Understanding plural ambiguities.
An experimental perspective

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(Joint work with Emmanuel Chemla and Benjamin Spector)

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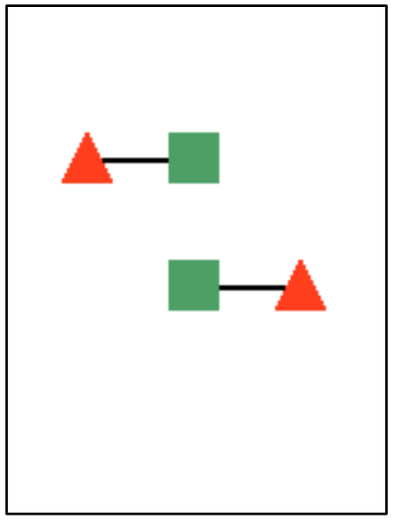
Institut Jean Nicod
École Normale Supérieure

Phenomenon

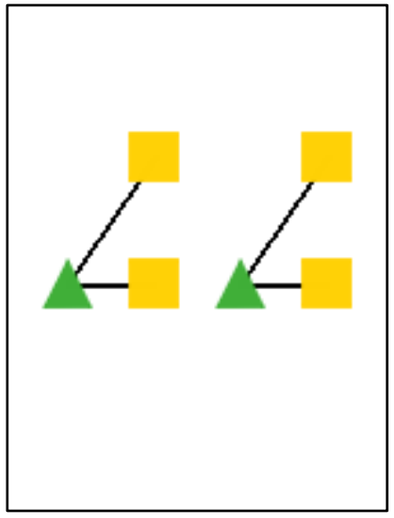
Two triangles are connected to two squares.

Cumulative reading



Two triangles are
connected to two squares
in total.

Distributive reading

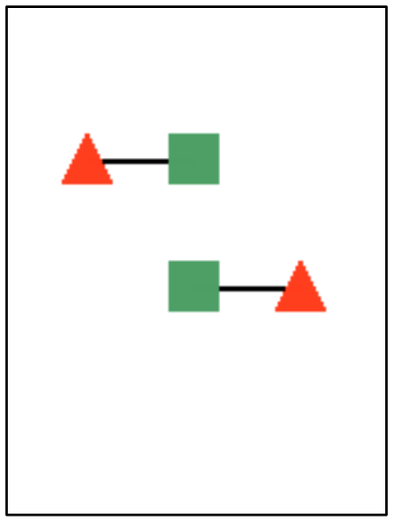


Two triangles are
connected to two squares
each.

Phenomenon

Two triangles are connected to two squares.

Cumulative reading



Two triangles are connected to two squares **in total.**

Lexical cumulatively hypothesis

There is a plurality of 2 triangles X and a plurality of 2 squares Y such that every member of X is connected to at least one member of Y and every member of Y is connected to at least one member of X.

Distributive reading

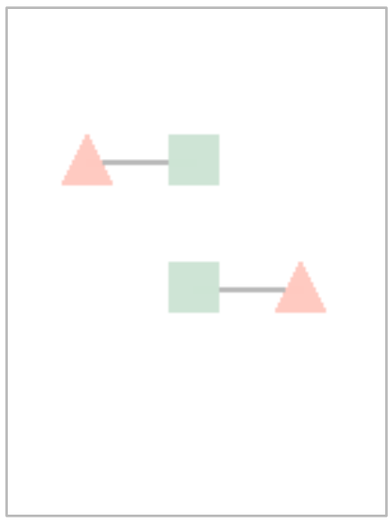
Two triangles are connected to two squares **each.**

(Krifka 1992, Landman 2000, Link 1987)

Phenomenon

Two triangles are connected to two squares.

Cumulative reading



Two triangles are connected to two squares **in total.**

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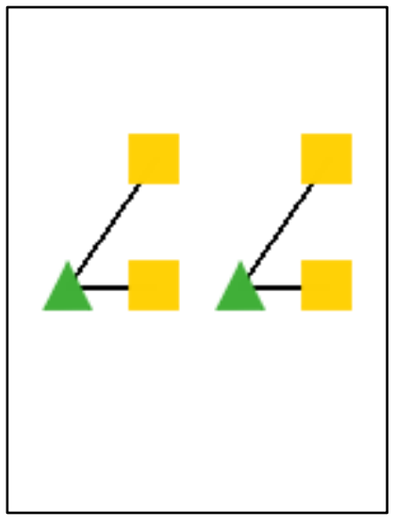
(Krifka 1992, Landman 2000, Link 1987)

Distributive reading



Two triangles are connected to two squares **each.**

Distributive operator (D) view

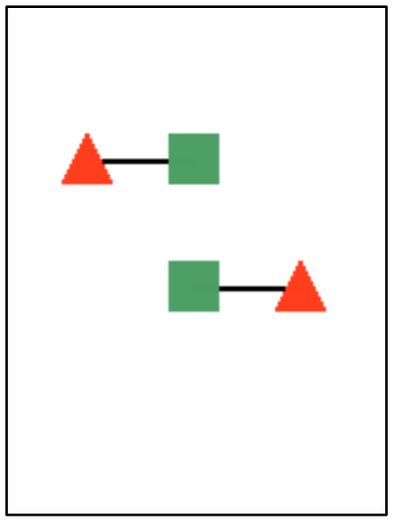
There is a plurality of two triangles X such that each individual of X is connected to a plurality of two squares Y.

(Champollion 2014, Link 1987)

Phenomenon

Two triangles are connected to two squares.

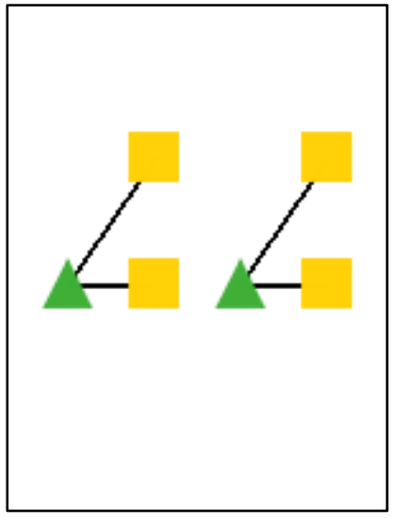
Cumulative reading



Two triangles are connected
to two squares **in total.**

[Two triangles [are connected to [two squares]]]

Distributive reading



Two triangles are connected
to two squares **each.**

[Two triangles [**D** [are connected to [two squares]]]]

Insertion of D operator

Questions - Goals

Q1: Psychological evidence for abstract representations during decision tasks

Priming paradigm

Q2: Psychological evidence for the online derivation of these representations (Cost / Dynamics)

Mouse-Tracking paradigm

Previous literature on preference: Frazier et al., 1999; Brasoveanu & Dotlačil, 2015

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Priming experiment

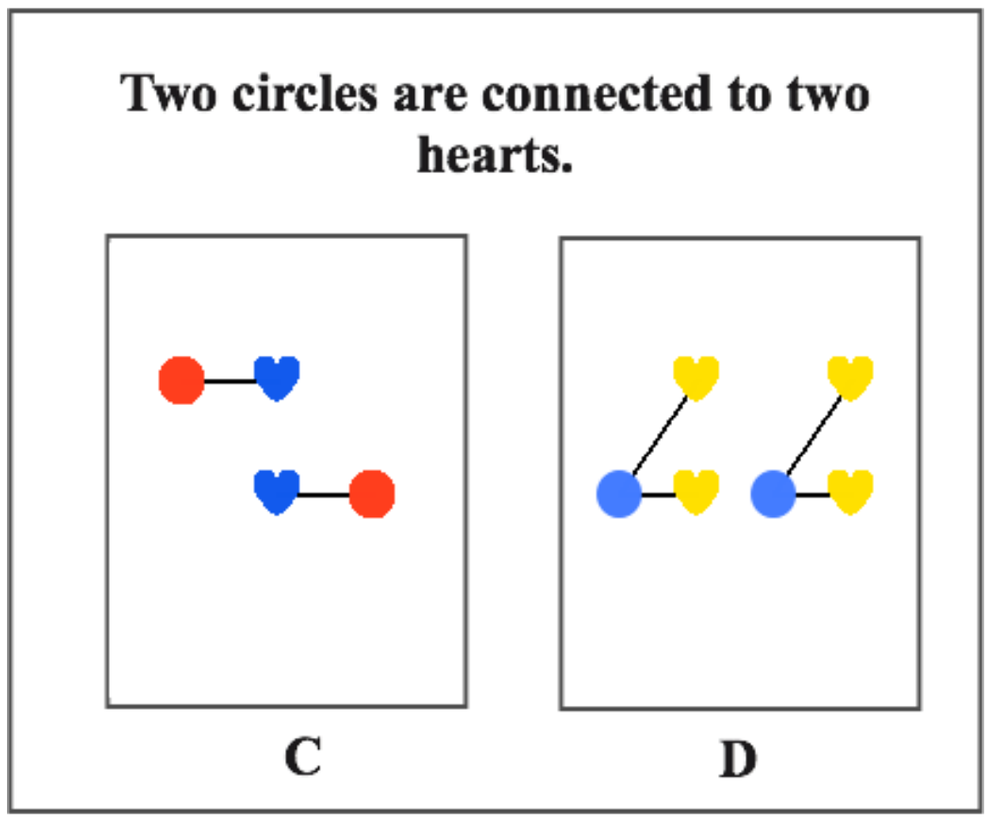
Sentence-Picture matching task (Raffray & Pickering 2010)

Trial N ***Prime***

Distributive prime

Cumulative prime

Trial N+1 ***Target***



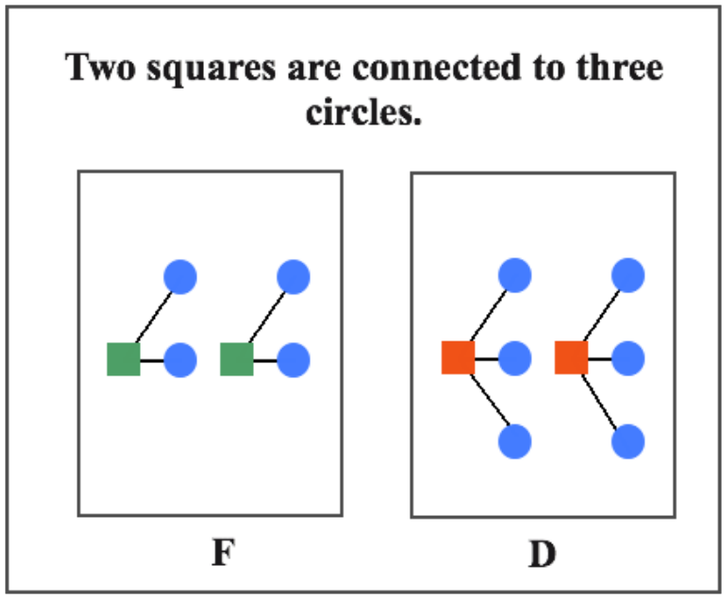
Both pictures can be good descriptions of the sentence under each reading.

Priming experiment

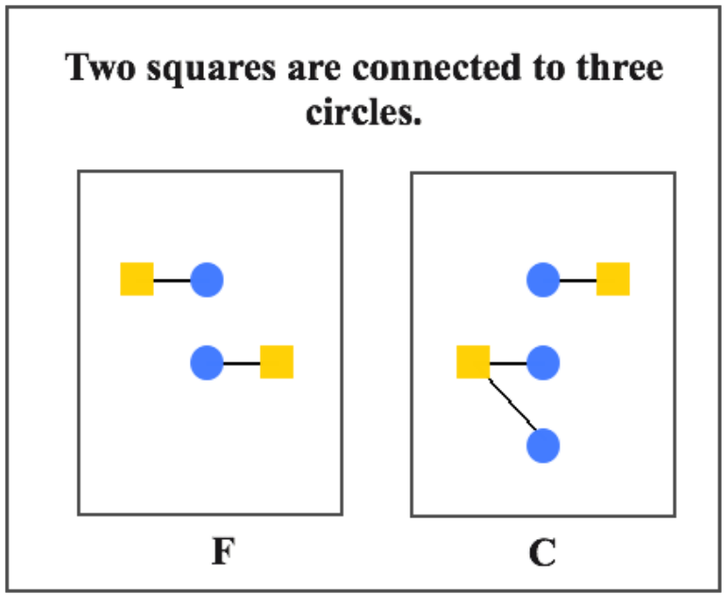
Sentence-Picture matching task (Raffray & Pickering 2010)

Trial N ***Prime***

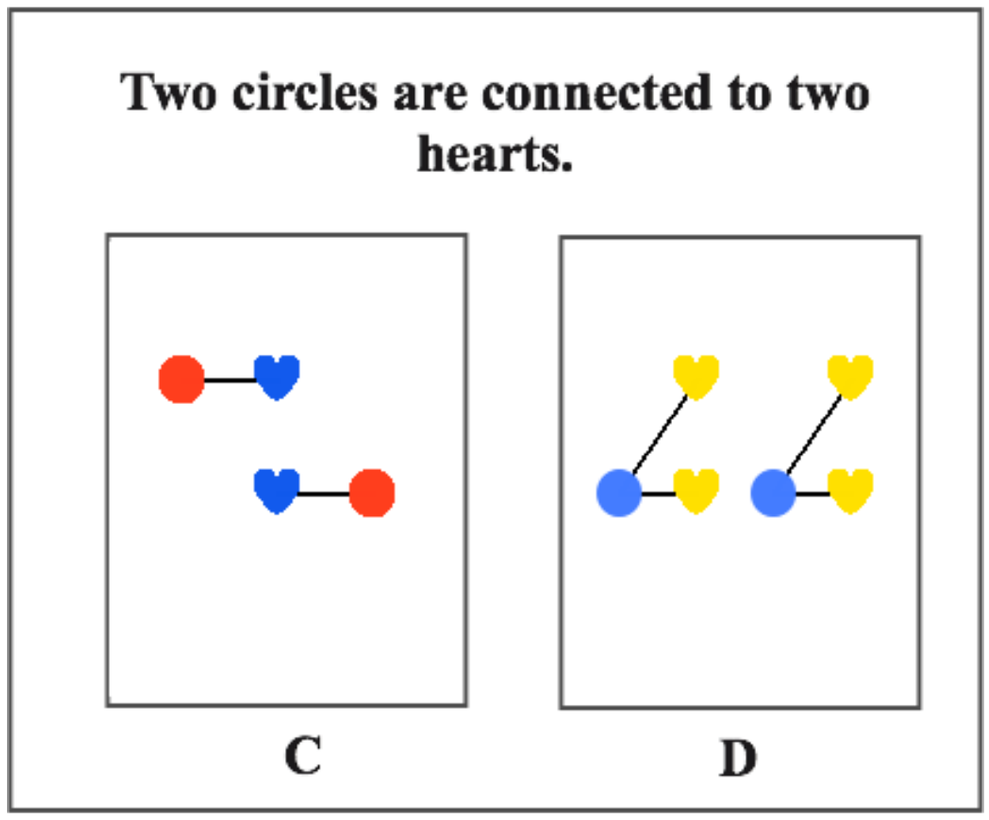
Distributive prime



Cumulative prime



Trial N+1 ***Target***



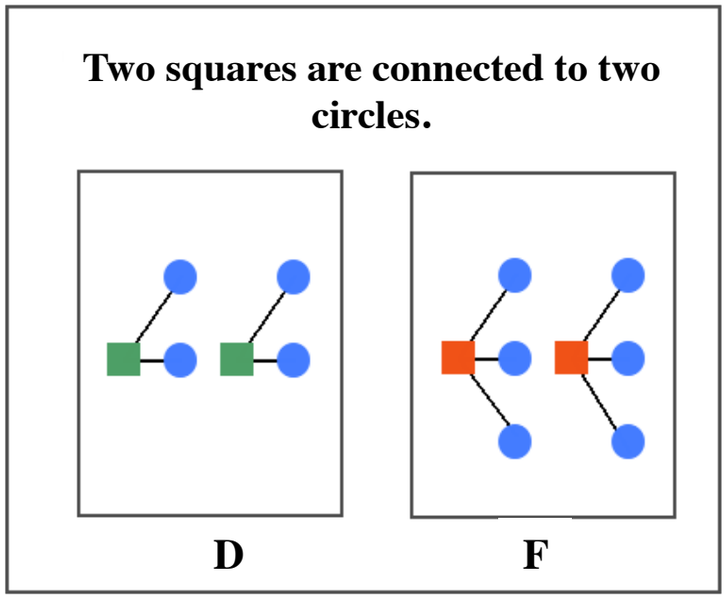
Different Numeral Combination
2-3 / 2-2

Priming experiment

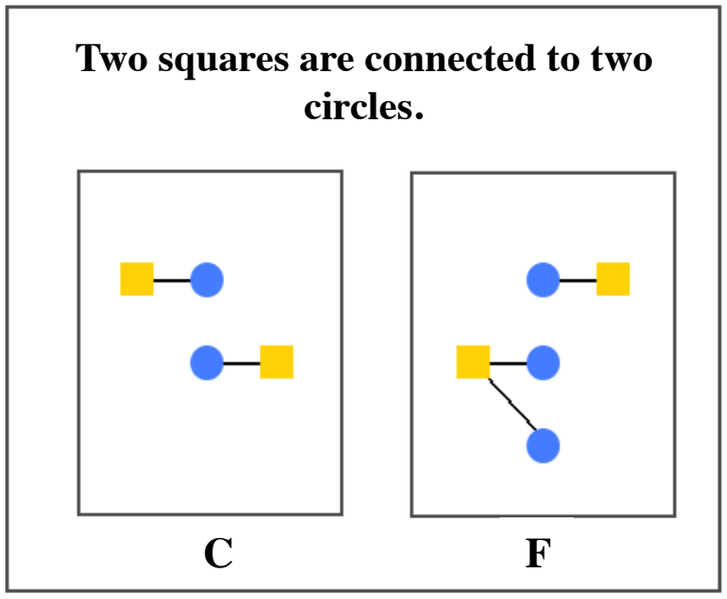
Sentence-Picture matching task (Raffray & Pickering 2010)

Trial N ***Prime***

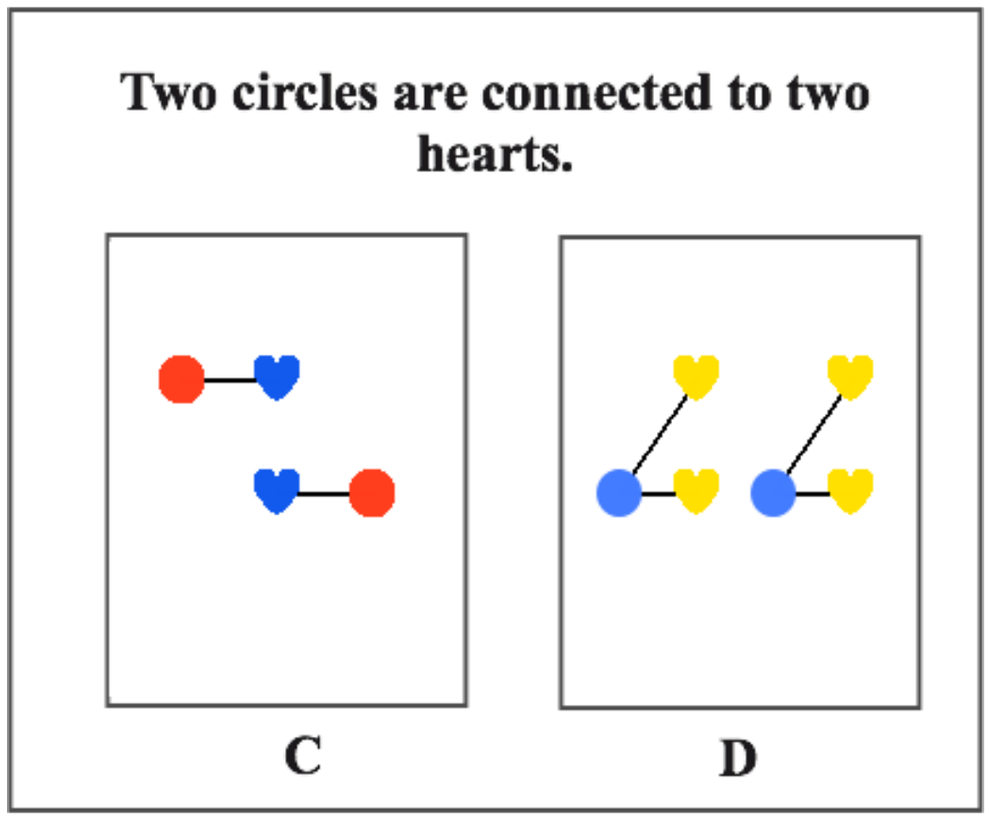
Distributive prime



Cumulative prime



Trial N+1 ***Target***

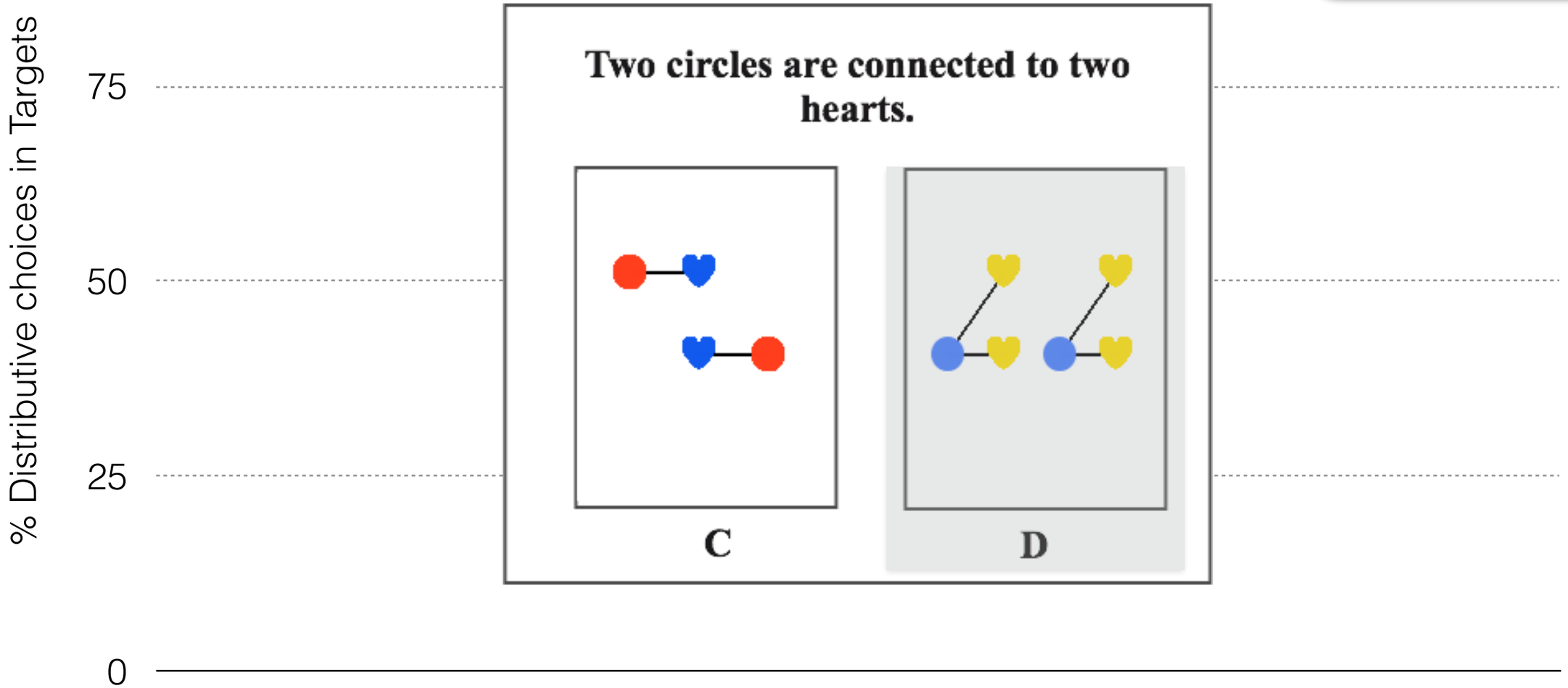


Different Numeral Combination
2-3 / 2-2

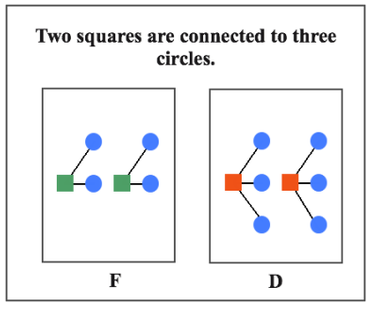
Priming experiment

Results (N=60)

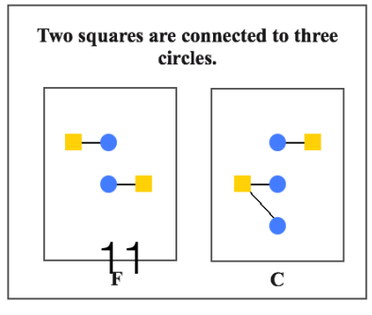
Accuracy in primes ~97%



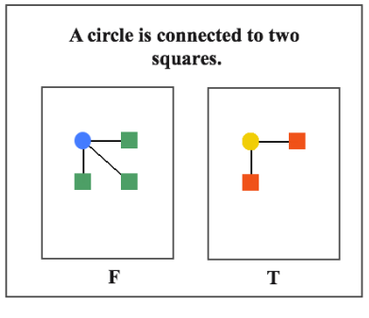
After Distributive primes



After Cumulative primes

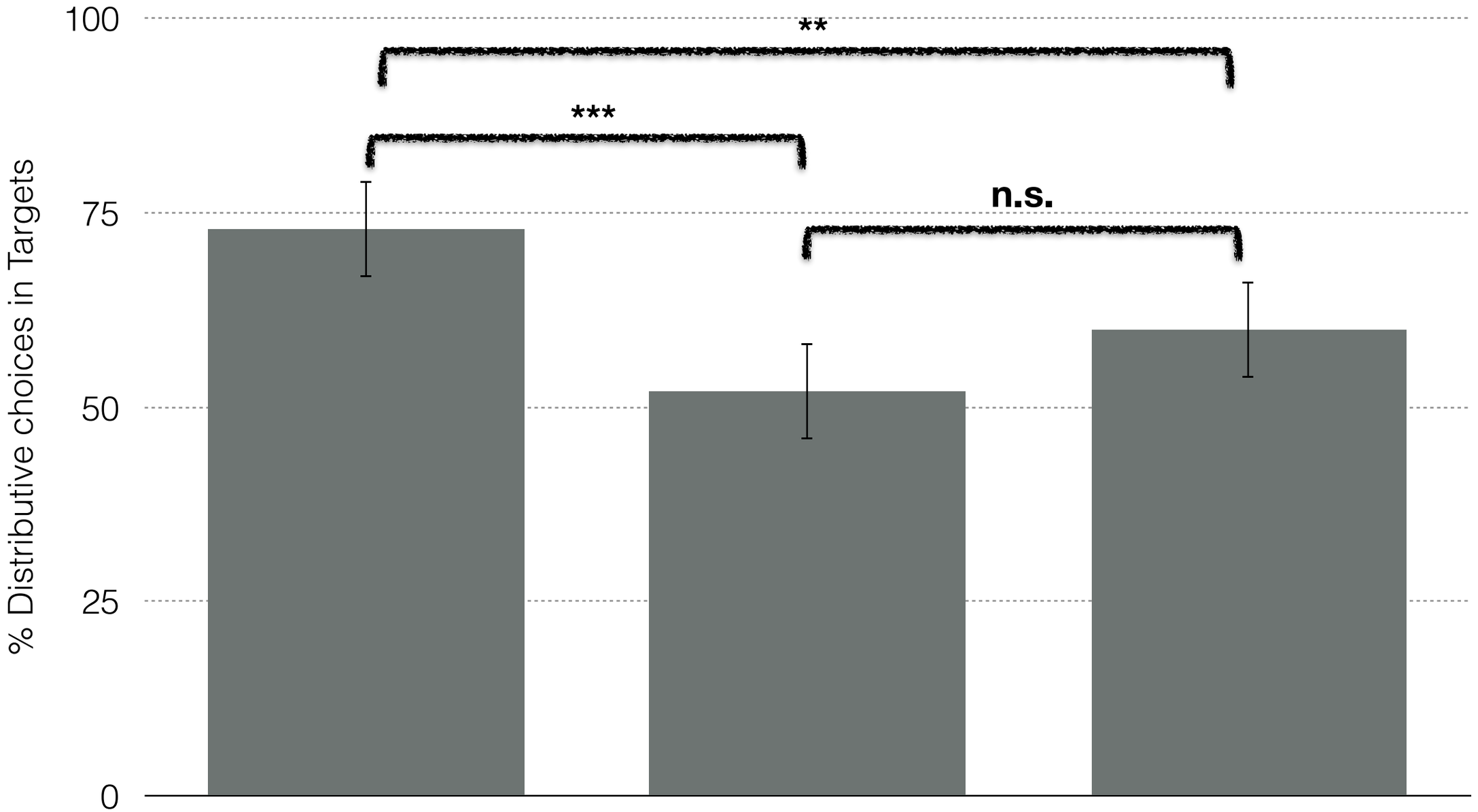


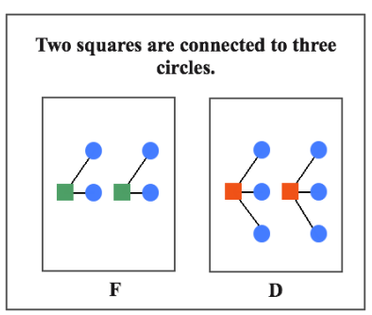
Baseline

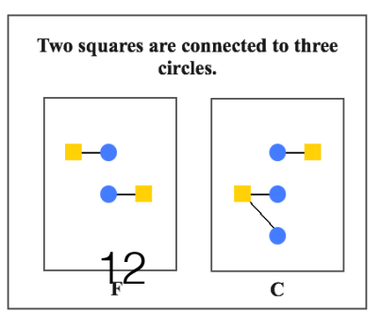


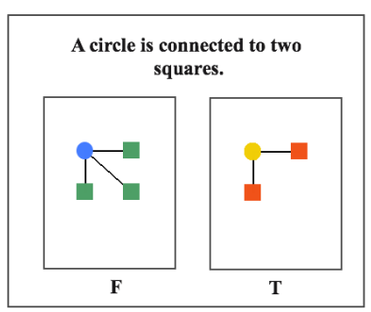
Priming experiment

Results (N=60)



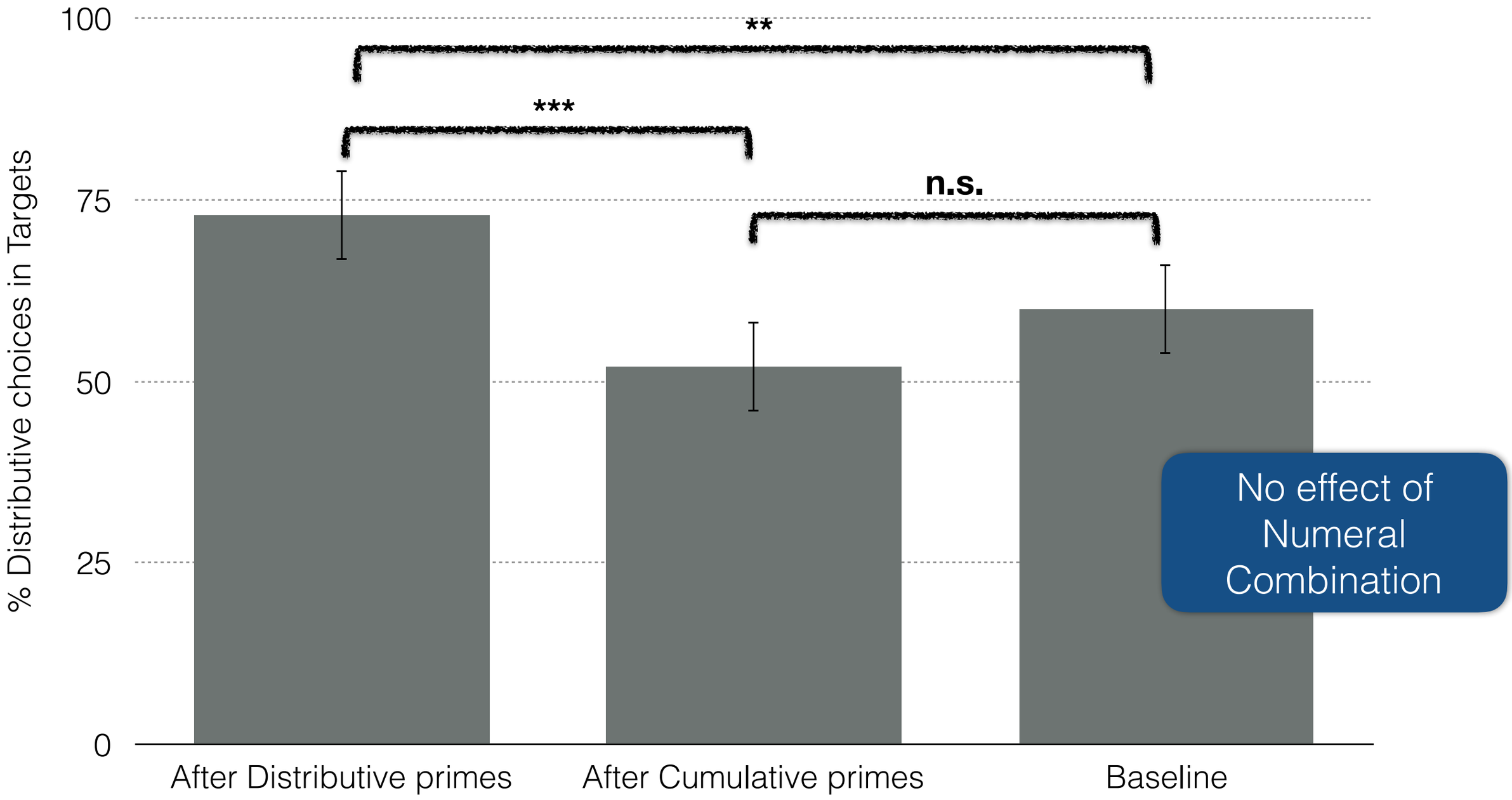


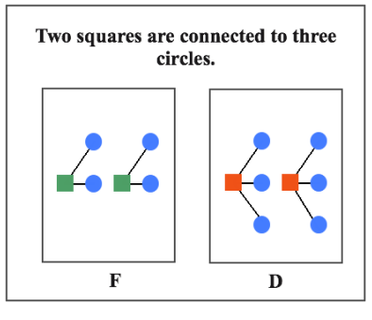


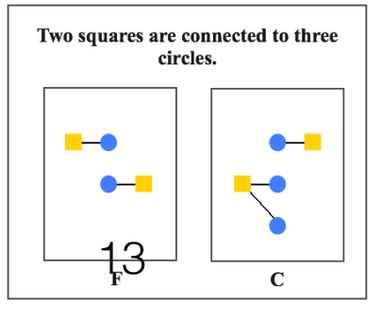


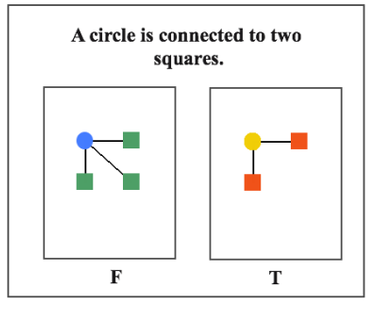
Priming experiment

Results (N=60)







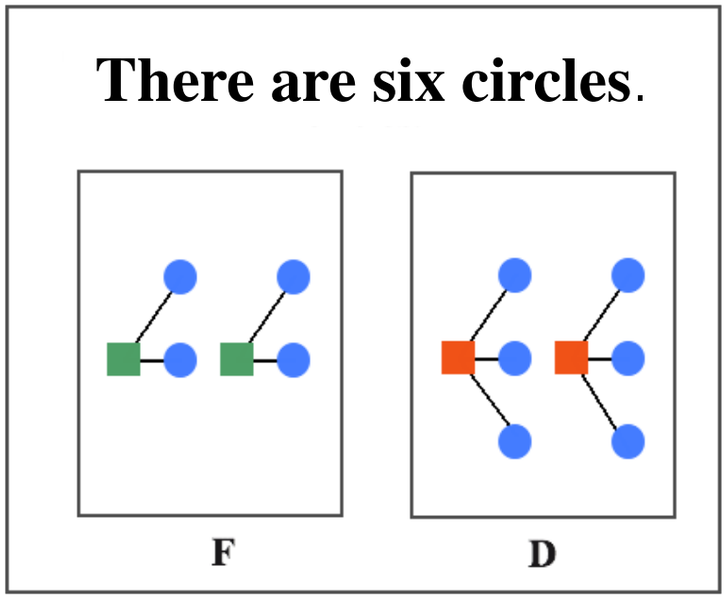


Visual priming effects?
Experiment 2

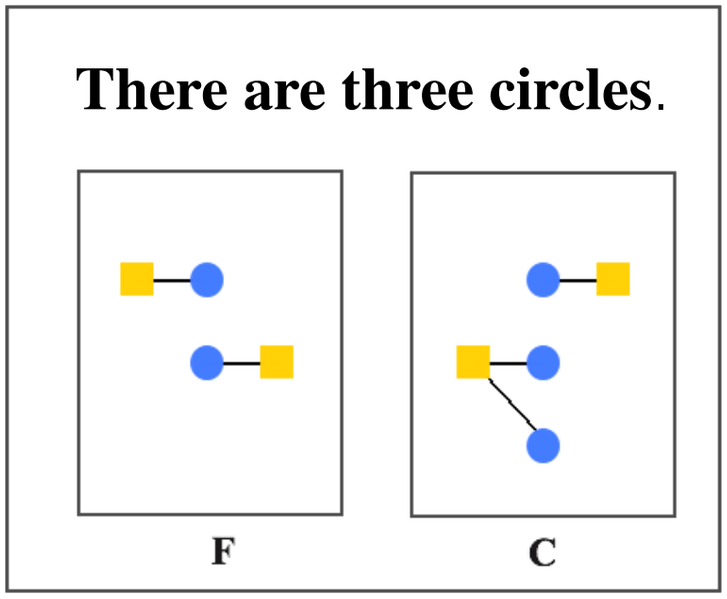
Replace the sentences in prime trials and keep the pictures!

Trial N ***Prime***

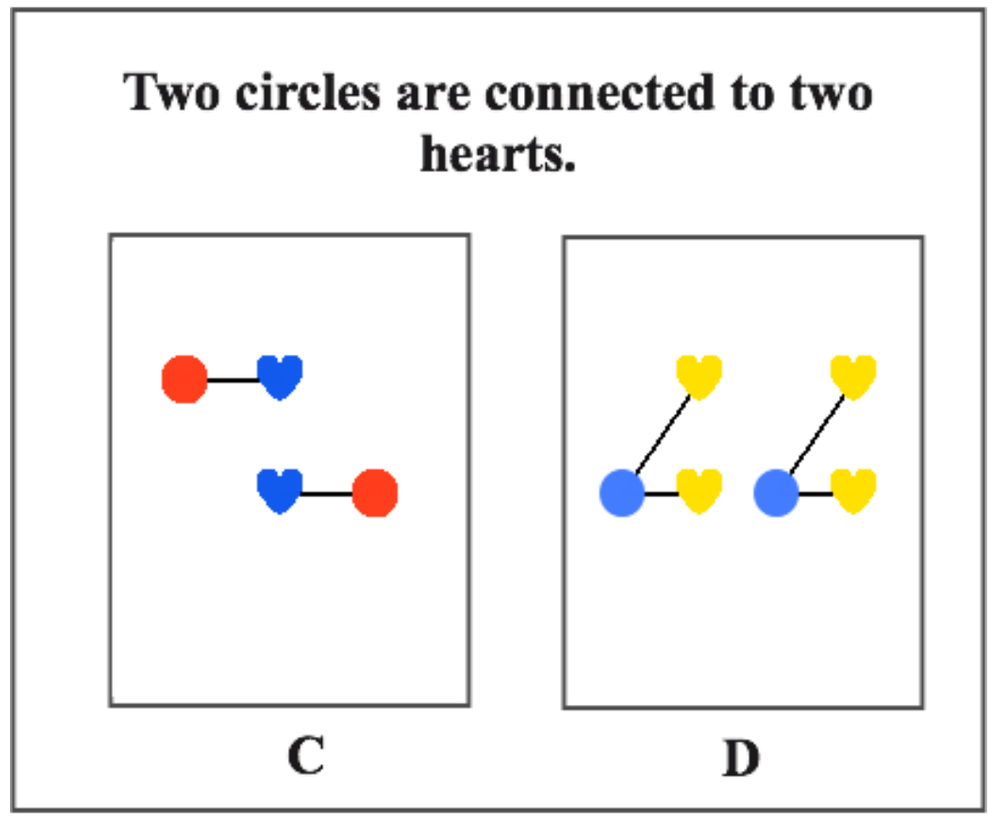
Distributive prime



Cumulative prime

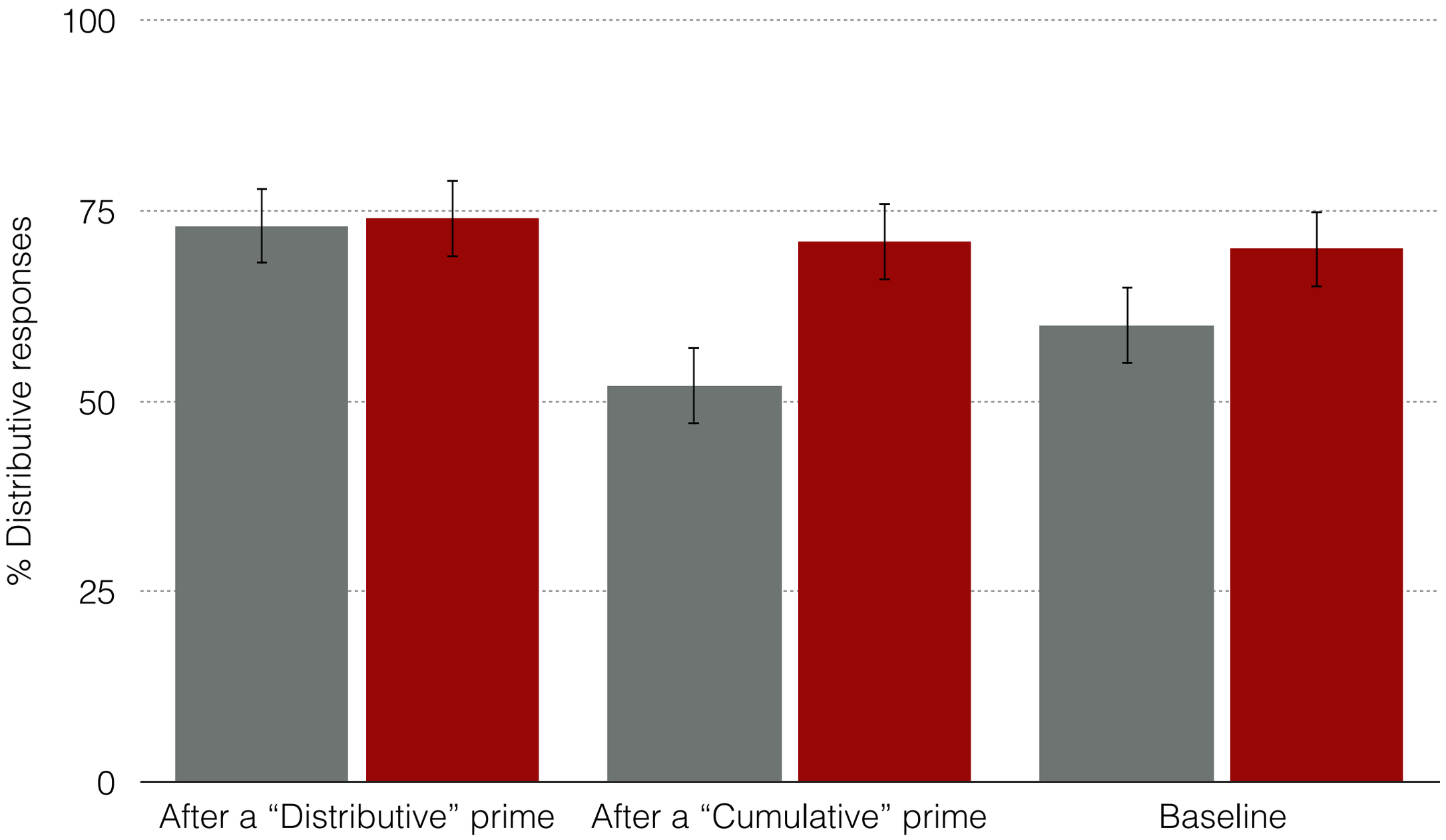


Trial N+1 ***Target***



Visual priming effects?

Experiment 2 - N=40

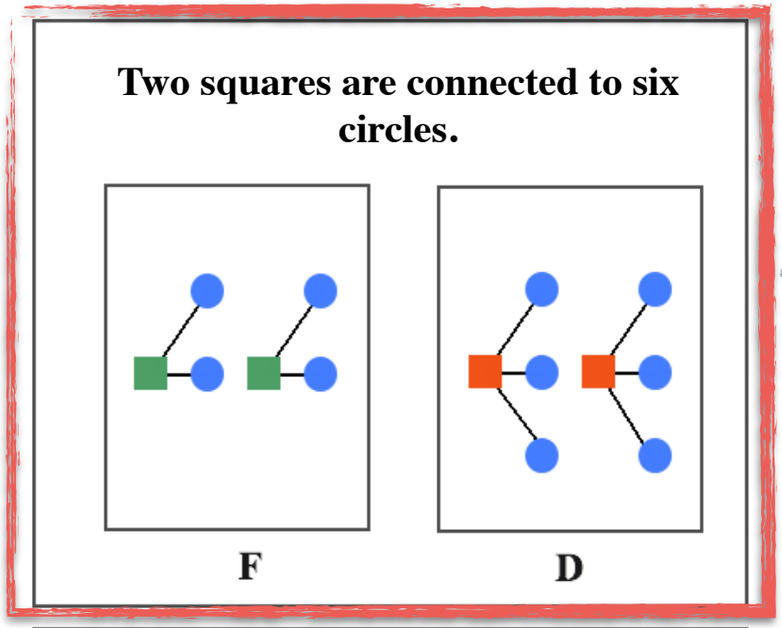


Visual priming effects?
Fancier control: Experiments 3

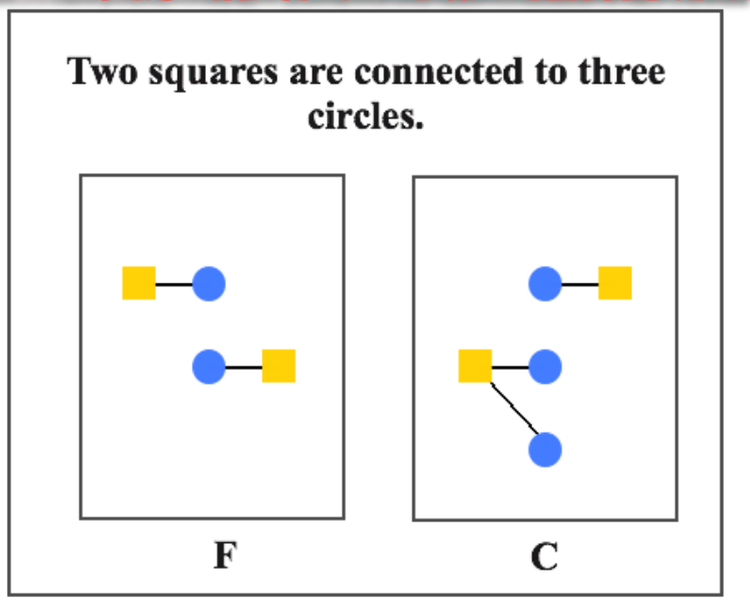
Replace the sentences in Distributive primes to make them Cumulative primes!

Trial N ***Prime***

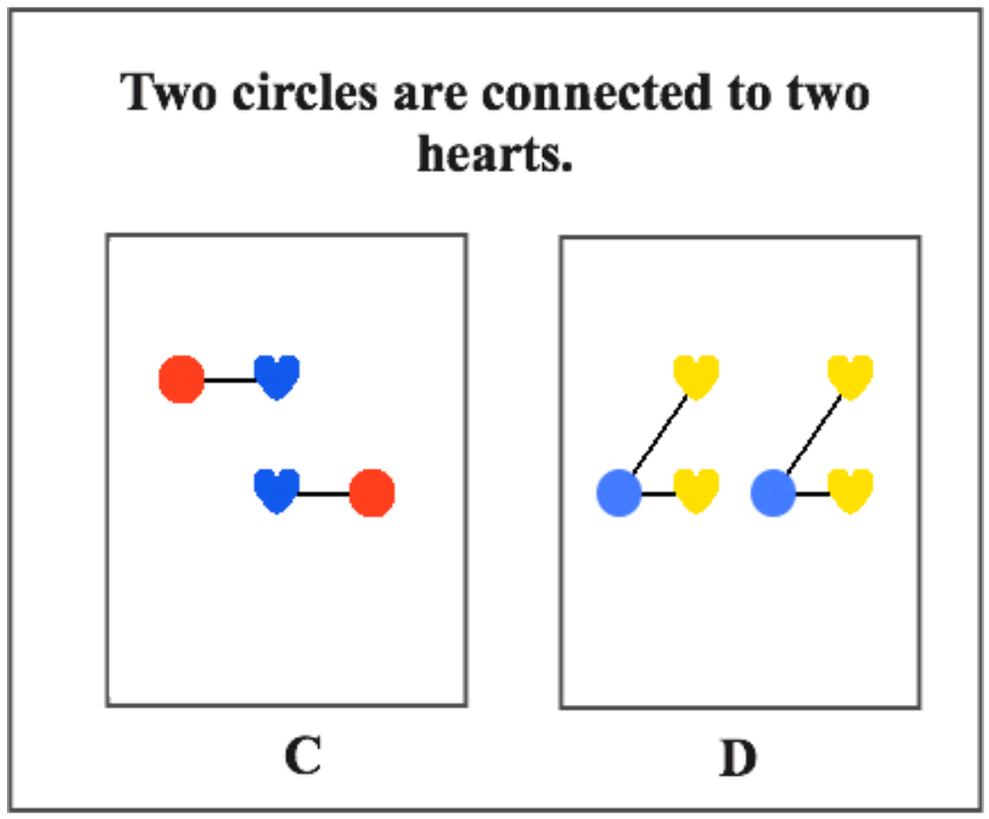
Distributive prime



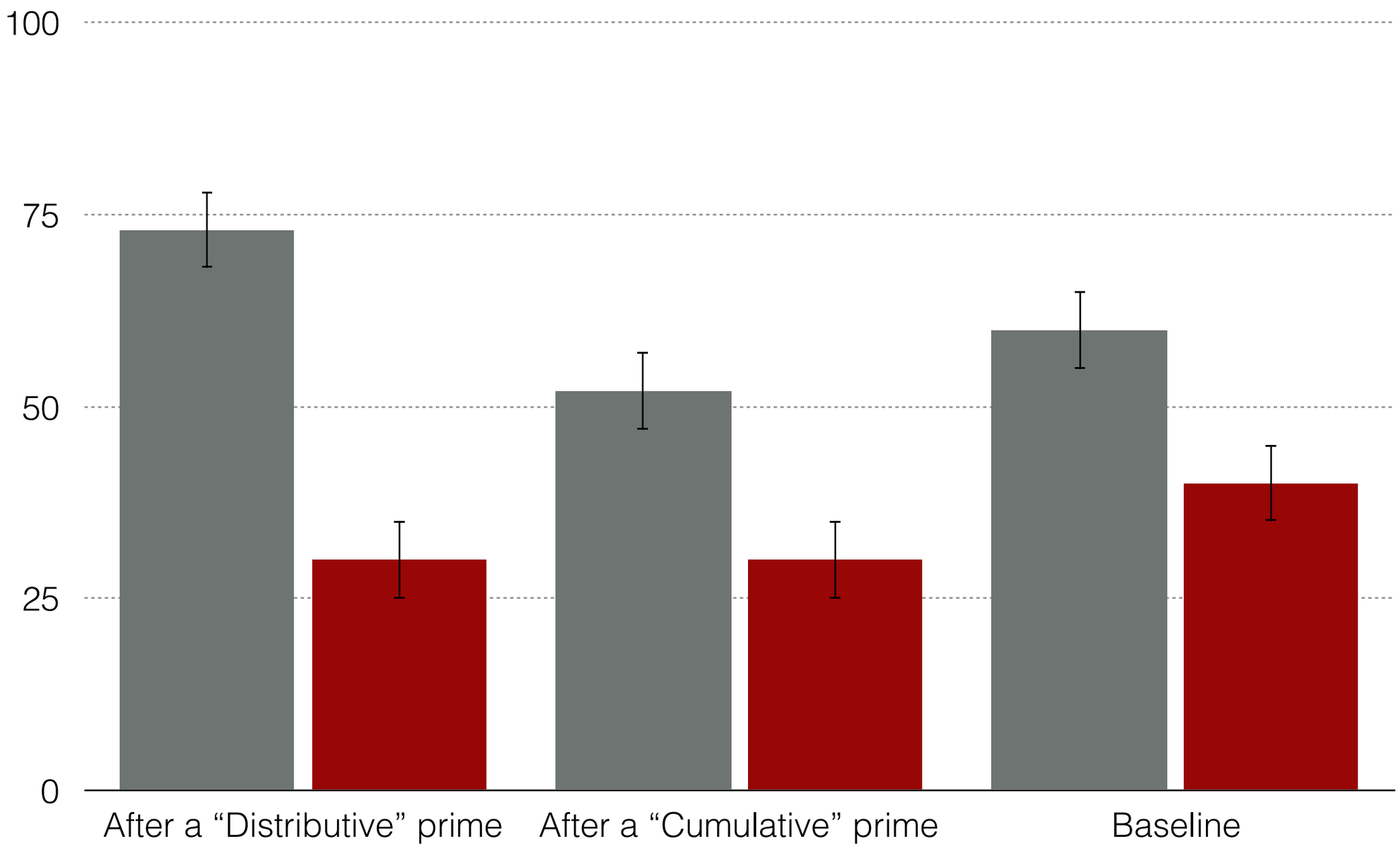
Cumulative prime



Trial N+1 ***Target***



Visual priming effects?
Experiments 3 (N=40)



Priming experiments

Summary and conclusions

- Participants access to both readings (High accuracy rate in primes)
- General accessing to ‘exact’ readings (High accuracy rate in primes)
- General reading priming is operative between conditions (Different rates for different primes independently of n°)
- Asymmetry between cumulative and distributive primes.

1. Priming driven specifically by a distributivity operator.
2. Availability of *at least* cumulative interpretations (?)

Questions - Goals

Q1: Psychological evidence for abstract representations during decision tasks

Priming paradigm

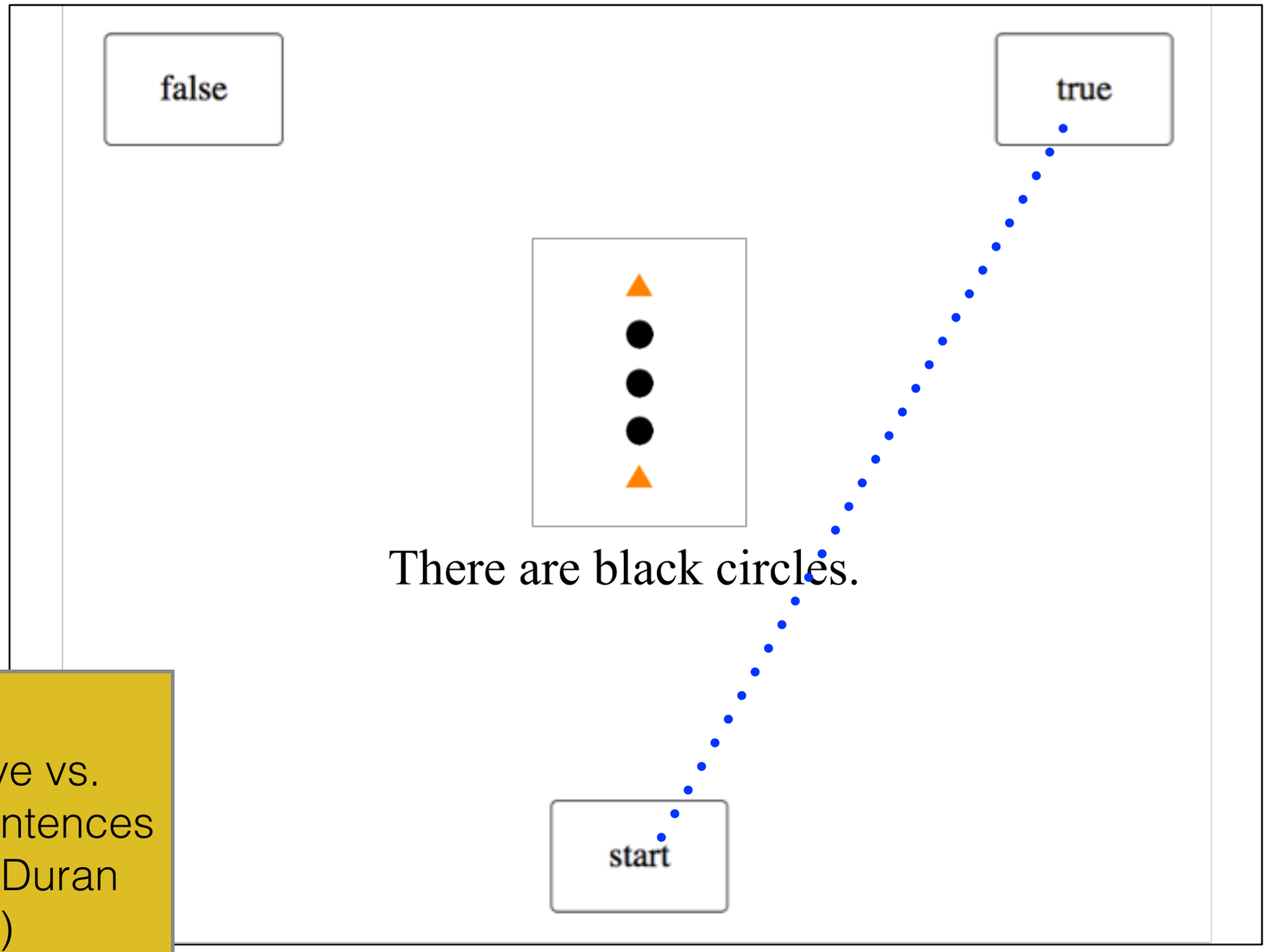
Q2: Psychological evidence for the online derivation of these representations (Cost / Dynamics)

Mouse-Tracking paradigm **Freeman & Amdaby 2010**

Previous literature on preference: Frazier et al., 1999; Brasoveanu & Dotlačil, 2015; a.o

Mouse tracking and online derivation

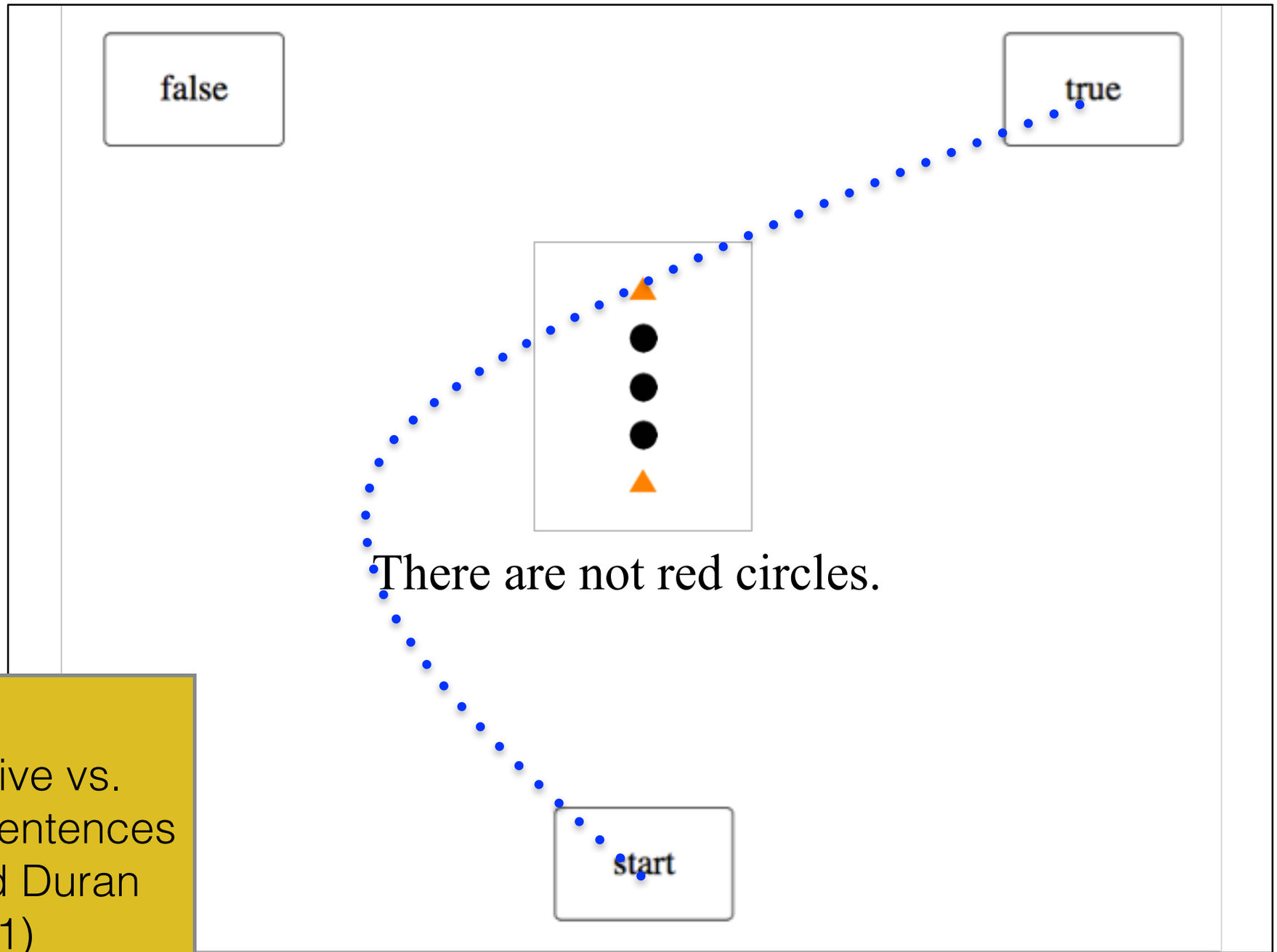
Truth-Judgment task



Affirmative vs. Negative Sentences (Dale and Duran 2011)

Mouse tracking and online derivation

Truth-Judgment task



Affirmative vs. Negative Sentences (Dale and Duran 2011)

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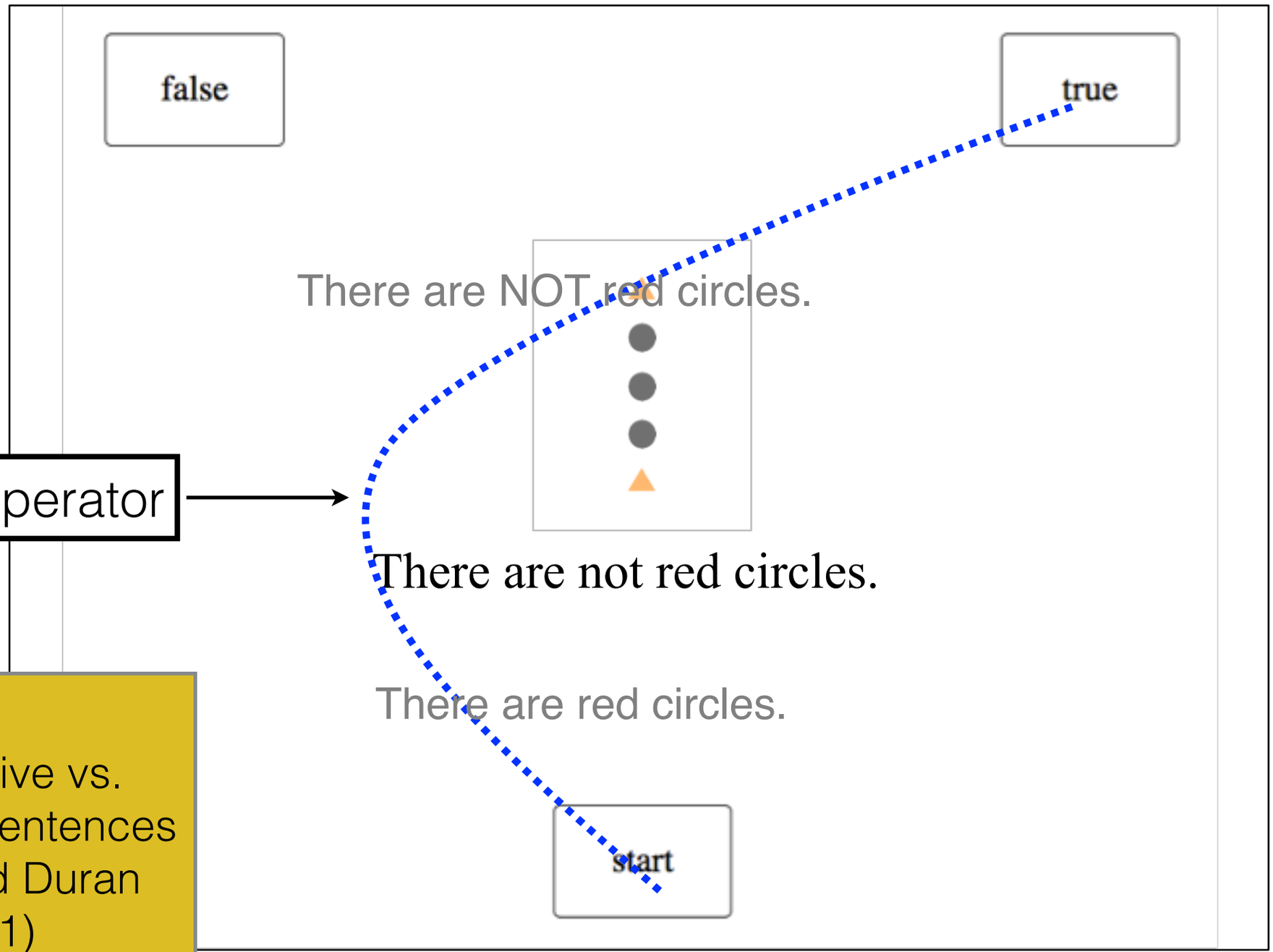

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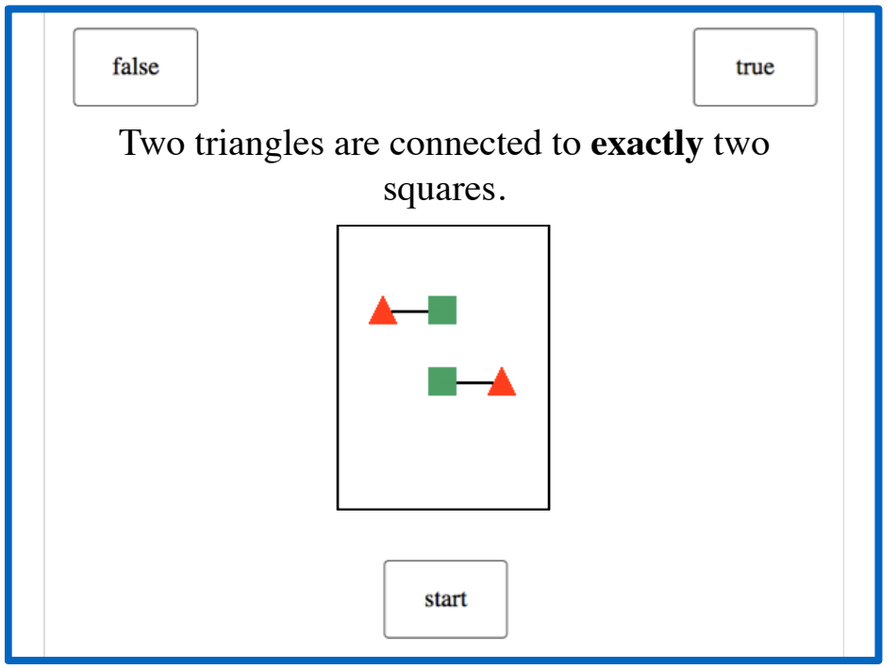
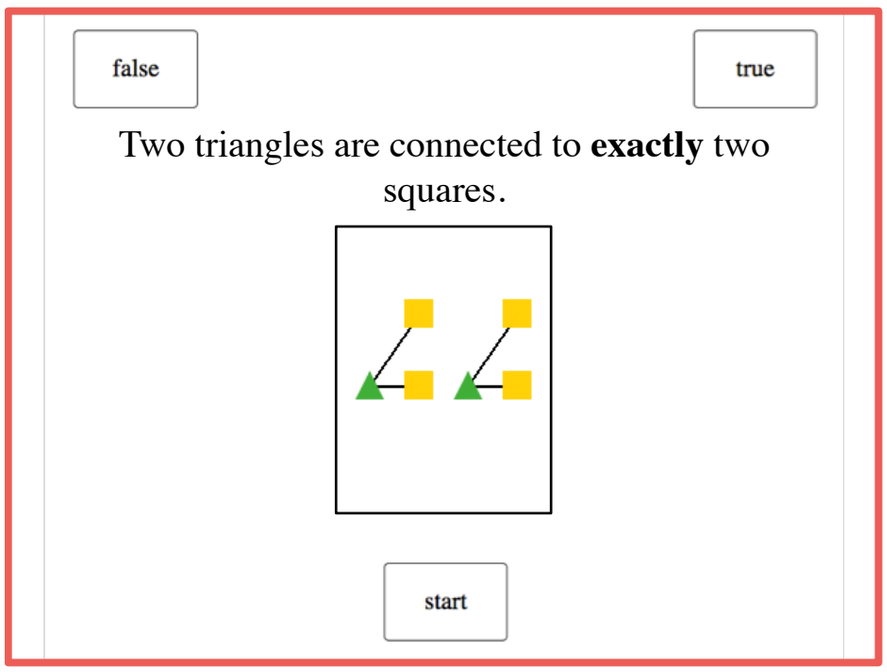
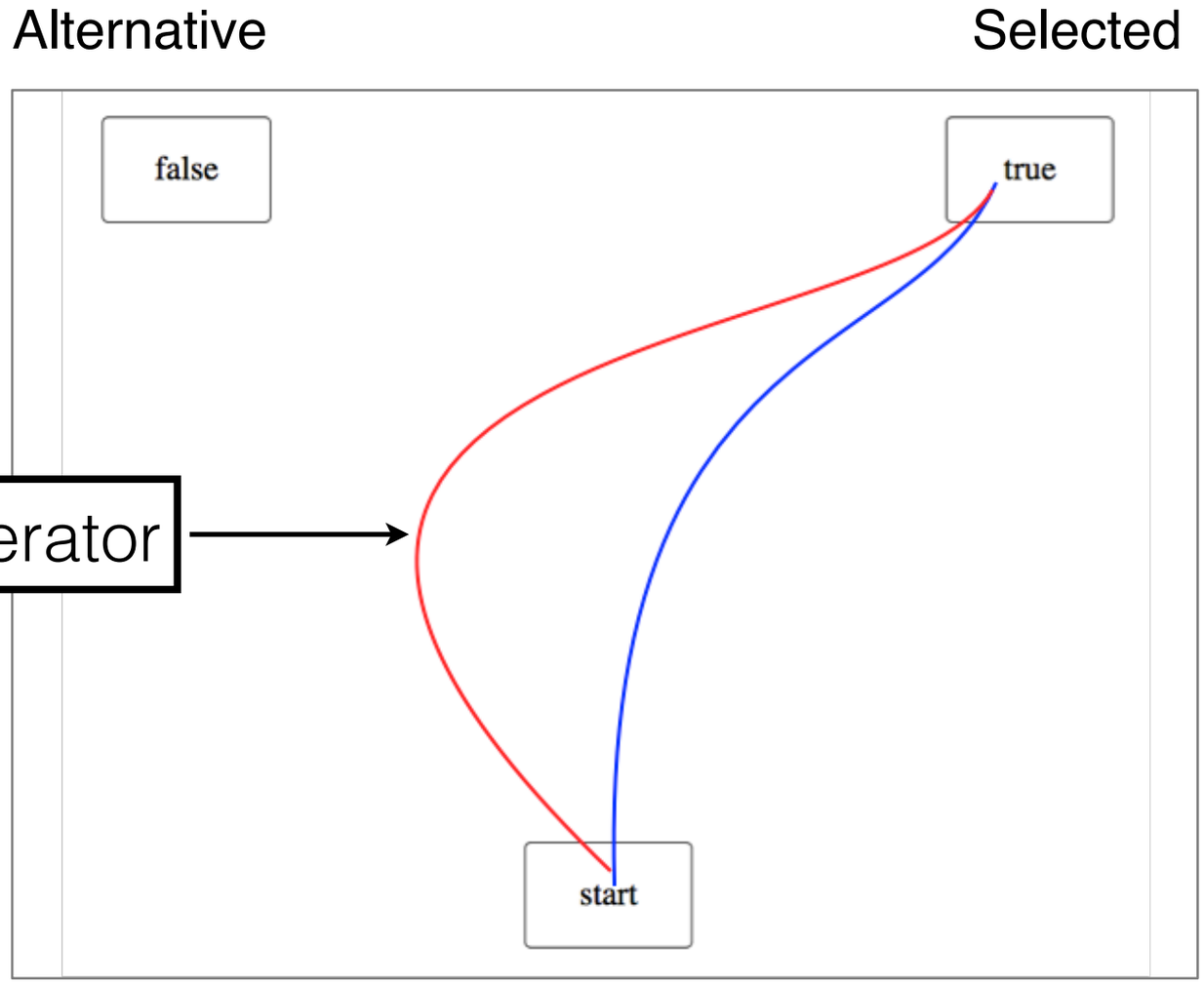


Cumulative



Distributive

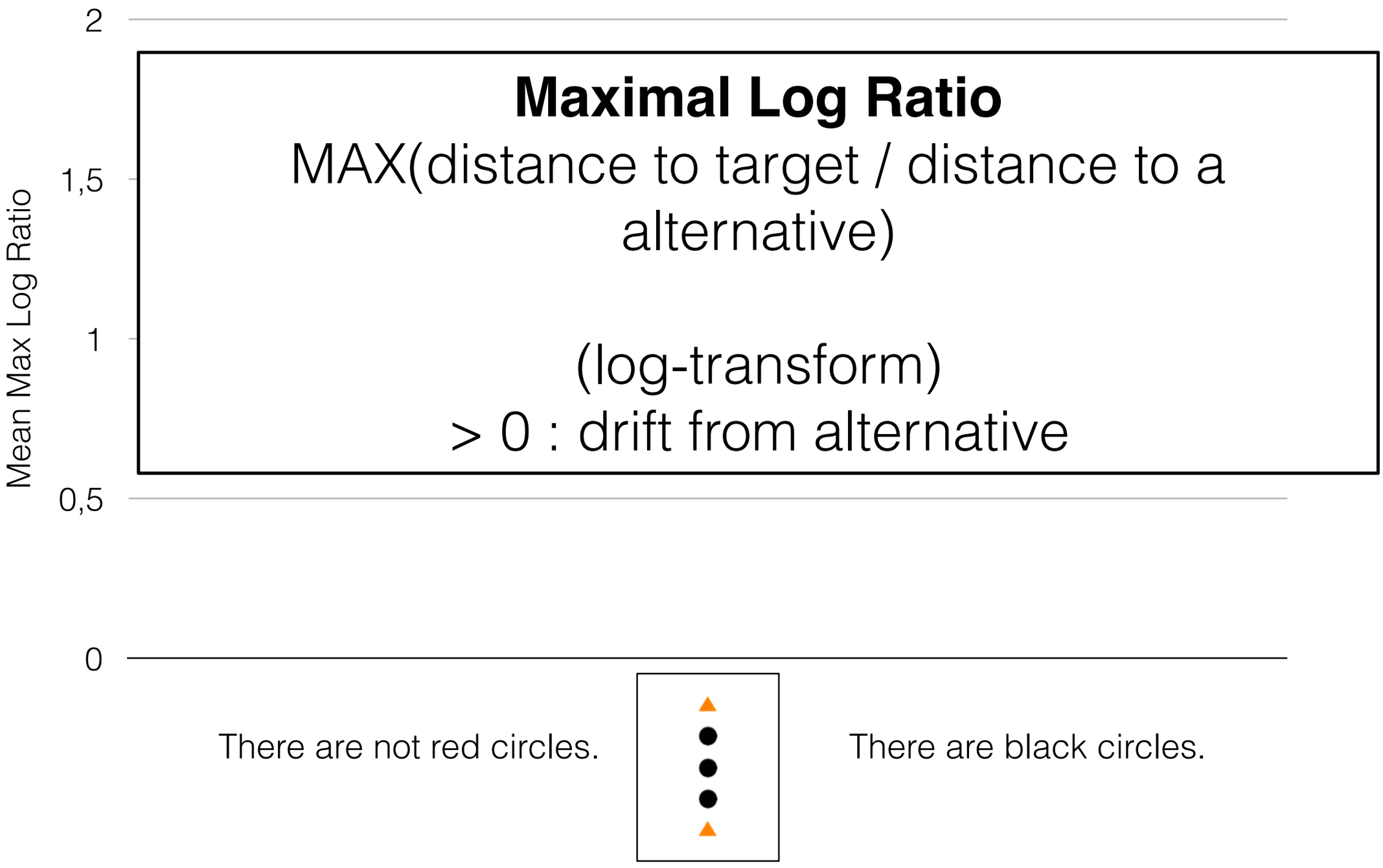
D operator



++ Controls with negation

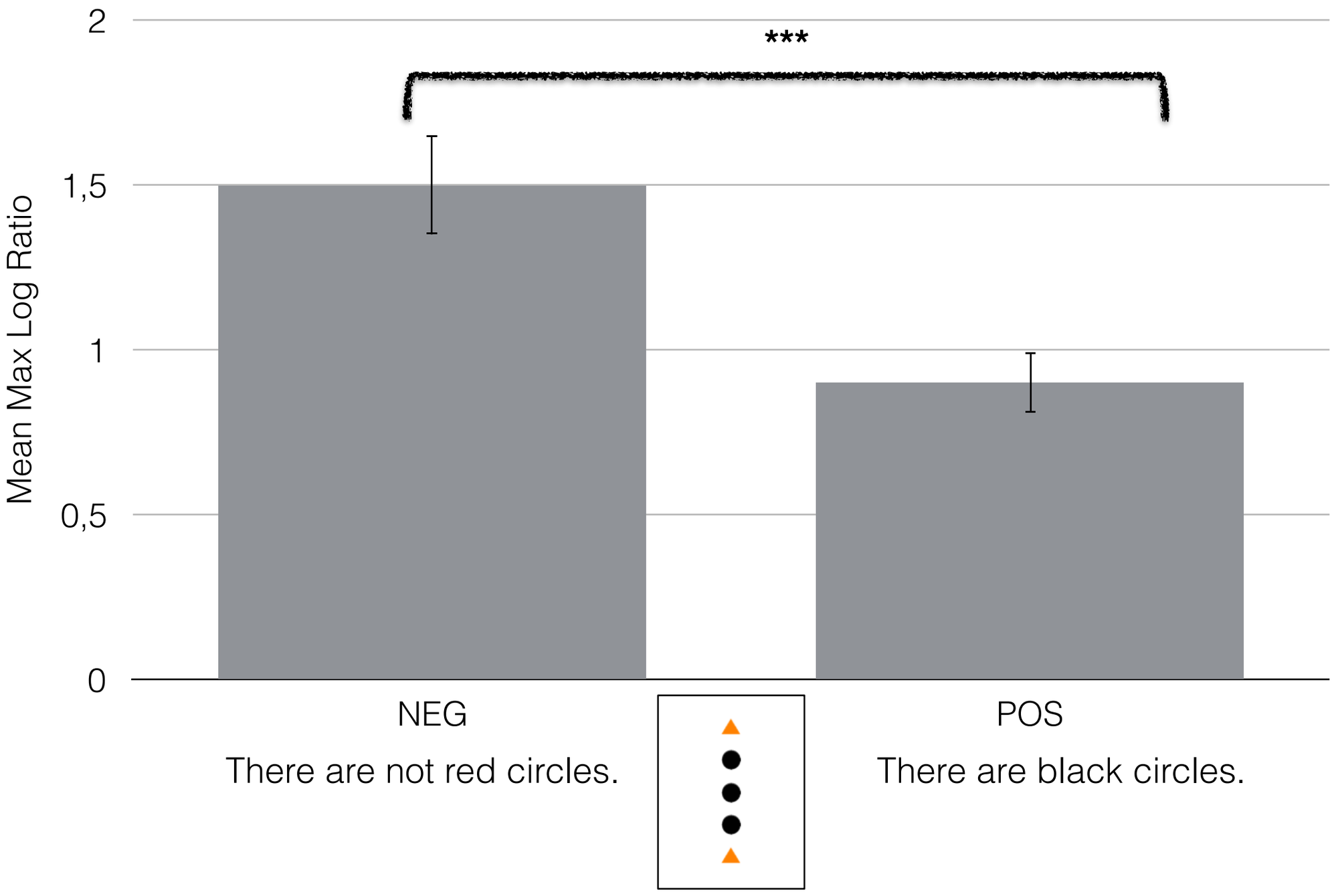
Mouse tracking and online derivation

Replication of negation effects (N=57)



Mouse tracking and online derivation

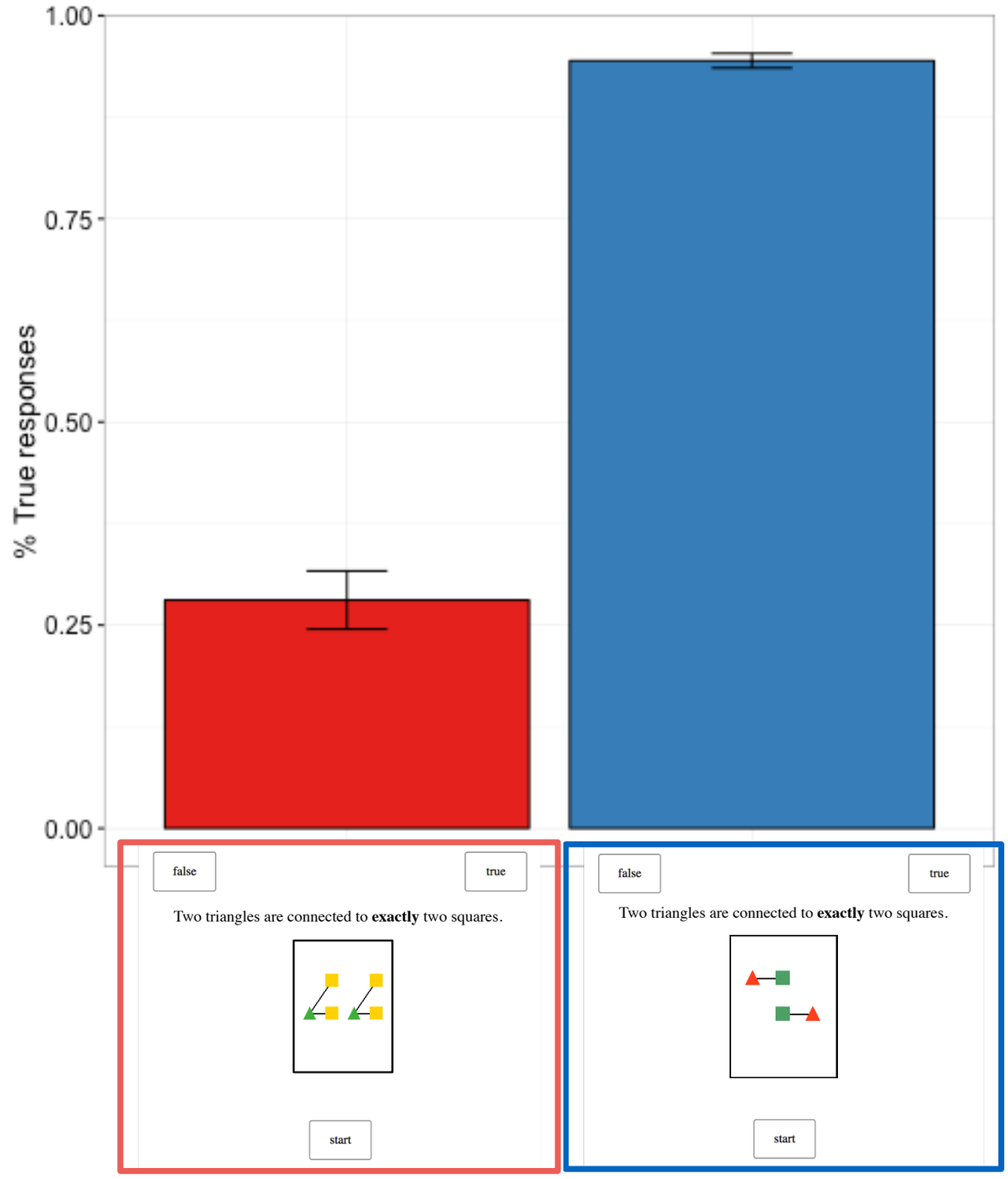
Replication of negation effects (N=57)



Mouse tracking and online derivation

Results for Plural ambiguous sentences (N=57)

- **Acceptance rate**
  Distributive < Cumulative

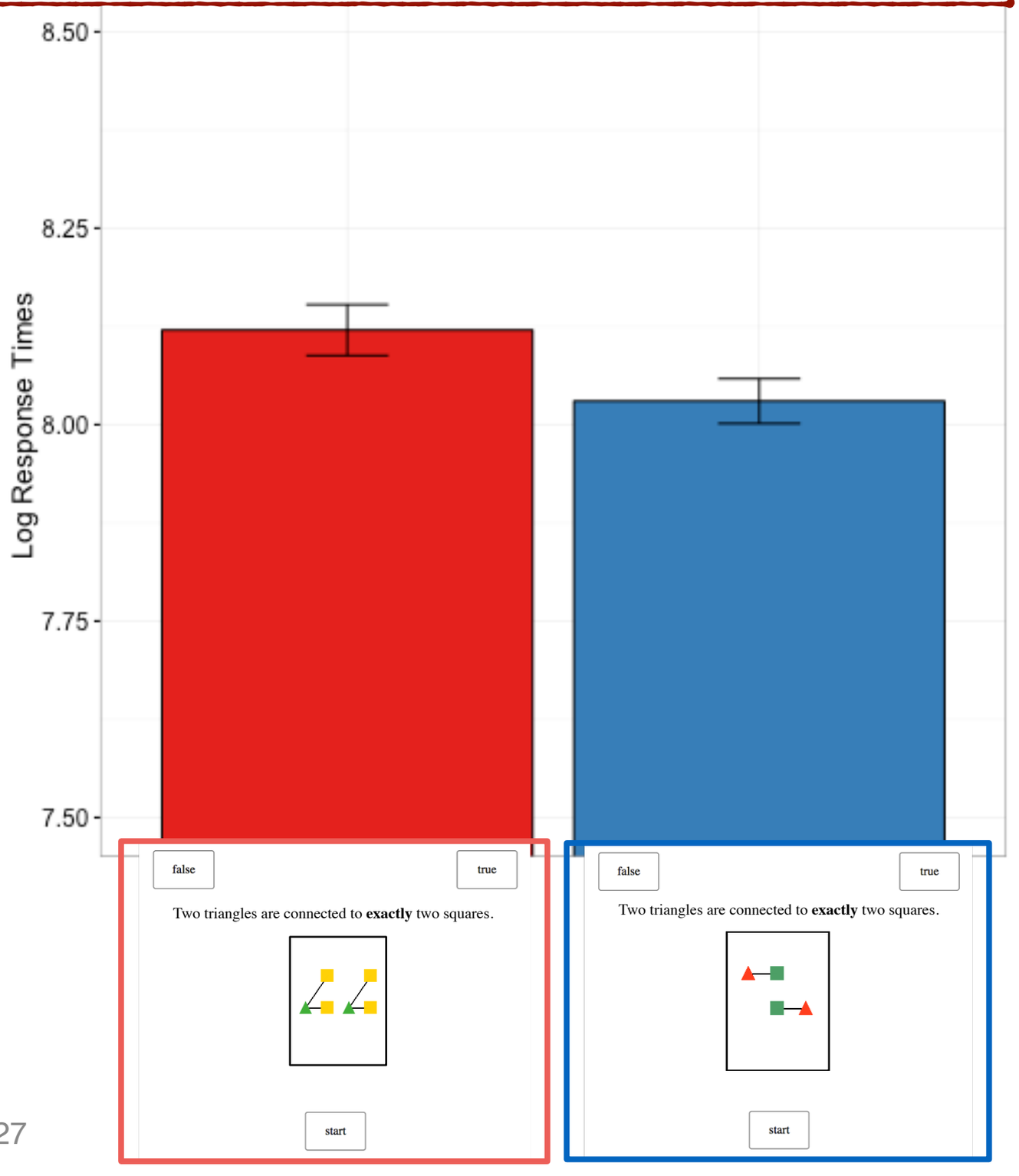


Mouse tracking and online derivation

Results for Plural ambiguous sentences (N=57)

- **Acceptance rate**
  Distributive < Cumulative

- **Response times**
  Distributive > Cumulative



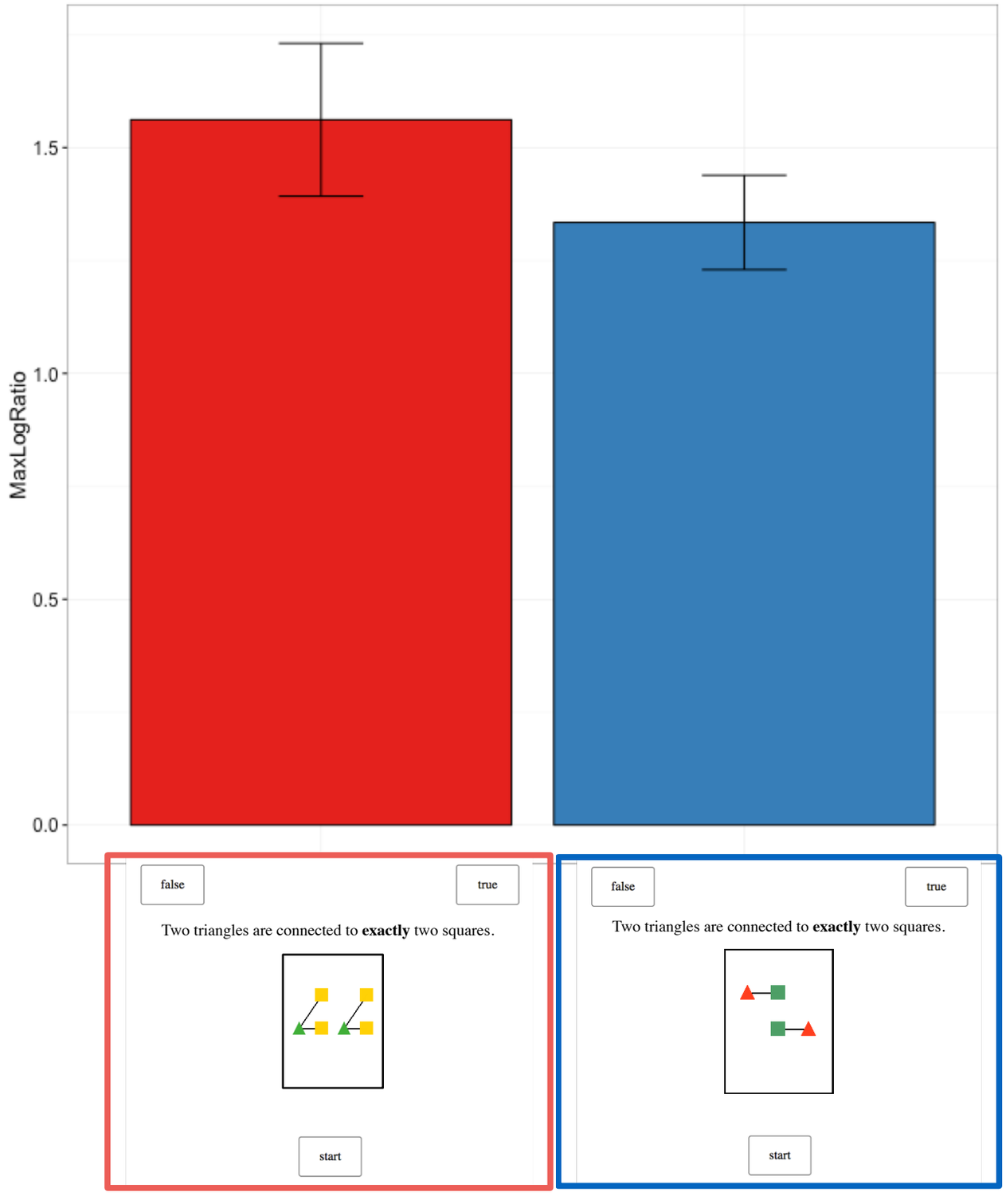
Mouse tracking and online derivation

Results for Plural ambiguous sentences (N=57)

- **Acceptance rate**
  Distributive < Cumulative

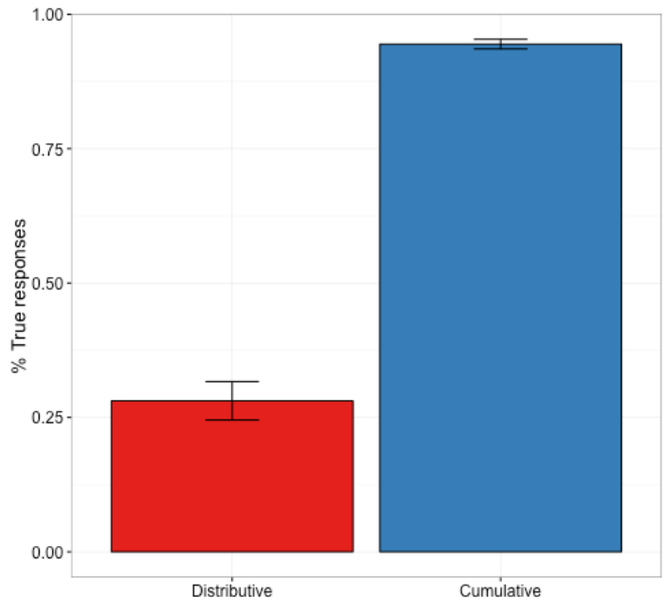
- **Response times**
  Distributive > Cumulative

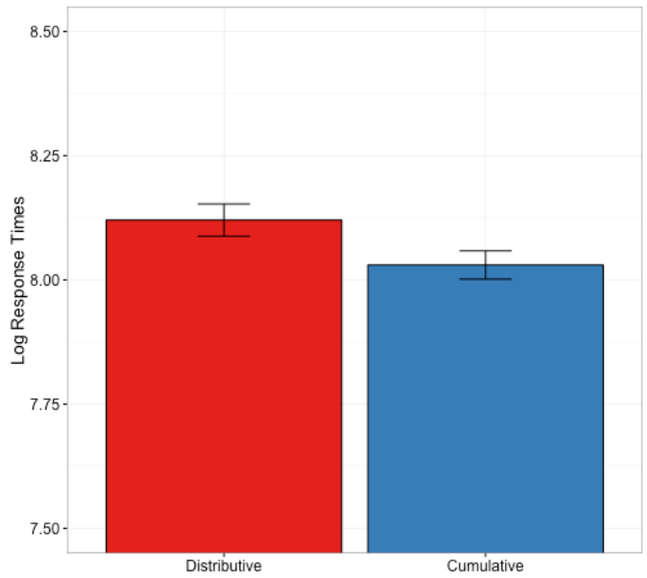
- **Mouse-tracking**
  Distributive > Cumulative

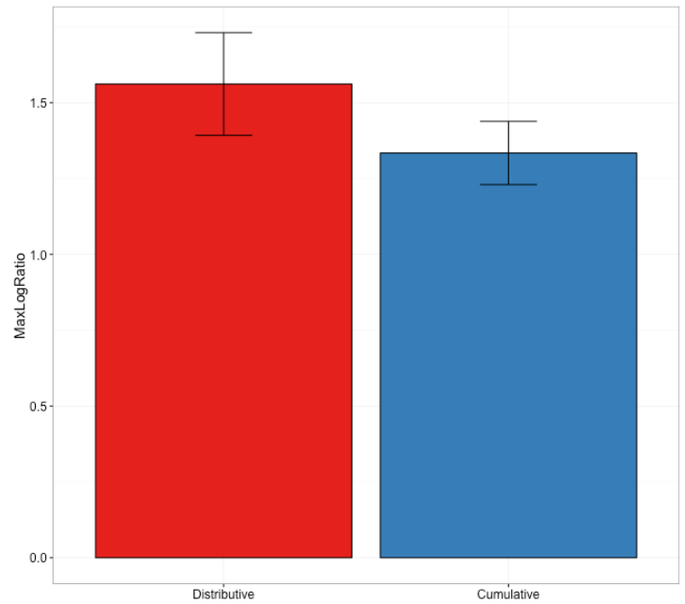


Mouse tracking and online derivation

Summary and conclusions







1. Cumulative readings are derived by default.
2. Cumulative representations are not enough to face distributive situations (i.e., pictures).
3. Distributive readings carry additional computational cost (two-step manner)

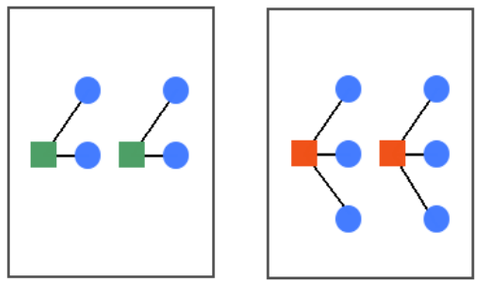
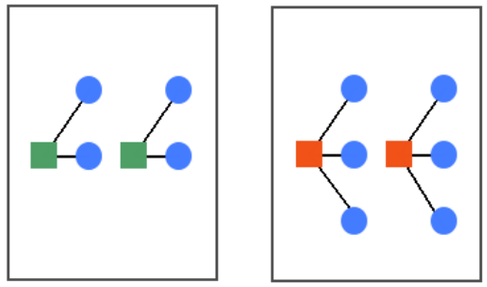
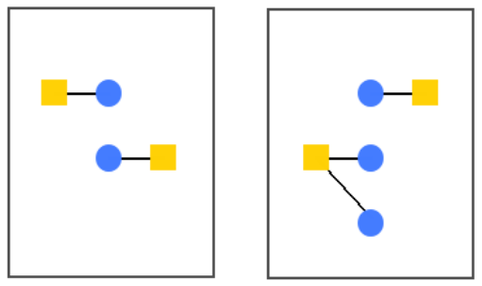
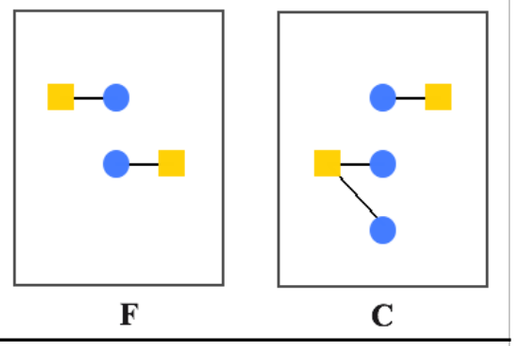
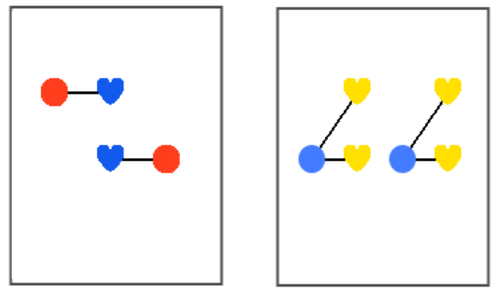
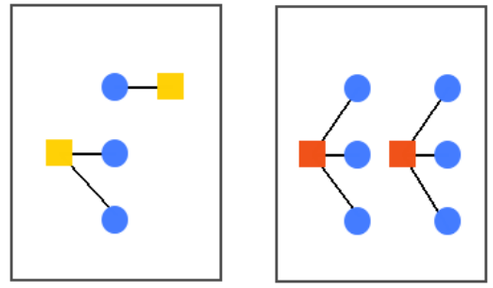
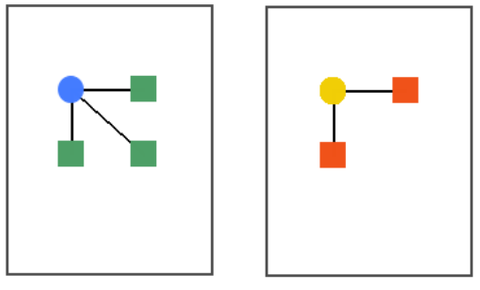
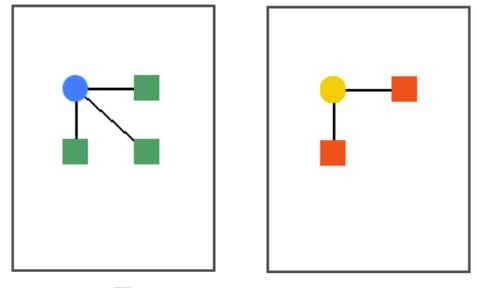
Mouse tracking and online derivation

Open questions

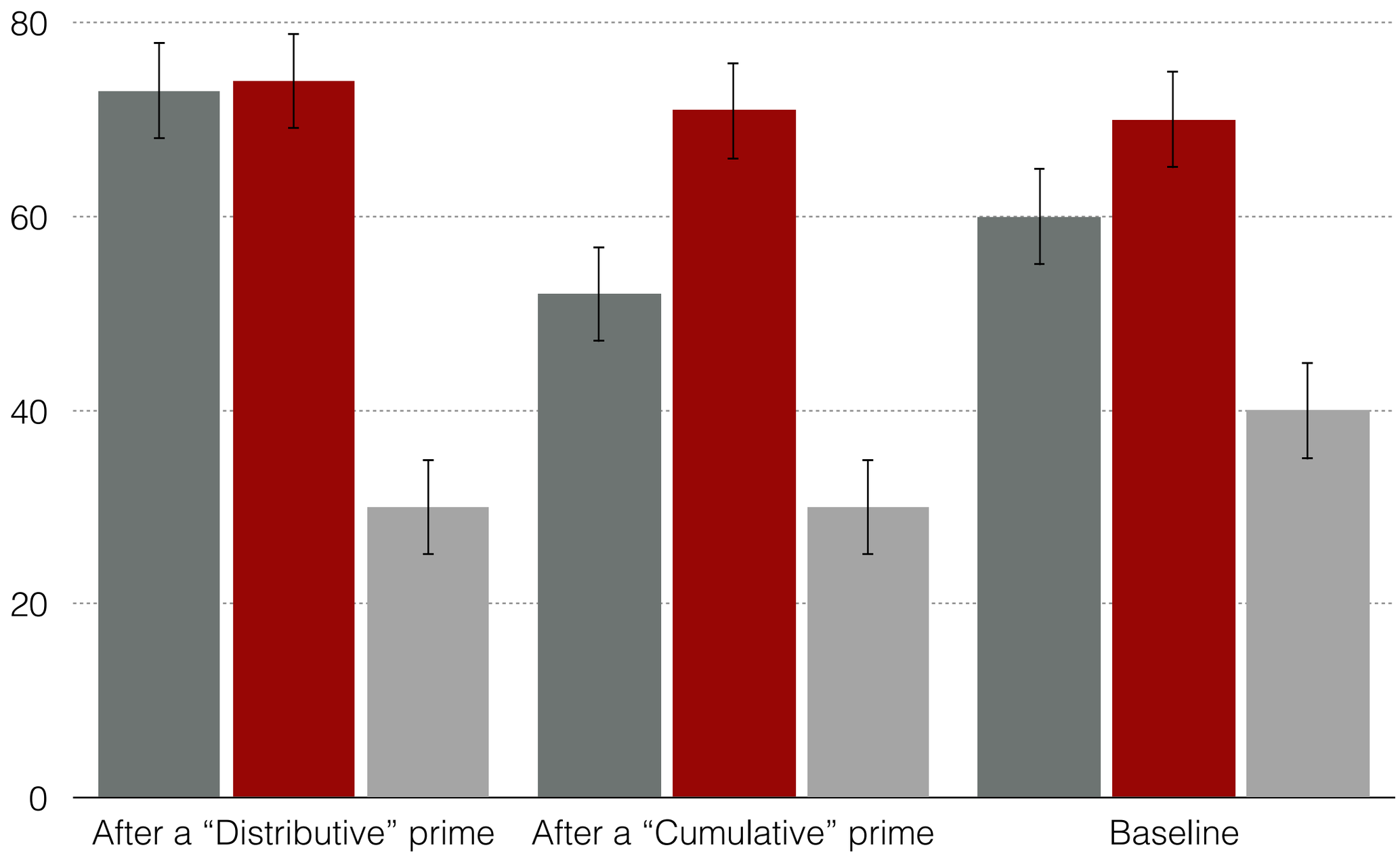
1. Differences in experimental paradigm: Are preference and cost going in opposite directions?

2. Different dynamics: parallel competition or two-step serial derivation?

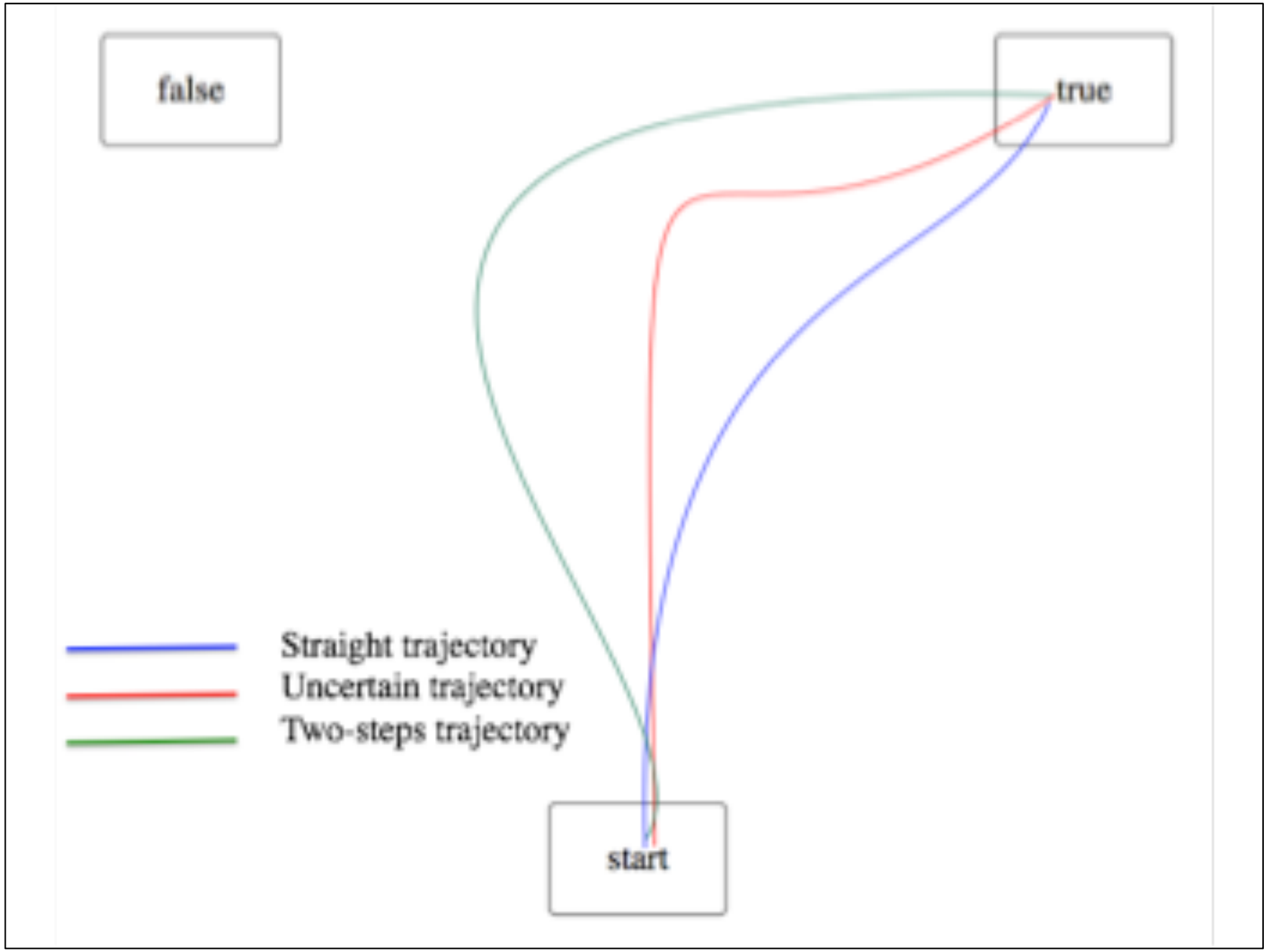
Thanks for you attention!

	Primes		Targets	
	Two-Two	Two-Three	Two-Two	Two-Three
Distributive	**Two squares are connected to two circles.**  D F	**Two squares are connected to three circles.**  F D		
Cumulative	**Two squares are connected to two circles.**  C F	**Two squares are connected to three circles.**  F C	**Two circles are connected to two hearts.**  C D	**Two squares are connected to three circles.**  C D
Control	**A circle is connected to two squares.**  F T	**A circle is connected to three squares.**  T F		

Visual priming effects?
Experiments 2 & 3

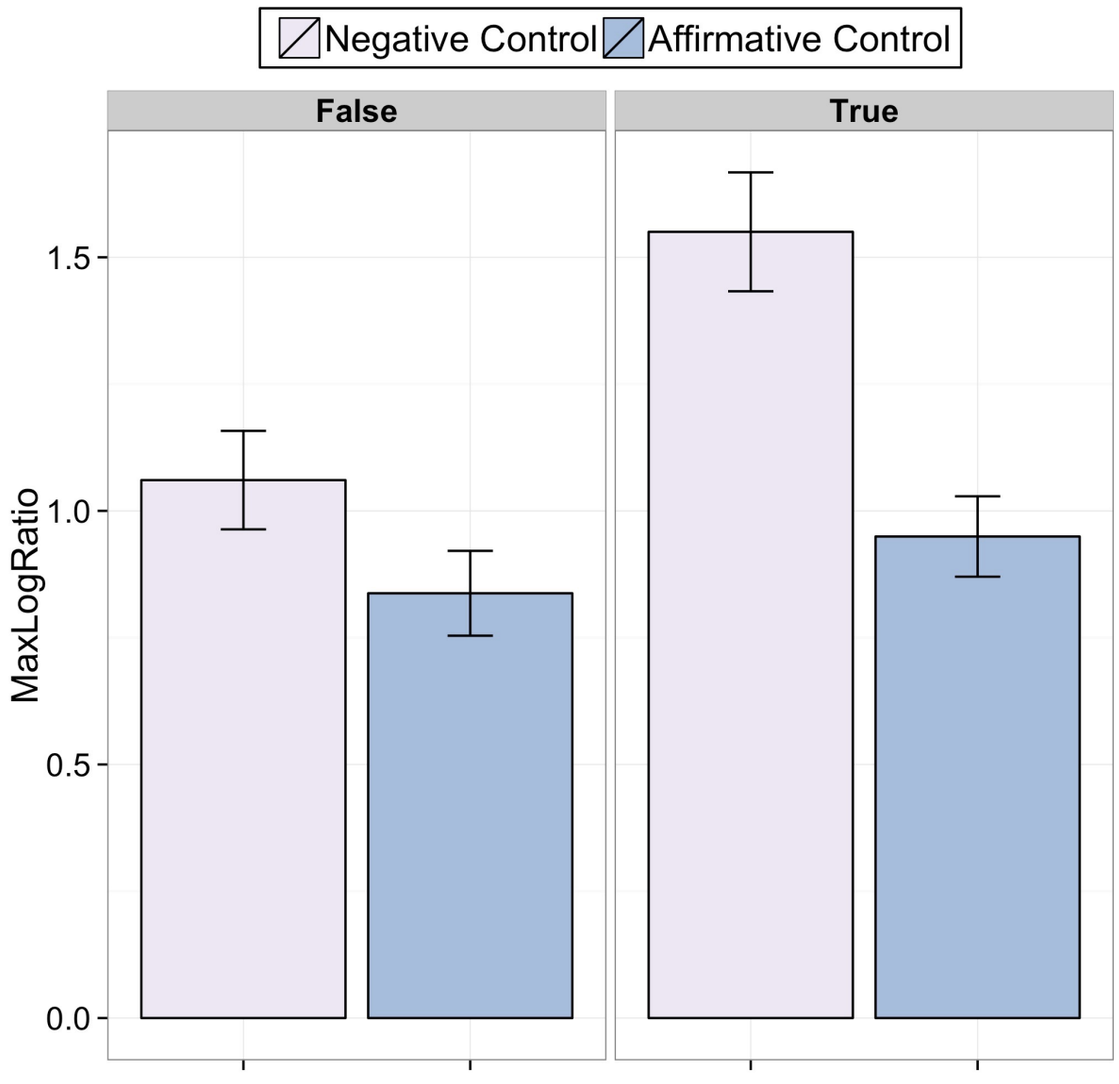


Mouse tracking vs. RTs



Controls for false sentences (Experiment I)

Inclusion of FALSE sentences (True and Negative) to test effects of FALSITY

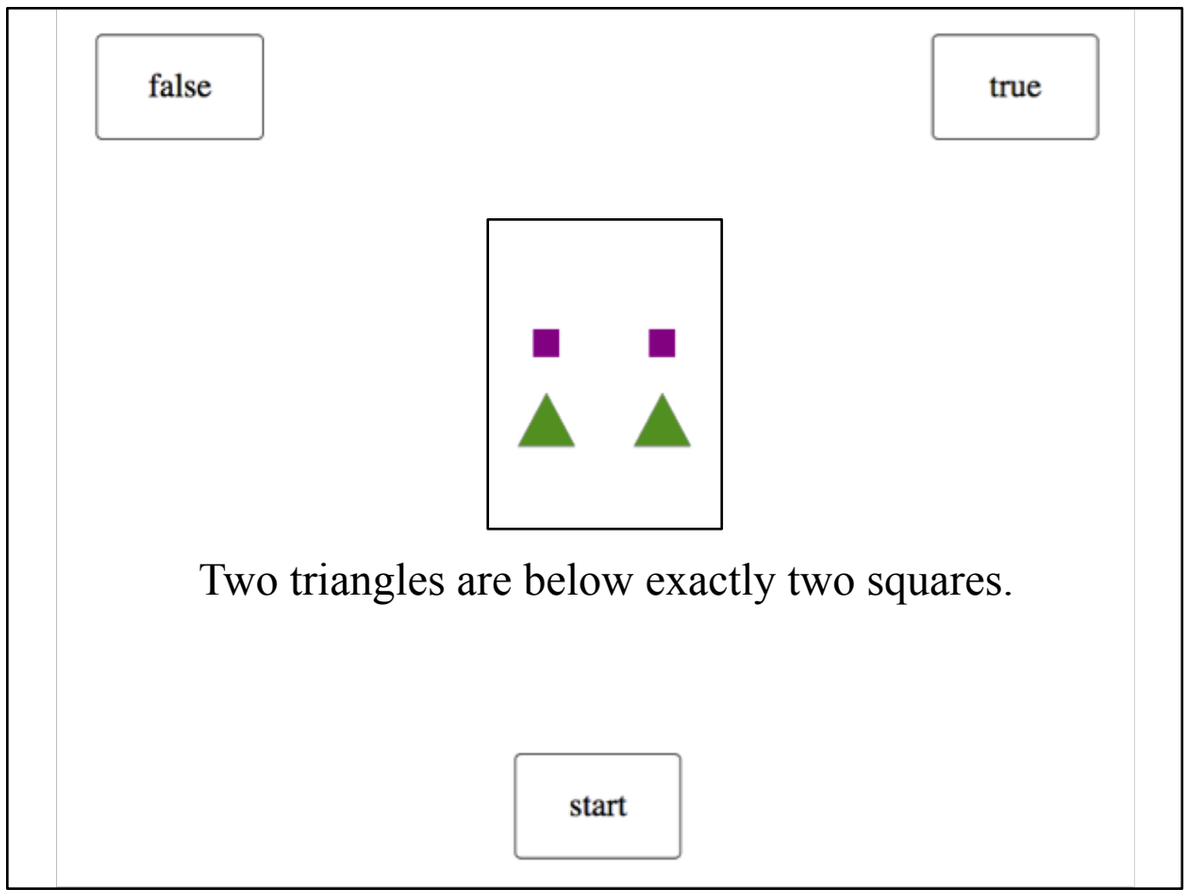


- Effect of truth value
- Interaction between truth value and negation

Note: Results slightly different in Experiment II (Only interaction)

Analyses on False items – Experiment I

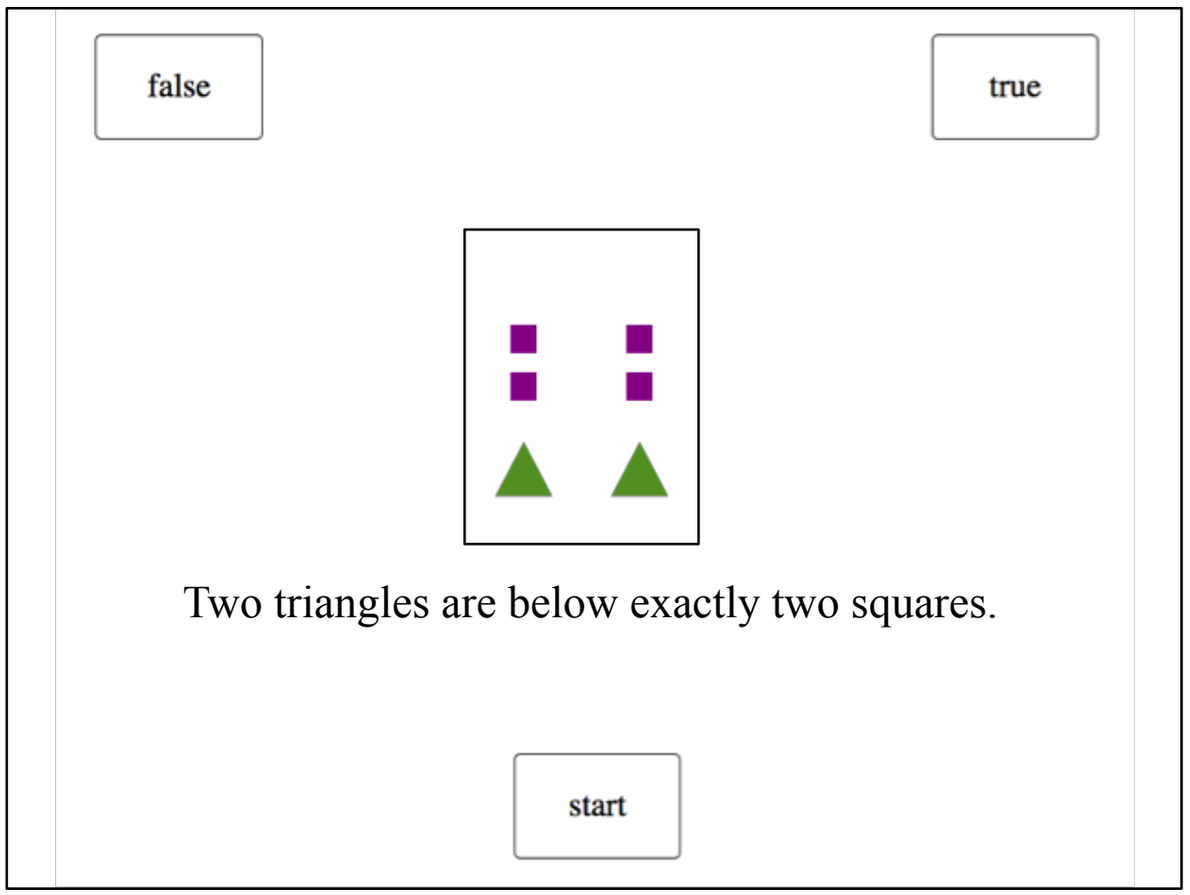
Cumulative condition



Participant says **True**: Access to a Cumulative reading of the sentence.

Participant says **False**: ? (~6%)

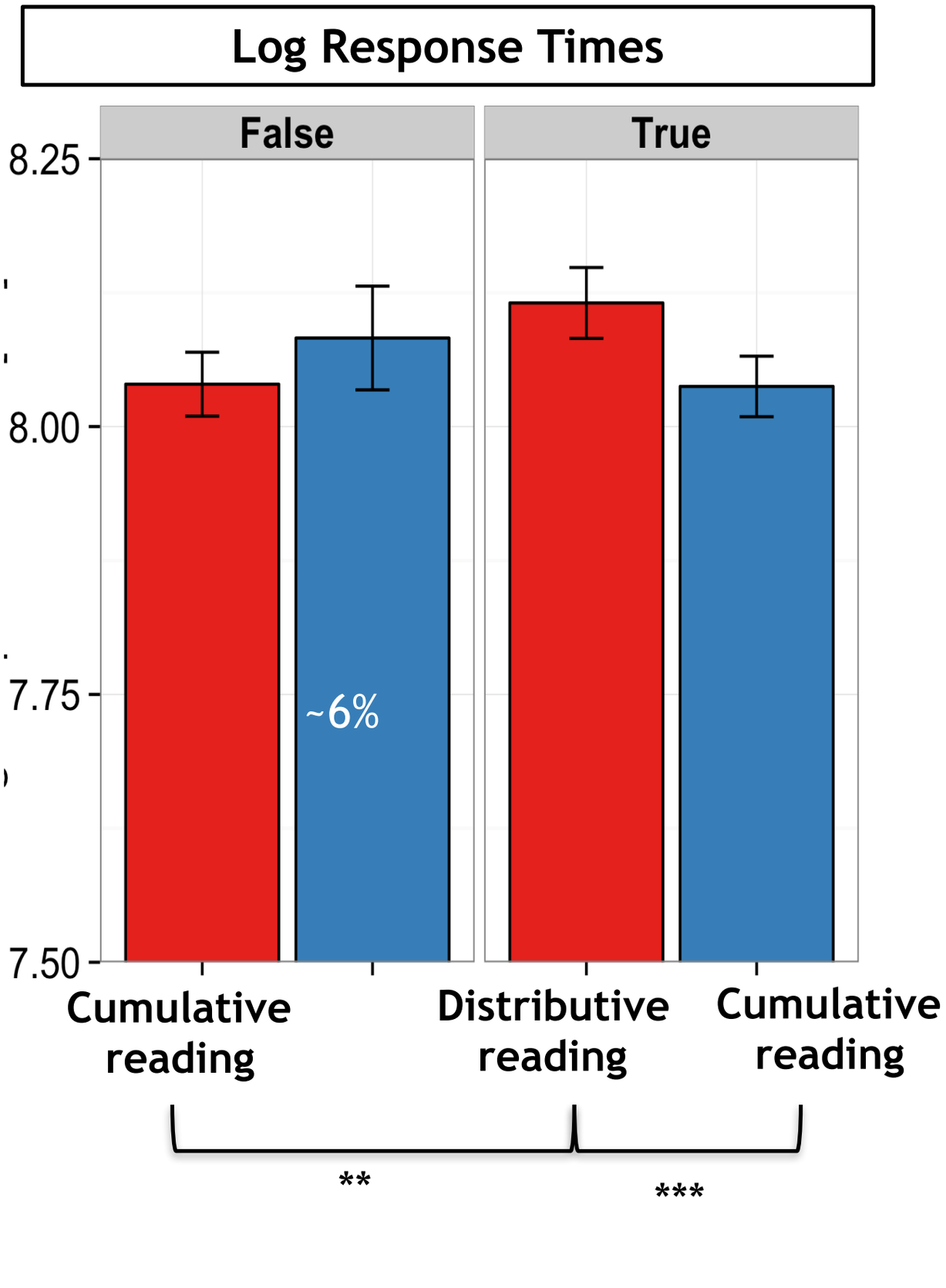
Distributive condition

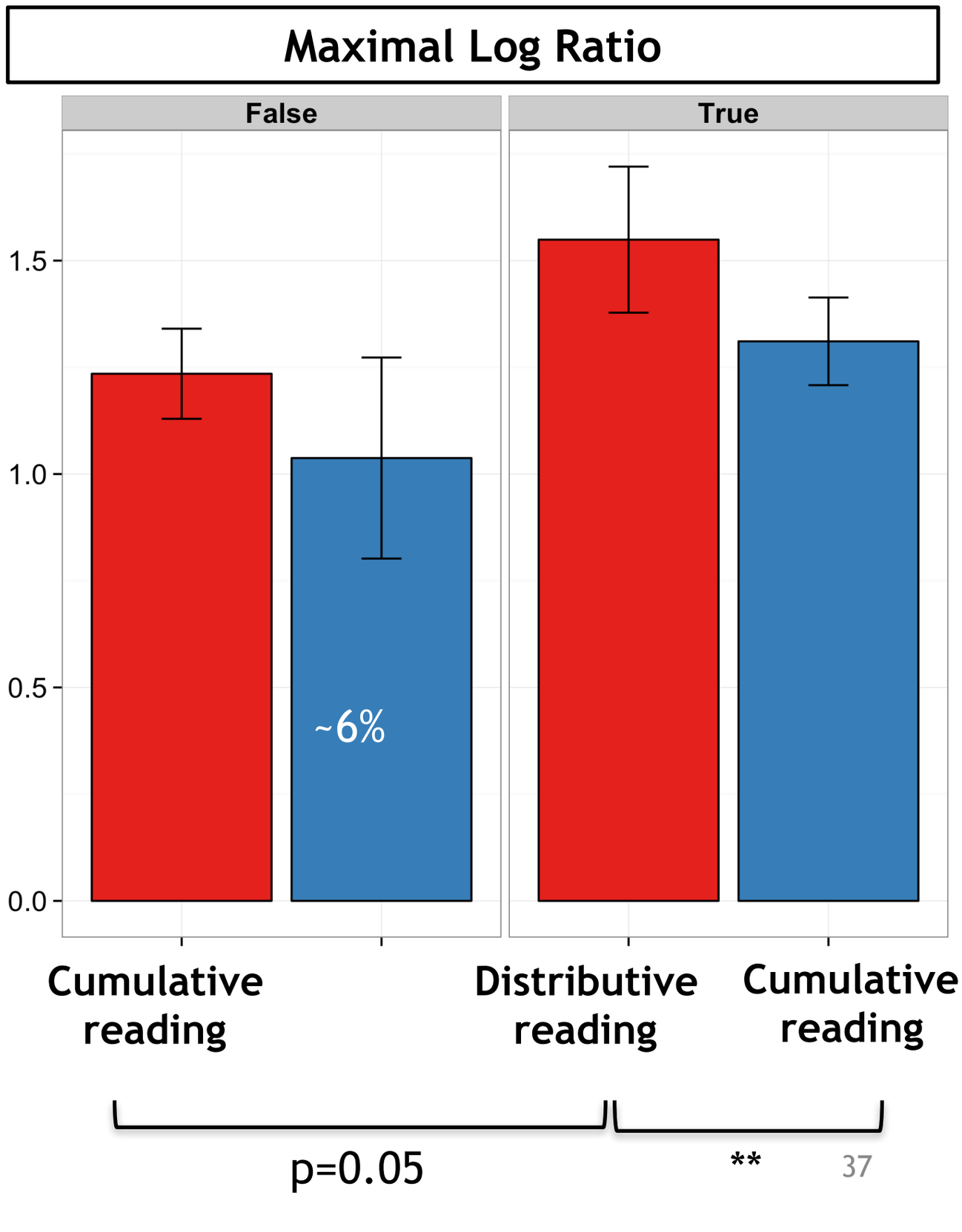


Participant says **True**: Access to a Distributive reading of the sentence.

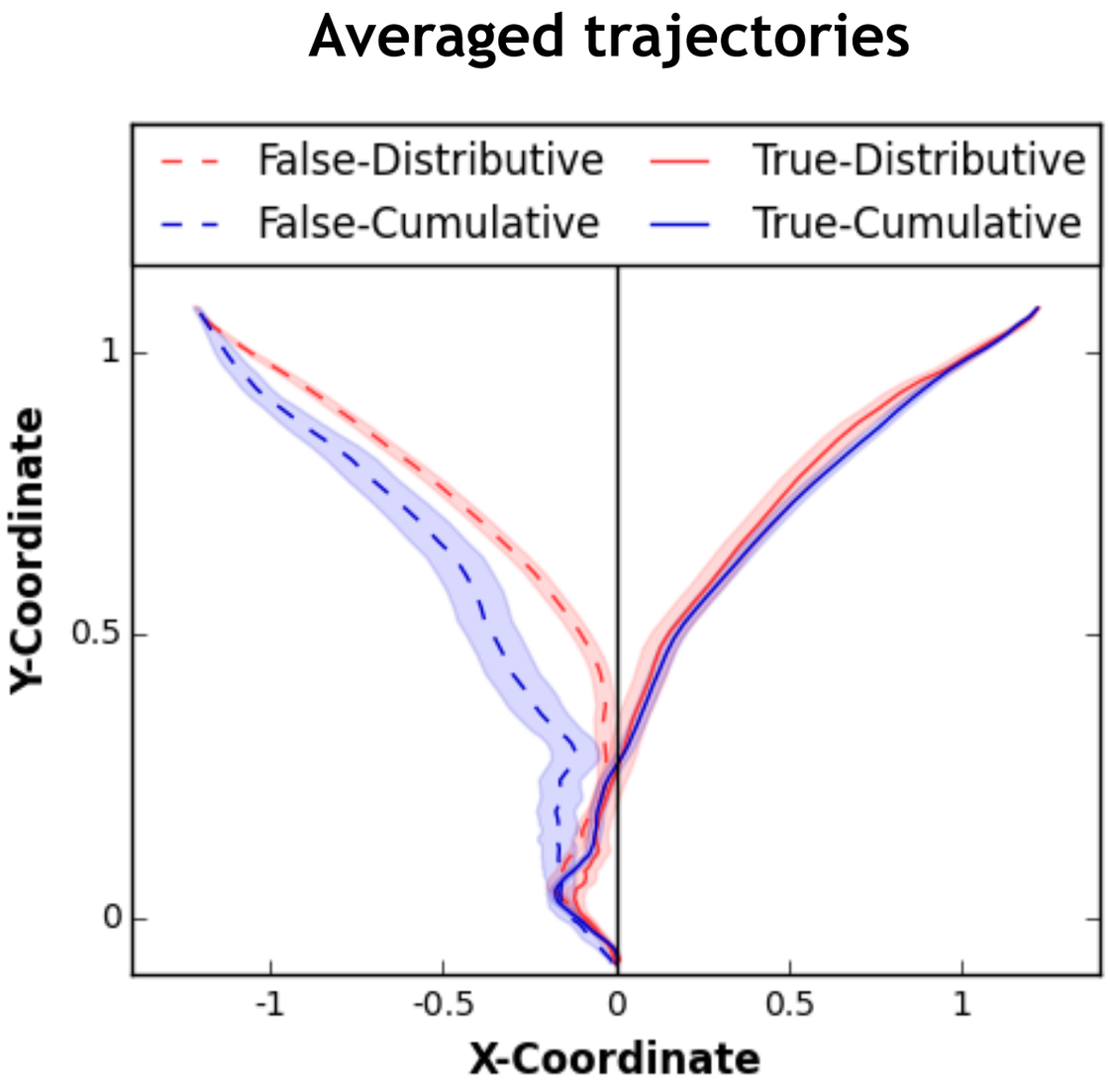
Participant says **False**: Access to a Cumulative reading of the sentence.

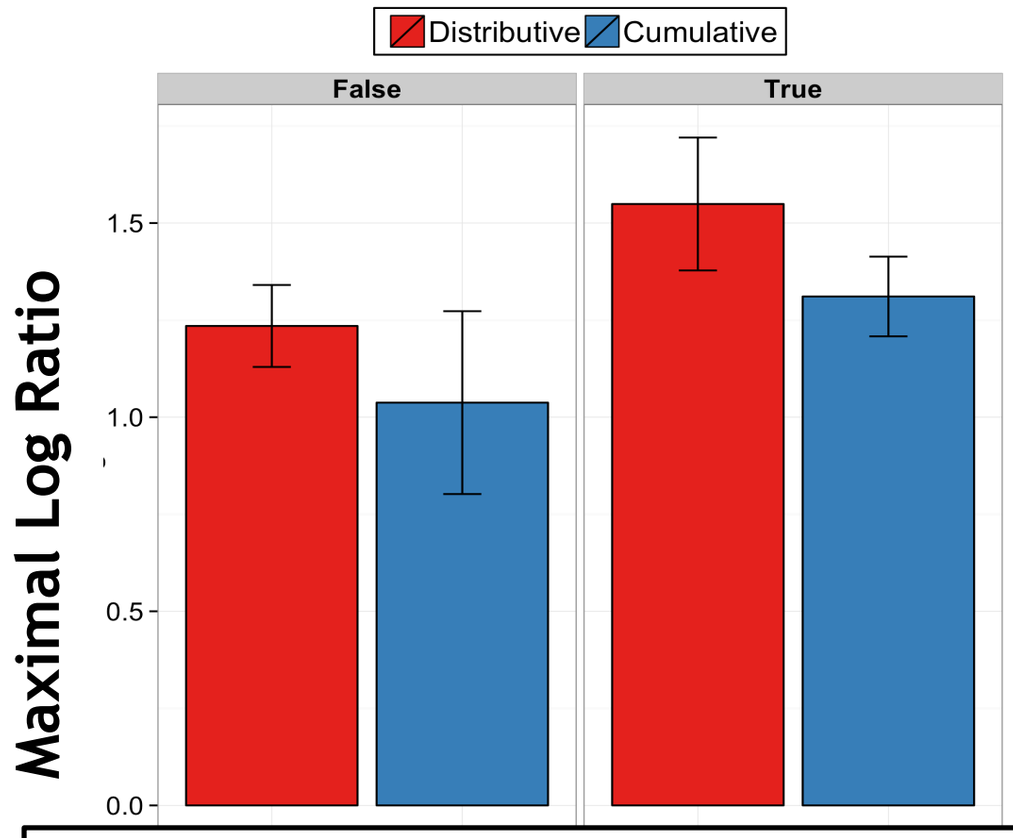
Analyses on False items – Experiment I





Analyses on False items – Experiment I





Occurrence of Max Log Ratio