DIFFICULTIES TRACKING ROLE-REFERENT SWITCHES CAN HELP TO EXPLAIN THE SUBJECT/OBJECT RELATIVE CLAUSE ASYMMETRY

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THE SUBJECT/OBJECT RELATIVE CLAUSE ASYMMETRY

- Subject-extracted relative clauses (RC) are easier to process (Wanner & Maratos, 1978; Traxler et al., 2002 ; Gordon & Lowder, 2012)

- Subject-Extracted Relative Clause
  - The girl that pushed the boy chased the dog

- Object-Extracted Relative Clause
  - The girl that the boy pushed chased the dog

PROCESSOR AND EXPERIENCE?

- Processing-based theories (e.g., Gibson, 1998; Just & Carpenter, 1992; Gordon, Hendrick, & Johnson, 2004)

- Experience-based theories (e.g., MacDonald & Christiansen, 2002, Levy, 2008)

- These theories do not explain why the grammar and input have evolved to create this bias against Object RCs

TRACKING ROLE-REFERENT BINDINGS

- Context with one girl
  - **PUSH:** AGENT=GIRL; PATIENT=BOY
  - **CHASE:** AGENT=GIRL; PATIENT=DOG
  - The girl chased the dog.

- Context with two girl referents
  - RCs disambiguate the referent
  - The girl that pushed the boy chased the dog [Subject RC]

- Speakers need to **track** the role-referent bindings in these scenes

NON-LINGUISTIC BIAS FOR SRCS

- Features of non-linguistic events could influence RC use in language.

- Subject RC: the girl is the **agent** of both the main and relative clause
  - The girl that pushed the boy chased the dog

- Object RC: the girl is the **agent** of the main clause and **patient** of the relative clause
  - The girl that the boy pushed chased the dog

- It may be harder to track role-referent bindings in Object RCs because of the switch in roles.

MULTIPLE OBJECT TRACKING (MOT)

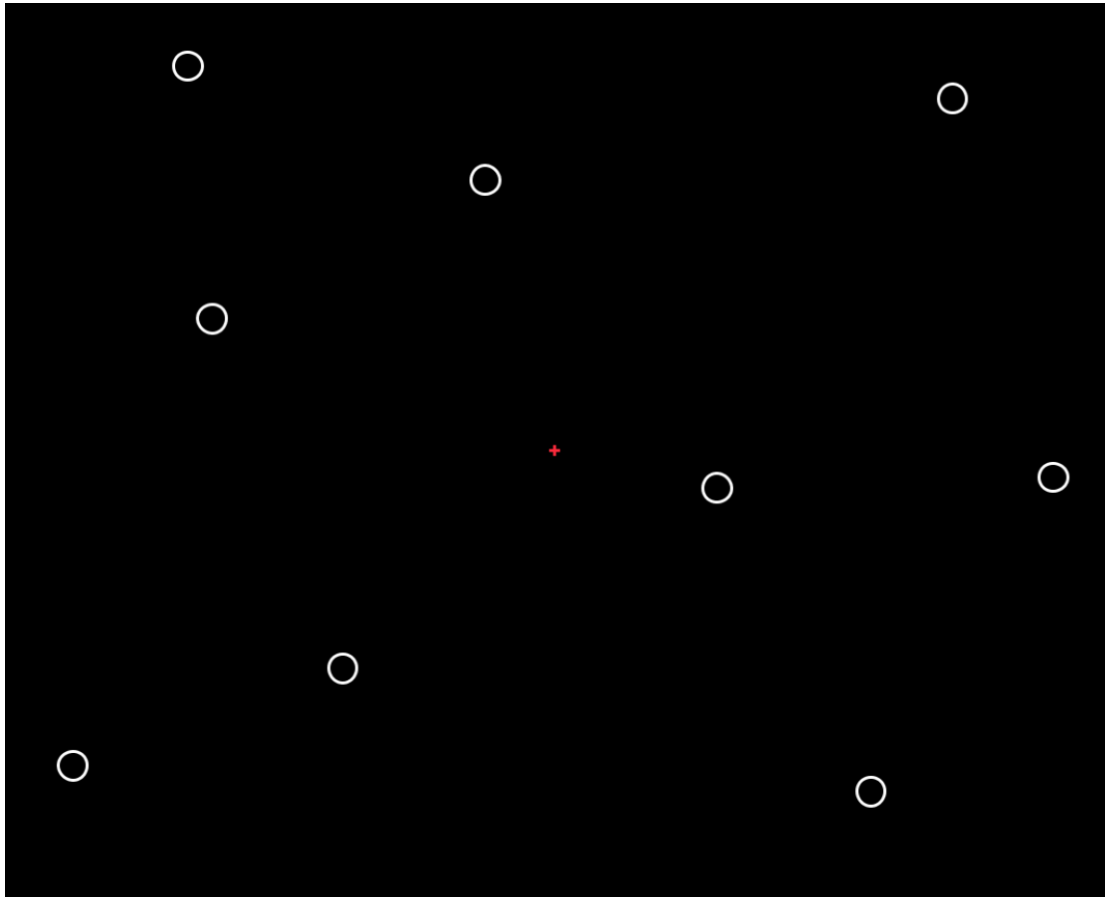
- Viewers are presented with an array of identical objects and have to track particular targets as they all move around randomly (Pylyshyn & Storm, 1988)

- Participants can identify agents and patients based on movement in MOT (Gao, Newman, & Scholl, 2009)

- Tracking agents and patients in push events (Jessop & Chang, 2018)
  - Participants can track two push events
  - Described in transitive sentences at above chance levels

MULTIPLE PUSH TRACKING

1. 9 identical circles move around randomly
2. First push event
3. Random motion (1 second)
4. Second push
5. Random motion (10 seconds)
6. Test (objects change colour)



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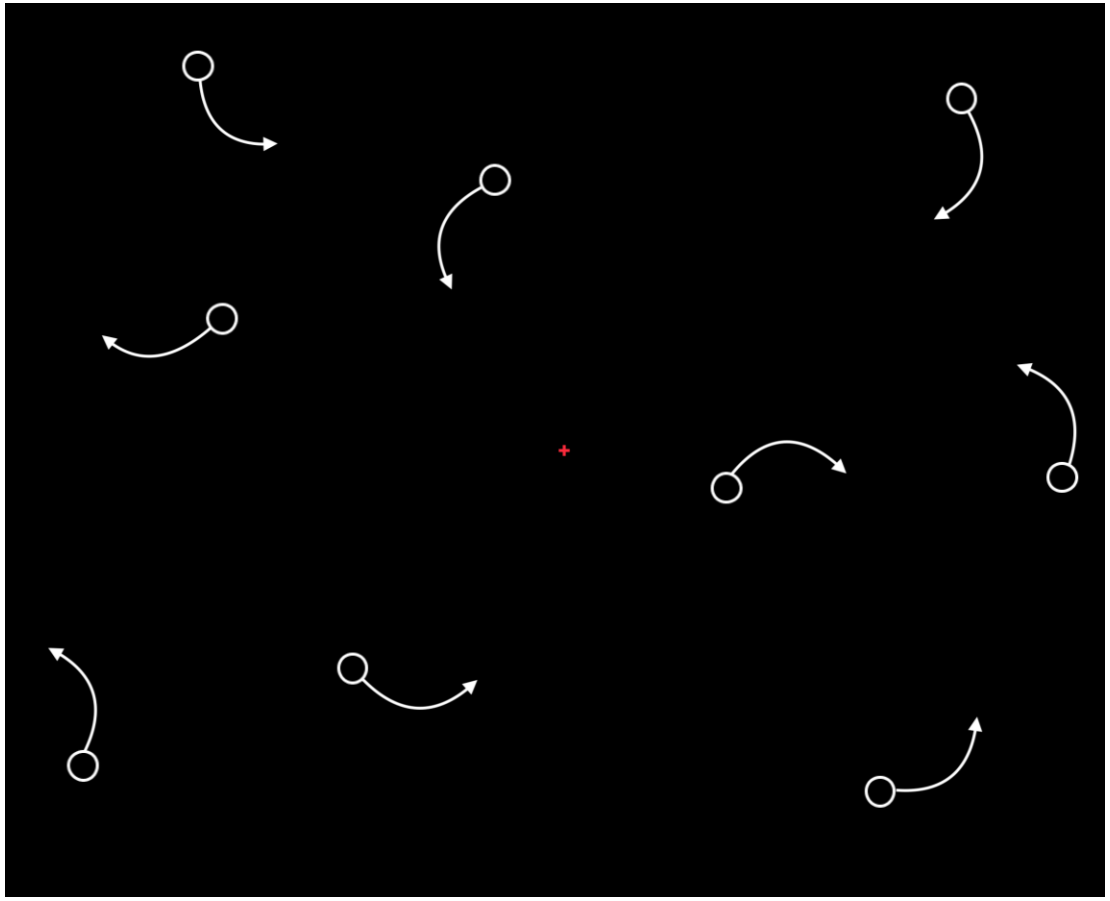

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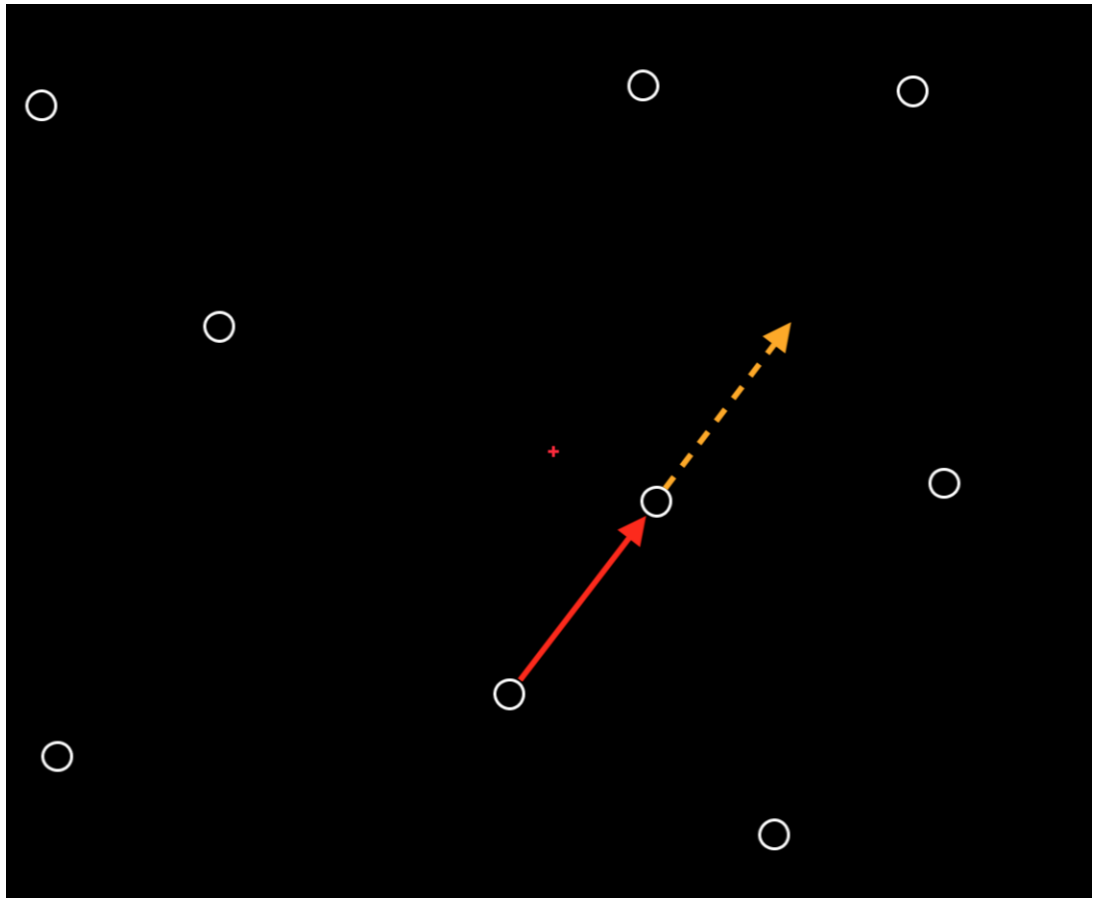

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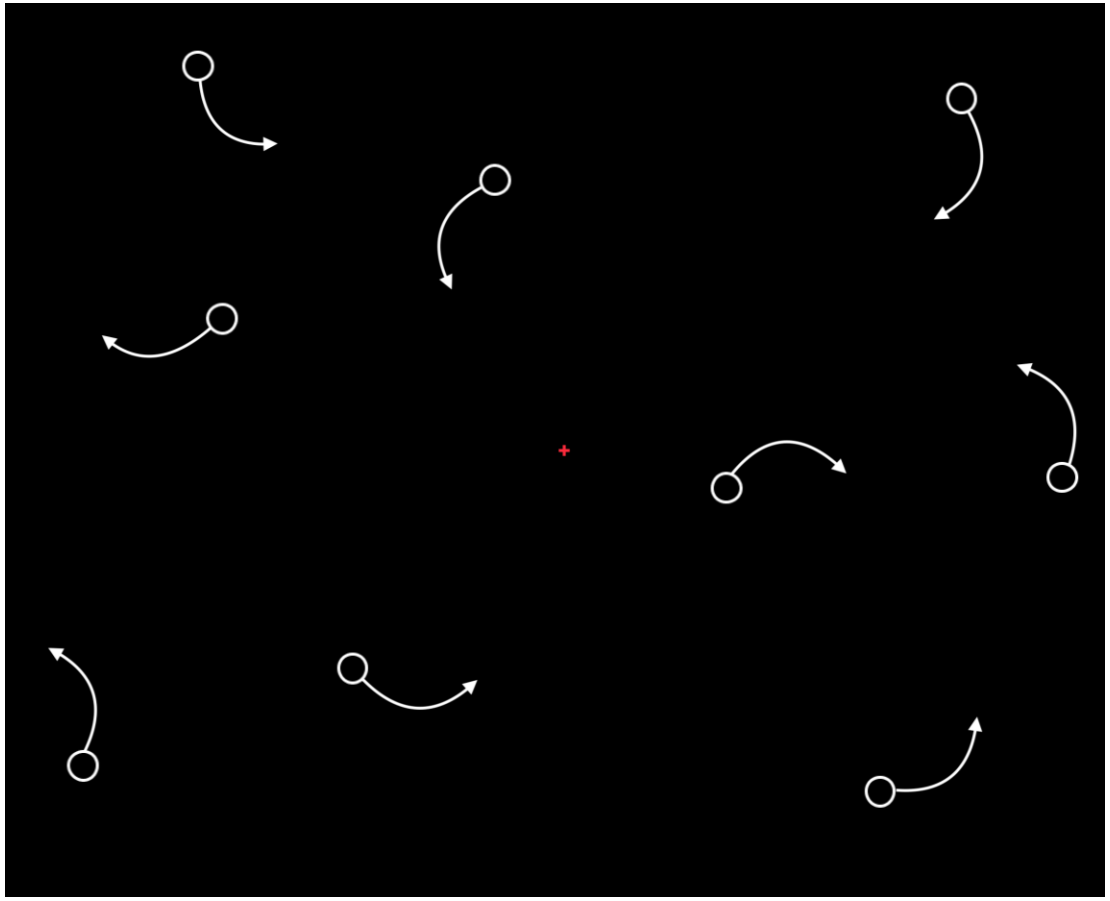

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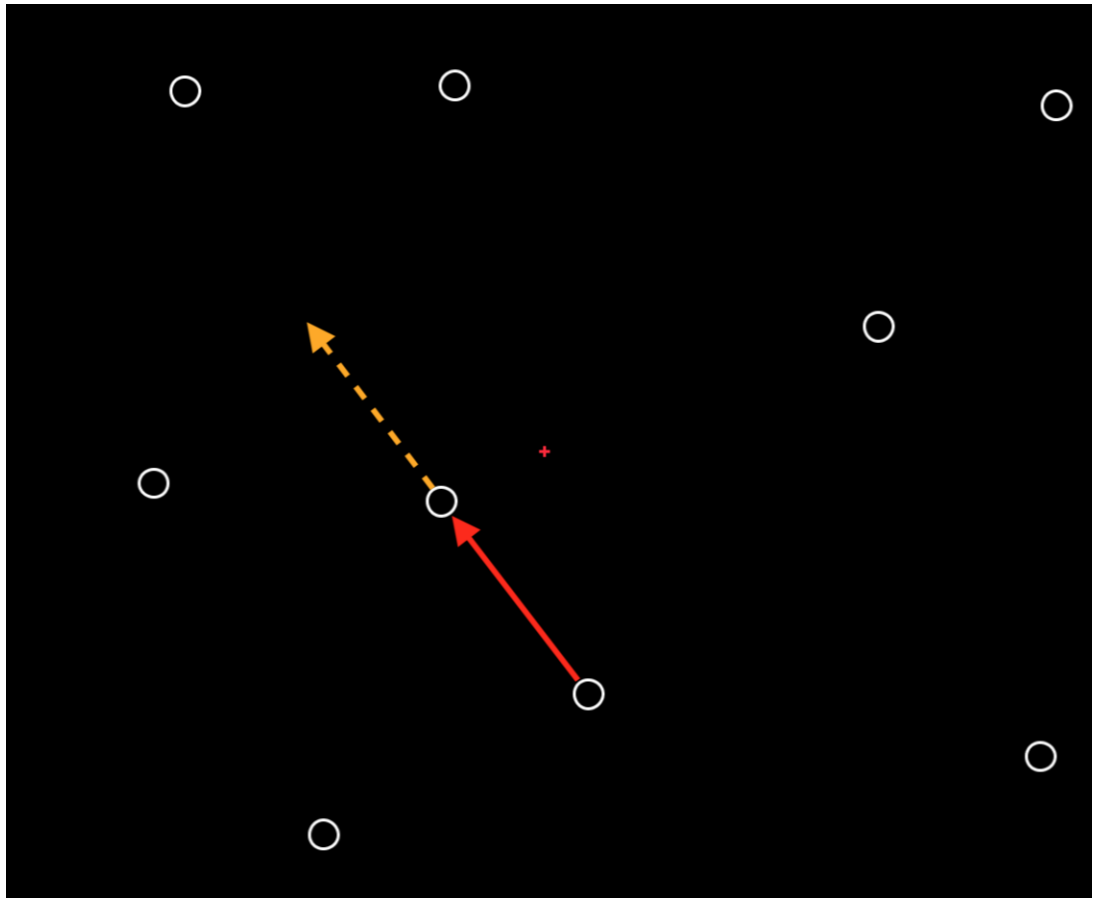

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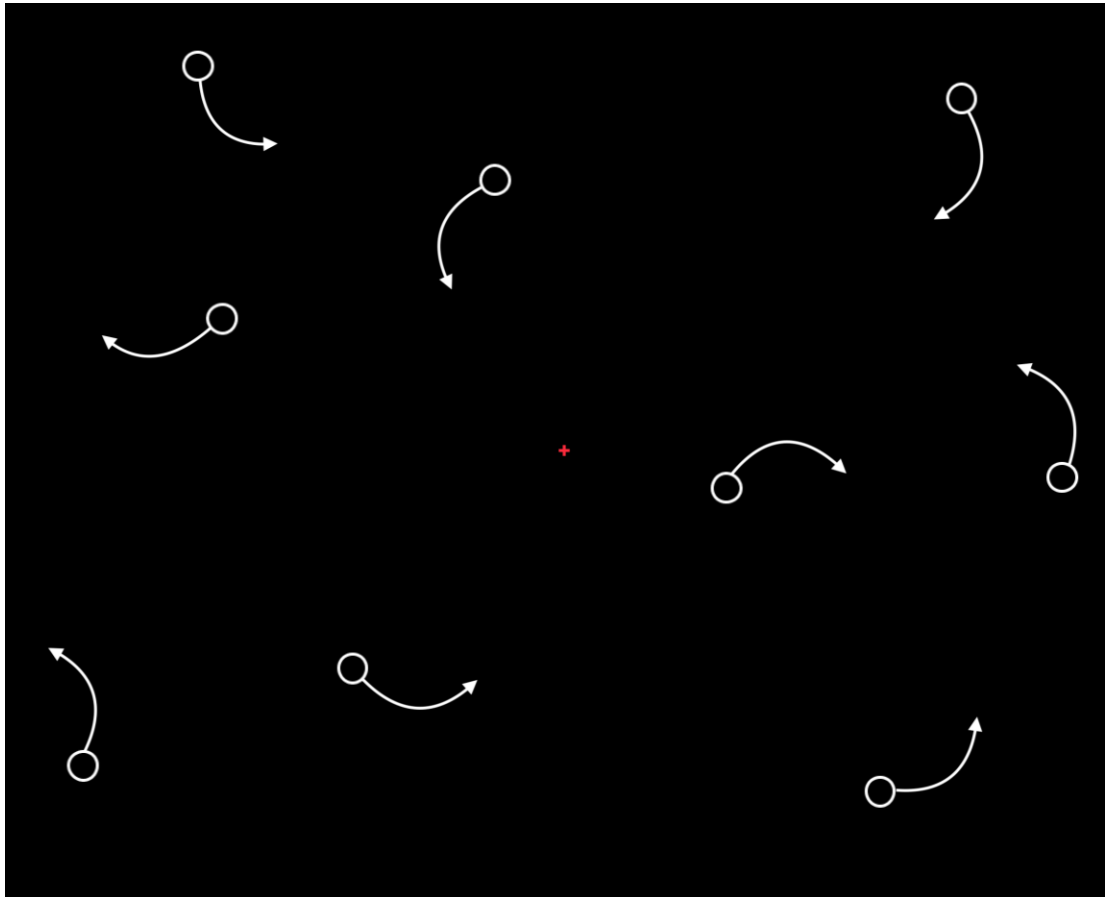

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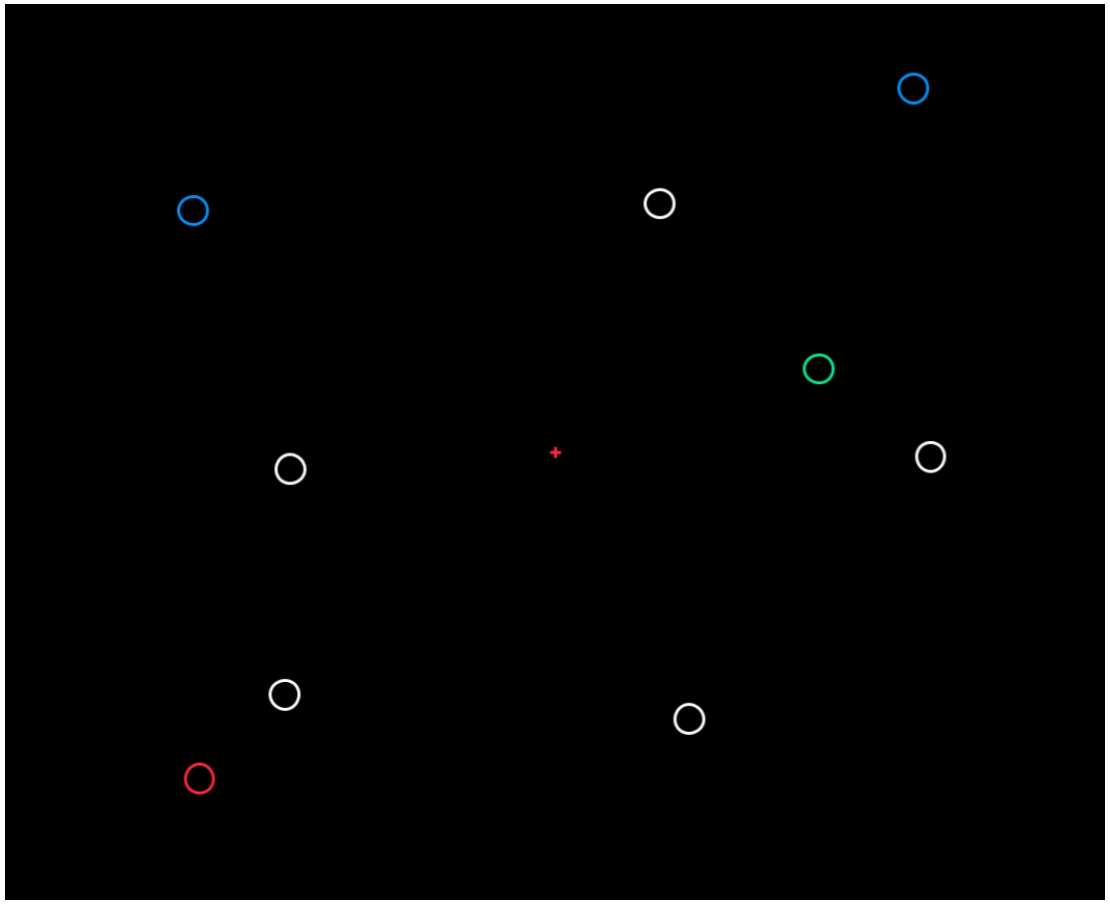
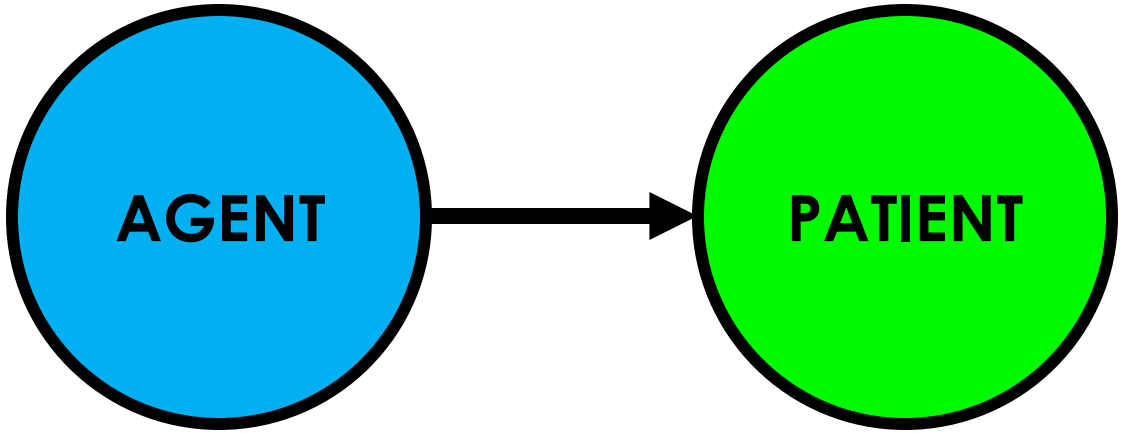
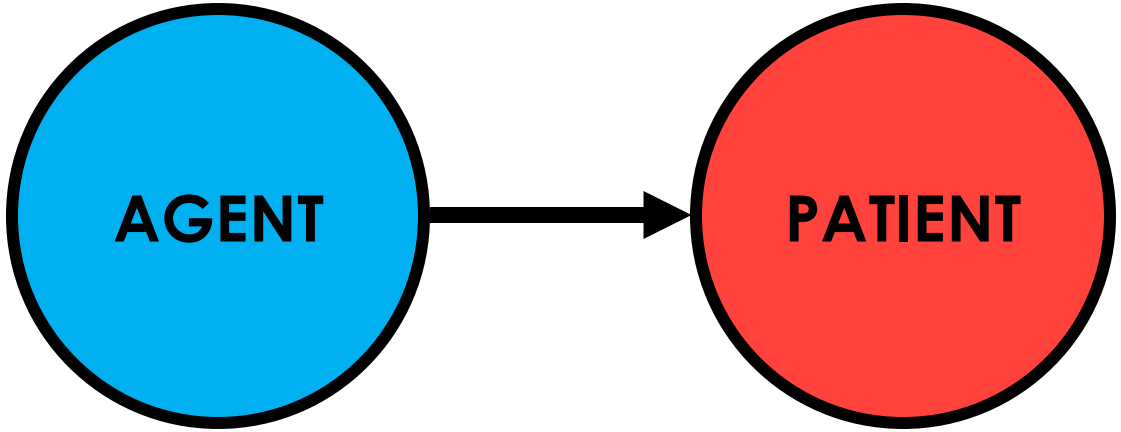


Events matching Subject RCs

Push 1

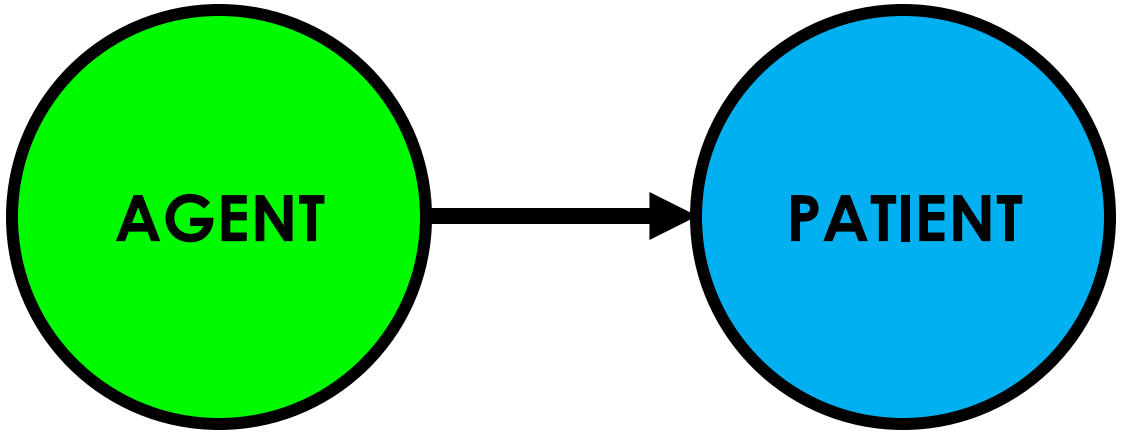


Push 2

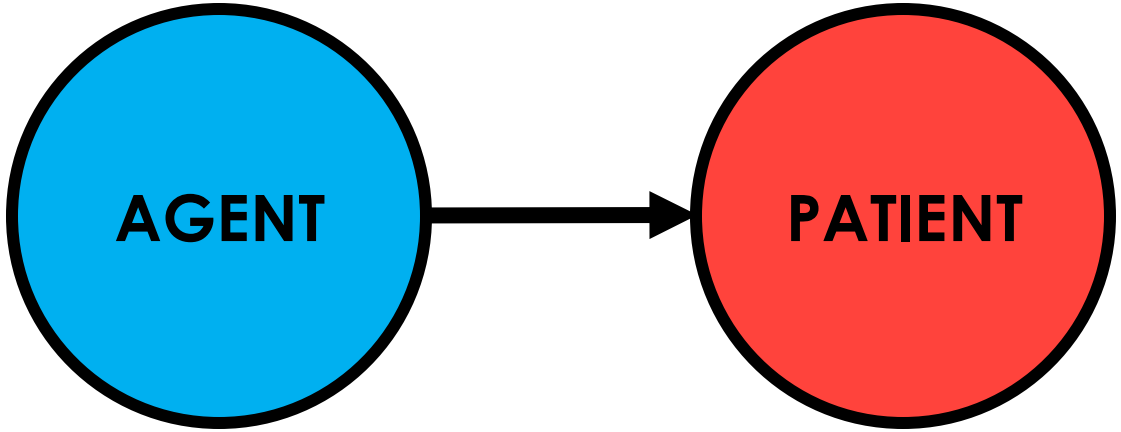


Events matching Object RCs

Push 1



Push 2



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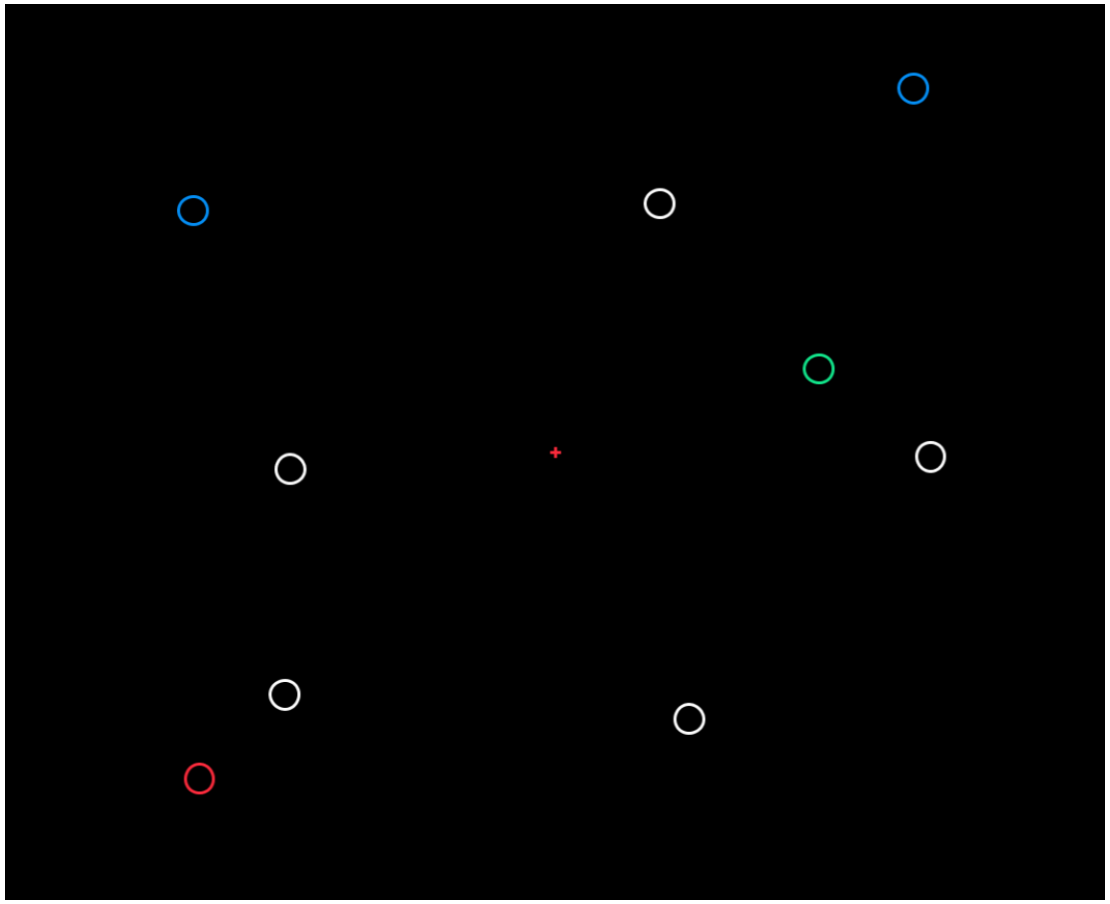


Overview of Experiments

- **Six studies which mainly vary the structures used to describe the event**
  - **By changing the language demands between the studies, we were able to assess whether linguistic processes are contributing to the relative clause asymmetry**

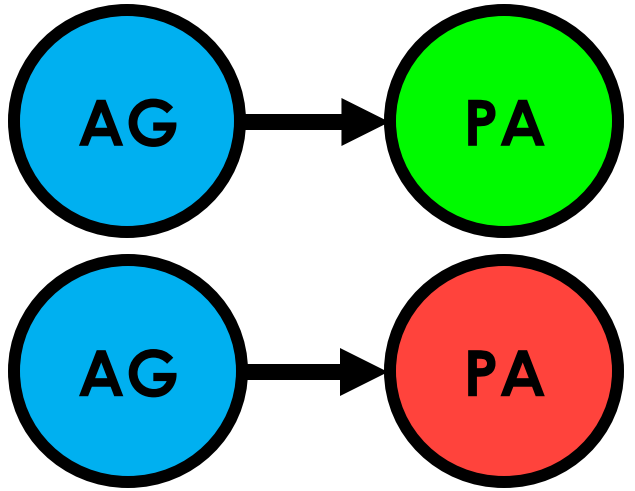
- **EXP 1** – Subject RCs or Object RCs
- **EXP 2** – Subject RCs or Passive Relatives
- **EXP 3** – Active transitive

- **EXP 4** – agent's consistency (active transitive)
- **EXP 5** – patient's consistency (active transitive)
- **EXP 6** – patient's consistency (passive transitive)

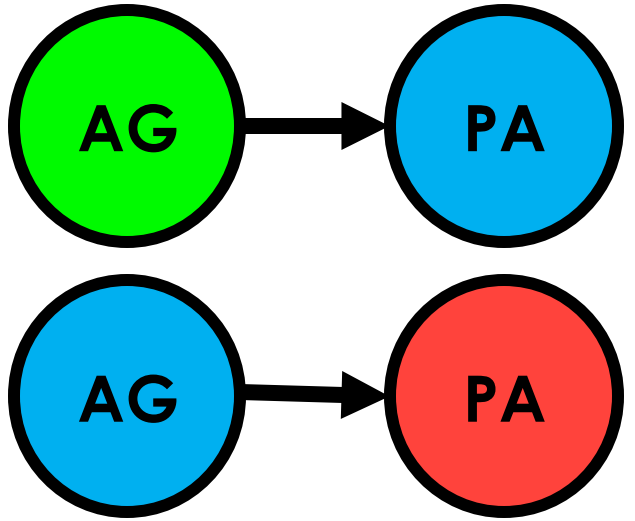
EXPERIMENT 1

- 22 participants (English-speaking adults)
- Watched scenes where the event configurations matched either **Subject RCs** or **Object RCs**
- They described the events with either…
  - **The blue that pushed green pushed red** [SRC]
  - **The blue that green pushed pushed red** [ORC]
- Accuracy = correct structure + referent positions

Subject RC Event

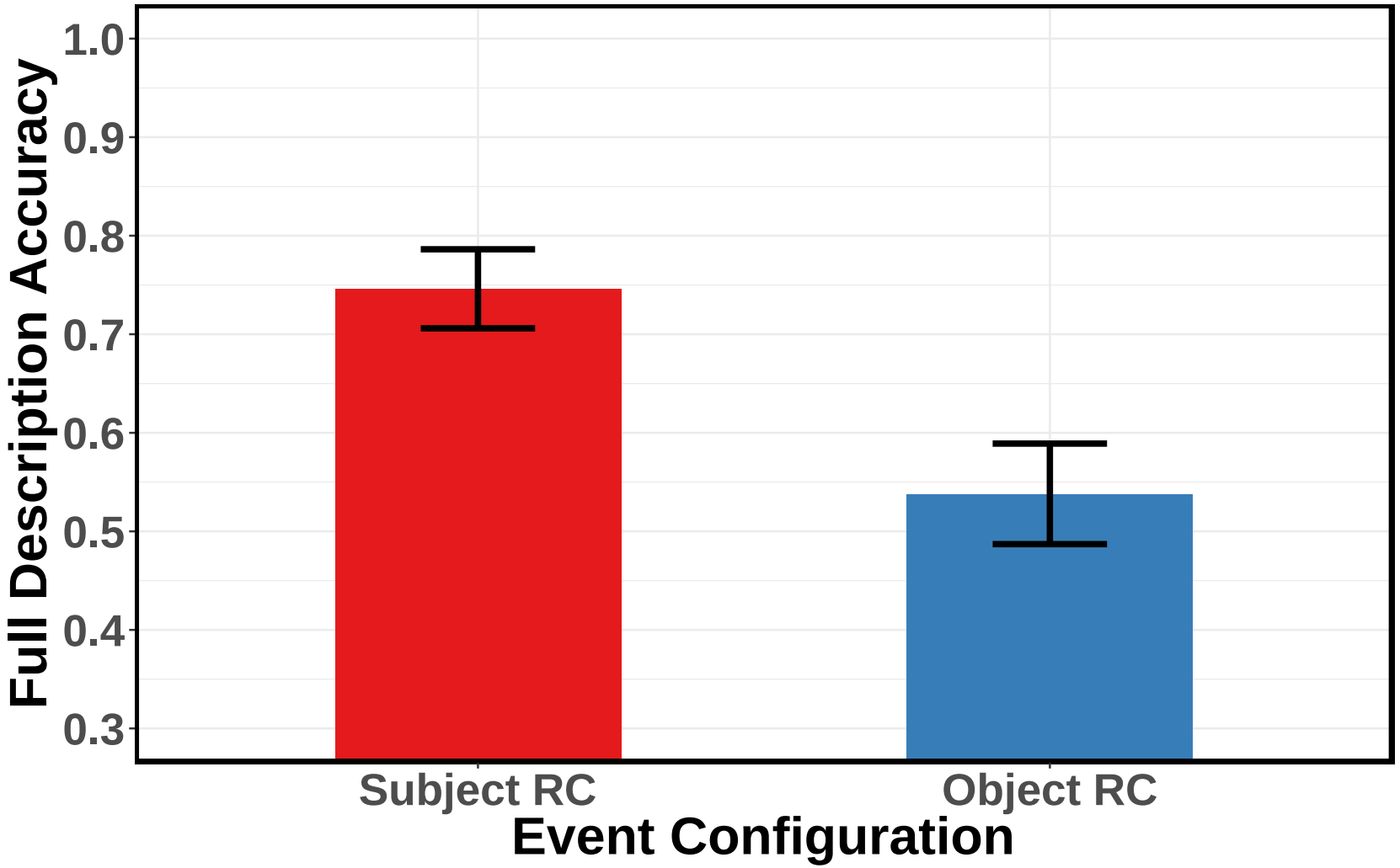


Object RC Event



RESULTS FOR EXPERIMENT 1

β = -1.1139, *SE* = 0.138, χ^2 = 33.82, *p* < .001



EXPERIMENT 2

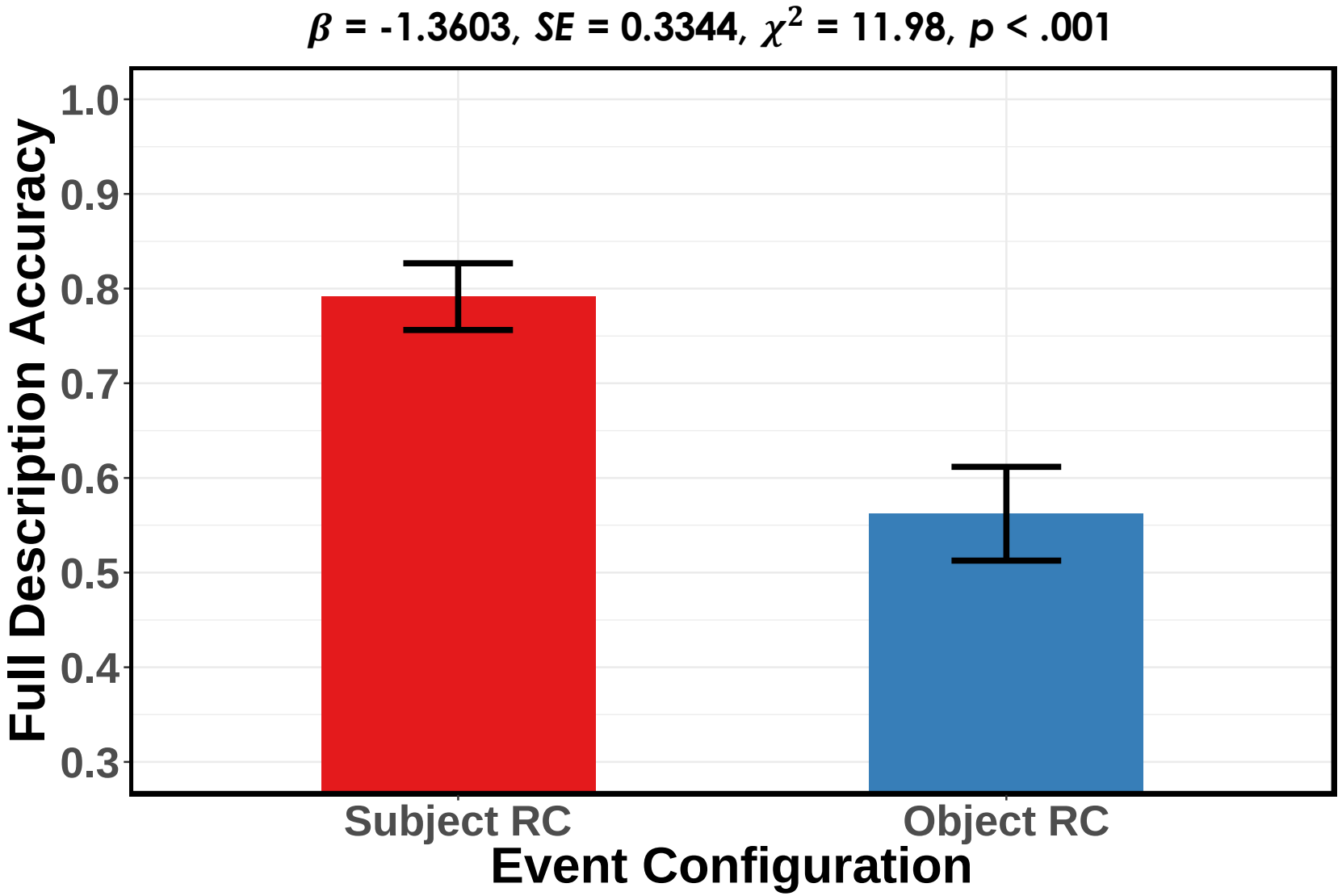
- The asymmetry could be due to difficulties in using an Object RC structure with animate referents

- English speakers show a preference for passive relatives when describing animate referents (e.g., Gennari, Mirković, & MacDonald, 2012)

- Identical to experiment 1, but the participants (*N*=20) produced either an Subject RC or passive relative at test.

- **The blue that was pushed by green pushed red**

RESULTS FOR EXPERIMENT 2



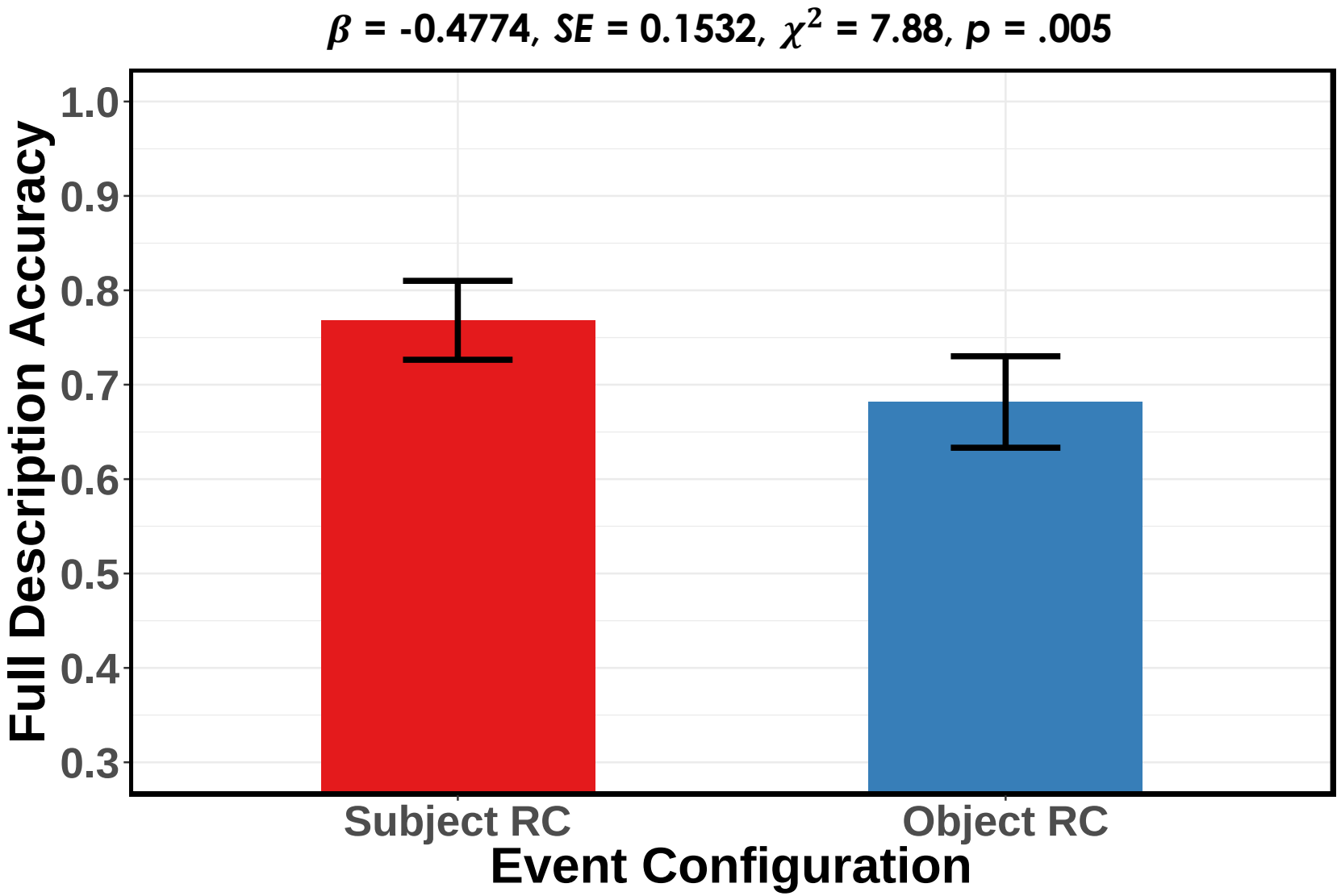
EXPERIMENT 3

- The test structures were different, so the results could still be due to linguistic factors

- Produced a simple active transitive sentence in both conditions
  - **Blue pushed Red**

- Participants (*N* = 20) were tested on only one of pushes alongside two foil objects in different colours.

RESULTS FOR EXPERIMENT 3



OUTSTANDING QUESTIONS

- Is this difference specific to agent consistency across the two events?
- Or would an overlapping patient show a similar effect?

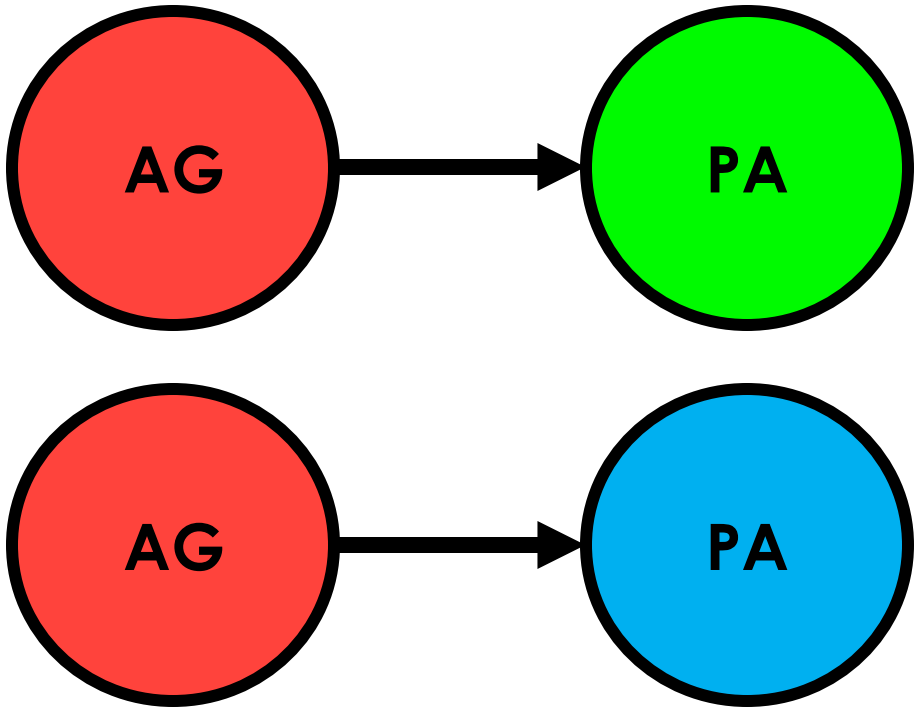
- Does thematic role consistency increase accuracy?
- Or does inconsistency reduce accuracy?

EXPERIMENTS 4-6

- Varied which target appeared in both events, and whether they played the same or different roles
  - **EXP 4:** Agent overlap
  - **EXP 5-6:** Patient overlap

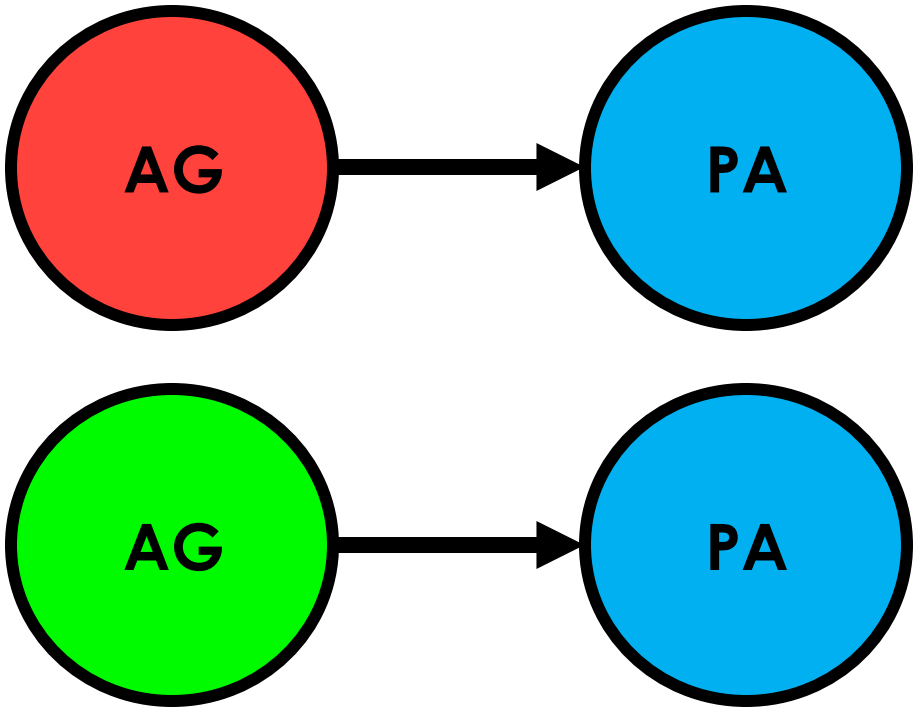
SAME ROLE CONDITION

Exp 4: Agent Overlap



RED IS AN AGENT TWICE

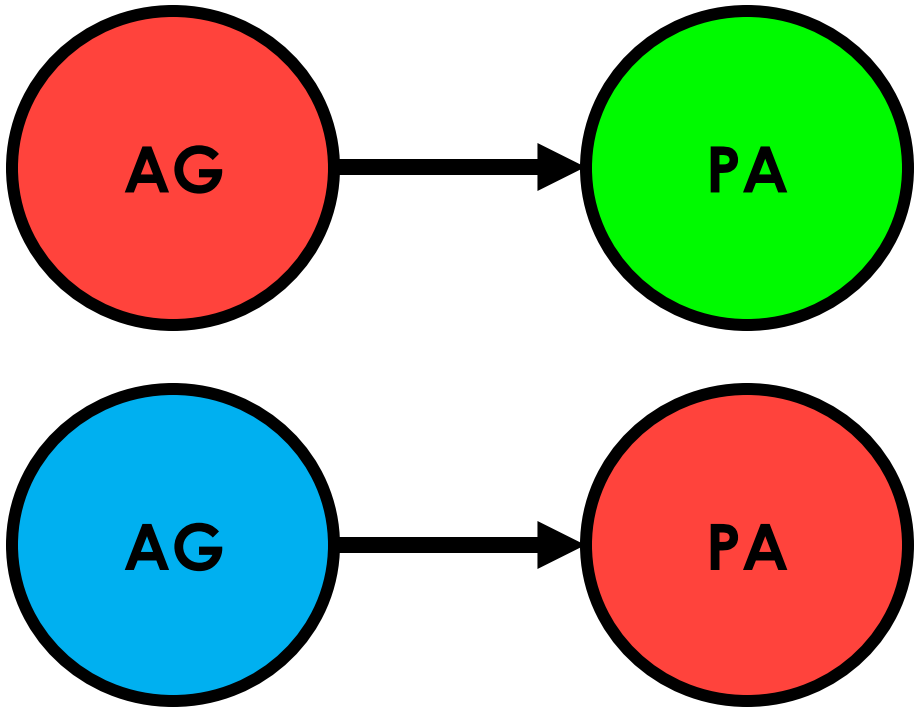
Exp 5-6: Patient Overlap



BLUE IS AN PATIENT TWICE

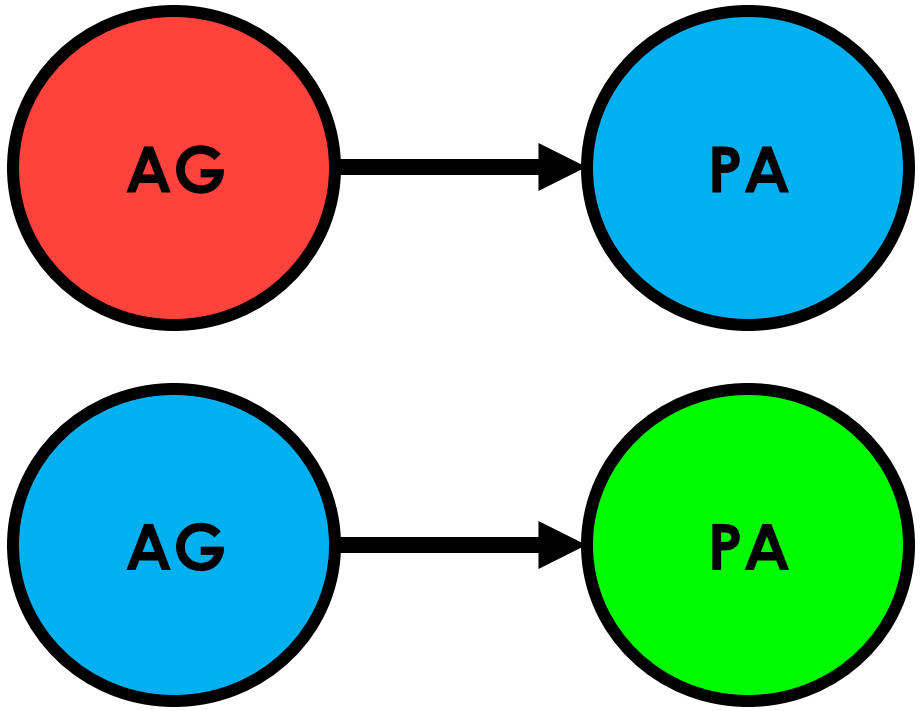
DIFFERENT ROLE CONDITION

Exp 4: Agent Overlap



RED IS AN AGENT → PATIENT

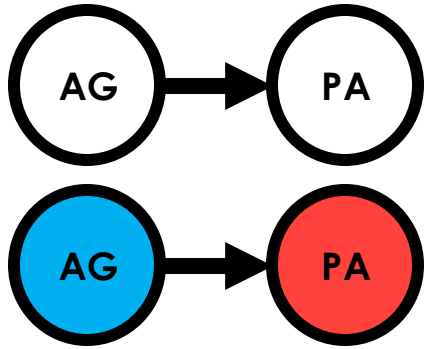
Exp 5-6: Patient Overlap



BLUE IS A PATIENT → AGENT

EXPERIMENTS 4-6

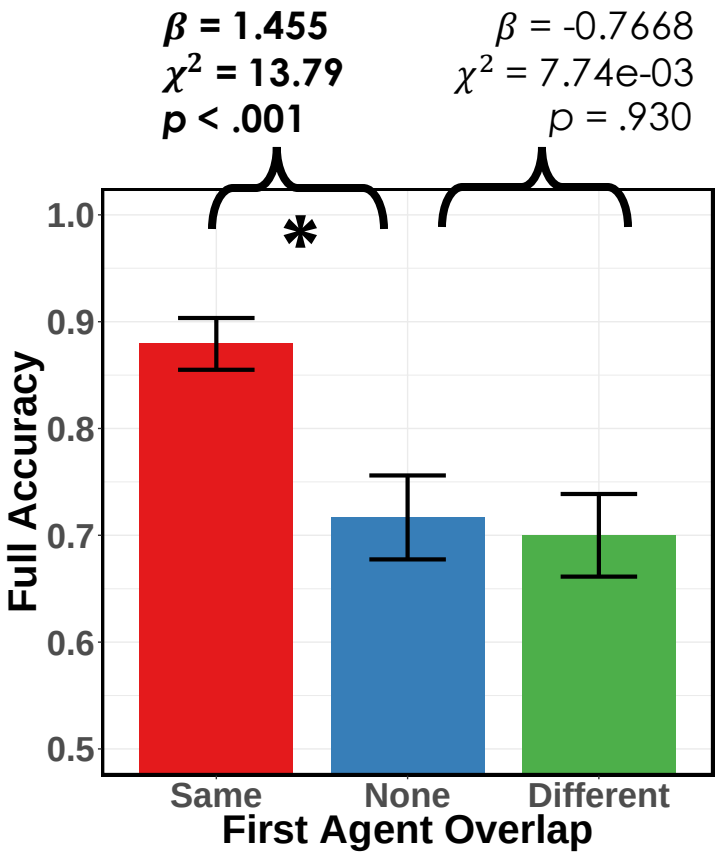
- Compared these overlap trials to a control condition with no overlapping circles between the pushes



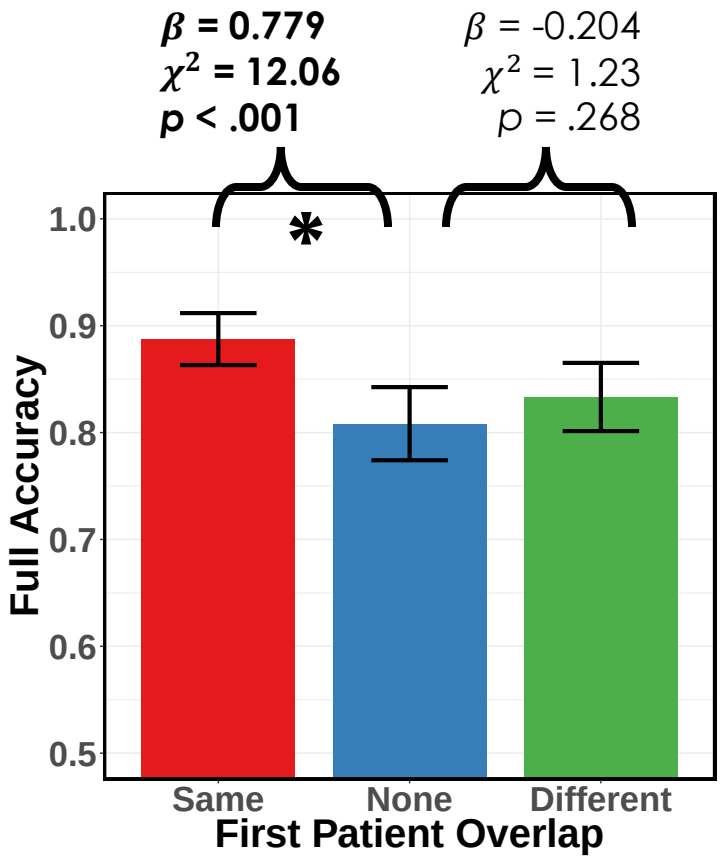
- All interactions were described with…
  - **EXP 4-5:** Active transitive
  - **EXP 6:** Passive transitive

RESULTS EXPERIMENTS 4-6

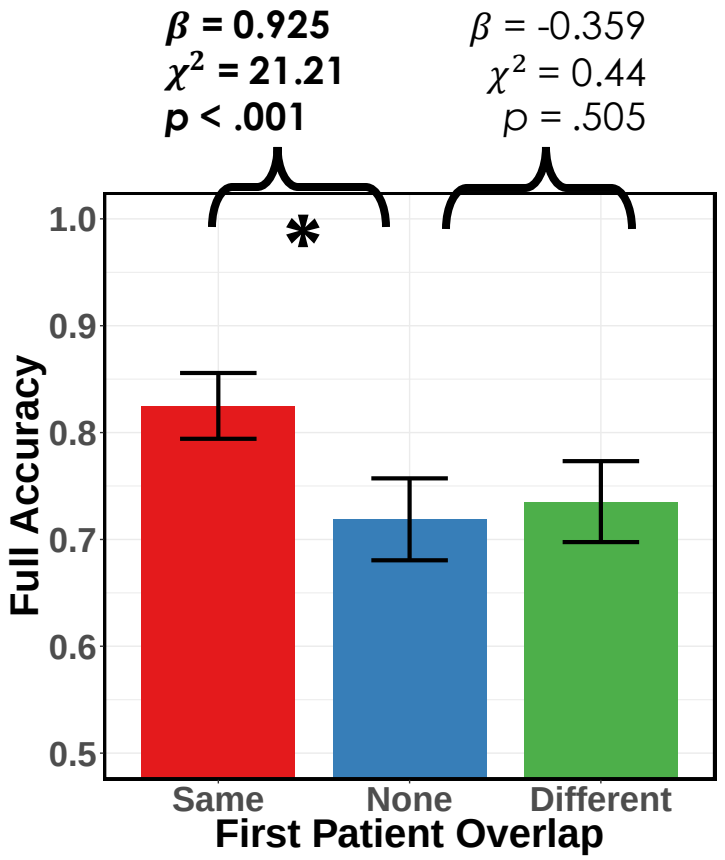
Experiment 4
Same: Agent overlap
Structure: Active Transitive



Experiment 5
Same: Patient overlap
Structure: Active Transitive



Experiment 6
Same: Patient overlap
Structure: Passive Transitive



RESULTS SUMMARY

- Higher production accuracy for visual events corresponding to Subject RCs than Object RCs using a range of different sentence structures (exp. 1-3)

- This appears to be due to thematic role consistency, as similar differences were observed in other event configurations (exp. 4-6)

- MOT task with identical circles and colour names as nouns – no useful cues to distinguish their roles

- Non-linguistic processes associated with tracking role-referent bindings may drive the Subject RC bias we observed (e.g., role consistency)

IMPLICATIONS

- Non-linguistic role-referent tracking may be an important contributor to the subject relative clause bias.

- Production-distribution-comprehension (MacDonald, 2013)
  - Role-referent consistency creates a production bias for Subject RCs
  - Production could create a bias in the input distribution
  - Input distribution is used to learn language representations

- Cross-linguistic preference for subject relative clauses
  - Even in languages which might be expected to have a bias for Object RCs (e.g., Chinese: Vasishth et al. 2013; Korean: Kwon et al. 2010)

IMPLICATIONS

- Vision and language are traditionally viewed as different modules (Fodor, 1983)

- Language production is affected by visual manipulations in a tracking task

- Statistical learning systems have trouble generalizing across role-referent bindings (Fodor & Pylyshyn, 1988)
  - A model trained with "John loves Mary" will not necessarily be able to produce "Mary loves John"
  - Models of production have incorporated variable bindings like those use in vision for tracking objects (Dual-path model, Chang, 2002)

- Powerful representations that originally evolved for vision might may play a central role in explaining the productivity of language