Interplay of episodic and semantic memory in repeat object reference

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Object-State Representation

• Successful sentence comprehension often involves tracking objects that undergo a change in state

  • *"The man will chop the tomato. And then he will smell the tomato."*

• Successful comprehension requires knowing that the tomato being smelled is the chopped tomato state

• Left IFG is implicated in selecting between competing **episodic** state representations of the object before and after change (Hindy et al., 2012)

Bottom-up interference

• Local Coherence Effects (Tabor et al., 2007)

  • Bottom-up information that is incoherent in the full context is still activated during reading

• Repeated Name Penalty (Gordon, 1998; Almor, 2004)

  • Accounts claim that processing difficulty when reading repeated noun phrases arises from readers erroneously introducing a new entity into the discourse

"The man will chop the tomato. And then he will smell the tomato."

• The repeated full noun phrase may activate generic knowledge about tomatoes (including their intact form) purely bottom-up. This generic knowledge may compete with the current episodic chopped form.

"The man will chop the tomato. And then he will smell it."

• The pronoun can only (re)activate the antecedent and not generic knowledge. Hence any competition must be between the episodic intact and chopped forms.

Questions

1. Are bottom-up effects the sole contributor to previous findings of competition between object-states

2. How does language which exclusively taps into episodic representations of objects, compared to episodic and semantic representations, influence the processing of events

ROI Selection

LIFG: anatomically defined as the anterior IFS, BA45, and BA45

Stroop: each subject's top 10% of voxels highest t-values for Conflict-Neutral trials within the LIFG mask
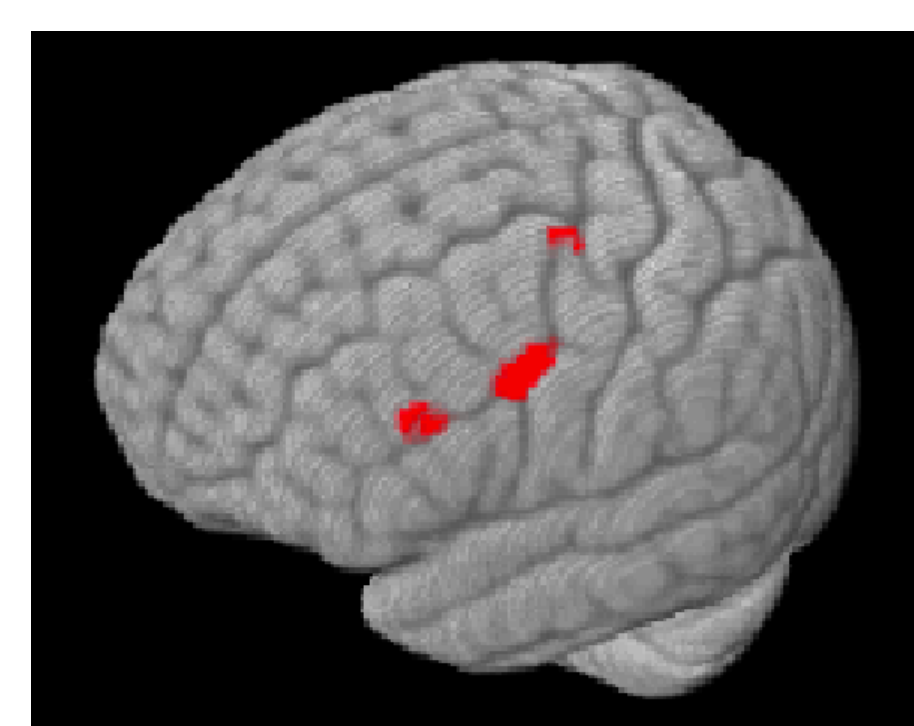
Conflict-Neutral trials ; p < .001

Stimuli

Repeated Noun, Minimal Change

The man will weigh the tomato. And then he will smell the tomato.

Repeated Noun, Substantial Change

The man will chop the tomato. And then he will smell the tomato.
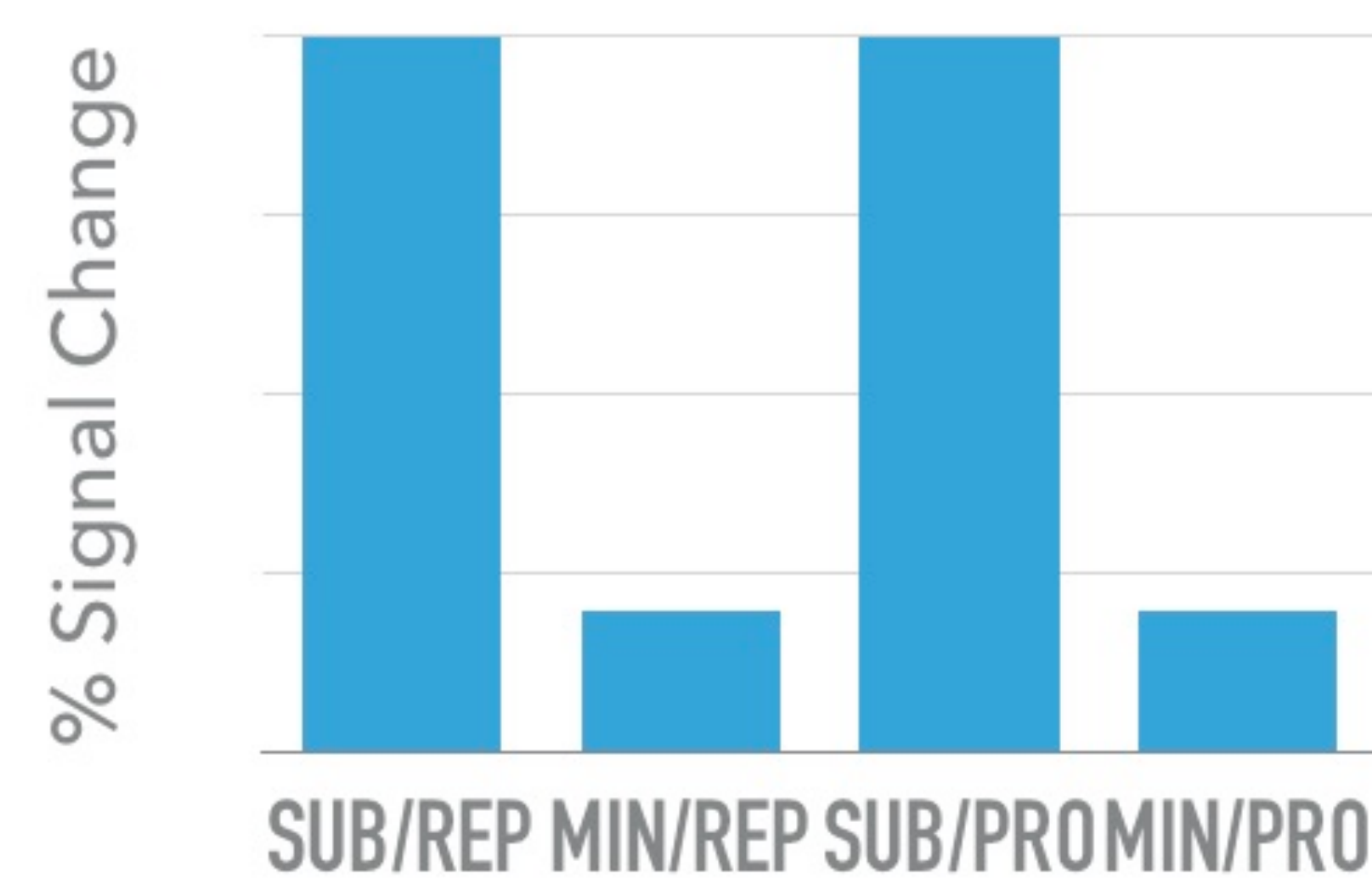
Pronoun, Minimal Change

The man will weigh the tomato. And then he will smell it.

Pronoun, Substantial Change

The man will chop the tomato. And then he will smell it.

Predictions

• **Intersecting Object Histories (Altmann & Ekves, 2019)**

  ○ Competition arises between **episodic** representations of the object before and after change

  ○ Increased activation for substantial over minimal change for both repeated nouns (e.g. Hindy et al., 2012) and pronouns

• **Bottom-up Accounts**

  ○ Competition arises between the **episodic** representation and activation of an object's canonical, **semantic** form

  ○ Increased activation for substantial over minimal change for repeated nouns but not pronouns (no canonical form of "it")


Methods

Participants: 18 right-handed, native English speakers

Functional Acquisition: 100 experimental trials across 5 runs (15 catch trials), each trial consisted of two 3 second sentence presentations, optimized jittered fixation between trials
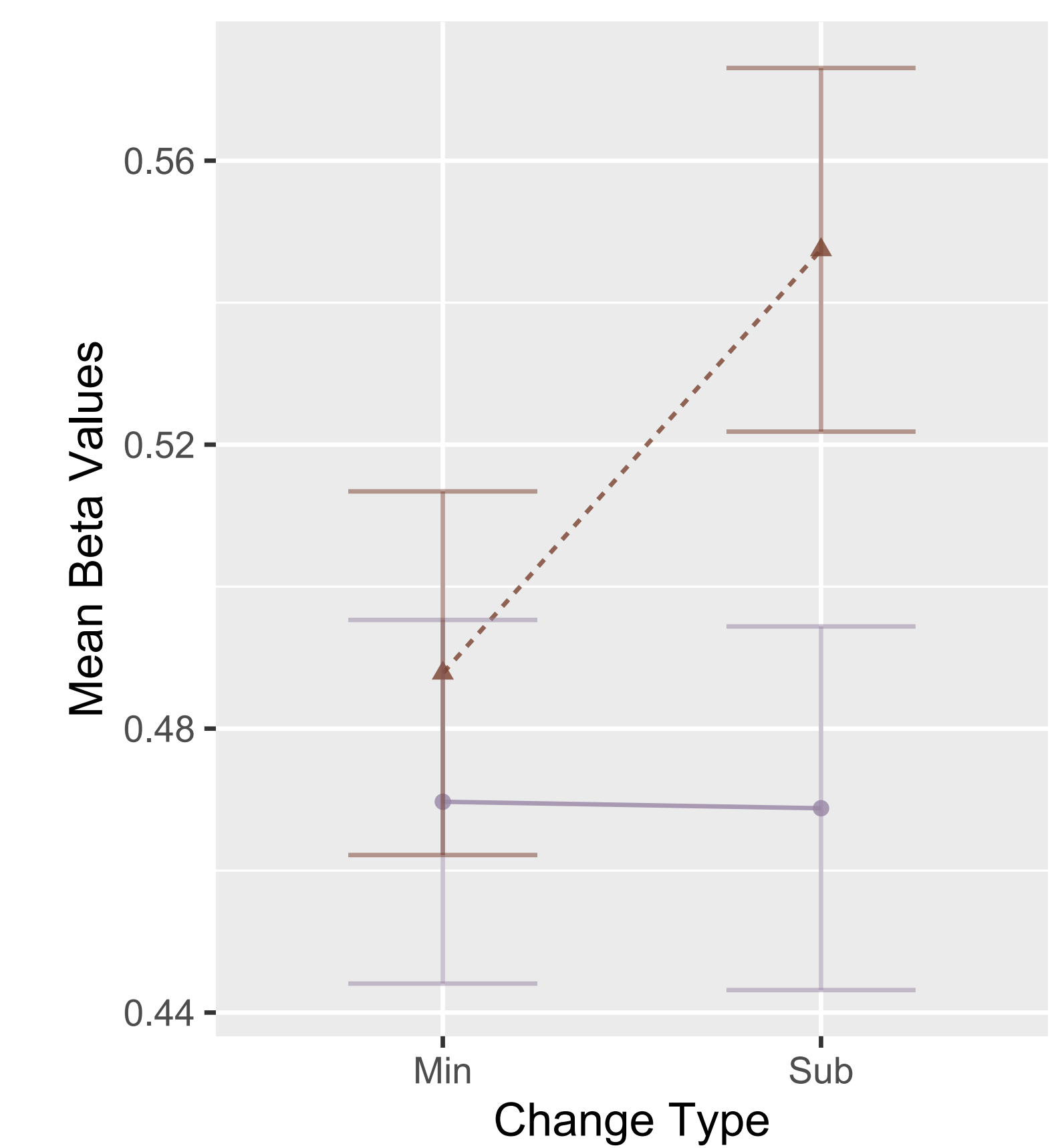
Functional Analysis: default fMRIPrep preprocessing (Esteban et al., 2018), first- and second-level analysis conducted in AFNI (Cox, 1996), each trial type modeled as a 6 second block, REML estimation, nuisance regressors: AAC0-5, FD, rotations and translations

Results
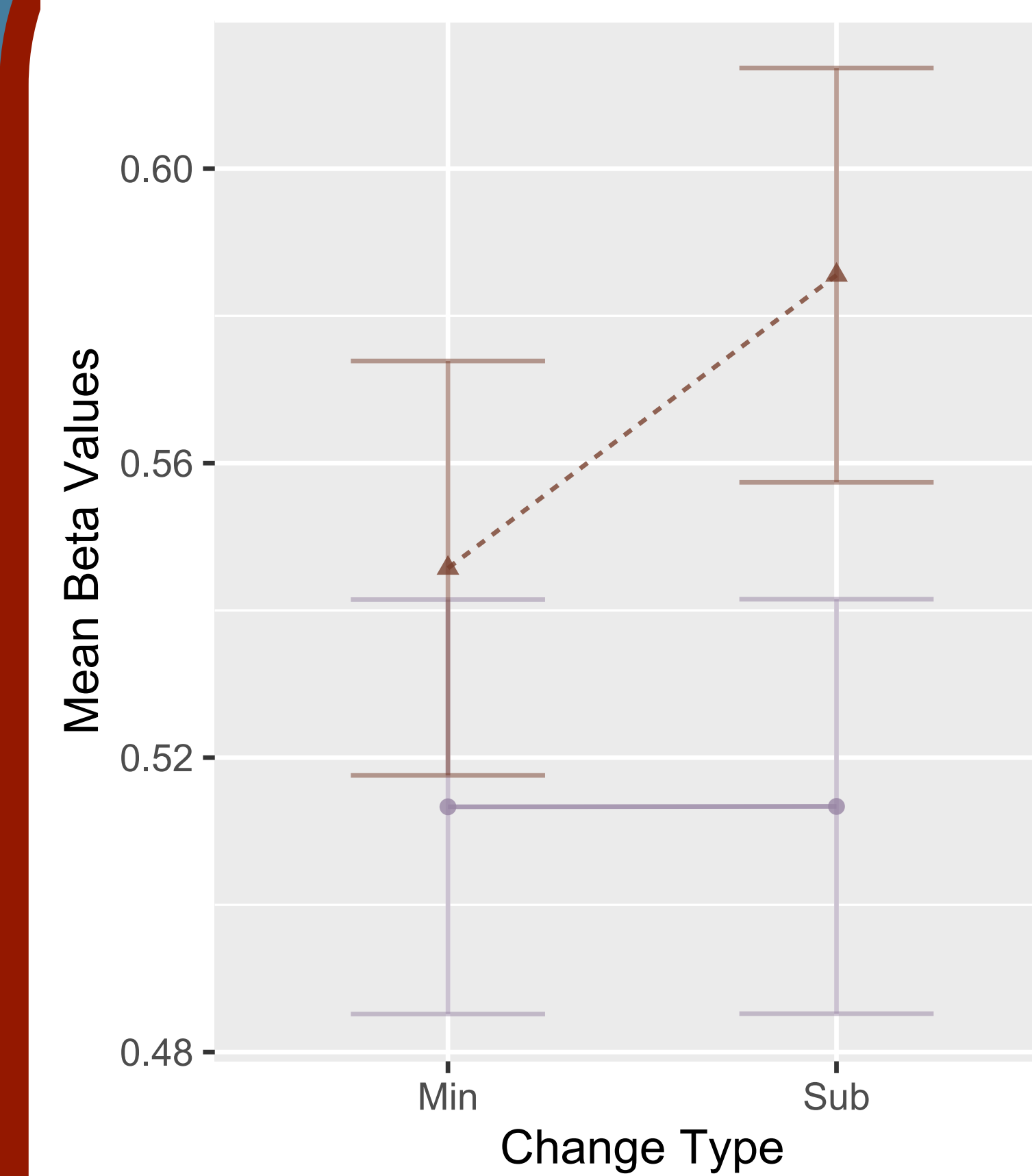
Error Bars: FLSD

Stroop Voxels

• "chop" - "weigh… the onion": p=.99

• "chop" - "weigh… it": p=.16

LIFG Voxels

• "chop" - "weigh… the onion": p=.97

• **"chop" - "weigh… it": p=.02**

Whole Brain

• Yellow Cluster: "chop… it" - "chop… the onion"

• Blue Cluster: Stroop Conflict - Neutral trials

• Significant with cluster based correction
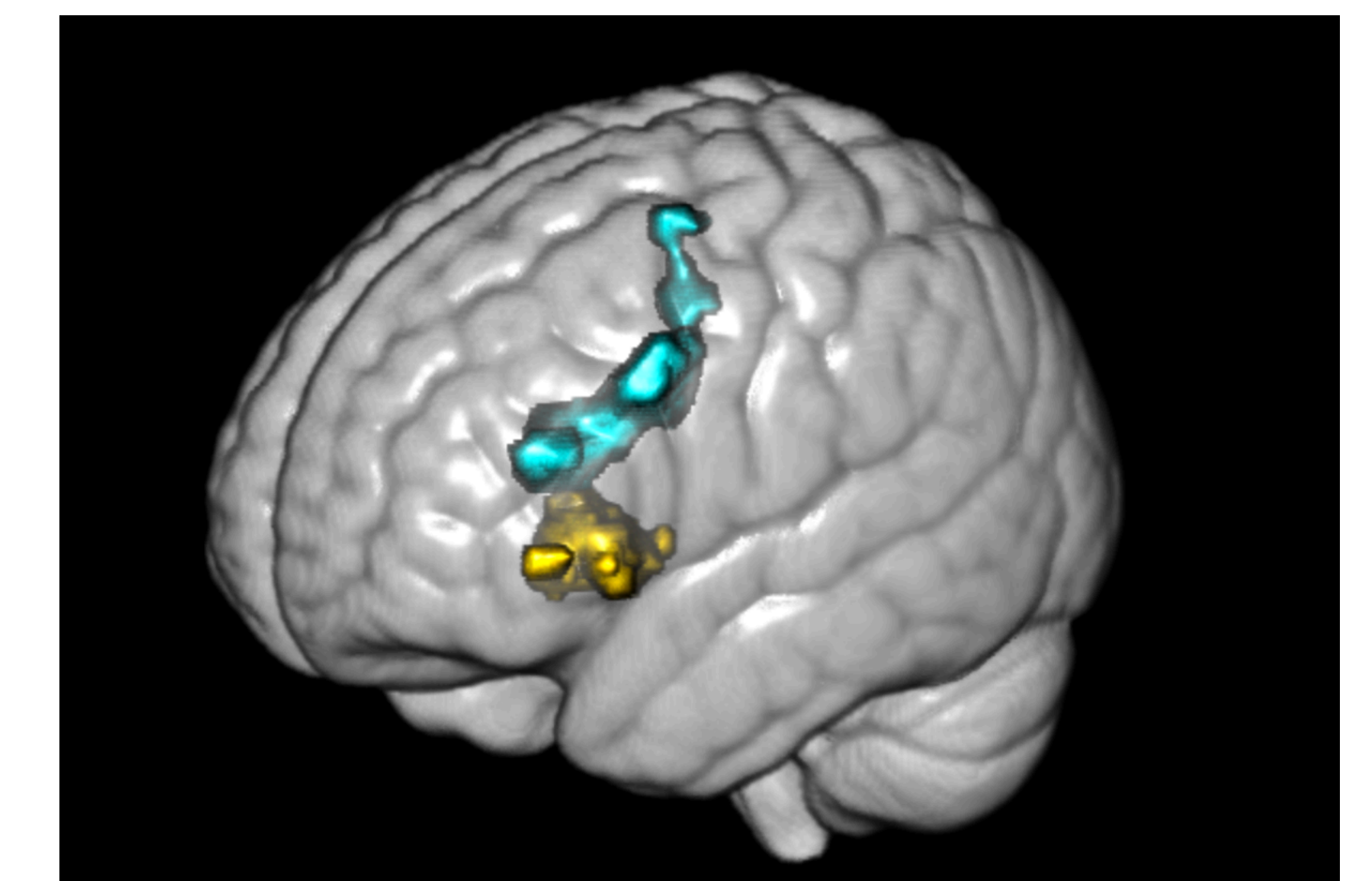
Discussion

Activation increases primarily observed in pronoun reference to changed objects

• Consistent with an account of competition between different episodic states of a token

• Although Stroop voxels pattern similarly, the effect seems to be driven primarily by other voxels within LIFG, consistent with accounts of functional distinctions within LIFG (e.g. Badre & Wagner, 2007)

No state change effects observed for repeated noun conditions (e.g. Hindy et al. 2012)

• Introduction of pronoun conditions introduce additional inficility for repeated nouns and possibly attenuate a state-change effect

Summary

The effects shown here support an account of event comprehension in which the trajectory of an object's changes in state are maintained and compete for selection when subsequently referred to, and show that previously observed state-change effects are not solely driven by bottom-up, semantic activation during reading.

Future Work

• Explore the contribution of hippocampus in tracking object change over time, especially w.r.t. subfield specialization

• Examine the degree to which the competition effects observed here are specific to language or more general cognition

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