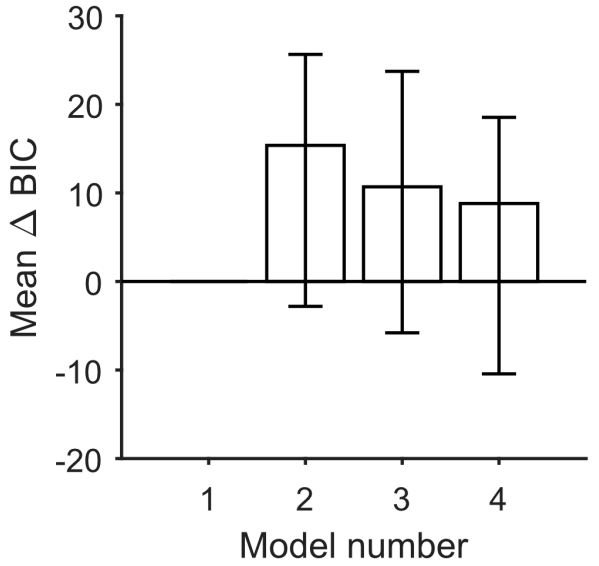




Fig. from Calder-Travis & Ma (2020)

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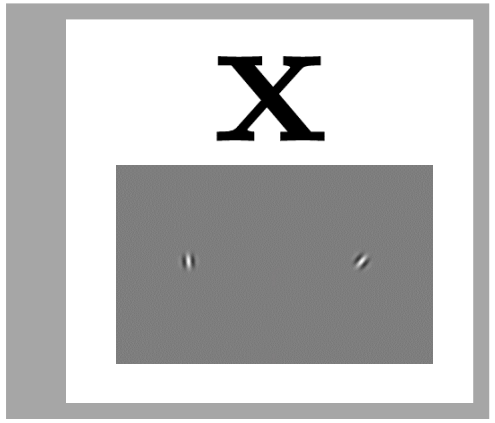


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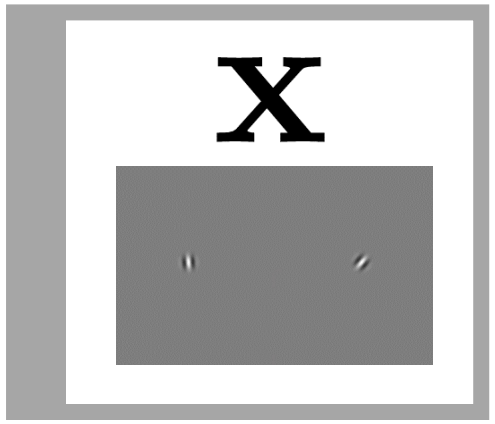


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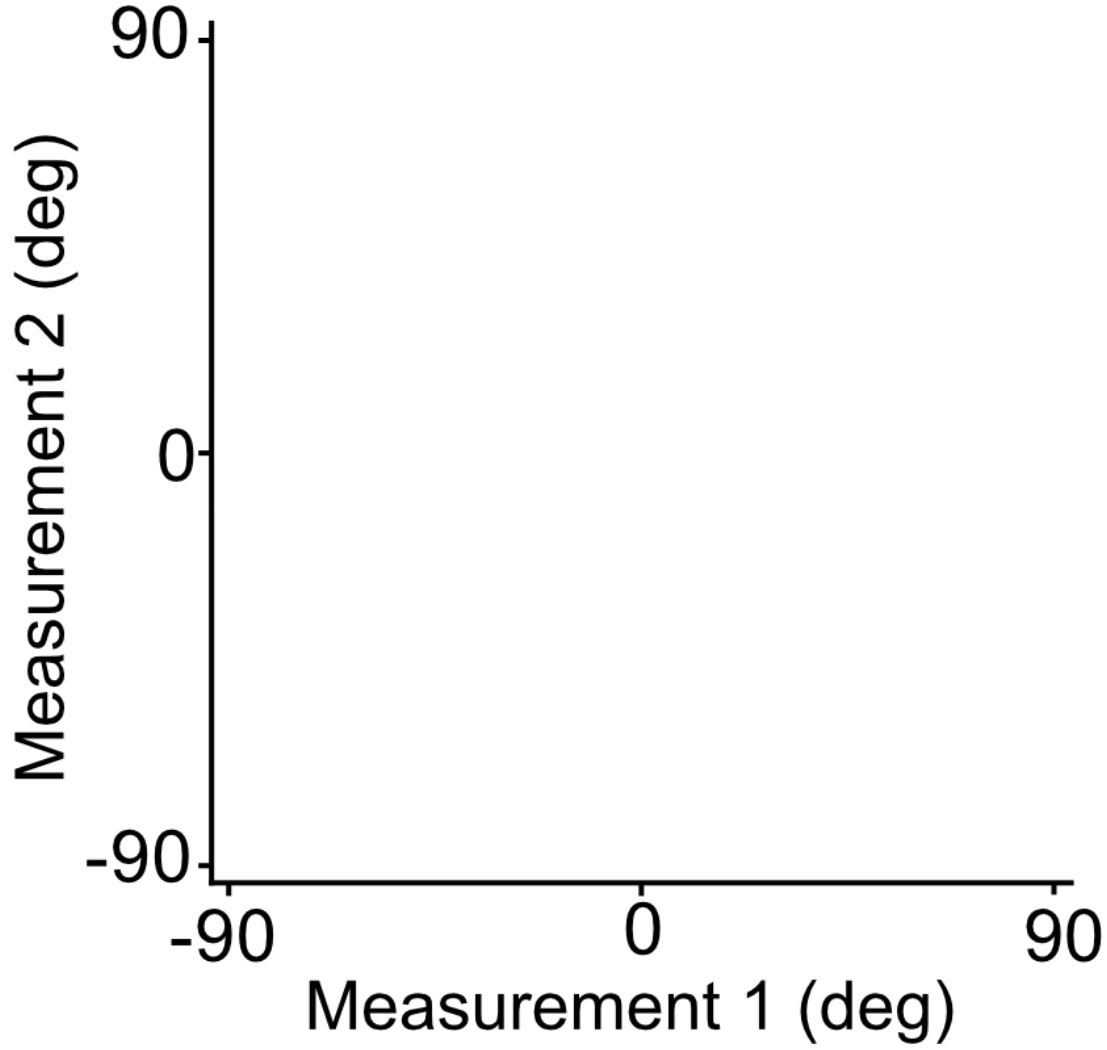

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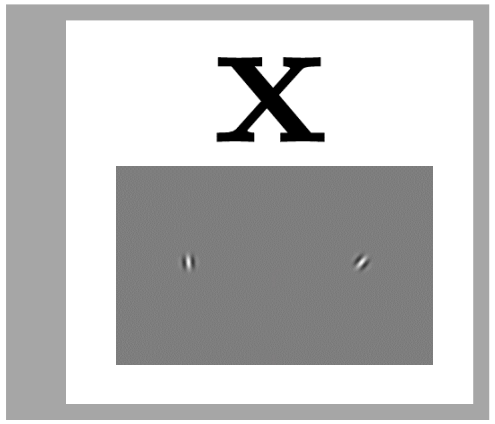


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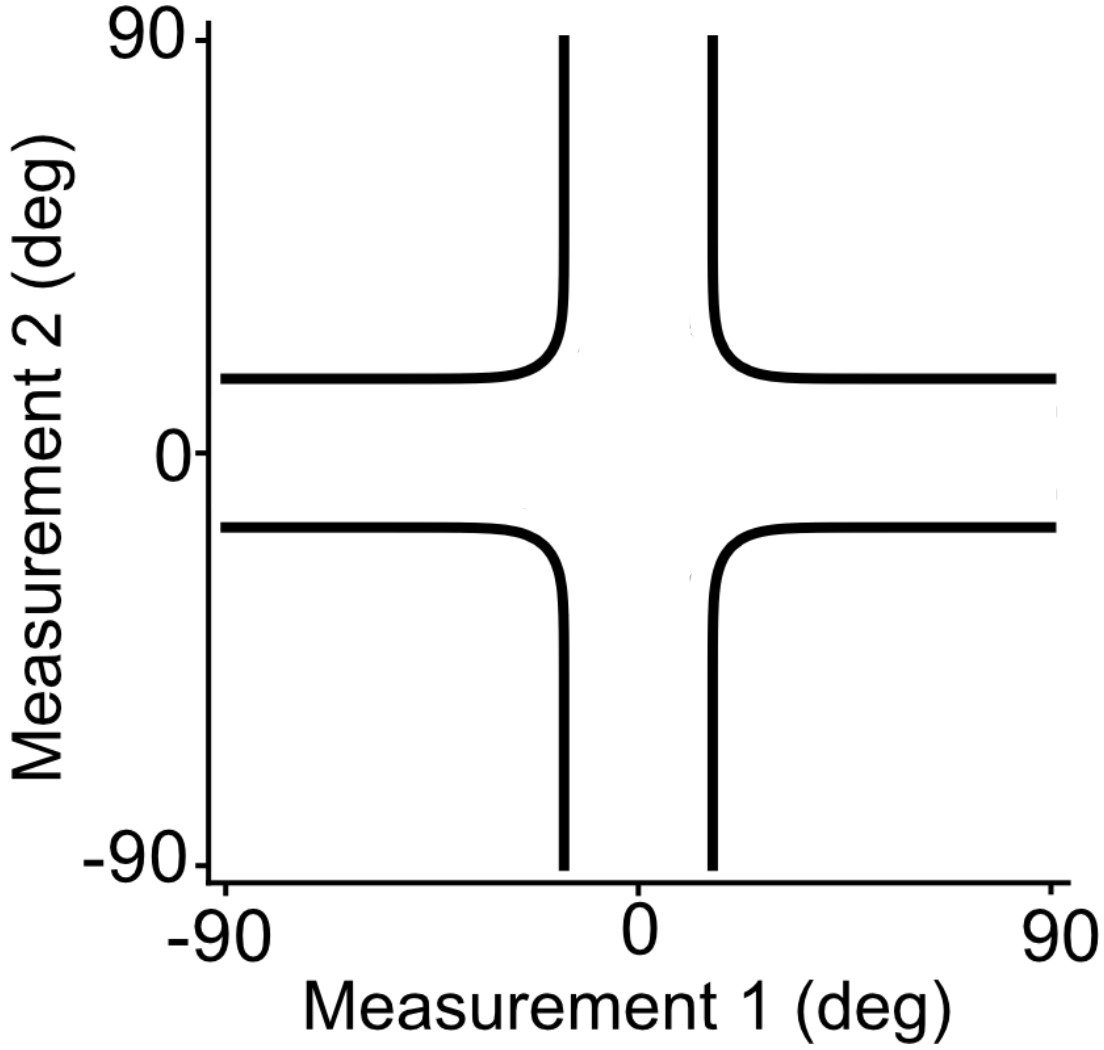

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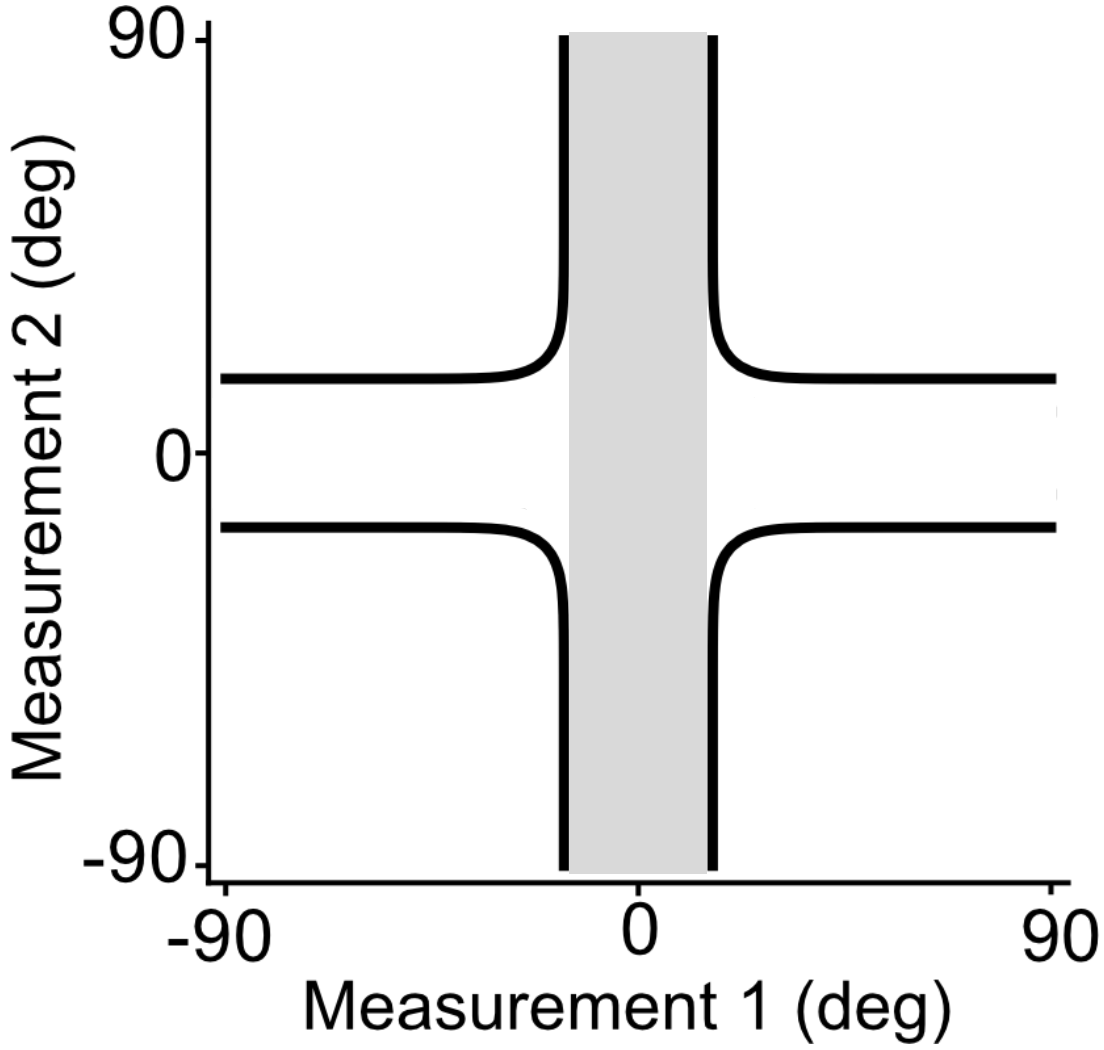

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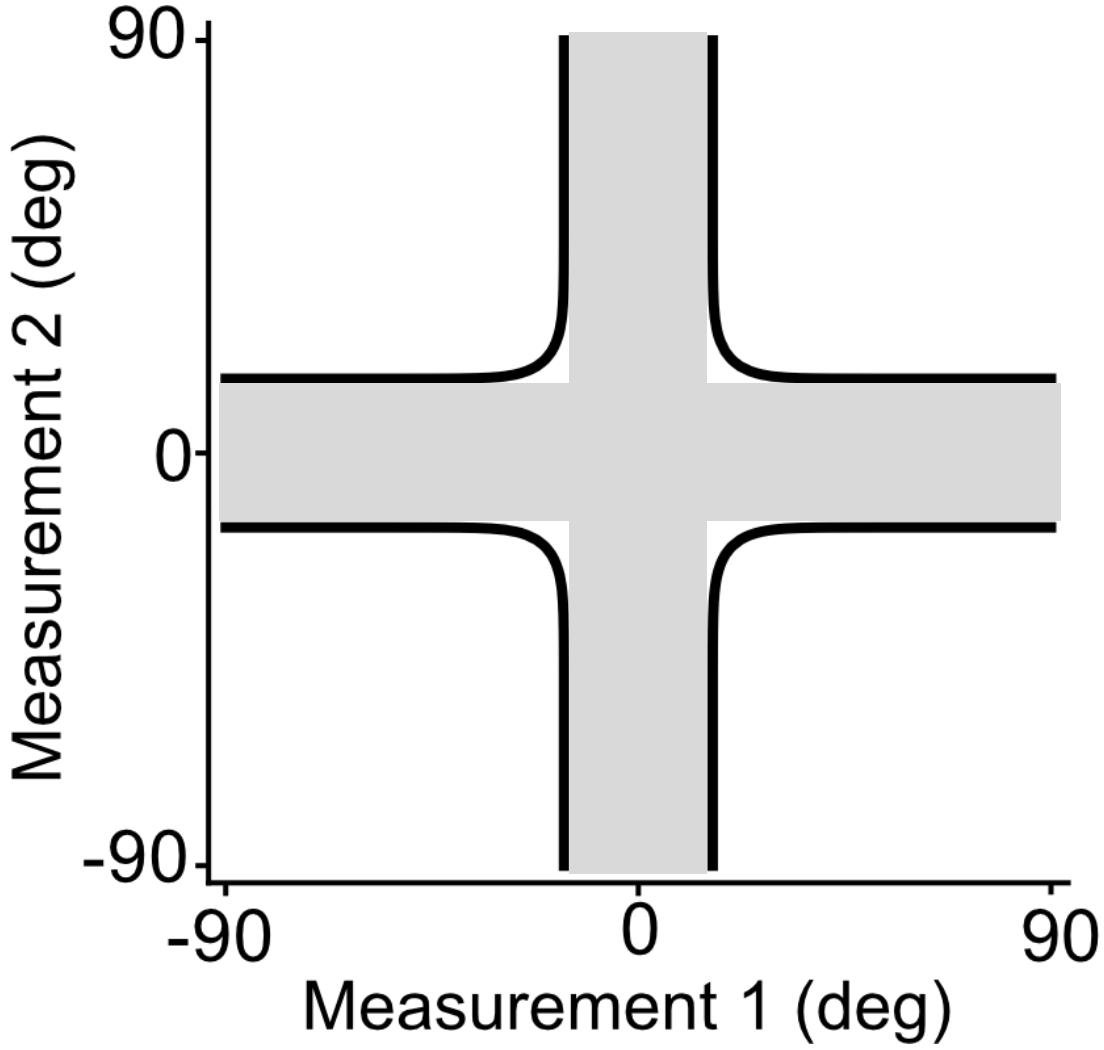

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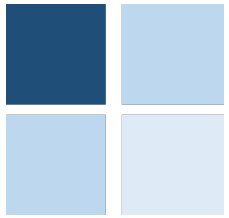
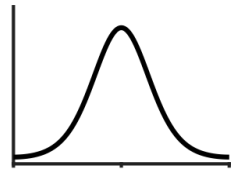
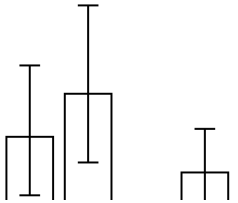


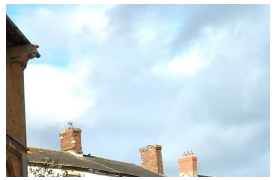
6. Different distractor “environments”



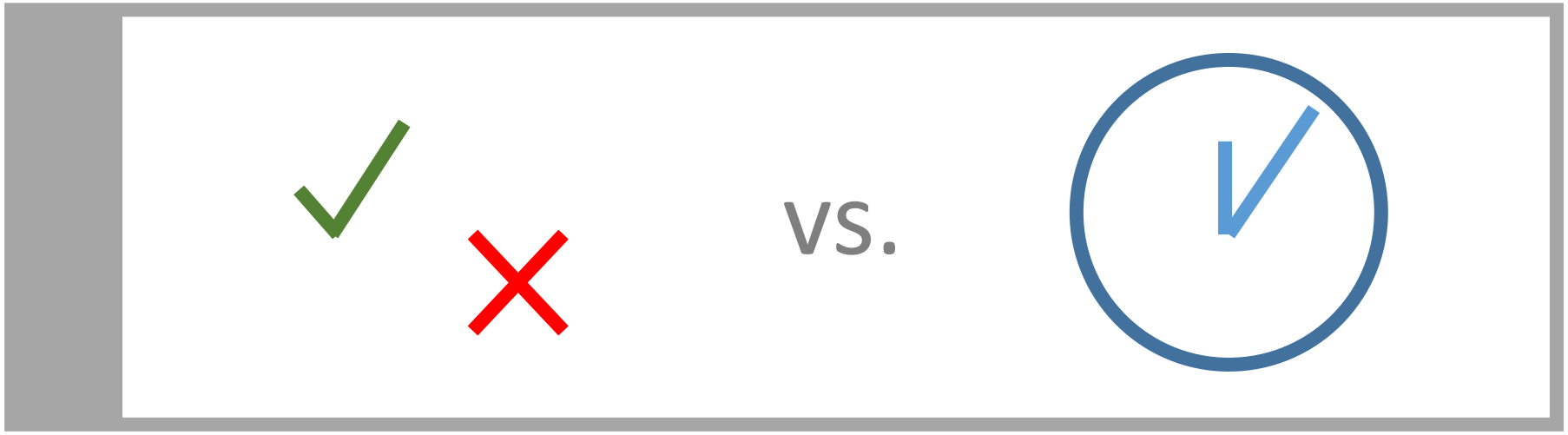
7. Comparison with non-Bayesian model

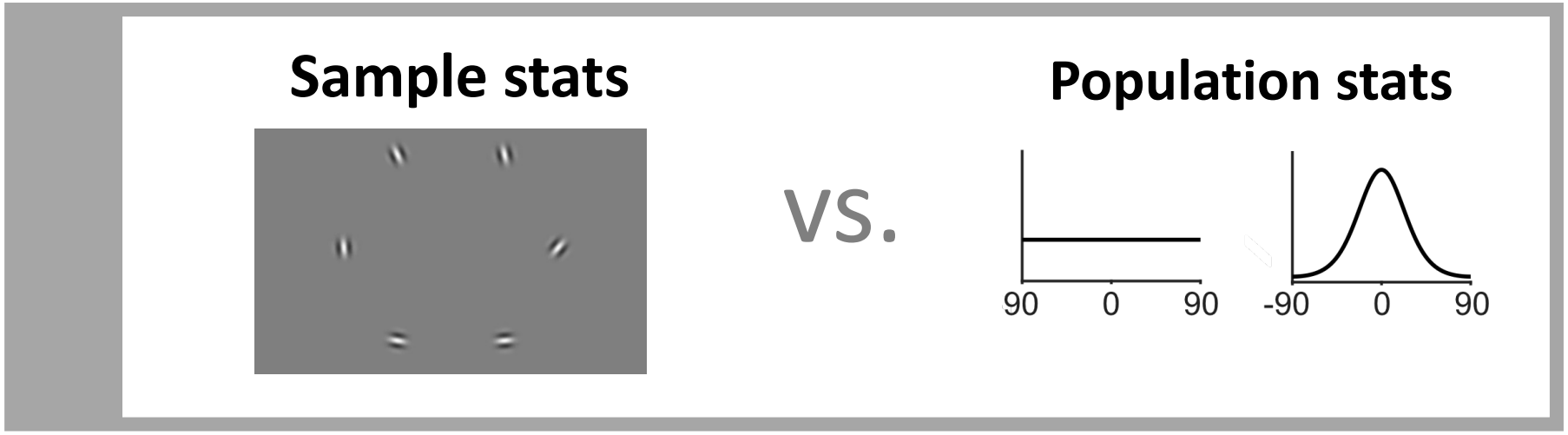


8. Limitations



# Differences from Duncan and Humphreys



# Limitations

**Where are the chairs?**

- Saccades
- Complex stimuli/scene


Palmer et al., 2000

# Component processes

**Isolate objects**

**Encode sensory information**

**Decision mechanism**

**Saccade selection**

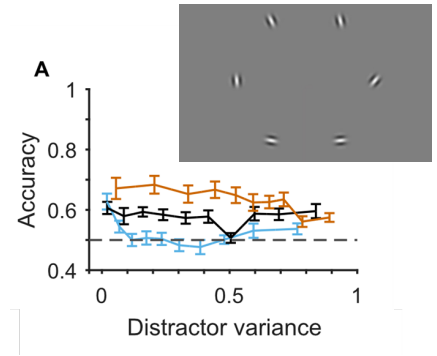
**Integration of previous saccades**

Wolfe, Alvarez, Rosenholtz, Kuzmova and Sherman (2011); Shen and Ma (2019); Najemnik and Geisler (2005) ; Horowitz and Wolfe (1998)

# Conclusions

Fig. from Calder-Travis & Ma (2020) & Mihali & Ma (2020)

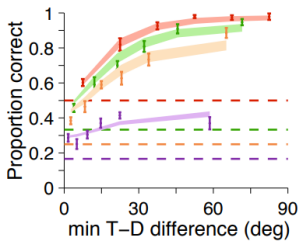
- Psychophysics → precise characterisation of heterogenous distractor effects

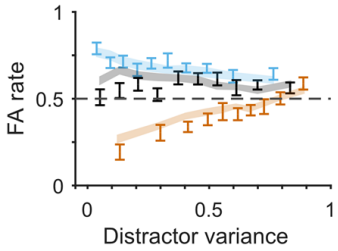



- Psychophysics → isolate a component process

**Decision mechanism**

- Bayesian/SDT models provide a good account across visual search tasks and contexts



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