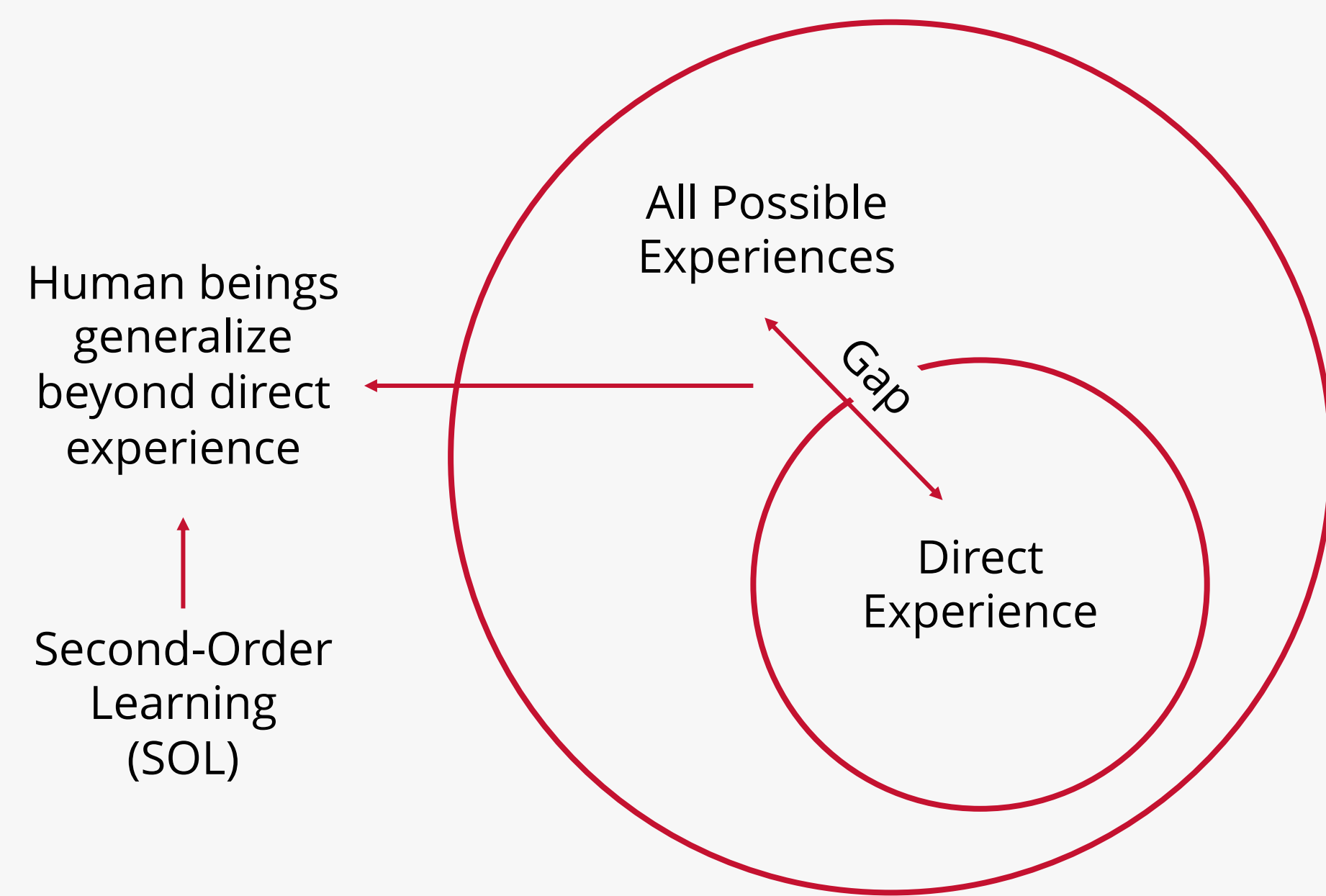


# Touch and Go: Spatial Contiguity's Shifting Role in Categorical Causal Learning From Childhood to Adulthood

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How do human beings build a representation of the world that supports novel generalizations?



Second-Order Learning (SOL)<sup>1,2</sup> supports indirect structure-building by stacking associations through shared elements.

## OPEN QUESTIONS

1. Can adults and children similarly engage in SOL?
2. Does SOL extend to categorical contexts and generalize across causal event types (Blicket detector<sup>3</sup> and Michottian launching<sup>4</sup>) and spatial contiguity conditions?

## METHOD

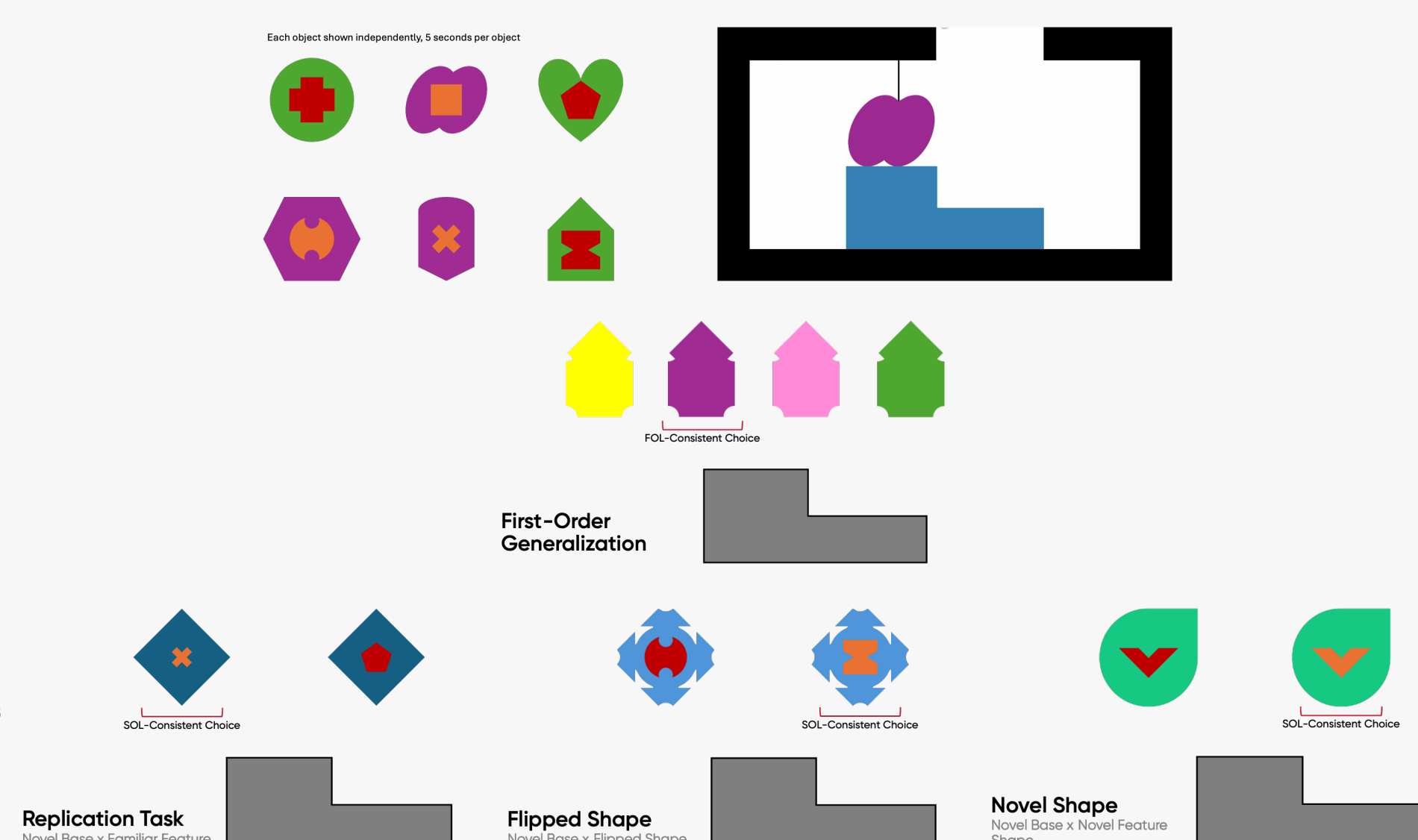
### Participants

Exp 1: 59 children (3–6 yrs; M = 53.78 mo)  
Exp 2: 73 adults (18–26 yrs; M = 20.51 yrs)

### Design

2 Event type (Detector vs. Launching) × 2 Spatial contiguity (Contact vs. Gap), within-subjects.

### Schematic



## EXPERIMENT 1: CHILDREN

### Binomial Tests (conditional on 1st-order prediction)

Test Trial	Freq.	OR	p
Second-Order Prediction	96/147	1.88	<.001
Flipped Shape	84/147	1.33	.099
Novel Shape	77/147	1.10	.621

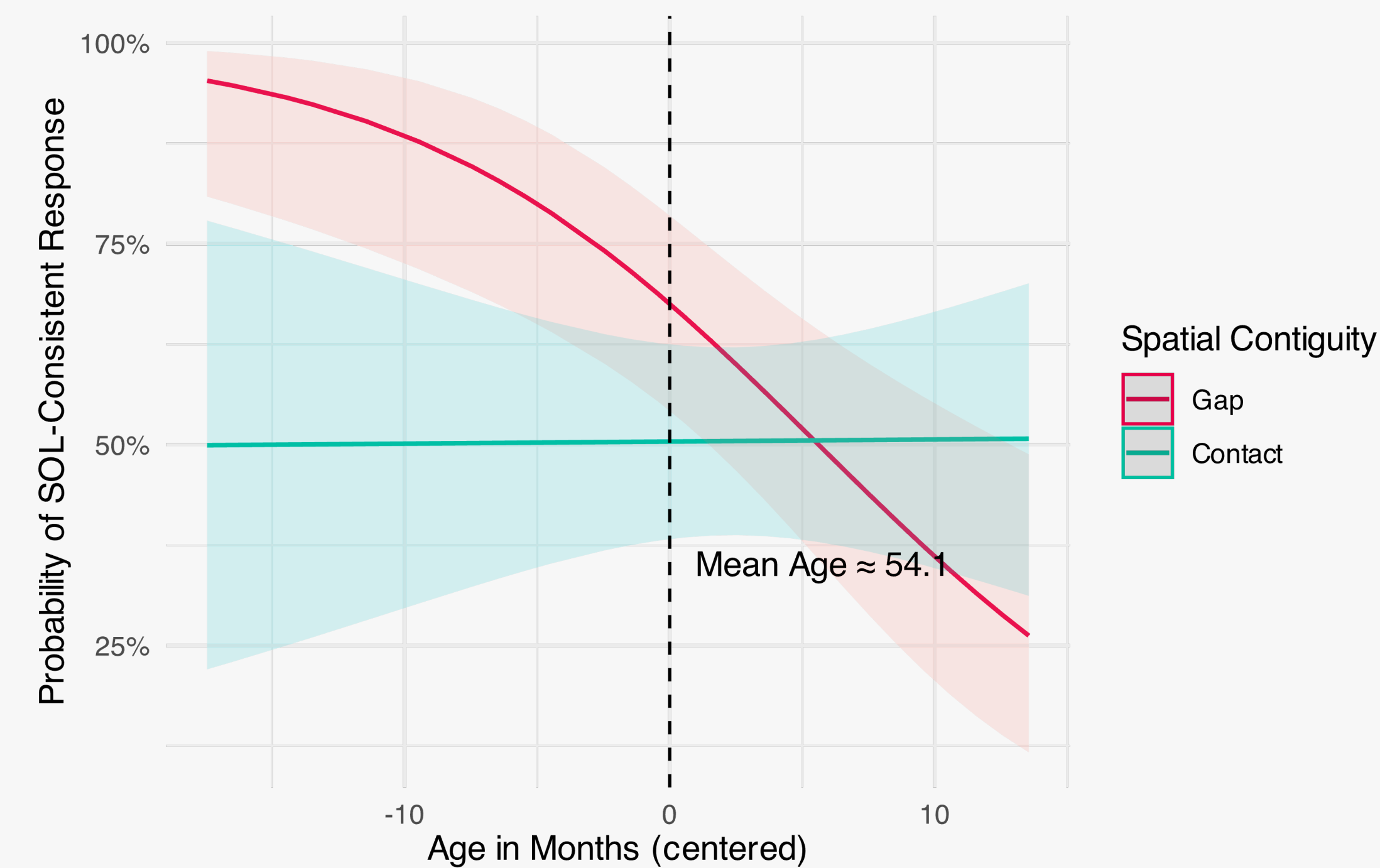
### Binomial Tests (conditional on 1st- & 2nd-order prediction)

Test Trial	Freq.	OR	p
Flipped Shape   SOL	62/96	1.82	.006
Novel Shape   SOL	60/96	1.67	.018

### SOL by Event Type & Contiguity (cond. on 1st-order)

Event	Freq.	OR	p
Detector-Contact	23/32	2.56	.020
Launching-Contact	19/41	0.86	.755
Detector-Gap	28/37	3.12	.003
Launching-Gap	26/37	2.37	.020

Marginal Effects of Age and Spatial Contiguity on Second-Order Learning with Familiar Feature Conflict



Age × Spatial Contiguity interaction on flipped shape trial. Younger children facilitated by gaps; older by contact (BF = 17.05).

## EXPERIMENT 2: ADULTS

### Binomial Tests (conditional on 1st-order prediction)

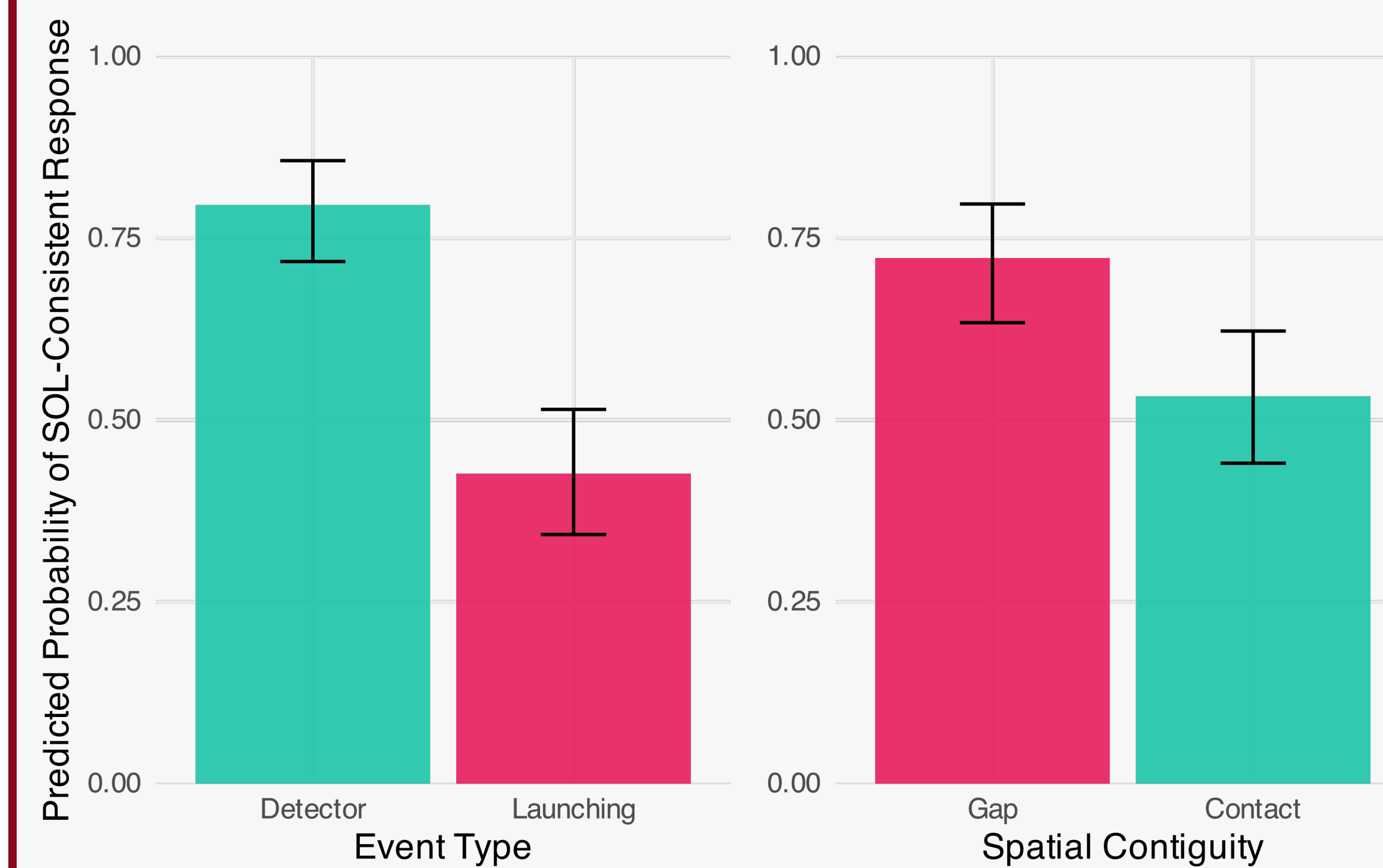
Test Trial	Freq.	OR	p
Second-Order Prediction	162/266	1.56	<.001
Flipped Shape	122/266	0.847	.198
Novel Shape	163/266	1.58	<.001

### Binomial Tests (conditional on 1st- & 2nd-order prediction)

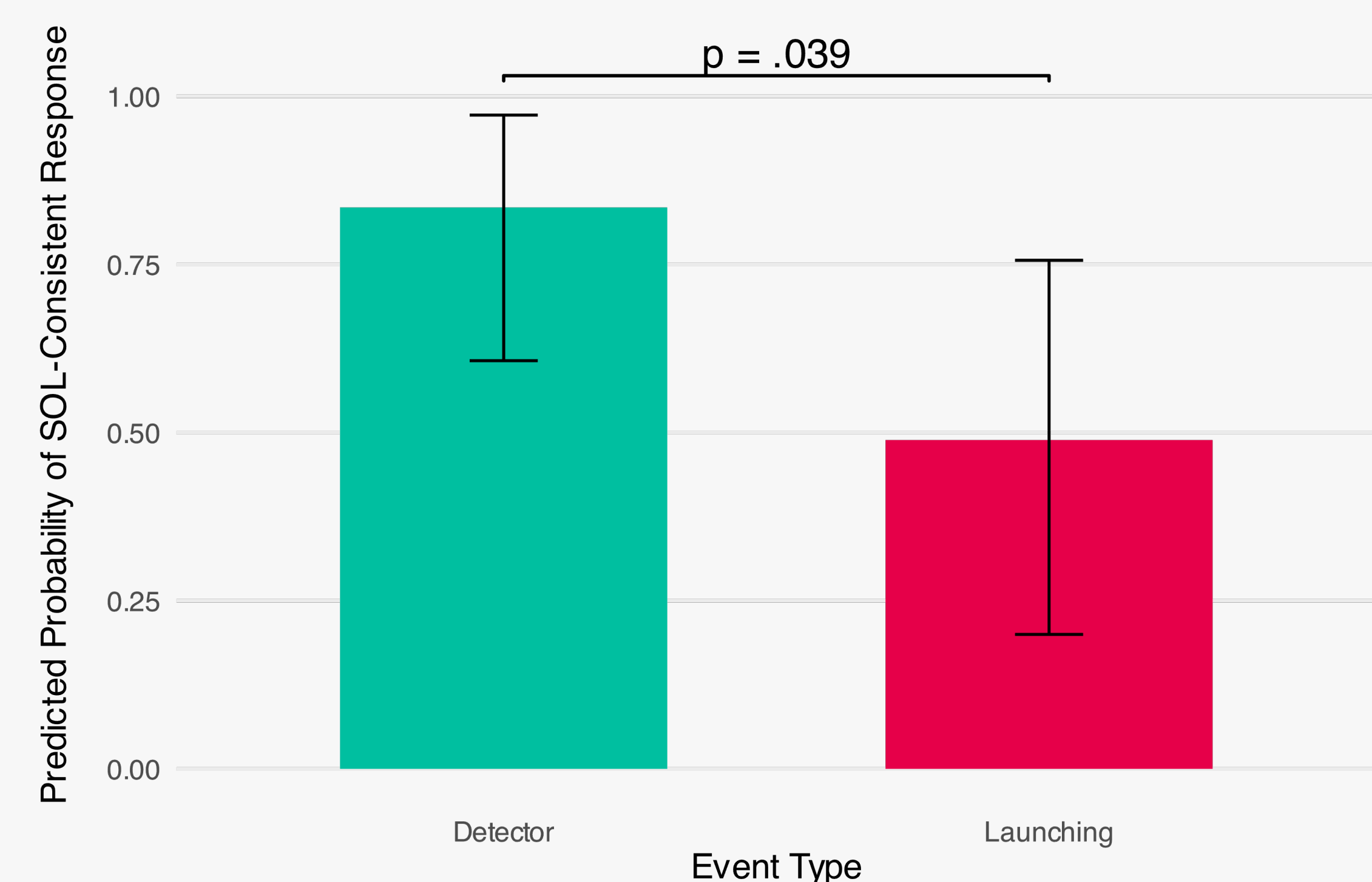
Test Trial	Freq.	OR	p
Flipped Shape   SOL	96/162	1.45	.022
Novel Shape   SOL	122/162	3.05	<.001

### SOL by Event Type & Contiguity (cond. on 1st-order)

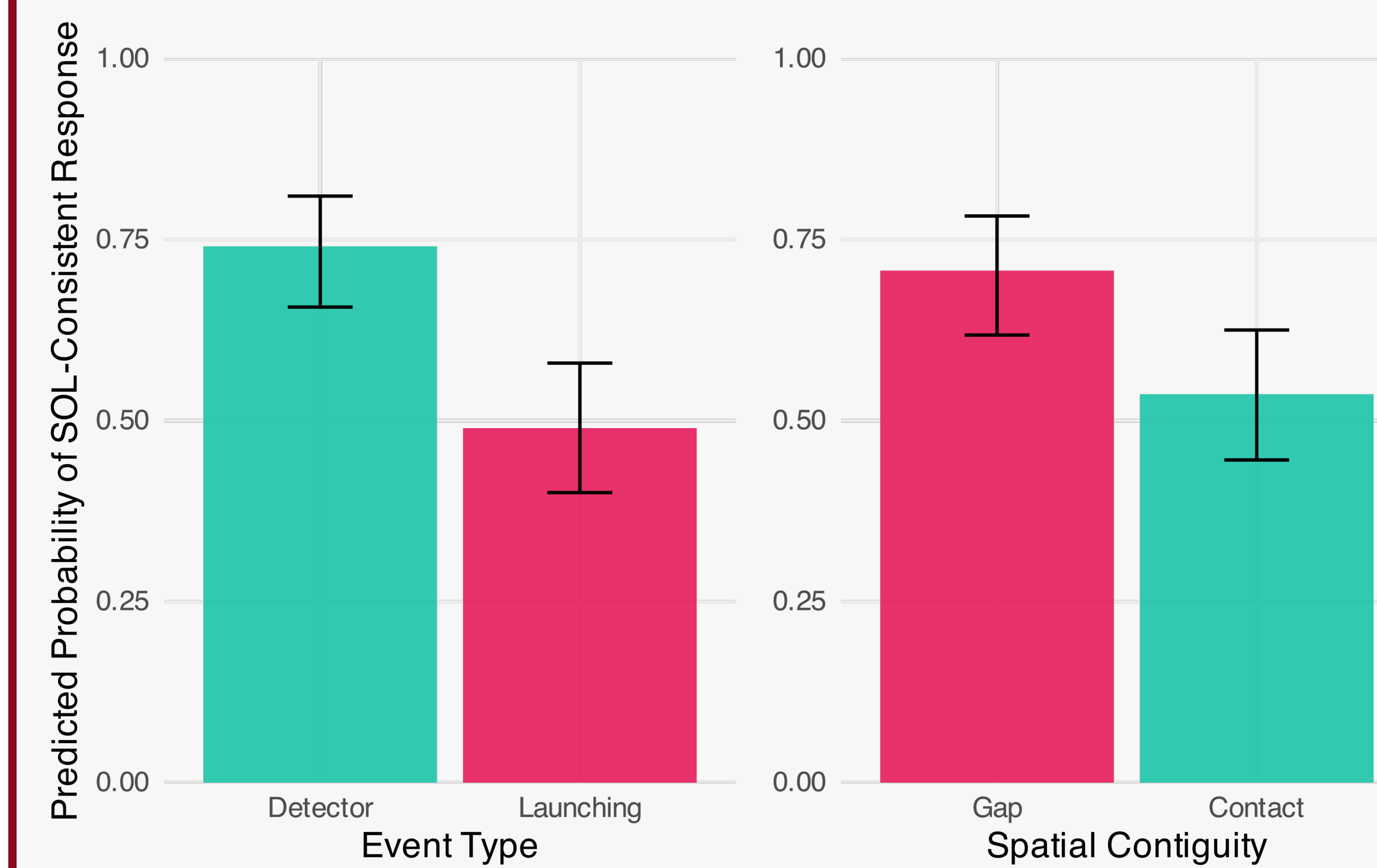
Event	Freq.	OR	p
Detector-Contact	53/68	3.53	<.001
Launching-Contact	18/67	0.37	<.001
Detector-Gap	52/66	3.72	<.001
Launching-Gap	39/65	1.50	.136



Main effects of event type and spatial contiguity on second-order prediction. Adults show robust SOL for Detector but impaired for Launching.



Main effect of event type on novel shape trial. Children's SOL stronger for Detector than Launching events.



Main effects on novel shape trial. Event type and contiguity effects persist with novel stimuli.

## KEY FINDINGS

- **Categorical SOL is robust.** Both children and adults engaged in second-order learning at the category level, extending beyond exemplar-based prediction.
- **Developmental crossover.** Younger children's SOL was facilitated by spatial gaps, while older children's SOL was facilitated by contact—may reflect the development of expectations about contact as a cue for physical causality.
- **Event-type dissociation in adults.** Adults showed robust SOL for Blicket detector events but were significantly impaired—even below chance—for Michottian launching events with contact.
- **Event-type sensitivity in children.** Under increased categorical task demands, children also showed differential performance across event types, with stronger SOL for detector events.

## THEORETICAL INTERPRETATION

These findings align with a dual-timescale framework<sup>5</sup> of associative learning:

- **Short-term associative learning** extracts relations within episodes, enabling flexible SOL across contexts.
- **Long-term associative learning** integrates across experiences, forming stable context-specific expectations (e.g., contact predicts causation in launching events).

Spatial contiguity's role shifts as expectations strengthen from a potential distractor for young children to a facilitating cue for older children.

Even adults' causal inference retains sensitivity to event-specific expectations rather than being fully abstract.

## CONCLUSIONS

Developmental changes in sensitivity to spatial contiguity and event types reveal that causal inference is not a static competence, but a dynamic process shaped by accumulated experience.

## REFERENCES

1. Benton, Rakison, and Sobel, 2021 (JECp)
2. Choi and Rakison, 2025 (CogSci Proceedings)
3. Gopnik & Sobel, 2000 (Child Development)
4. Michotte, 1963
5. Rakison and Lupyan, 2008 (Monograph SRCD)