The syntax-to-semantics mapping in real-time language production: A view from psych verbs

Monica L. Do (monicado@sas.upenn.edu)

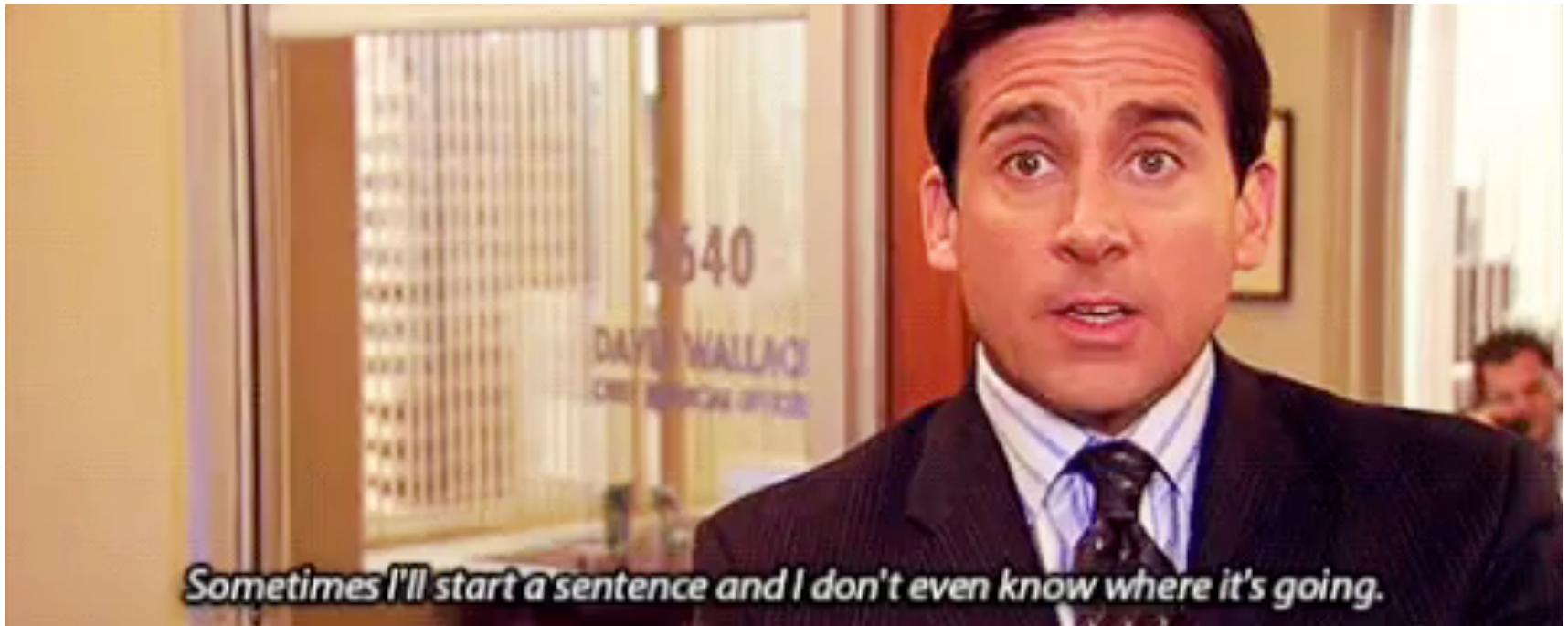**Elsi Kaiser (emkaiser@usc.edu)**

LSA 2019

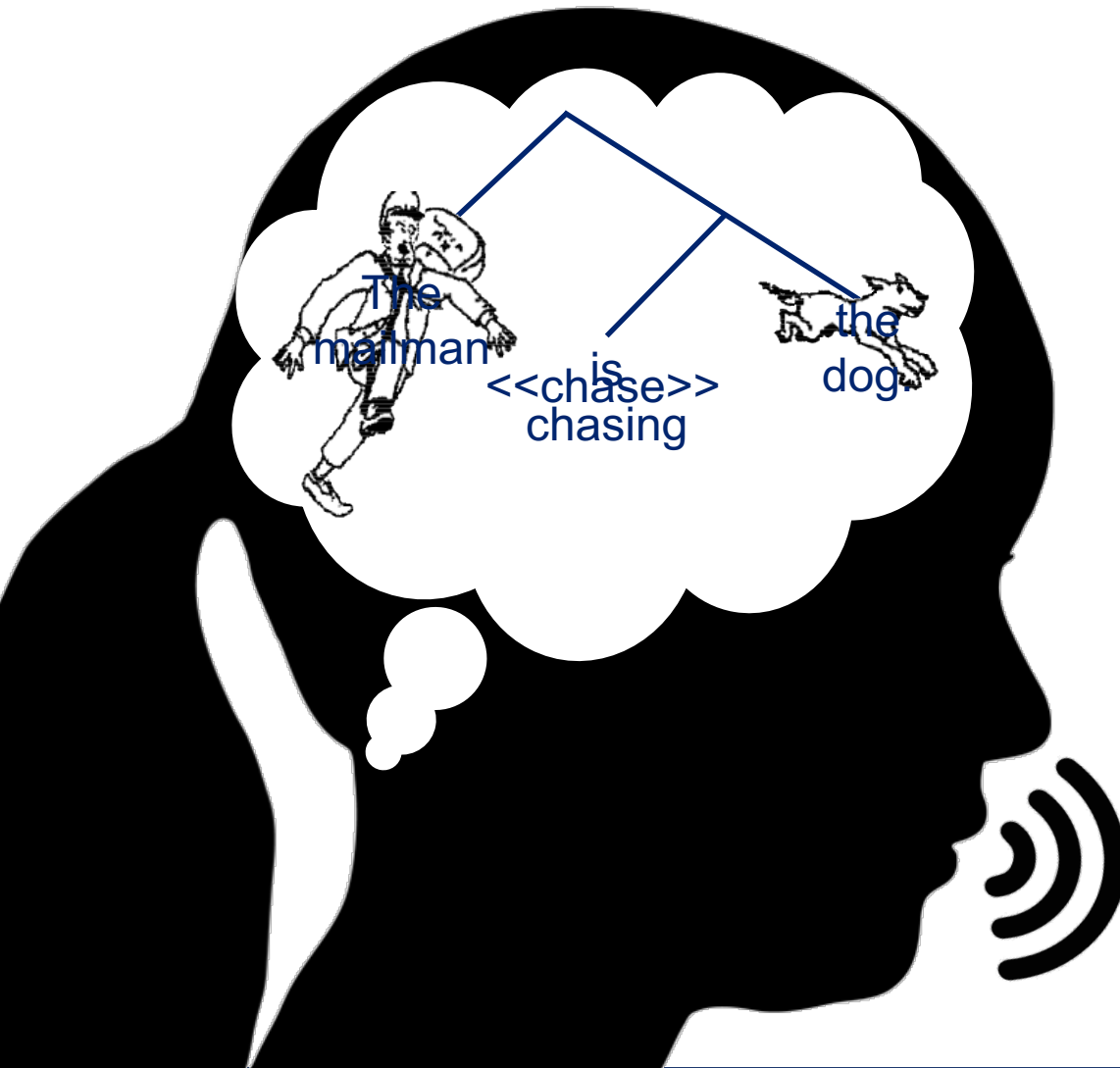**January 6, 2019**

UNIVERSITY of PENNSYLVANIA

How does production work?

- **Production is Incremental:** Only some parts of our sentences are planned before speaking. The rest is planned on the fly!! [1]

Sometimes I'll start a sentence and I don't even know where it's going.

[1] Levelt, 1989

How does production work?
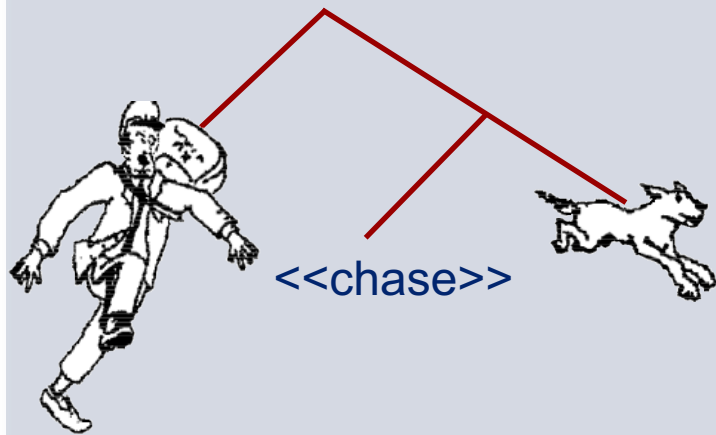
Production is Multi-Stage:[1]

[1] Levelt, 1989

How does linguistic encoding work?

- **Encoding is hierarchical:** We ***do not*** encode our messages simply following the linear word order of the sentence[1]

- **What kind of hierarchical structure do we use to linguistically encode our sentences?**
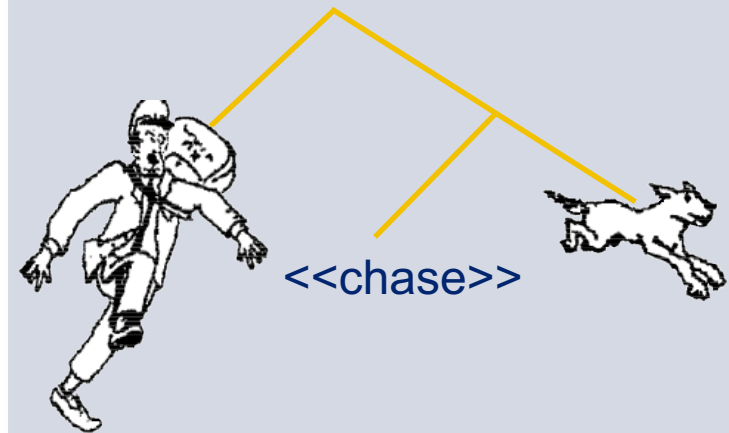
Syntactic Structure

<<chase>>

Start with the SUBJECT of the sentence

BUT:
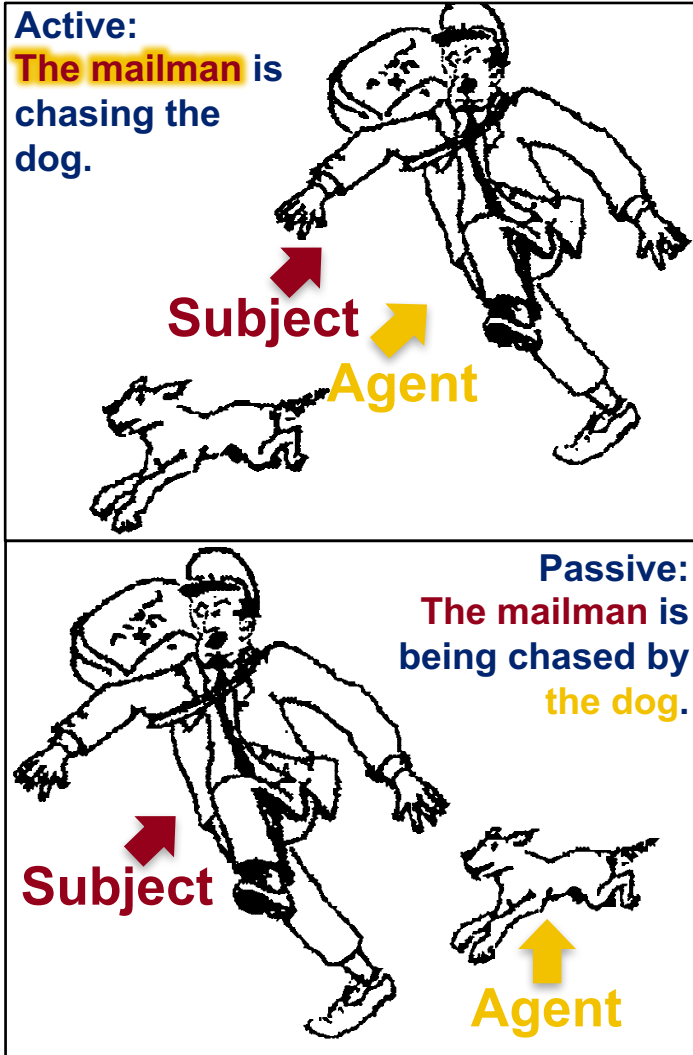In active sentences, these accounts make the same predictions

Thematic Structure

<<chase>>

Start with the AGENT of the sentence

[1] Do & Kaiser, 2018, *JML;* Griffin and Bock, 2000; Lee et al., 2014

One Potential Solution: Passives

Active:
The mailman is chasing the dog.

Subject
Agent

Passive:
The mailman is being chased by the dog.

Subject
Agent

- **Griffin and Bock, 2000:** Passives separate syntactic from thematic hierarchy
  - See-and-describe
  - Visual world eye-tracking
- **Subjecthood is privileged:**
  - Participants look to subject first, even if it's not the agent.

- **BUT, other factors may 'boost' subjecthood effect**
  - Subjects always human[1]
  - Unclear when agent of optional by-phrases planned[2]

[1] Clark & Begun, 1971 [2] Thompson and Lee, 2009

The Question

What kind of hierarchical structure do we use to linguistically encode our sentences?

Does encoding begin with

the most **syntactically prominent** element (**Subject**)

or

the most **thematically prominent** element (**Agent**)

of a sentence?

Our Solution: Pysch(ological State) Verbs

Experiencer-Stimulus

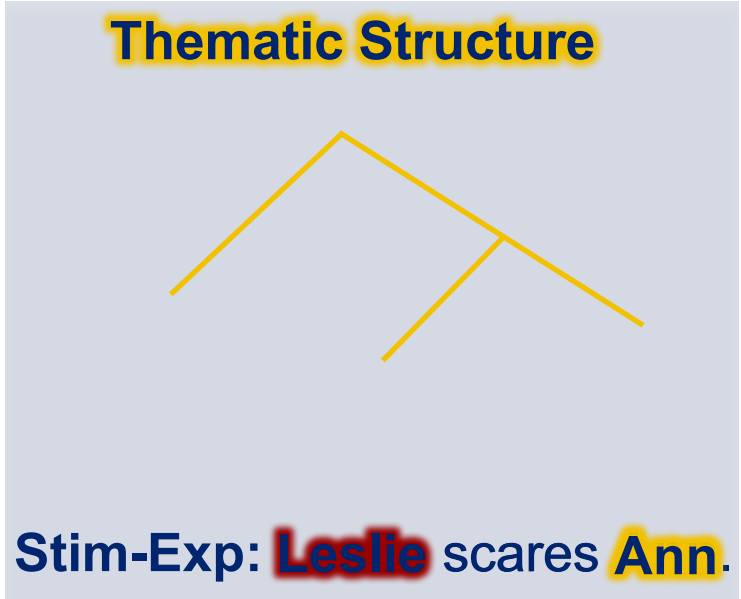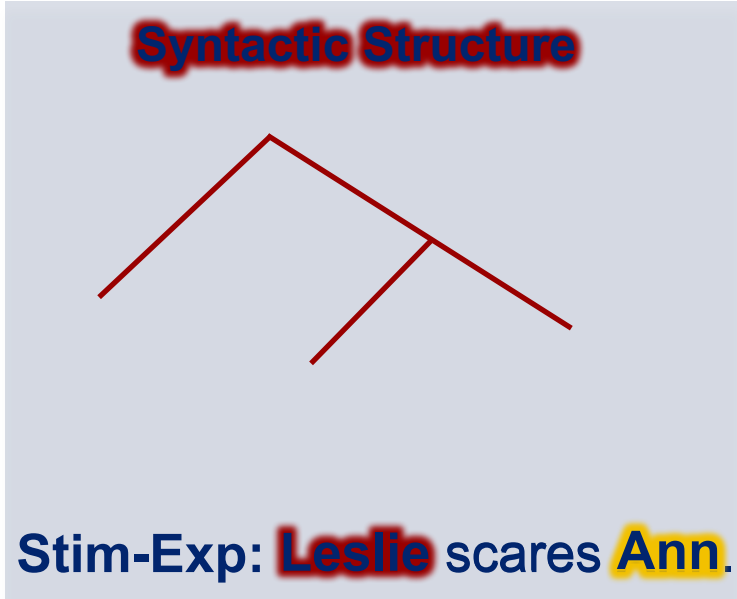- **Loves**
- **Hates**
- **Fears**
- **Adores**

…

Stimulus-Experiencer

- **Amazes**
- **Scares**
- **Frustrates**
- **Confuses**

…

Our Solution: Psych(ological State) Verbs

- Syntactically, the same surface form

  Exp-Stim: Leslie loves   Ann.

  Stim-Exp: Leslie scares **Ann**.

- Thematically, Experiencers more prominent than Stimulus in standard thematic hierarchies[1]

Thematic Hierarchy

Agent

Experiencer

Sources
Goals
Locatives
Instruments
Stimulus

Patient

Syntactic Structure

Stim-Exp: Leslie scares **Ann**.

Thematic Structure

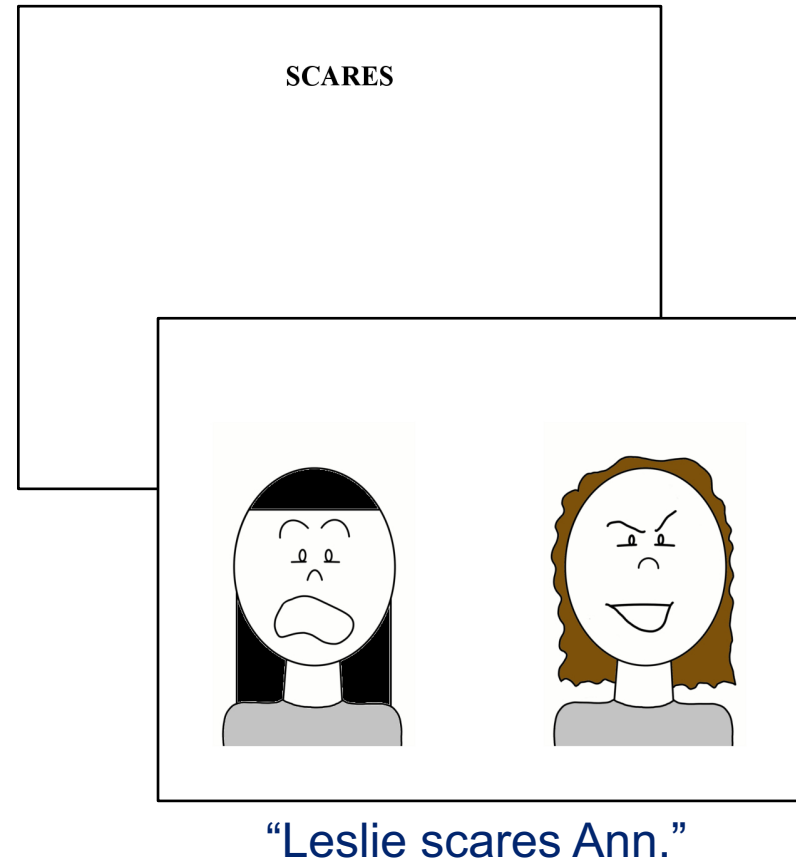**Stim-Exp: Leslie** scares **Ann**.

[1] Grimshaw, 1980; Jackendoff, 1987; Belletti & Rizzi, 1988

Why Psych(ological State) Verbs?

1. **These verbs are rarely investigated experimentally:** We want to extend prior psycholinguistic work beyond the Agt-Pat structure

2. **They provide a different way to tap into how linguistic encoding unfolds:** We want a minimal contrast that teases apart the most **syntactically prominent** element (**Subject**) from the most **thematically prominent** element (**Experiencer**) of a sentence.

Psych Verbs: Methods & Design

- **'See-and-Describe'**:
  1. Trained on names of characters
  2. See a verb prompt
  3. See a critical image
  4. Participants (n=34) **produce** sentence about the image using verb

- **3 Verb Types * 8 trials each**
  - **Experiencer-Stimulus:** e.g. *loves*
  - **Stimulus-Experiencer:** e.g. *scares*
  - **Agent-Patient:** e.g. *confronts*

- **We analyzed (i)** speech onset times, and (ii) eye-movements to subject during encoding (400-1000ms after image)

- **3 post-experiment questionnaires:** Image clarity, Visual salience, Autism Spectrum Quotient

SCARES

"Leslie scares Ann."

Hypotheses & Predictions

Does encoding begin with the most syntactically prominent or thematically prominent element?			
	Agt-Pat **Leslie** confronts Ann.	**Exp-Stim** **Leslie** fears Ann.	**Stim-Exp** **Leslie** scares **Ann.**
Syntactic: Subject			
Thematic: Agt/Exp			
Multi-Factorial Both things important			

Psych Verbs: Speech Onset Times
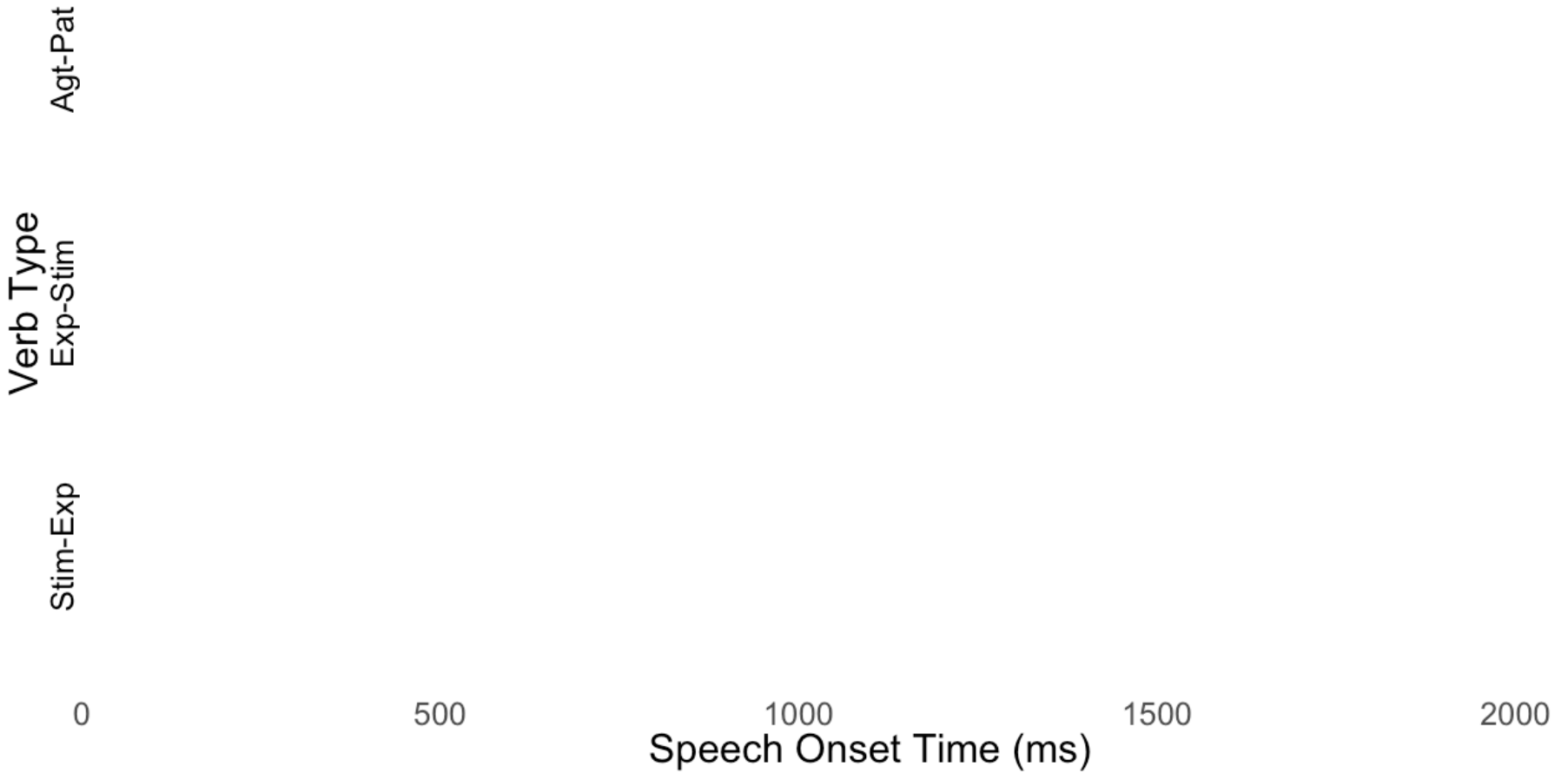
Psych Verbs: Eye-movements

1. **Patterns before and after SPEECH ONSET**

   - **Not theoretically relevant** to hypotheses about **linguistic encoding, which happens well-before speaking**
   - **Just checking:** Do eye-movements make sense based on prior work?

2. **Patterns immediately after IMAGE APPEARS**

   - **This tells us about how linguistic encoding unfolds**

Psych Verbs: The "sanity check"

Agt-Pat: Leslie confronts Ann.   **Exp-Stim:** Leslie loves Ann.   **Stim-Exp:** Leslie scares Ann.

Psych Verbs: Eye-movements

1. **Patterns before and after SPEECH ONSET**

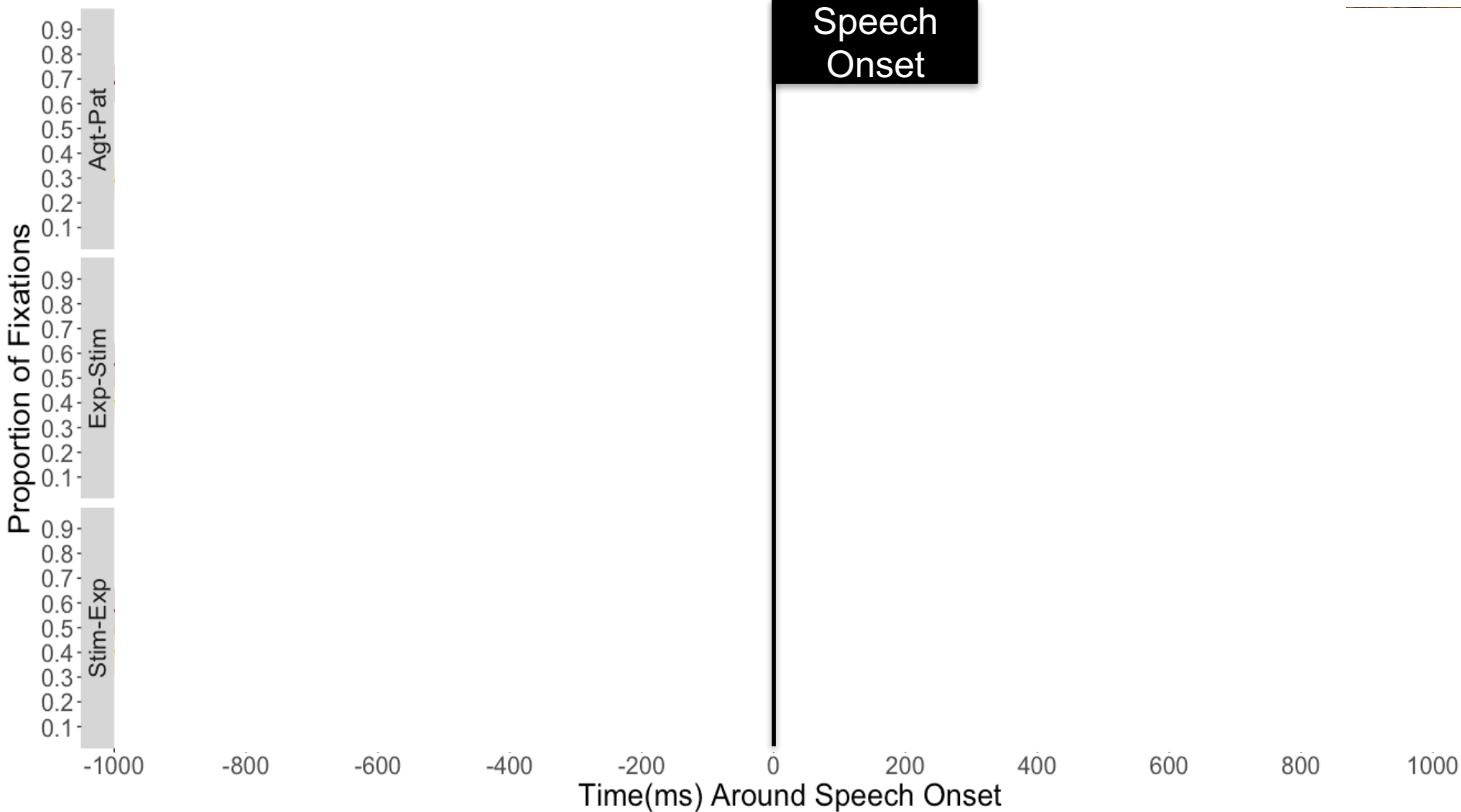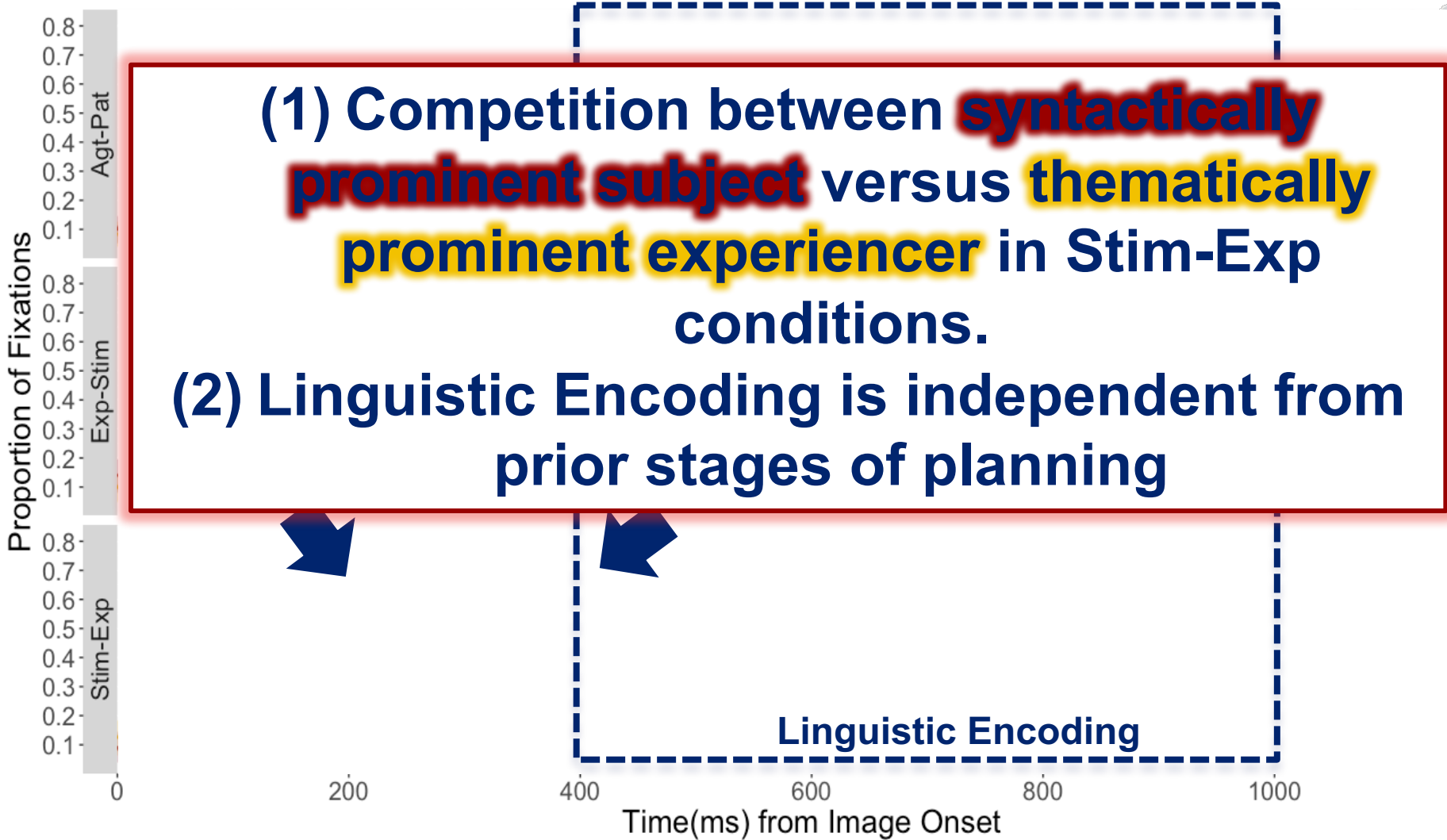   - **Not theoretically relevant** to hypotheses about **linguistic encoding, which happens well-before speaking**
    - **Just checking:** Do eye-movements make sense based on prior work?

2. **Patterns immediately after IMAGE APPEARS**

    - **This tells us about how linguistic encoding unfolds**

Psych Verbs: Eye-Movements @ Encoding

Agt-Pat: Leslie confronts Ann.   **Exp-Stim:** Leslie loves Ann.   **Stim-Exp:** Leslie scares Ann.

(1) Competition between syntactically prominent subject versus thematically prominent experiencer in Stim-Exp conditions.

(2) Linguistic Encoding is independent from prior stages of planning

Linguistic Encoding

Time(ms) from Image Onset

Hypotheses & Predictions

Does encoding begin with the most syntactically prominent or thematically prominent element?			
	Agt-Pat Leslie confronts Ann.	**Exp-Stim** Leslie fears Ann.	**Stim-Exp** Leslie scares Ann.
Syntactic: Subject	**Subject** Leslie	**Subject** Leslie	**Subject** Leslie
Thematic: Agt/Exp	**Subject** Leslie	**Subject** Leslie	**Object** Ann
Multi-Factorial Both things important	**Subject** Leslie	**Subject** Leslie	**Both things have to align!**

Psych Verbs: What did we find?

1. **Psych verbs, as a class, are not categorically more difficult to plan** for production than Agent-Patient verbs.

    - Exp-Stim and Stim-Exp do not show the same data patterns

2. **Linguistic encoding is driven by <u>alignment</u>** of syntactic to thematic prominence – not by syntax alone

    - Slower speech onsets & prolonged competition between looks to subject & object in Stim-Exp conditions

3. **Message Conceptualization and Linguistic Encoding are separate processes** in production

    - Eye-movements before during message conceptualization did not predict movements during encoding
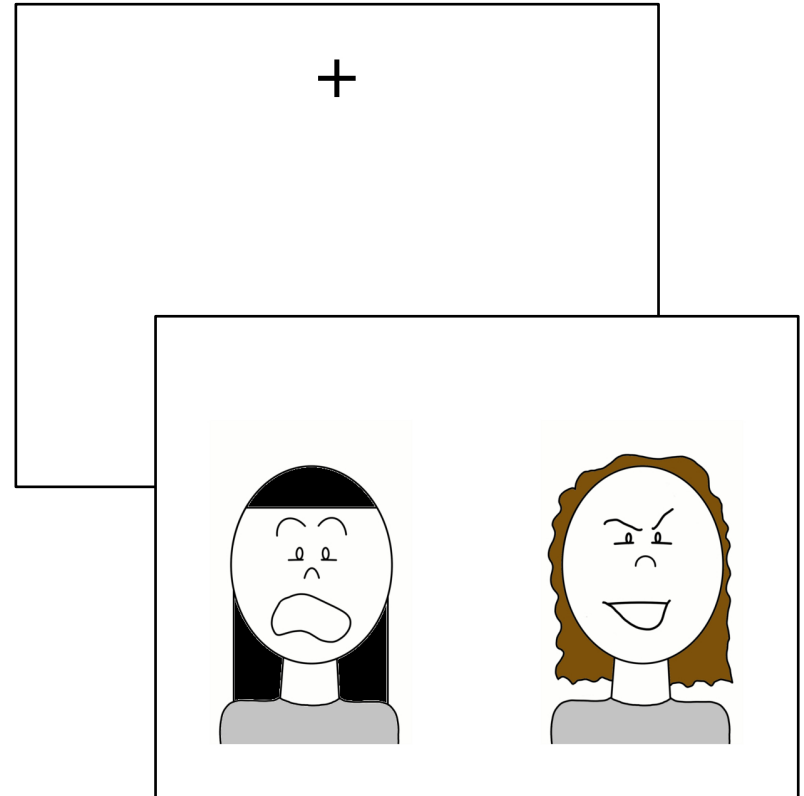
But how much of our effects were visually driven?

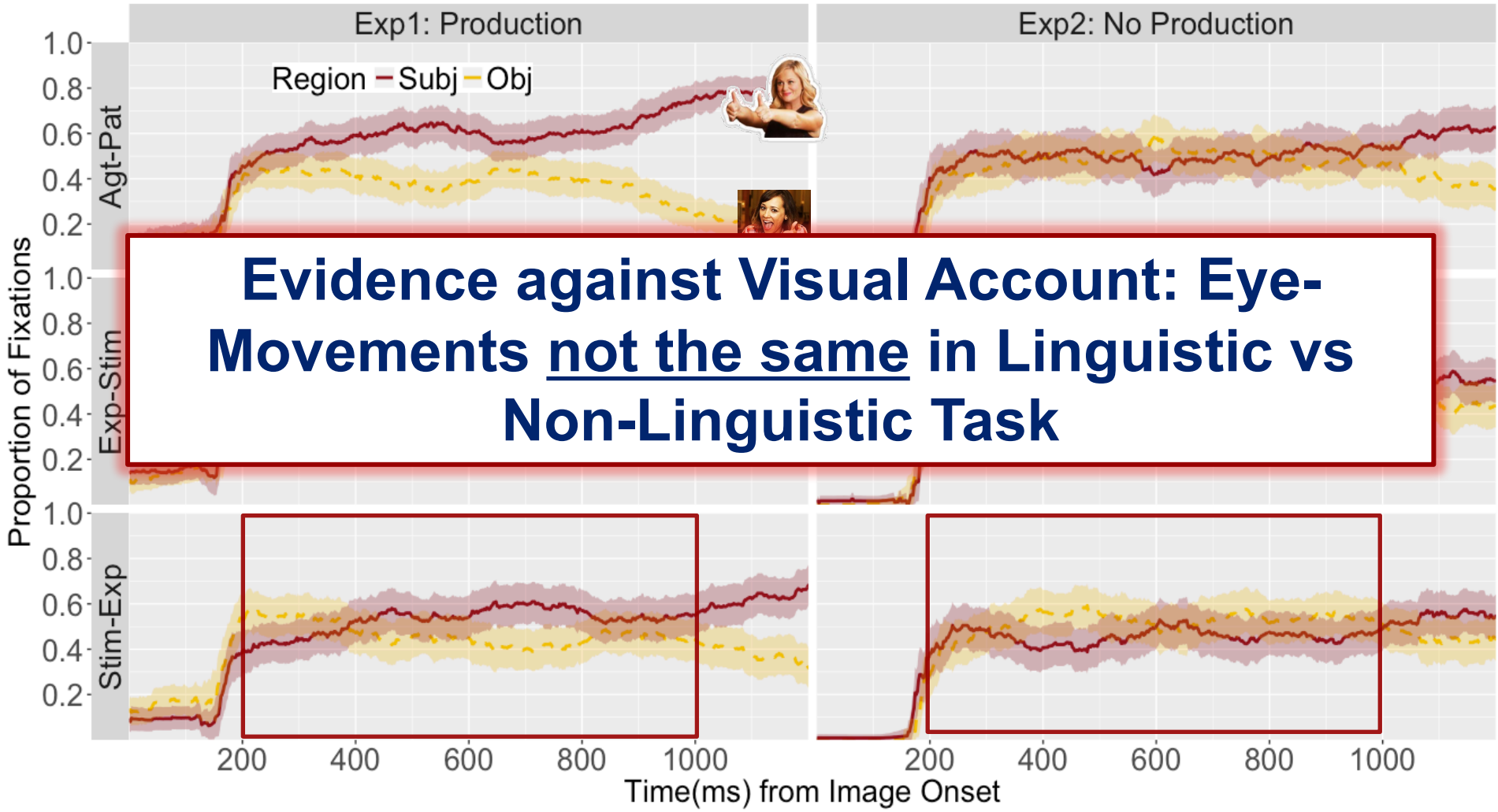# Experiment 2: Are results in Experiment 1 visually driven (rather than linguistic)?

- **Goal: Make sure that** results for Stim-Exp verbs in Exp 1 due to **misalignment** between syntactic and thematic prominence, *not*
  - Interpretability (codeability) of images, and/or
  - Wonkiness of some facial expressions

- **Prediction:** If Exp1 results were visually driven, early eye-movements when there is **no linguistic task** should be the same as when preparing to produce a sentence

Exp2. Non-Linguistic Task: Methods & Design

- **'Picture Inspection'**:
  1. Fixation Cross
  2. Participants (n=18) inspected images for sense of 'quality' and 'content'
  3. **No sentence production**

- **Same images as Exp1**
  - To ensure participants attend to images, randomly interspersed rating task

- **Across verb types, measured:**
  - Proportion of looks to subject

- **2 post-experiment questionnaires:**
  1. Visual Salience
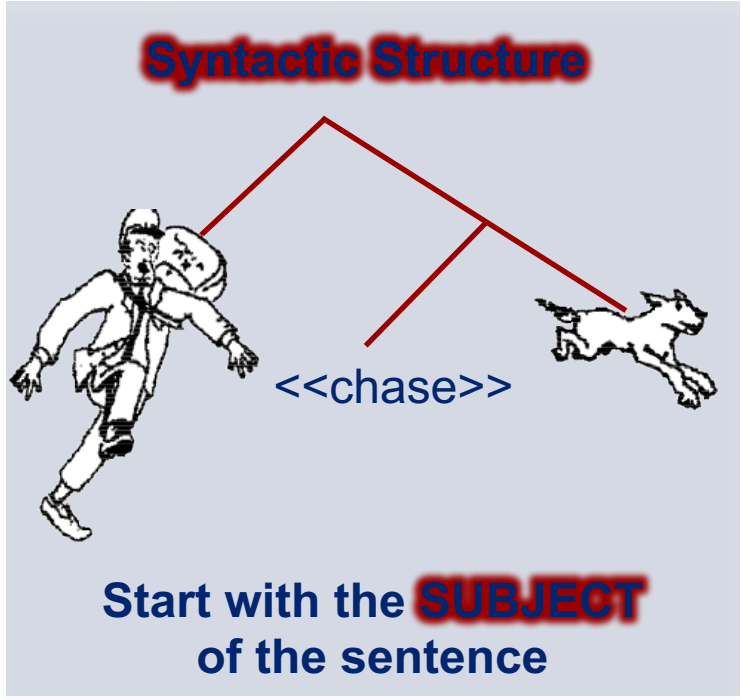 2. Autism Spectrum Quotient

Picture Inspection: Eye-Movements in Exp2

Evidence against Visual Account: Eye-Movements <u>not the same</u> in Linguistic vs Non-Linguistic Task

How does linguistic encoding work?

- **What kind of hierarchical structure do we use to linguistically encode our sentences?**

Syntactic Structure

<<chase>>

Start with the SUBJECT of the sentence

BUT:
In active sentences, these accounts make the same predictions

Thematic Structure

<<chase>>

Start with the AGENT of the sentence
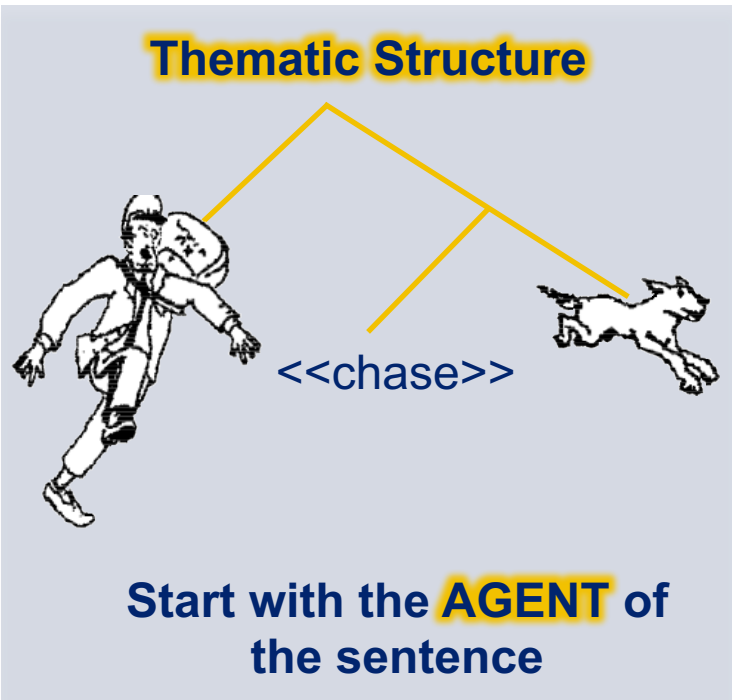
[1] Do & Kaiser, 2018, *JML;* Griffin and Bock, 2000; Lee et al., 2014

How does linguistic encoding work?

- **What kind of hierarchical structure do we use to linguistically encode our sentences?**

- **Exp1: <u>Alignment</u> of syntactic-to-thematic structures (not just one structure) matters:** When these hierarchies are not aligned, linguistic encoding is delayed.
  - Only Stim-Exp (mismatched) verbs showed slower speech onset
  - Only Stim-Exp (mismatched) verbs showed slower preferential fixations to subj/obj

- **Exp2: Results are linguistically, not visually, driven**
  - Different pattern of eye-movements when people planning for speech vs when they are just looking at images

Current/Future Directions

1. **Thematic Hierarchies: What does it mean to be the most prominent element of an 'event'?**

    *   **Experiencer-Stimulus Relationship:** In the right contexts, can the Stimulus be *more* prominent than the Experiencer?

    *   **Source-Goal Asymmetries:** Other work has shown a massive goal-bias in language.[1]

        The butterfly flew <u>from</u> the chair <u>to</u> the lamppost.

        In the right contexts, can sources be more prominent than goals?

2. **What are the psychological underpinnings of the Thematic Hierarchy?**

    *   Are linguistic asymmetries homologous to those in non-linguistic cognition?

    *   Perception[2], Attention[3]

[1] Lakusta & Landau, 2005, 2012; Papafragou, 2010 [2] Hafri et al., 2013, 2018 [3] Do, Papafragou, Trueswell, & Robinson, in prep

References

Bock, J. K., and Warren, R. K. (1985). Conceptual accessibility and syntactic structure in sentence formulation. *Cognition* 21, 47–67.

Clark, H. H. and Begun, J. S. (1971). The Semantics of Sentence Subjects. *Language and Speech* 14(1), 34-46.

Do, M. L. and Kaiser, E. M. (2018). Subjecthood and linear order in linguistic encoding: Evidence from the real-time production of wh-questions in English and Mandarin Chinese. *Journal of Memory and Language* 105, 60-75.

Do, M. L., A. Papafragou, A., Trueswell, J. C., and Robinson, N. (In prep). Discourse Effects on the Source-Goal Asymmetry.

Griffin, Z. M., and Bock, K. (2000). What the eyes say about speaking. *Psychological Science* 11, 274-279.

Grimshaw, J. (1990). *Argument structure*. Cambridge, MA: the MIT Press.

Hafri, A., Papafragou, A., & Trueswell, J. C. (2013). Getting the gist of events: Recognition of two-participant actions from brief displays. *Journal of Experiment Psychology: General* 142(3), 880–905.

Hafri, A., Trueswell, J. C., Strickland, B. (2018). Encoding of event roles from visual scenes is rapid, spontaneous, and interacts with higher-level visual processing. *Cognition* 175, 36-52.

Jackendoff, R. S. (1972). *Semantic interpretation in generative grammar.* Cambridge, MA: MIT Press.

Jackendoff, R. S. (1987). The status of thematic relations in linguistic theory. *Linguistic Inquiry* 18(3), 369-411.

Lakusta, L., & Landau, B. (2005). Starting at the end: The importance of goals in spatial language. *Cognition* 96, 1–33.

Lakusta, L., & Landau, B. (2012). Language and Memory for Motion Events: Origins of the Asymmetry Between Source and Goal Paths. *Cognitive Science* 36, 517–544.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation.* Cambridge, MA: MIT Press.

Papafragou, A. (2010). Source-goal asymmetries in motion representation: Implications for language production and comprehension. *Cognitive Science* 34, 1064–1092.

Thompson, C. K., and Lee, M. (2009). Psych verb production and comprehension in agrammatic Broca's aphasia. *Journal of Neurolinguistics* 22, 354–369.

Thank you!! 🐱

Monica L. Do (monicado@sas.upenn.edu) & Elsi Kaiser (emkaiser@usc.edu)