Investigating a Computational Basis for Configuration Effects in Spatial Working Memory

Jorge A. Menendez, Gi Yeul Bae, Colin Wilson & Jonathan I. Flombaum

The Vision Sciences Group
Johns Hopkins University

Configuration Effects in SWM

Is the probe square in a previously occupied position?

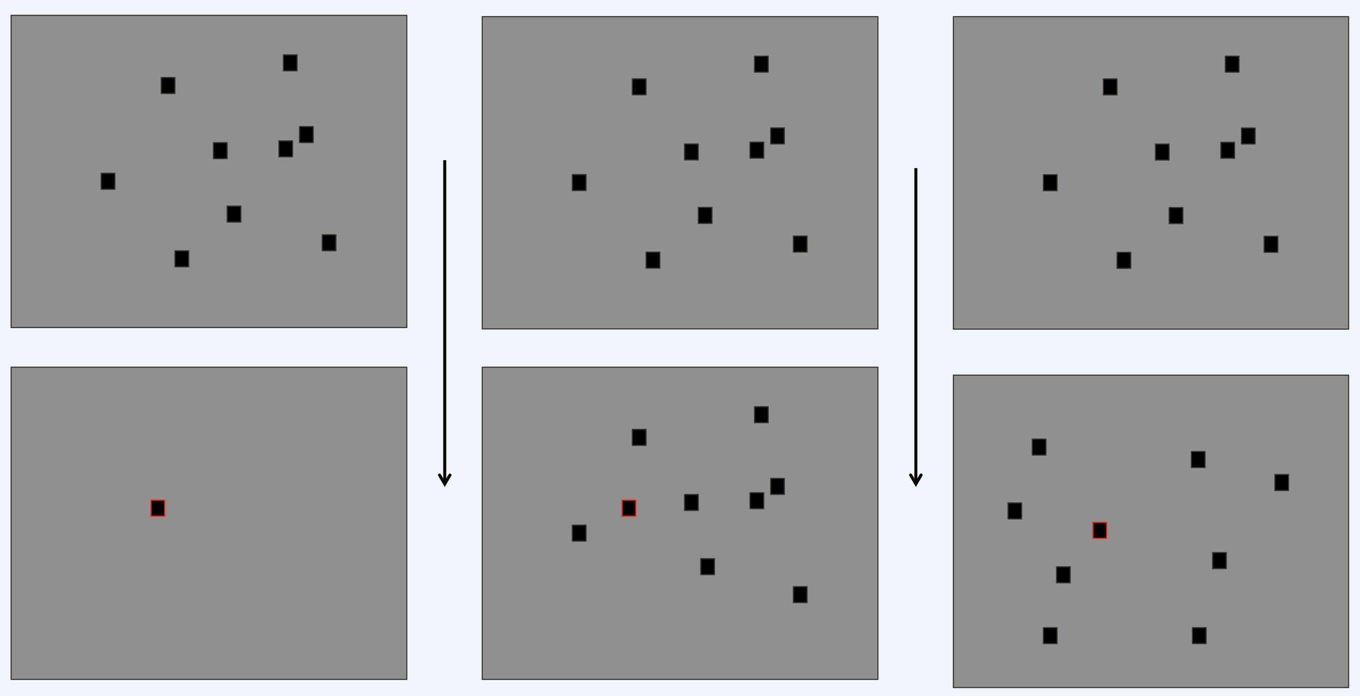
Jiang, Olson, & Chun (2000)

Single Probe Condition | **Identical Configuration Condition** | **Broken Configuration Condition**

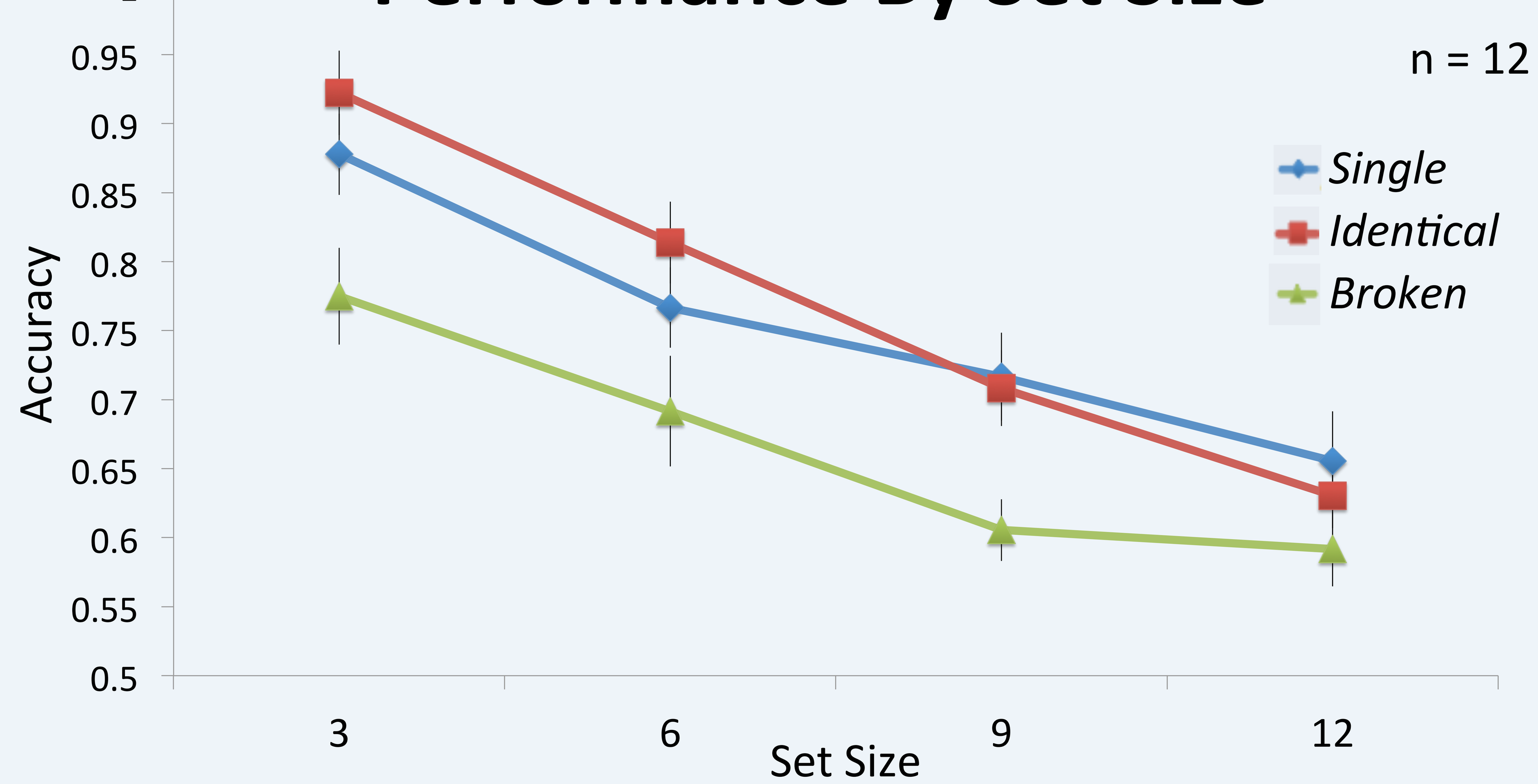
Memory Display

[900ms Blank]

Probe Display



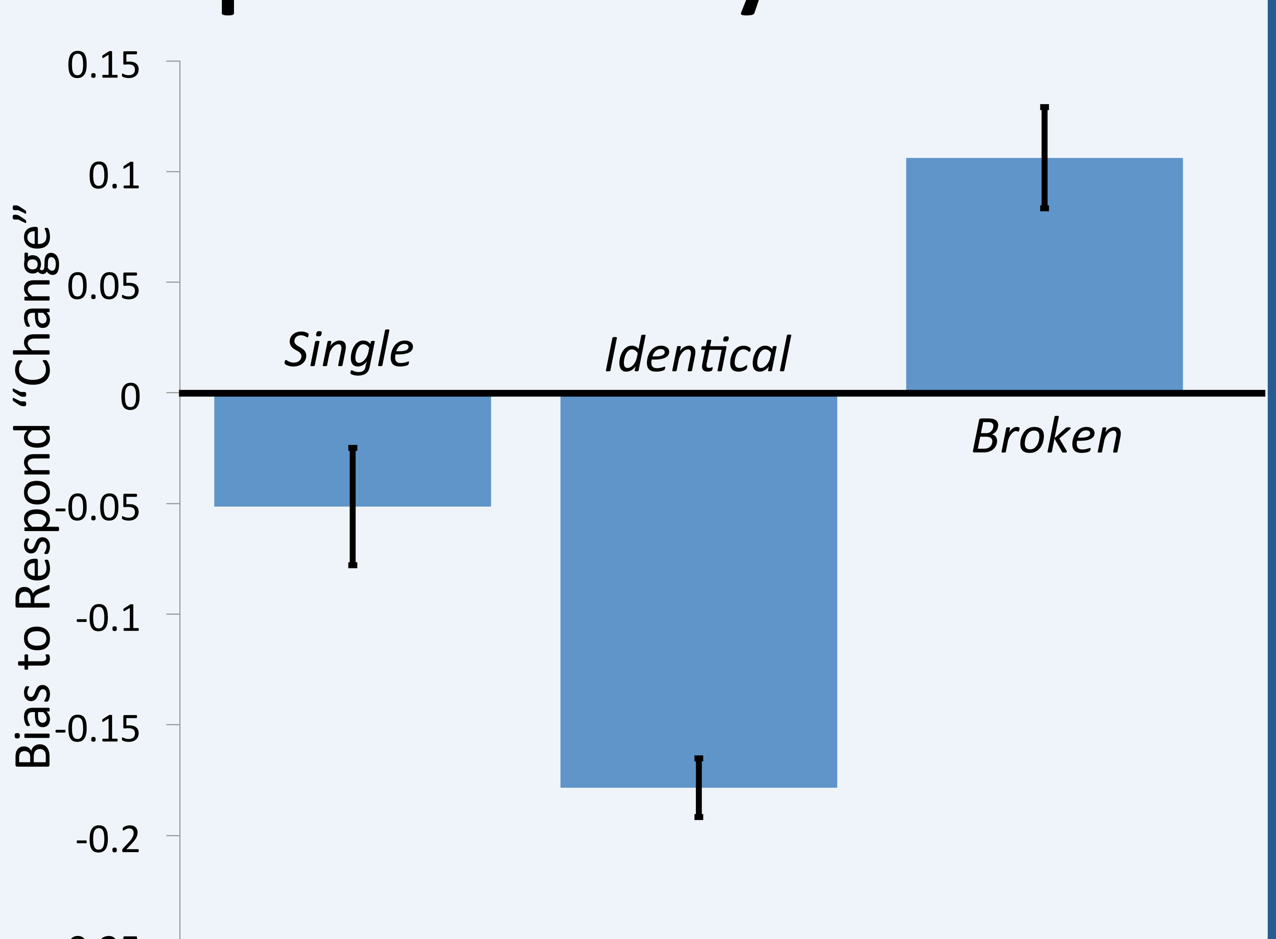
Performance By Set Size



Why are subjects making errors?

If we look closely at the proportion of "change" responses, we find that a significant amount of the error can be accounted for by a systematic bias depending on condition

Response Bias by Condition

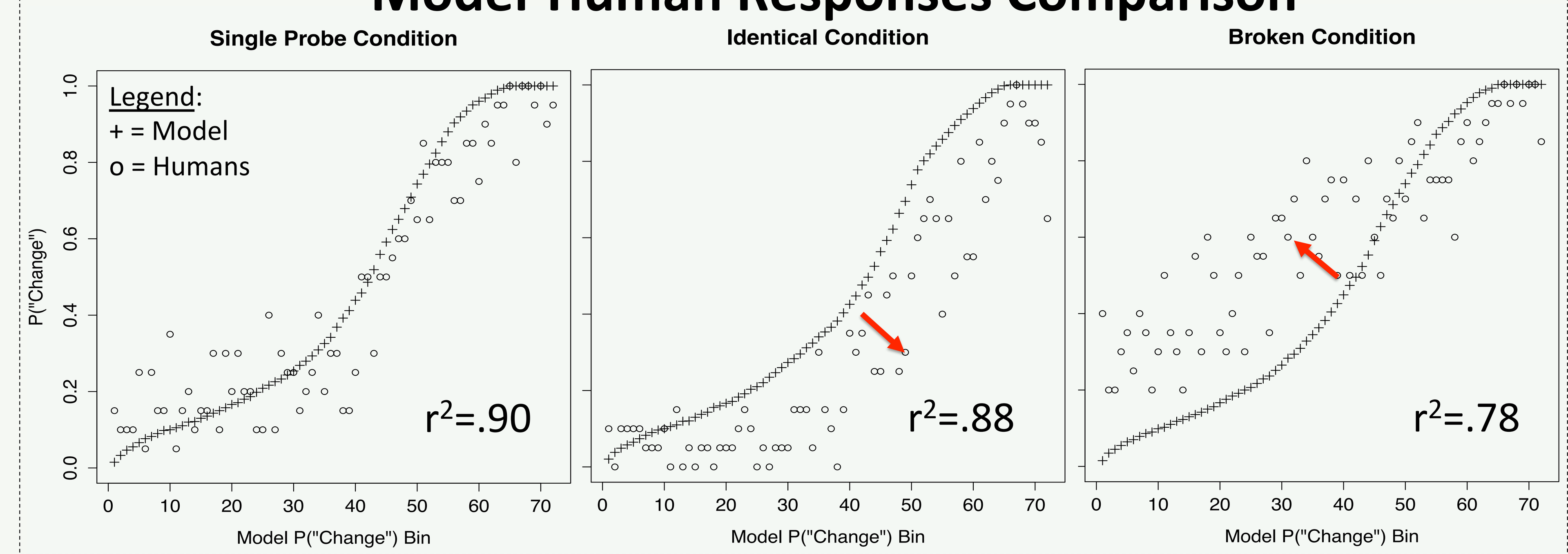


Configuration effects in SWM can be explained by the algorithms it uses, with no need to impose constraints on its contents

Preliminary Modeling: Single Probe Model

We first constructed the most straight-forward model possible: one that bases its decision solely on the probe item

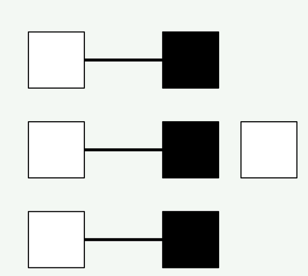
Model-Human Responses Comparison



Algorithm

1. Computes marginal probability of probe item occurring in the same location as any of the memory items
2. Computes probability of probe item being anywhere else (uniform distribution)
3. Makes a decision based on which probability is higher

Explains the single probe condition but fails to capture bias



Modeling the Bias: Borrowing from Apparent Motion

The Relative Velocity Principle: *The movement of neighboring elements should be similar*

Two ways of implementing this principle:

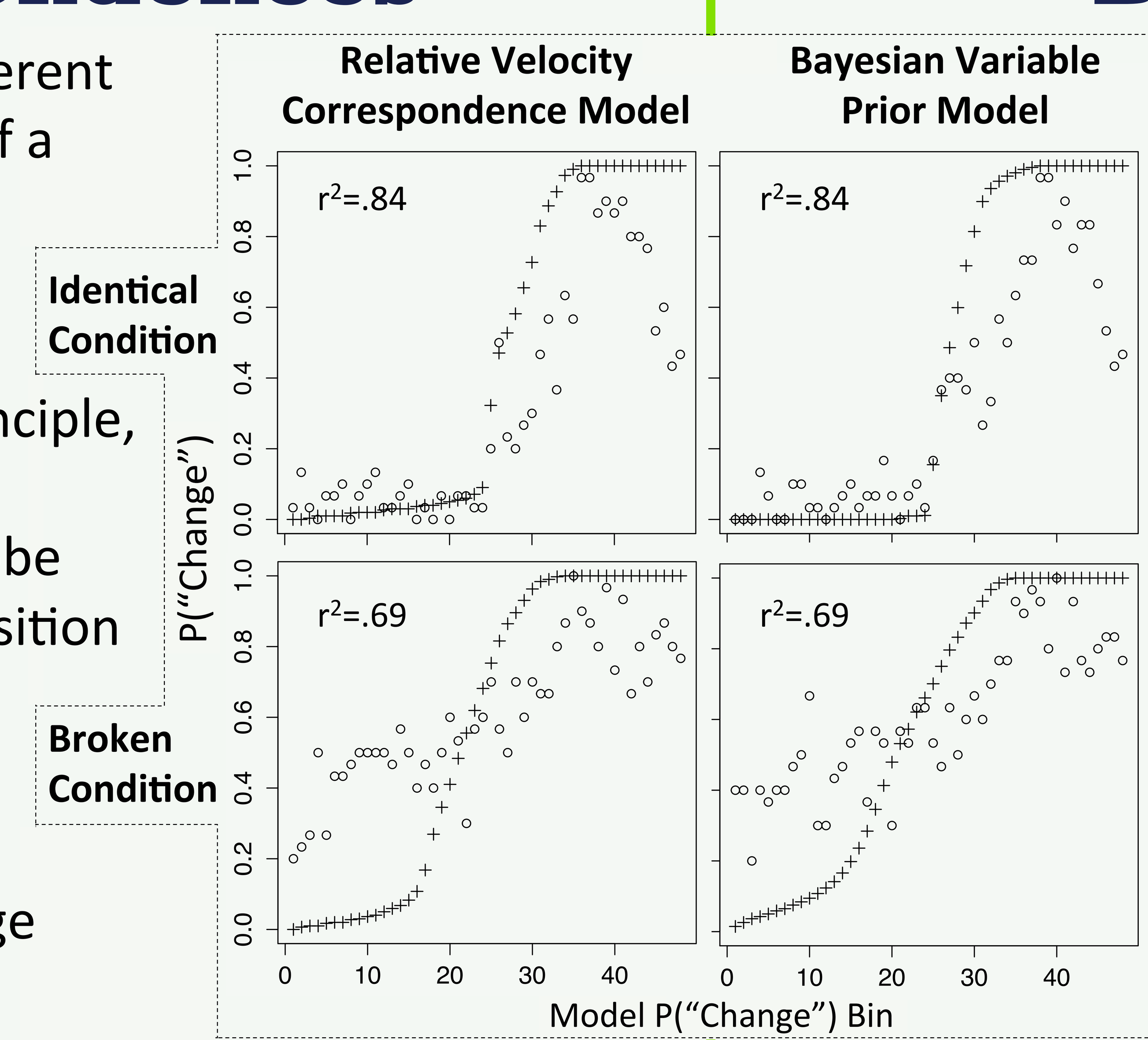
Dawson (1991)

Constraining Correspondences

This model produces two different measures of the probability of a "change" response:

1. Relative velocity algorithm that picks correspondences using the relative velocity principle, then makes a probabilistic judgment on whether the probe is in a previously occupied position
2. Single Probe Model

→The model then makes a response based on the average across both probabilities



Constraining Bayesian Prior

This model is a generative Bayesian probabilistic model that samples from a posterior probability distribution for each item to decide whether that item moved. Critically, it repeats this process many times, letting the prior fluctuate depending on the responses for all the items in the display:

- If many items are inferred to have changed position, then the prior probability of "change" increases
- If many items are inferred to have remained in the same position, the prior decreases

→ The model then takes the proportion of times the probe was determined to have changed position throughout the various iterations and uses this to produce a response