

# USING GENETIC PROGRAMMING TO DEVELOP THEORIES IN PSYCHOLOGY

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LSE

# ISSUES IN PSYCHOLOGY

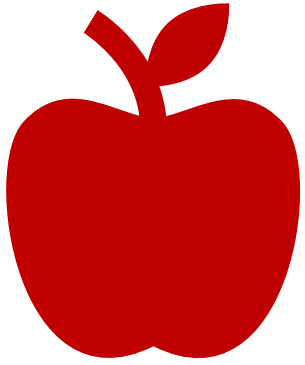
- Abundance of informal models
- Focus on explanation over prediction
- Abundance of data
- Too specialised

# HOW CAN GEMS HELP?

- Specify formal models with predictions
- Use published data
- Integrate operators from different domains
- Reduce bias
- New insights into classic experiments

# EXPERIMENTS IN PSYCHOLOGY

- Psychologists want to understand human behaviour
- Run experiments to collect data:
  - Reaction times
  - Performance measures
  - Accuracy
- These experiments involve *manipulations* to test effects

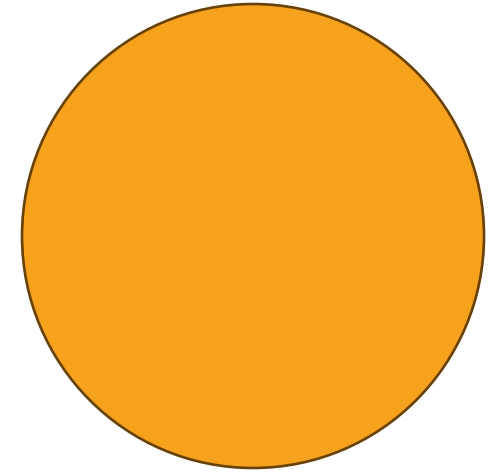


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# ATTENTION CUEING TASK EXAMPLE

- Very famous experiment in psychology
- Designed to investigate attention
- Popularised by Posner (1980)
  
- Cue a location, then present a 'target' either in the cued location, or in the uncued location

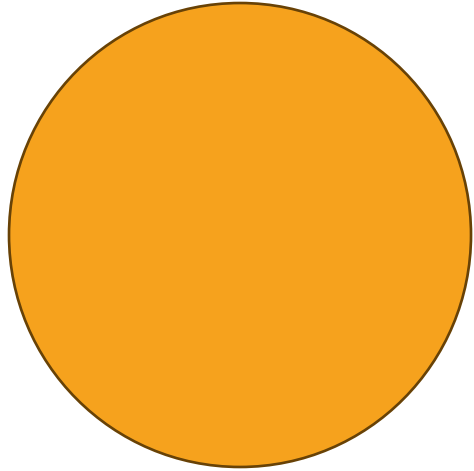




VALID TRIAL

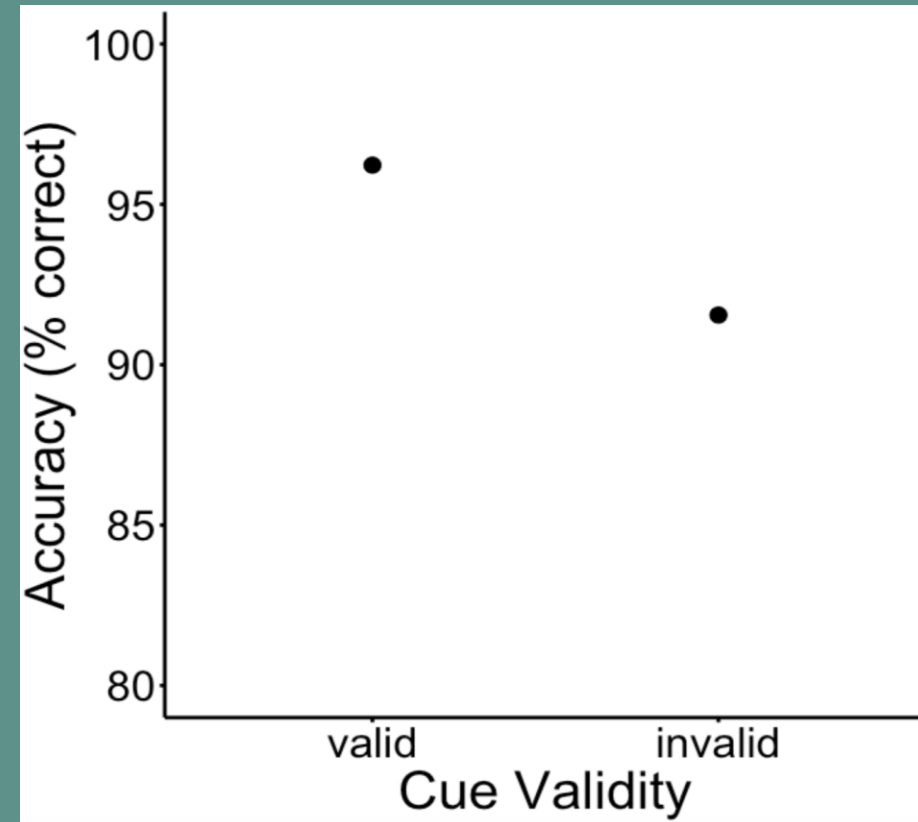
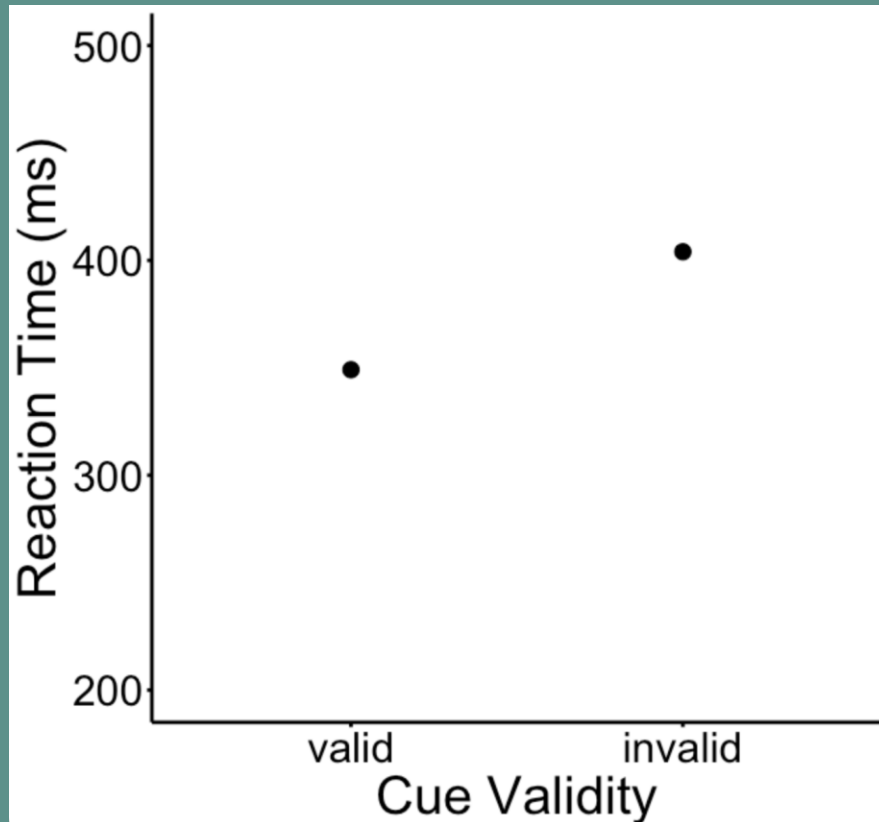






INVALID TRIAL

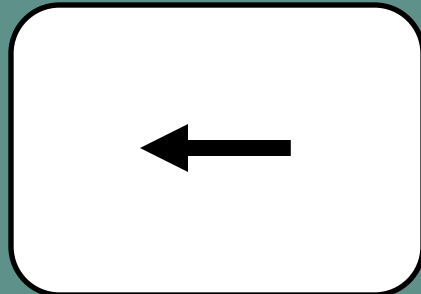
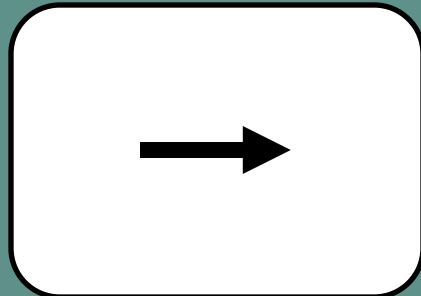
# KEY RESULTS



Data from: Arjona, A., Escudero, M., & Gómez, C. M. (2016). Cue validity probability influences neural processing of targets. *Biological Psychology*, 119, 171–183.

# CURRENT DATA

Cue phase  
(300 ms)



Target phase  
(100 ms)

Delay  
(370 ms)

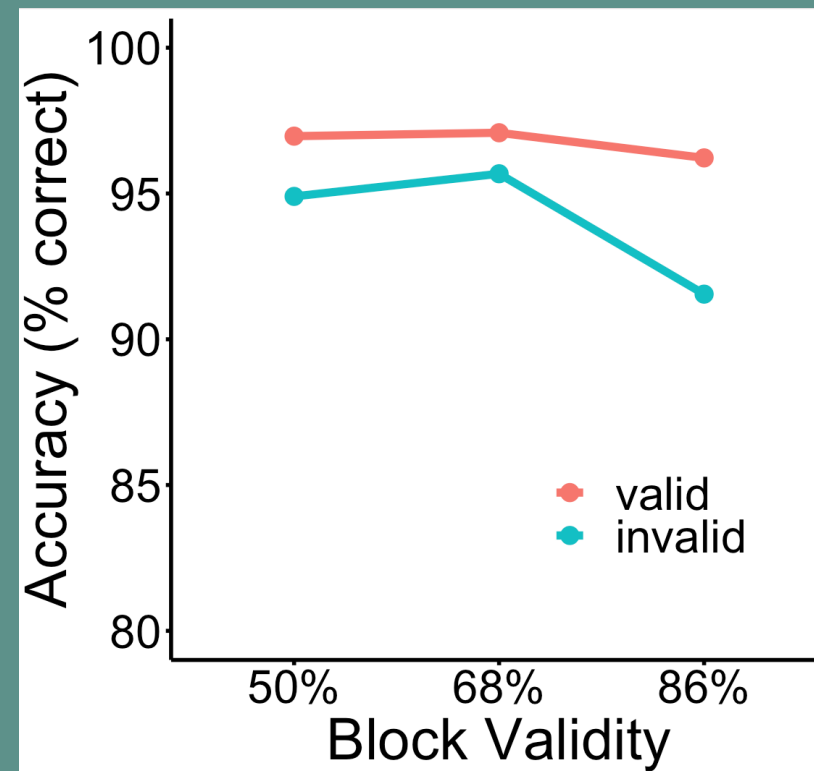
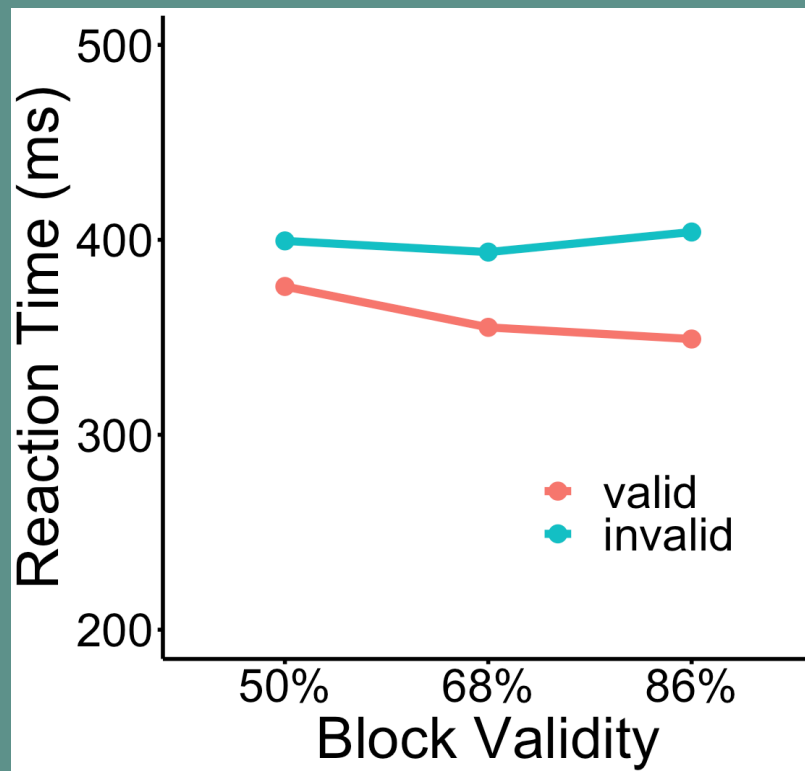


Different probabilities  
of validity:

- 50% of trials in a block VALID
- 68% of trials in a block VALID
- 86% of trials in a block VALID

# PUBLISHED RESULTS

- Responses are both **FASTER** and **MORE ACCURATE** in valid cue trials compared to invalid cue trials



# GEMS ARCHITECTURE

Attention

Location

Short-term-  
memory

Salient stimulus

Item

Clock



Slot 1

Slot 2

Slot 3

Attended  
stimulus  
(covert or overt)

Item

Learning

Cue strength

Response

Location

# GEMS OPERATORS

## Attention

Attend

Move attention

Detect

Respond

Wait

## Learning

Predict from cue strength

Predict from cue and percept

Predict from block validity

Predict from prior trial cue validity

## Short-term-memory

Put attended item in

STM

Rehearse

Retrieve

# EXPERIMENT IMPLEMENTATION

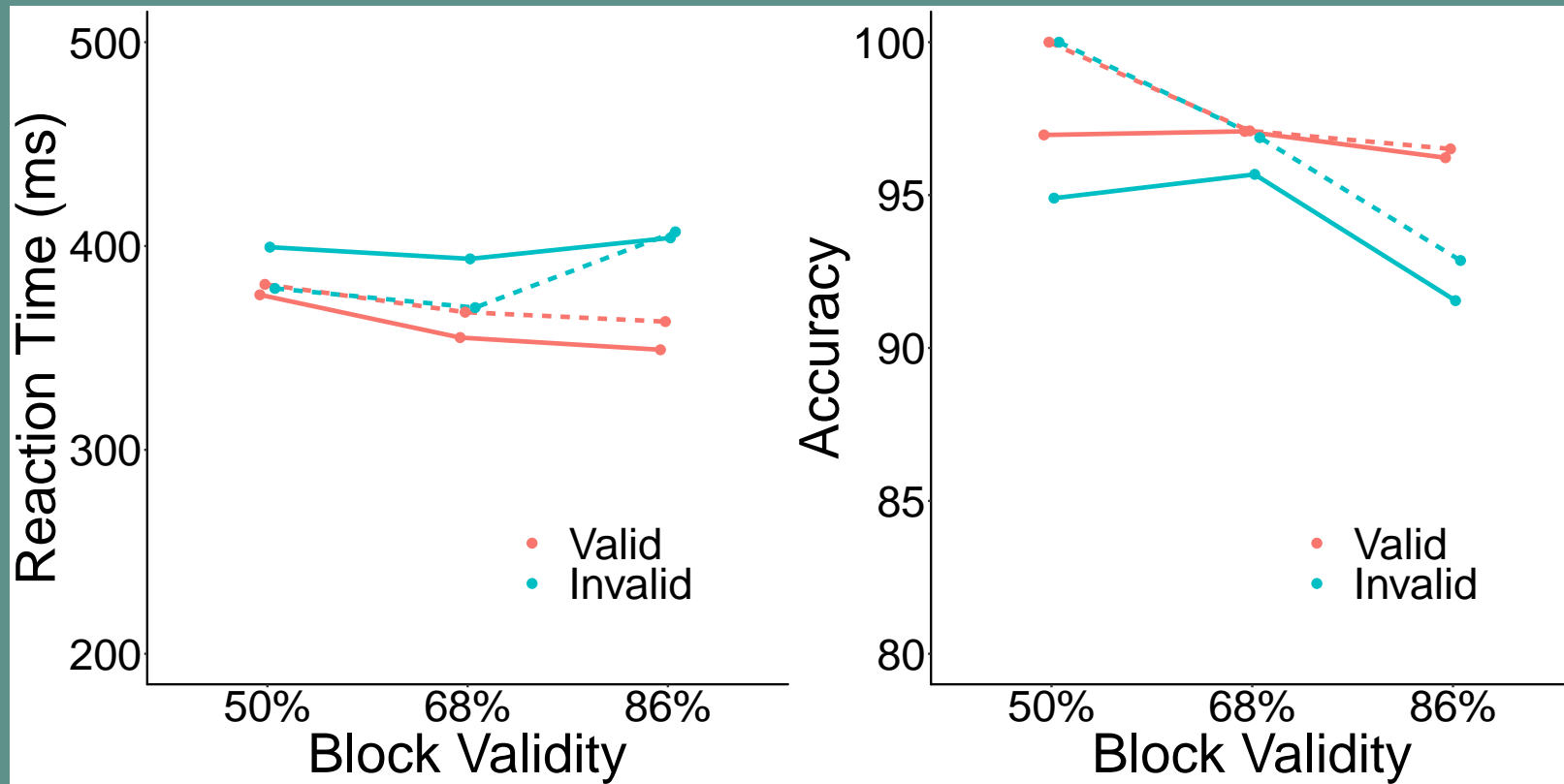
- Symbolic coding of cue and target
- Timeline of events
- 100 trials per block



# FITNESS EVALUATION

- Model outputs were compared to human data
  - Fitness was phased
- Best models were selected, some undergoing mutation and crossover
  - Repeated for 500 generations, with 5,000 models per generation

# MODEL FIT



Solid line: published data; Dashed line: model output

BEST MODEL

Prog4

Prog2

Wait

Prog4

If

Wait

Detect

Attention  
capture

Respond  
current

Prog2

Move  
attention  
right

Detect

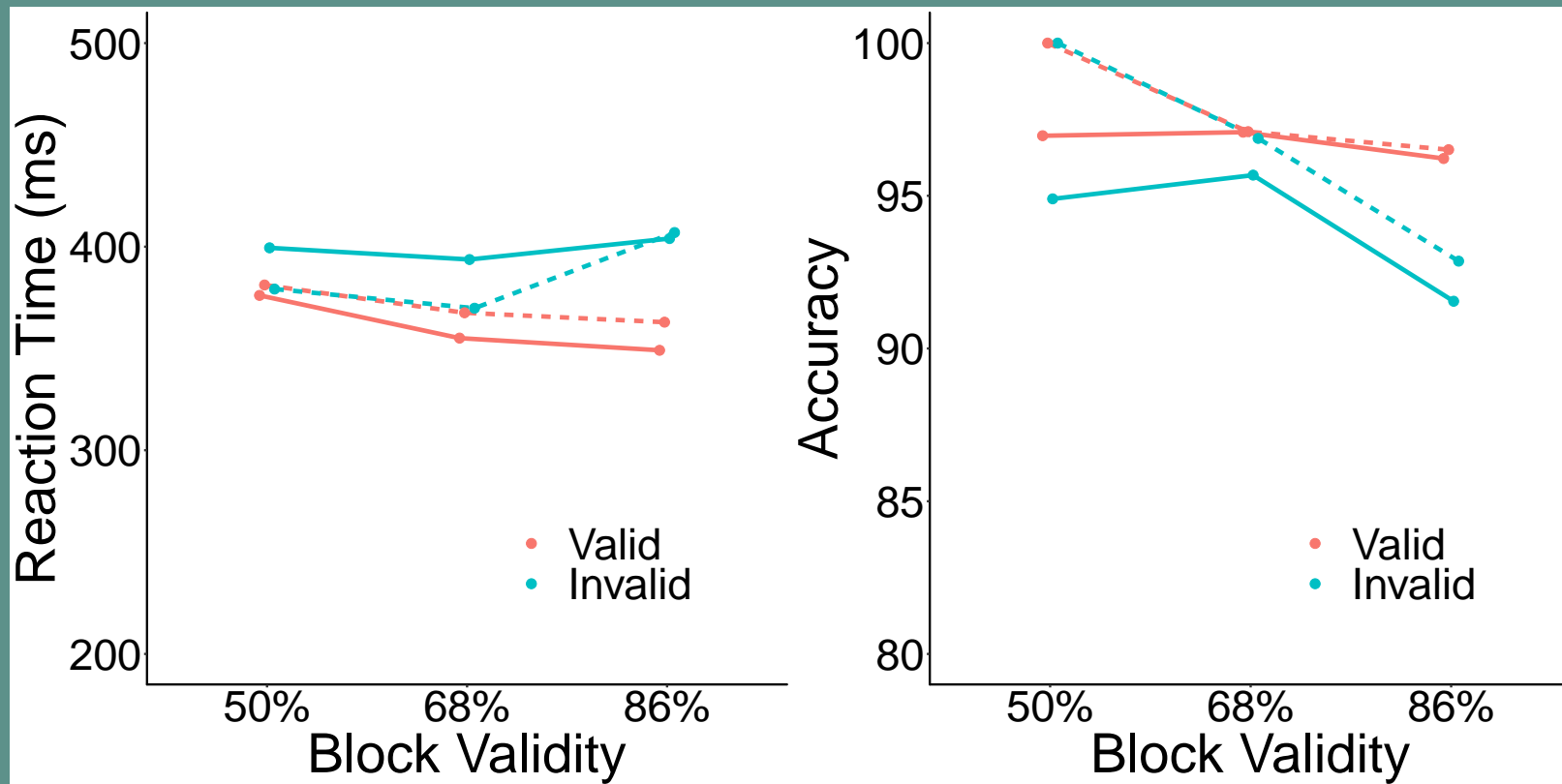
Predict  
from cue-  
strength

Respond  
left

Wait

Detect

# MODEL FIT



Solid line: published data; Dashed line: model output

# GEMS IMPACT

- Generated an interesting model that fits the human data well
- Can search a large space of candidate models
- Encourages collaboration