Supporting Information for:

Compositional Thought Before Compositional Language: Evidence From 9–11-Month-Olds

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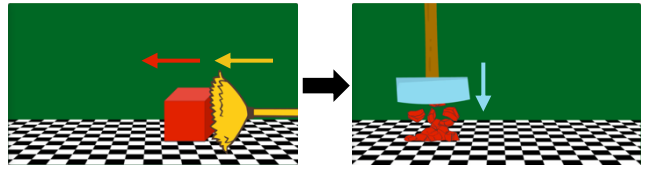
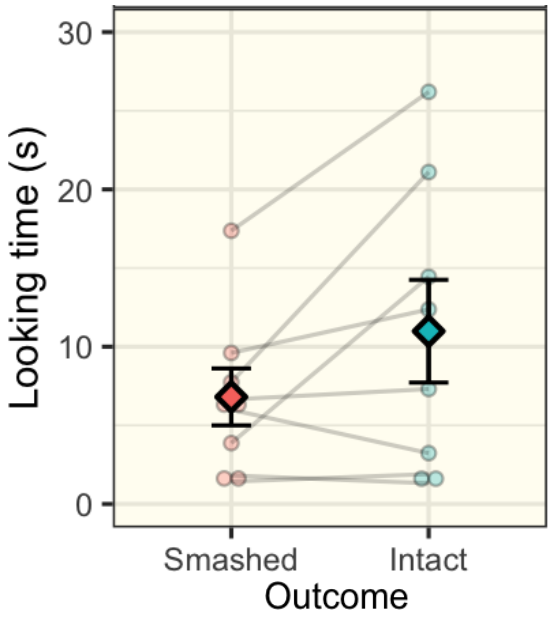
Poster at BCCCD 2026

Infants' failure in Push-First

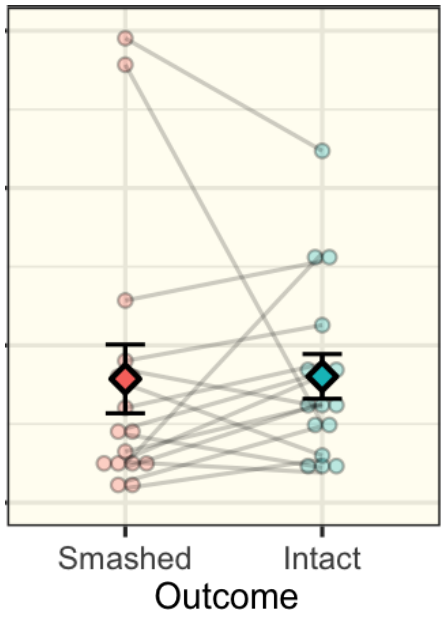


Exp 1 (n = 8)



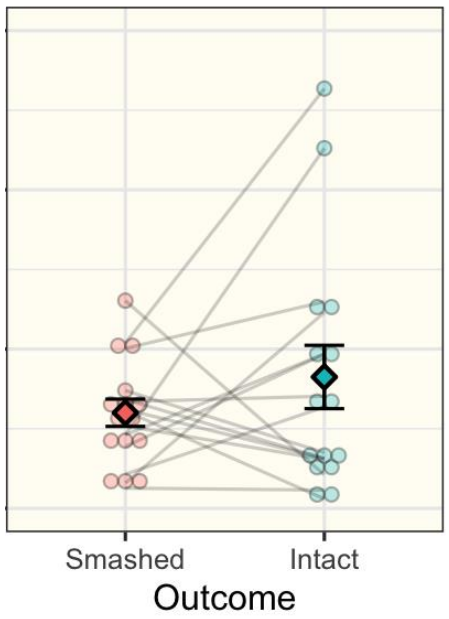
p = .22

Exp 2 (n = 16)



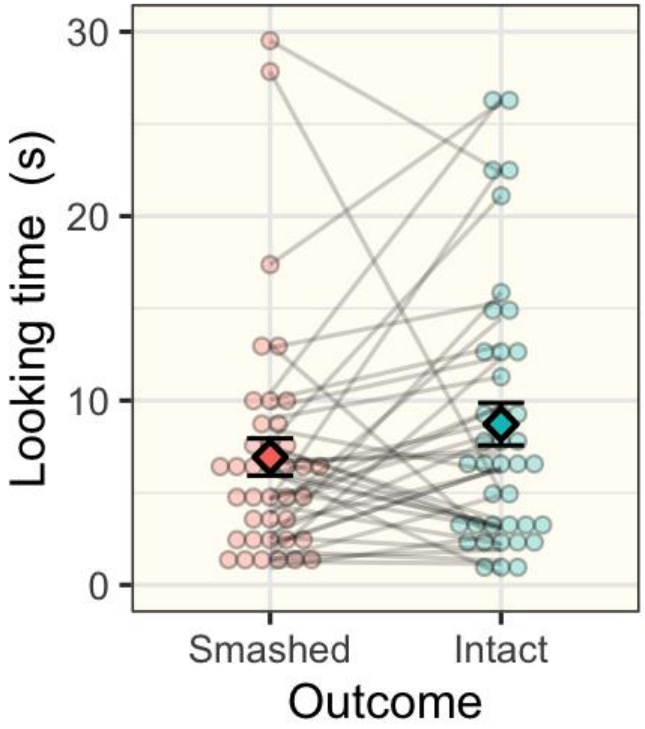
p = .28

Exp 3 (n = 15)



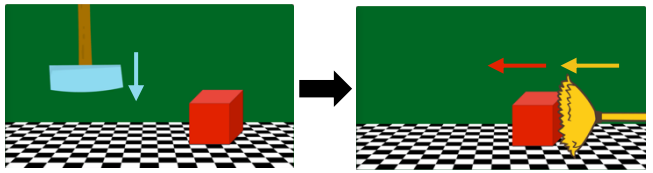
p = .90

Exp 1-3 (n = 39)

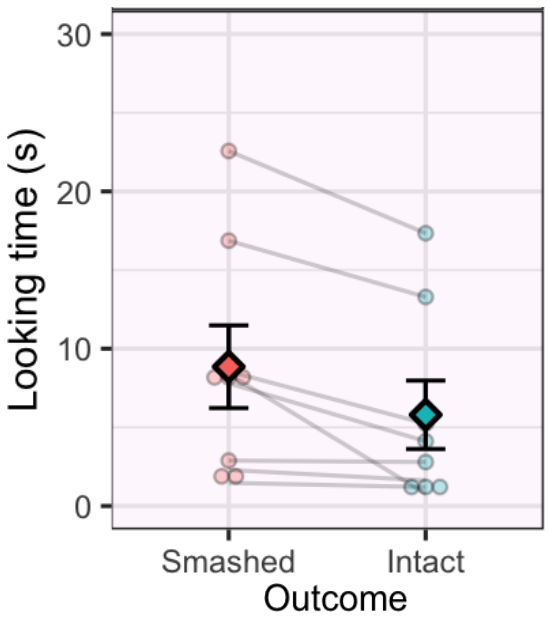


p = .25

Infants' success in Smash-First

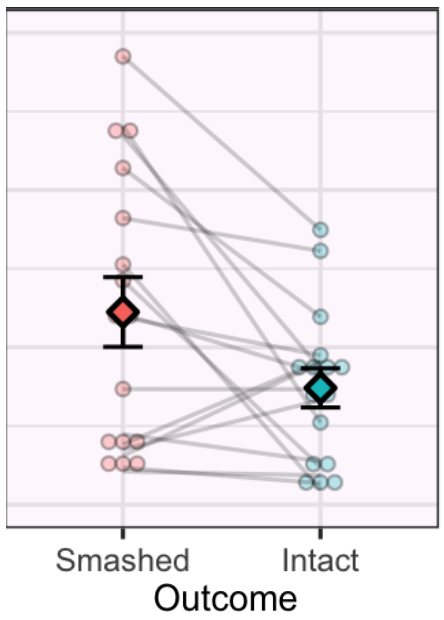


Exp 1 (n = 8)



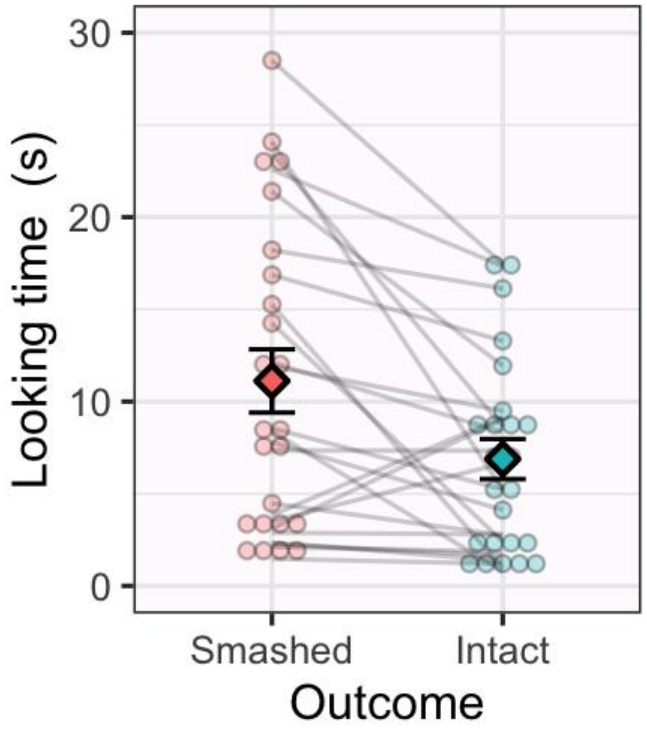
p = .067

Exp 2 (n = 16)

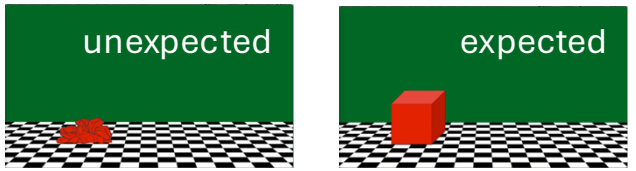


p = .076

Exp 1-2 (n = 24)

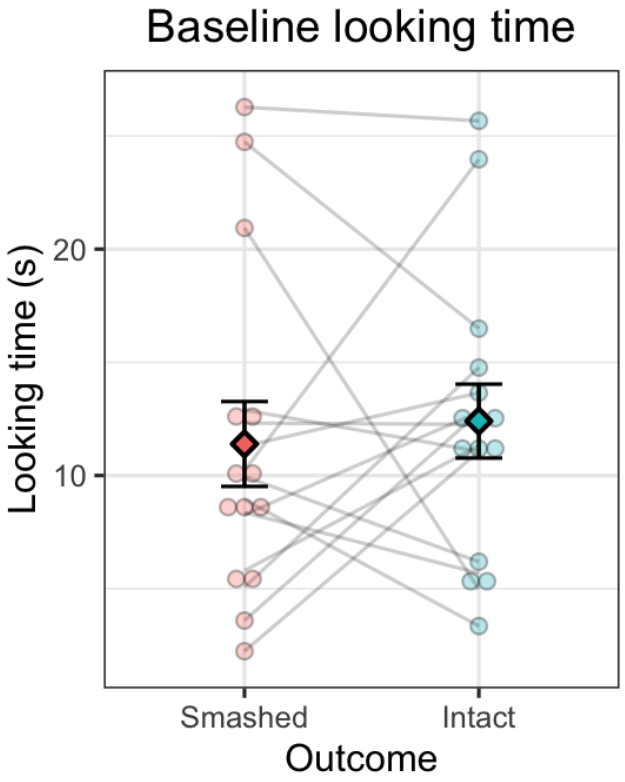


p = .011*

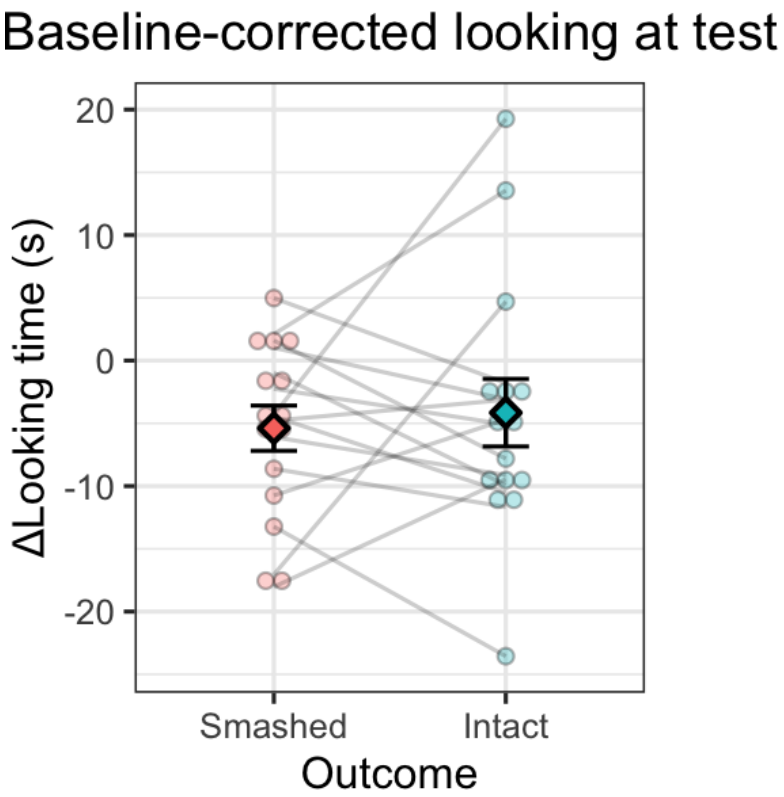


Why did 9–11-mos fail at Push-First but succeed in Smash-First?

1. Baseline preference: Smashed is more salient than Intact



p = .51
(log-transformed looking)



p = .67
(untransformed Δlooking)

Exp 3 (n = 15)

- Added trials to test baseline preference for each of the two outcomes at the beginning
- Subtracted baseline looking from looking at test
- **No evidence for baseline preference**

Why did 9–11-mos fail at Push-First but succeed in Smash-First?

1. Baseline preference: Smashed is more salient than Intact

No baseline preference (Exp 3)

2. Outcome bias: Unexpected effect (smashed when shouldn't) is more salient than unexpected null effect (intact when shouldn't)

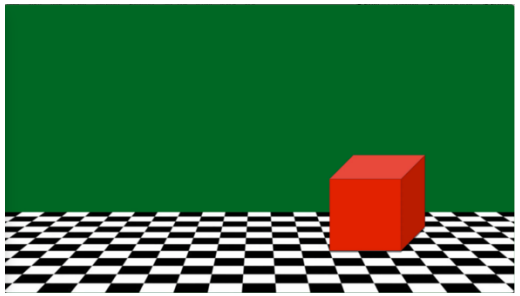
Test infants on single *smash()* functions

3. Working memory constraints: Push-First may be harder than Smash-First

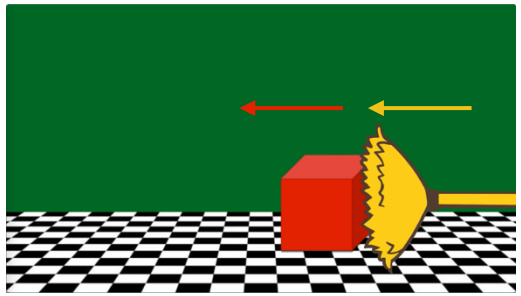
Is Push-First harder than Smash-First?

Push-First

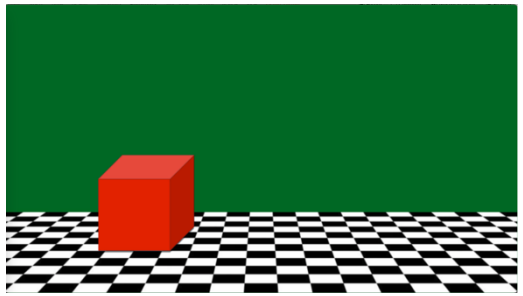
Initial state



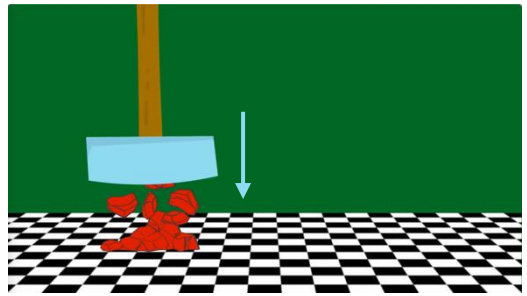
Apply 1st function



Intermediate state



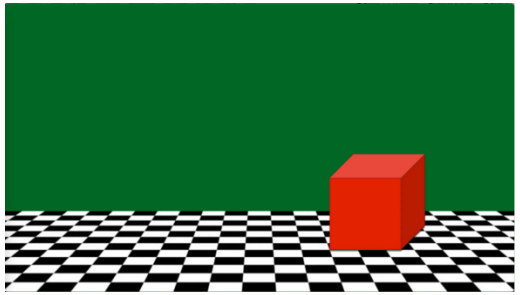
Apply 2nd function



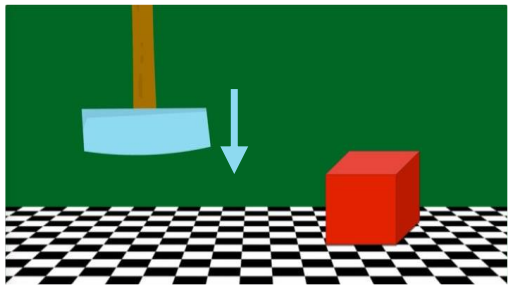
Updated from initial state,
Matters for outcome of 2nd function
Need to maintain this update

Smash-First

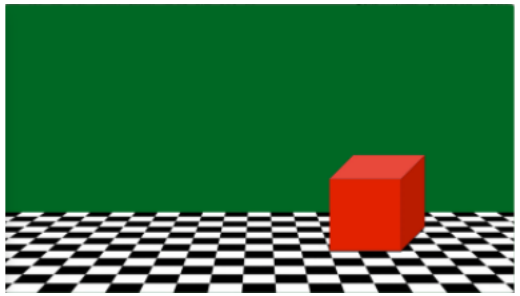
Initial state



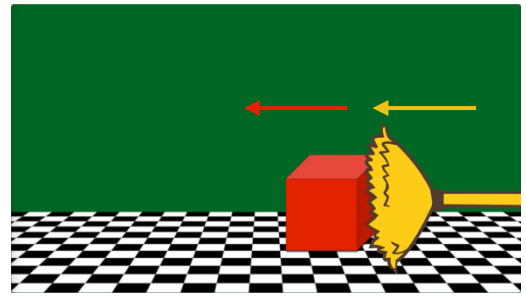
Apply 1st function



Intermediate state



Apply 2nd function



Same as initial state
No updating needed
It's okay to ignore 1st function

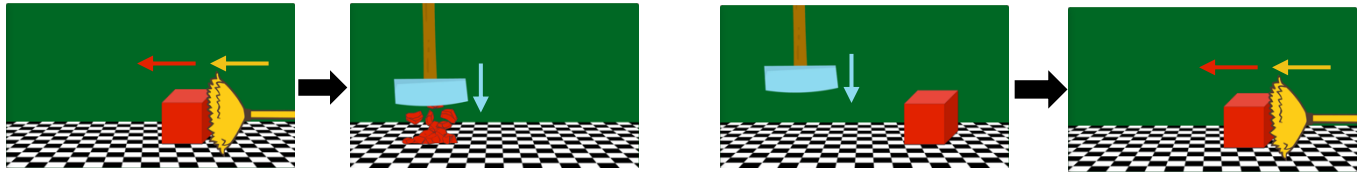
Is Push-First harder than Smash-First?

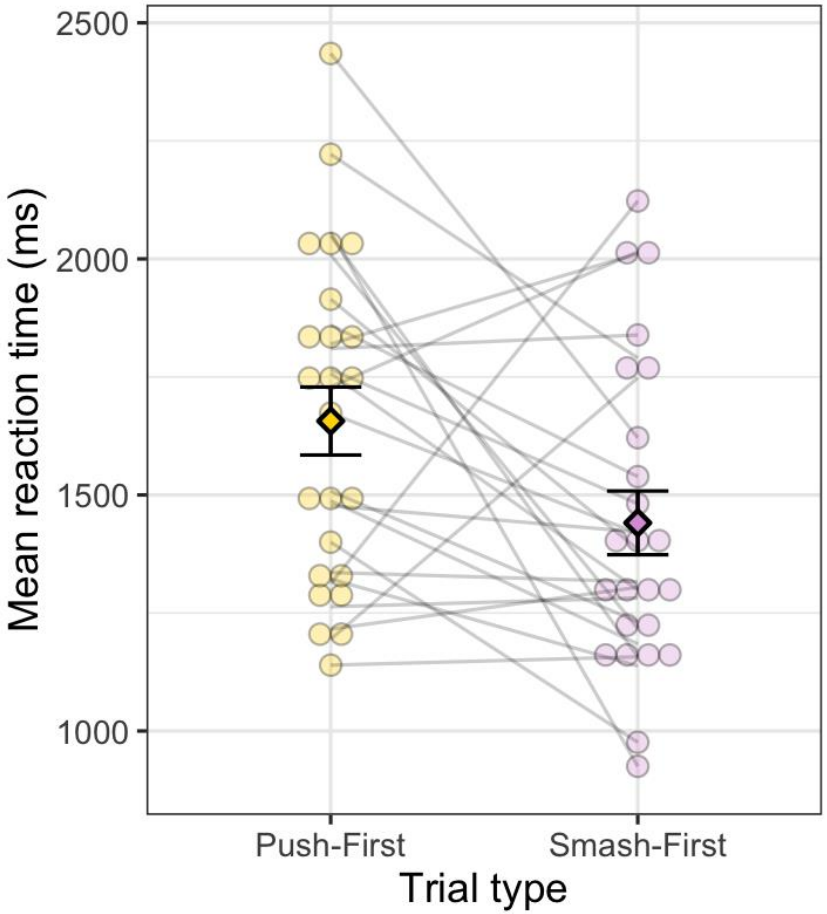
- Push-First requires genuine composition: to reason about *smash()*, need to maintain the updated location from the *push()*
- Smash-First
  - Allows a pruning strategy: can ignore *smash()* because it changed nothing
  - Infants can correctly reason about *smash()*, because obj location not updated

Two possibilities, both resulting from WM constraints:

1. Infants can only **attend** to the **last** function (as in Piantadosi et al. 2018)
2. It's **costly** to maintain a location **update** before *smash()* *and* reason about its effect on *smash()*

Teasing apart “attend-last” vs. “costly update”





1. Evidence from adult control study

- Adults were slower at processing Push-First compared to Smash-First

- Supporting “costly update”, even for adults

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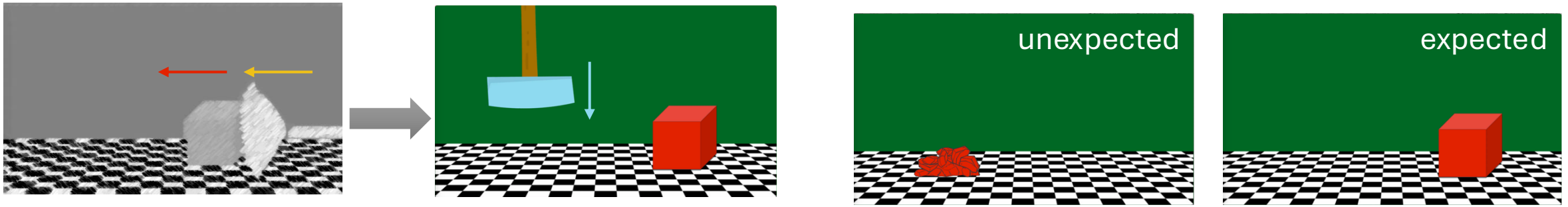
Teasing apart “attend-last” vs. costly update

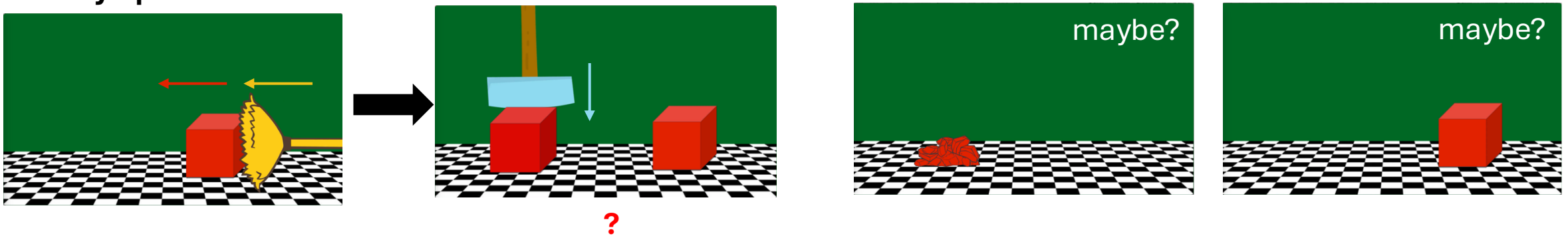
2. Test infants on other outcomes/conditions

2.1 Other outcomes under Push-First/Feeding

Attend-last:



Costly update

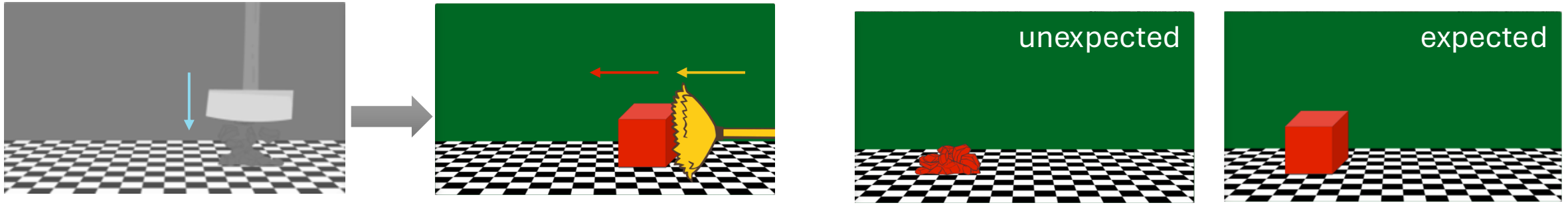


Teasing apart “attend-last” vs. costly update

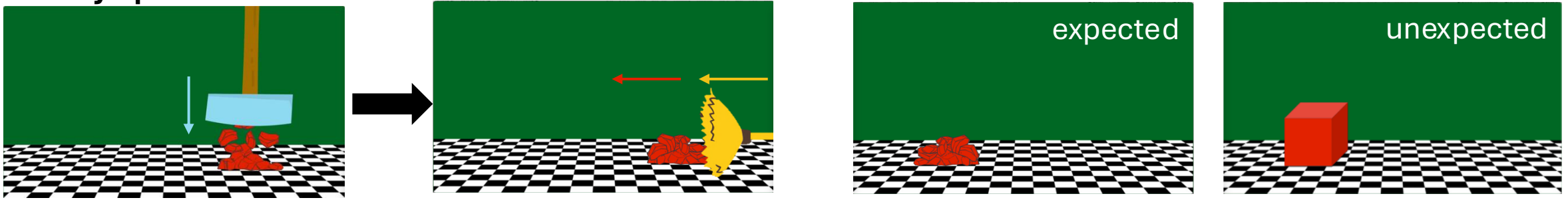
2. Test infants on other outcomes/conditions

2.2 Other conditions, e.g., object on smasher side, *smash()*, then *push()*

Attend-last:



Costly update

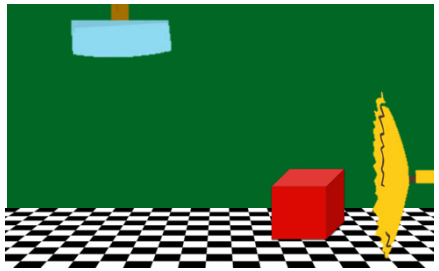


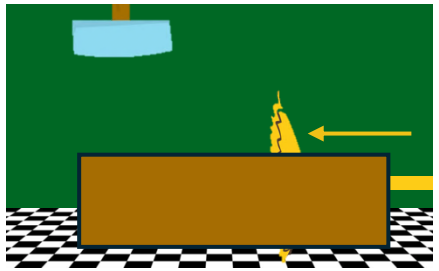
Next steps: reduce WM load?

1. Test older infants, e.g., mean = 15mos (Pomiechowska et al. 2024 - CDS)

2. Reduce uncertainty about the occluder
   - Add single-function training trials behind the occluder
   - “look, the physics stays the same behind the occluder”

3. Reduce uncertainty about the location
   - Visible tools at rest, visible broom during *push()*





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Reduce WM load, test infants on other conditions/outcomes