

Psycholinguistics: Syntax & Sentence Processing I

9.59; 24.905

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Ted Gibson

Practice sentences

1. Fred borrowed some money from Maria on Tuesday.
2. The apple which Mary found on the ground contained a worm.
3. The book was given to Mary by the teacher.
4. The woman who the book was given to was happy.
5. English-Japanese:
Mary told John that Bill found some money at the game.

Today's lecture

1. Syntax: Representational issues:
 1. Finite state transition networks?
 2. Trees?
 3. Empty categories?

Syntax: Representational Issues

Can syntax be modeled using Finite state transition networks (FSTNs) rather than context-free grammars (CFGs)?

That is, can we model syntax with one big complex rule, rather than a set of smaller rules?

Finite state transition network (FSTN):

- a set of states;
- a set of allowable transitions from one state to another;
- a subset of start states;
- a subset of final states.

Finite state transition networks (FSTNs)

Goal: a network of states that accepts the following set of intransitive verb sentences:

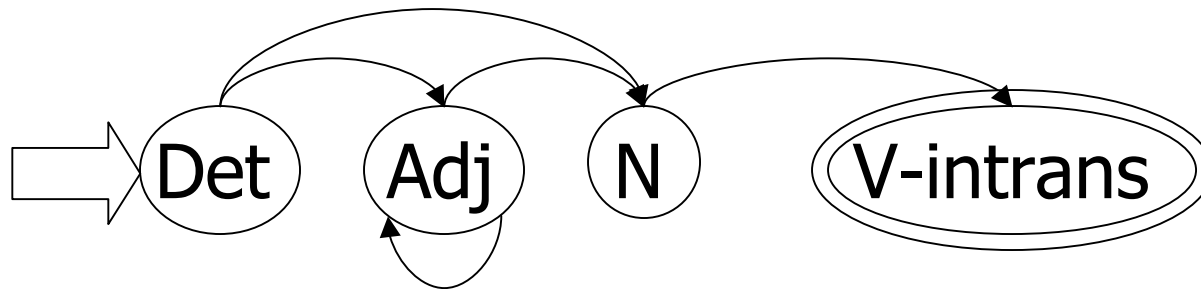
The dog ran.

The boy slept.

The big tall girl walked.

The large green ugly snake moved.

Finite state transition networks (FSTNs)



Det → the

N → dog, boy, girl, snake

Adj → big, large, tall, ugly, green

V-intrans → walked, ran, slept, moved

Finite state transition networks (FSTNs)

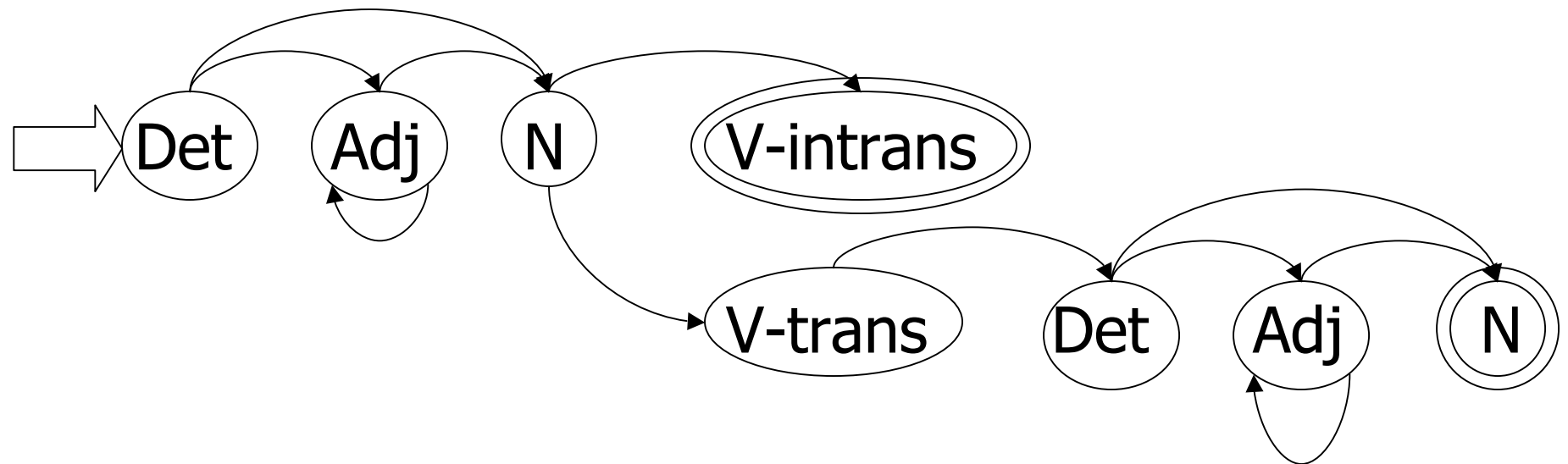
Now add states so that transitive sentences can be recognized:

The dog saw the girl.

The boy bought the dog.

The big tall girl found the large green ugly snake.

Finite state transition networks (FSTNs)



V-trans → bought, saw, found

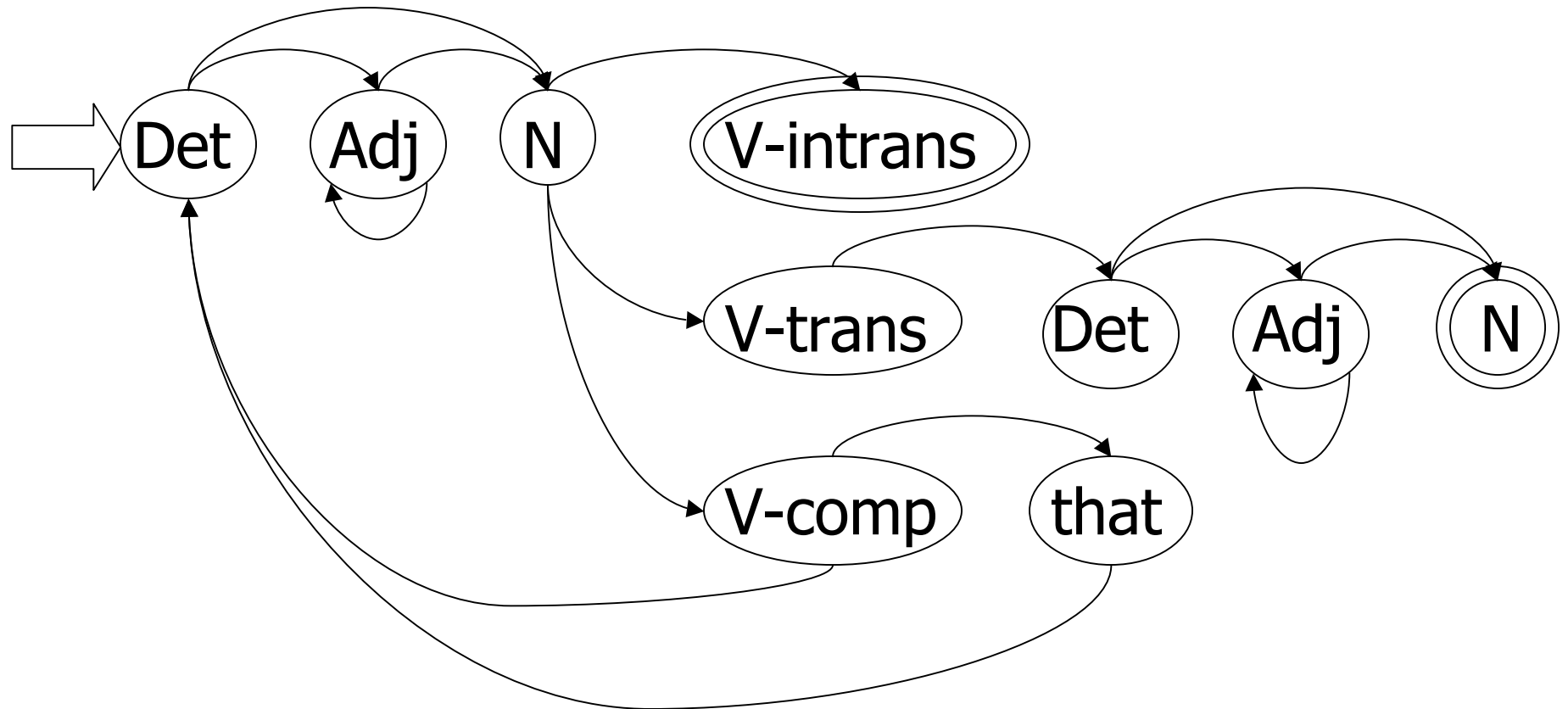
Finite state transition networks (FSTNs)

Now add states so that S-complement sentences can be recognized:

The girl thought that the boy bought the dog.

The large boy said that the big tall girl found the large green ugly snake.

Finite state transition networks (FSTNs)



V-comp → said, thought

Finite state transition networks (FSTNs)

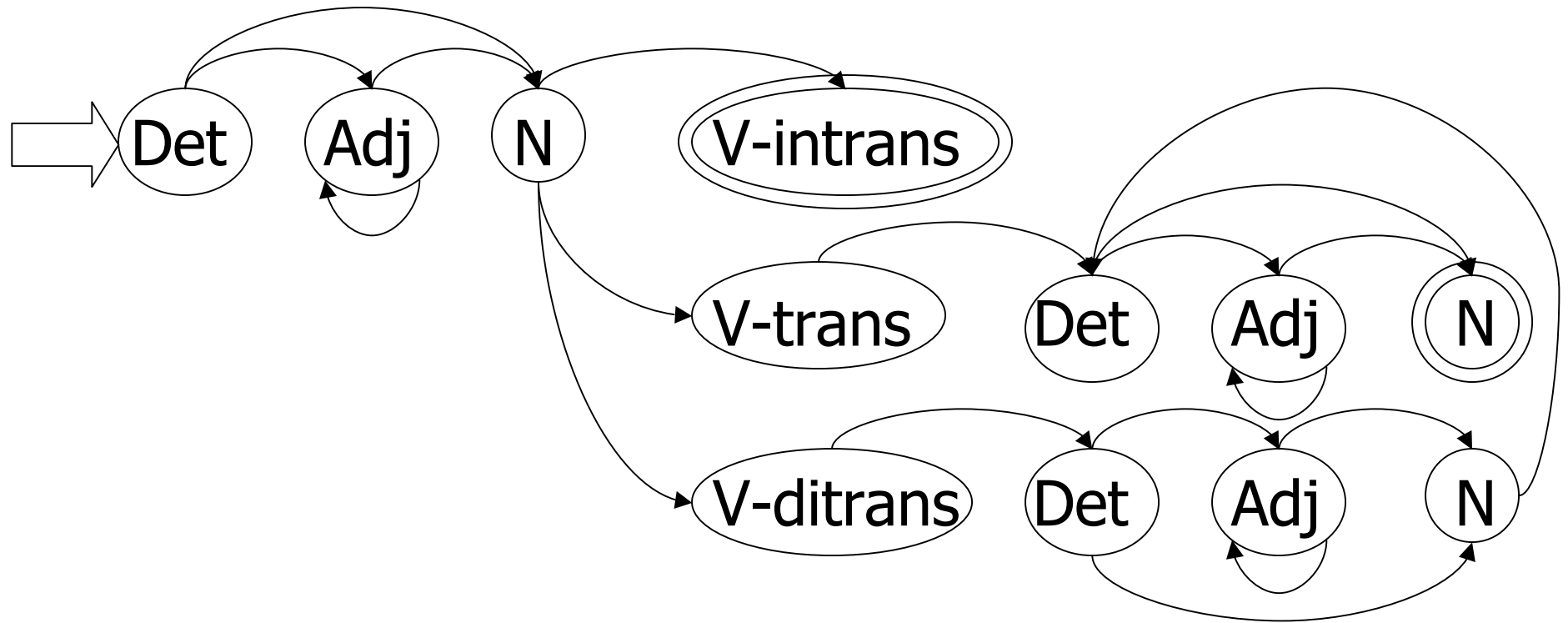
Problem for FSTNs: duplication of sub-networks.

E.g., there needs to be a separate sub-network for NPs for each position that an NP can occur:

- In subject position: a verb must follow
- In object position: no verb can follow
- In first object position of a double-object verb: a second NP must follow

Each of these positions must include all the structure of an NP: i.e., adjectives, prepositional phrase modifiers, relative clause modifiers etc.

Finite state transition networks (FSTNs)



V-ditrans → gave, sent

Finite state transition networks (FSTNs)

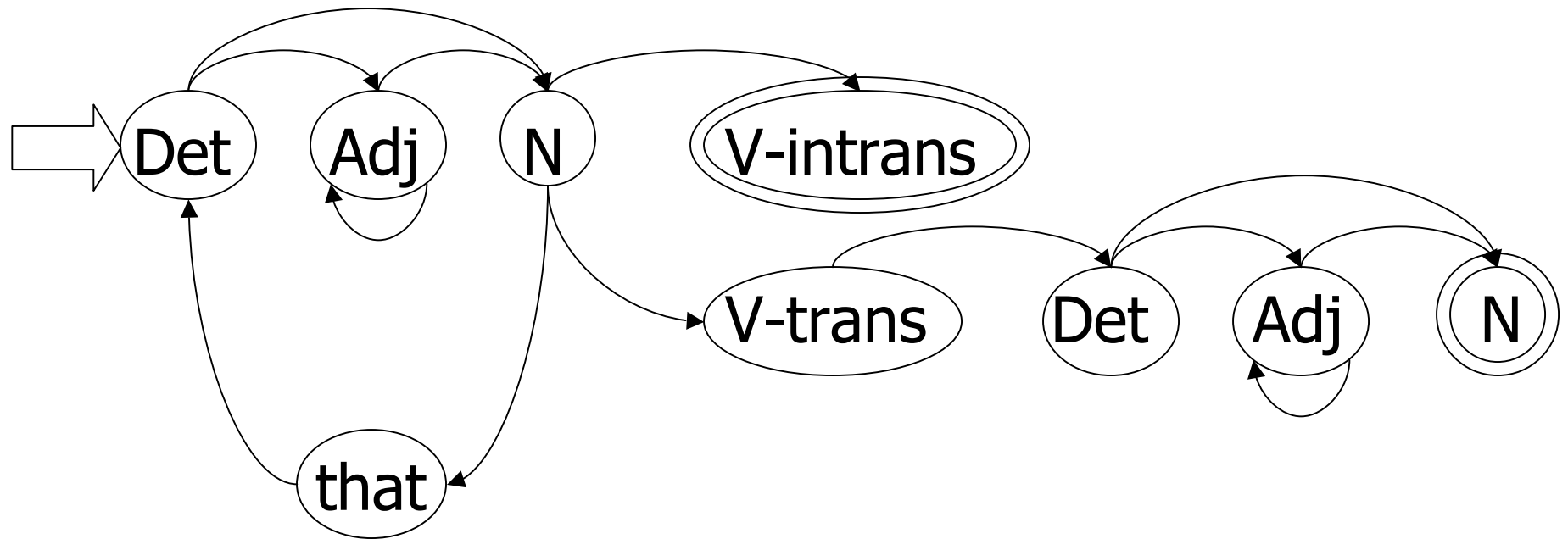
Problem for FSTNs: duplication of sub-networks.

This problem becomes very evident when trying to use FSTNs to represent long-distance dependencies, such as in wh-movement: wh-questions, relative clauses, topicalization.

E.g., relative clauses:

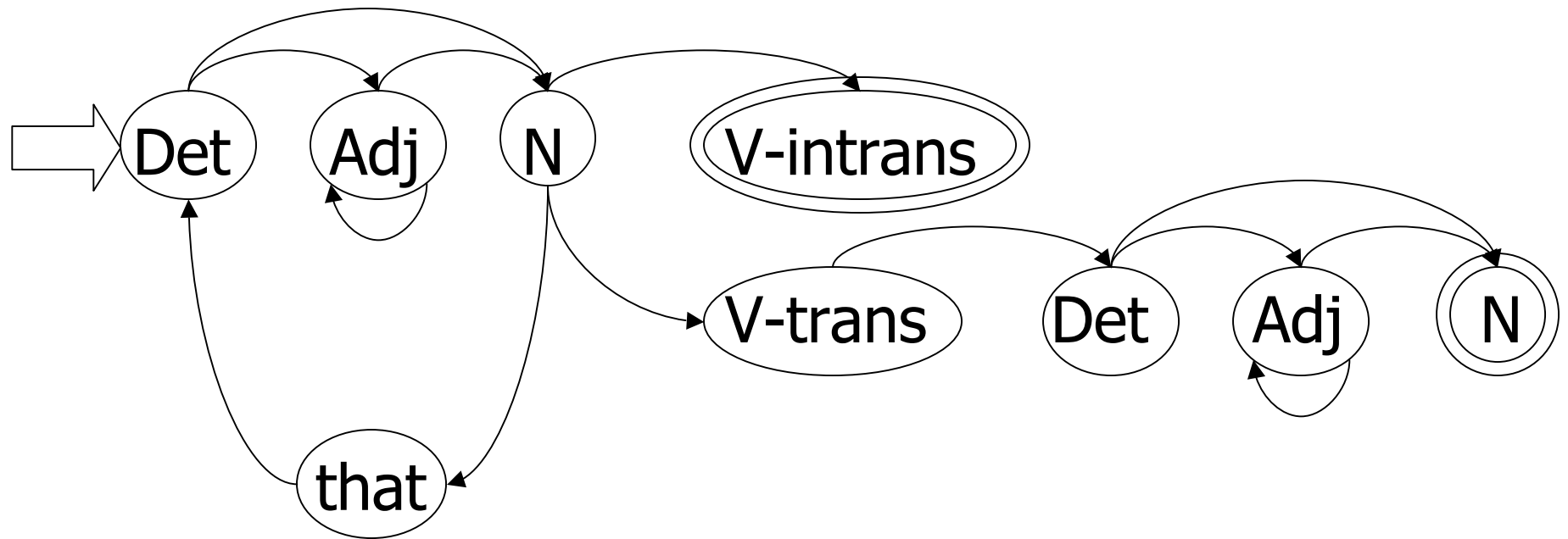
The dog that the boy found slept.

Finite state transition networks (FSTNs)



One attempt: add transitions to the existing network.
Problem: This net can recognize "the dog that the boy found", but then it can't get to the intransitive verb.

Finite state transition networks (FSTNs)



We can't add a transition between V-trans and V-intrans, because then we would accept non-sentences like " * the dog took slept."

Finite state transition networks (FSTNs)

The problem in representing a relative clause is that a relative clause needs to have an empty position somewhere in the argument structure of its verb.

The main clause network doesn't have this missing element.

The recognition device needs memory of which position is to be missing, but there is no memory in an FSTN.

So relative clauses for extraction of each different position have to be represented separately from the main clause: massive repetition.

Syntax: Open Representational Issues

1. Trees: What is the evidence for tree structures?

Interpretations with crossed branches are hard to obtain.

✓ Connection to the most local NP site "boy":

✓ Mary sent the flowers to the boy [that was in her class] .

✓ Connection to the topmost site "sent":

✓ Mary sent the flowers to the boy [on Wednesday] .

Connection to the site "flowers": blocked by crossed branches.

? Mary sent the flowers to the boy [that were very expensive] .

Syntax: Open Representational Issues

1. Trees: What is the evidence for tree structures?

Interpretations with crossed branches are hard to obtain.

✓ Connection to the most local NP site "blue suit":

✓ The man in the classroom wearing a blue suit [which had pinstripes] .

✓ Connection to the topmost site "man":

✓ The man in the classroom wearing a blue suit [who was coughing loudly] .

Connection to the site "classroom": blocked by crossed branches.

? The man in the classroom wearing a blue suit [which had good seating and blackboards] .

Experiment 1: Design

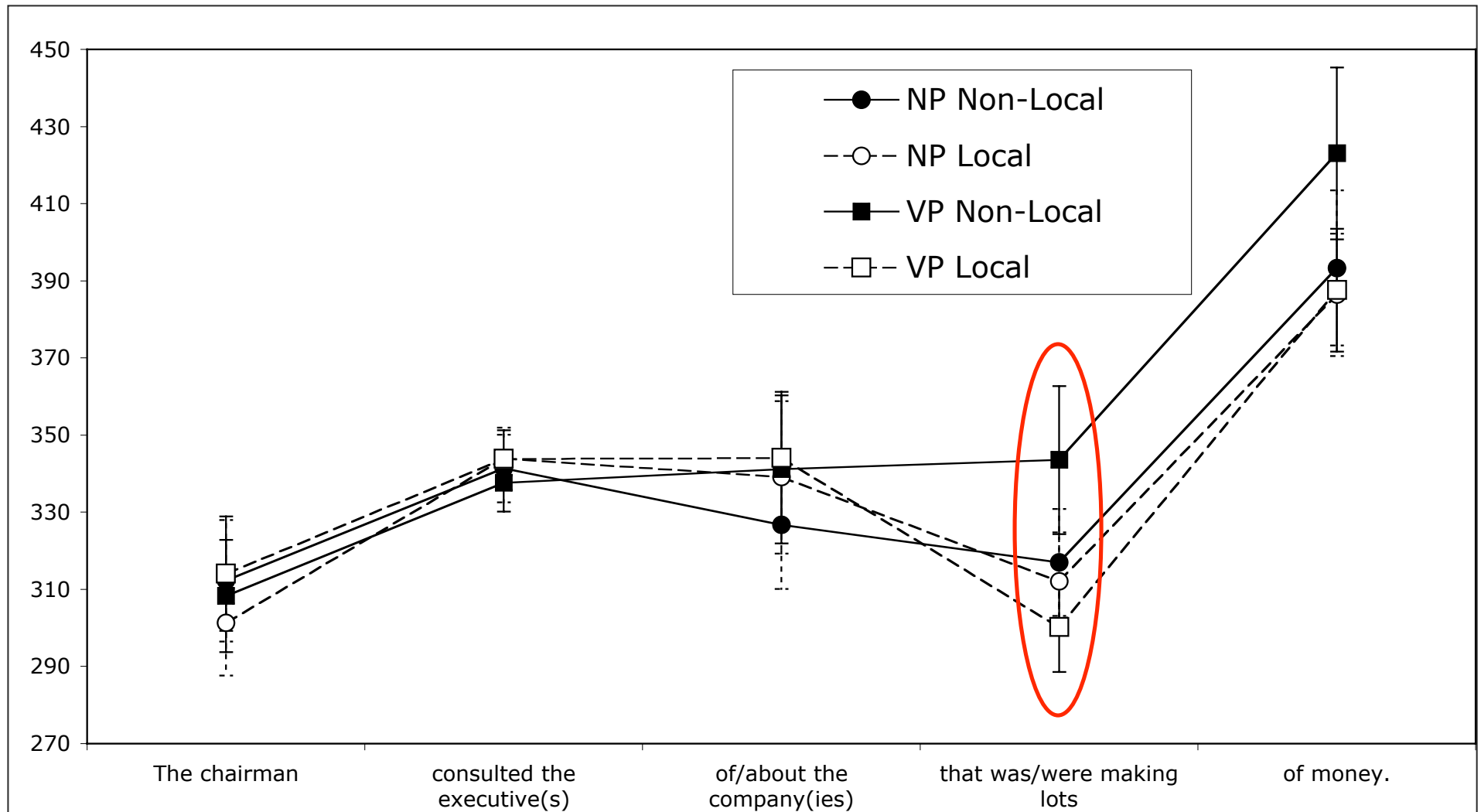
- Factors:

- Locality (Local vs. Non-local)
- PP Attachment site (NP vs. VP)

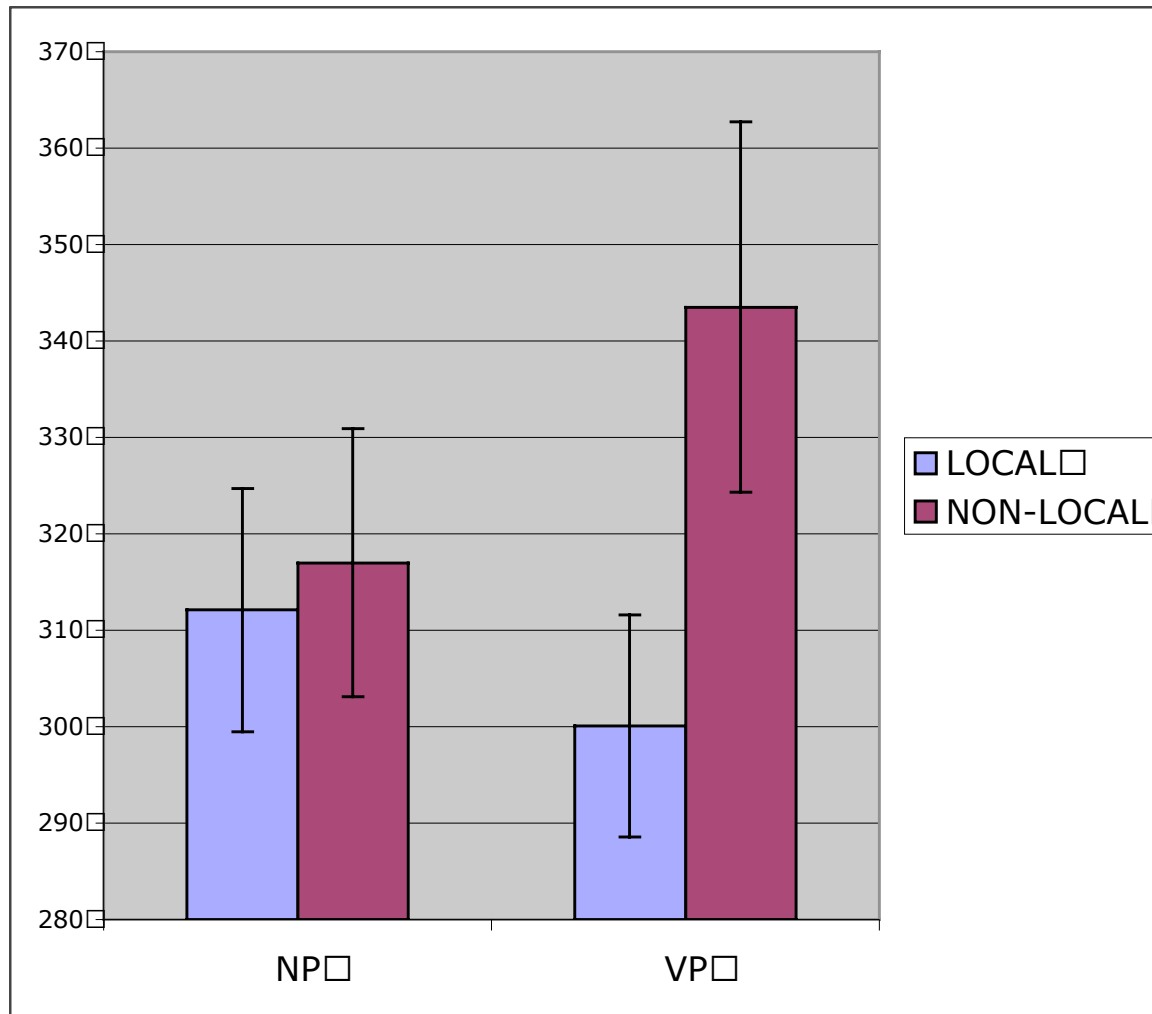
- Stimuli:

- (1) NP, Local: The chairman consulted the executives [PP of the company] [RC that was making lots of money].
- (2) NP, Non-local: The chairman consulted the executive [PP of the companies] [RC that was making lots of money].
- (3) VP, Local: The chairman consulted the executives [PP about the company] [RC that was making lots of money].
- (4) VP, Non-local: The chairman consulted the executive [PP about the companies] [RC that was making lots of money].

Experiment 1: Self-Paced Reading Results



Experiment 1: Self-Paced Reading Results



- Critical Region: *that was/were making lots*
- 2 x 2 interaction
- Main effect of locality; No ME of category
- Extraposed condition different from other three

Experiment 2: Design

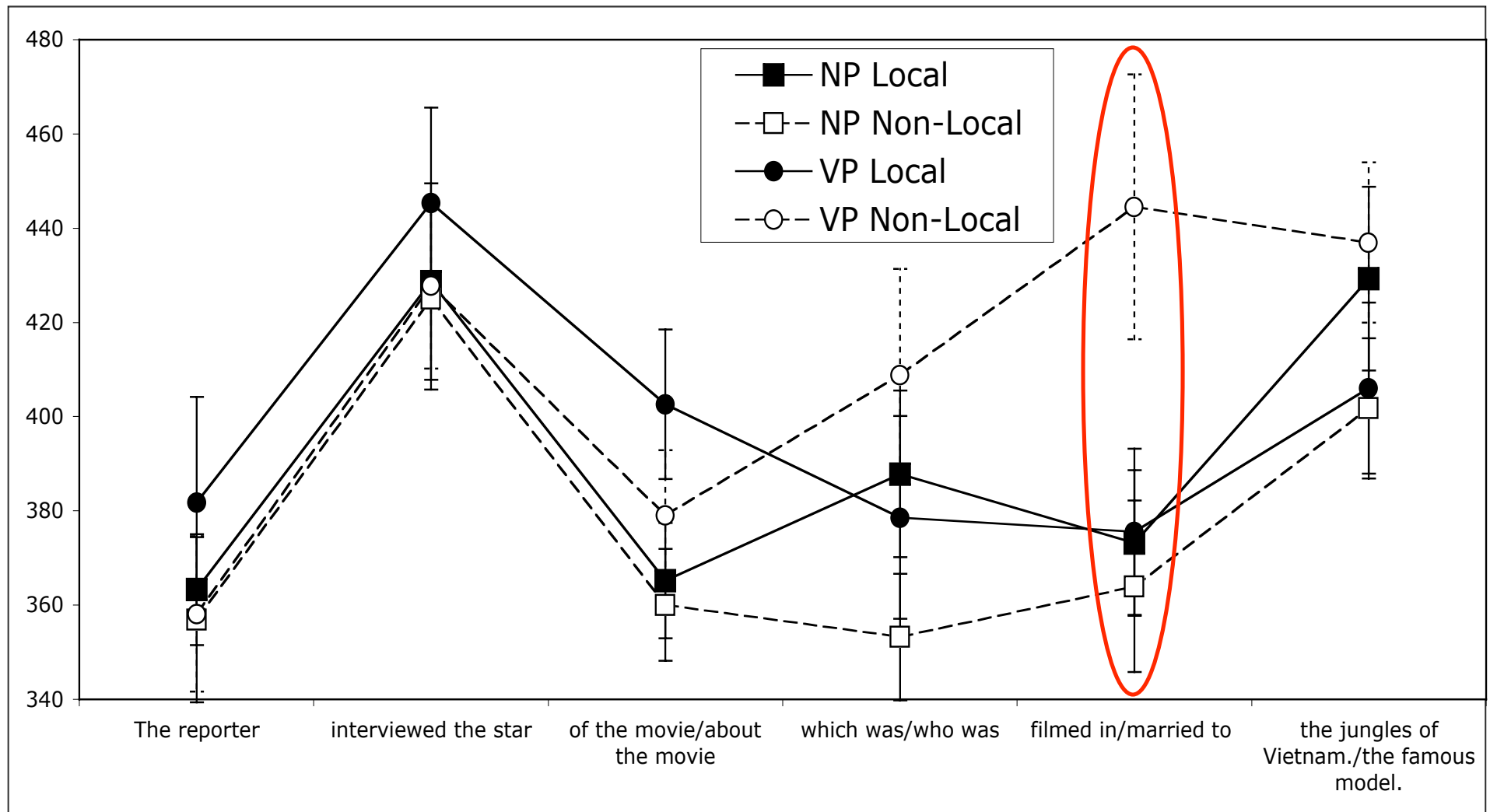
- Factors:

- Locality (Local vs. Non-local)
- PP Attachment site (NP vs. VP)

- Stimuli

- a) NP, local: The reporter interviewed the star [PP of the movie] [RC which was filmed in the jungles of Vietnam.]
- b) NP, non-local: The reporter interviewed the star [PP of the movie] [RC who was married to the famous model.]
- c) VP, local: The reporter interviewed the star [PP about the movie] [RC which was filmed in the jungles of Vietnam.]
- d) VP, non-local: The reporter interviewed the star [PP about the movie] [RC who was married to the famous model.]

Experiment 2: Self-paced Reading Results



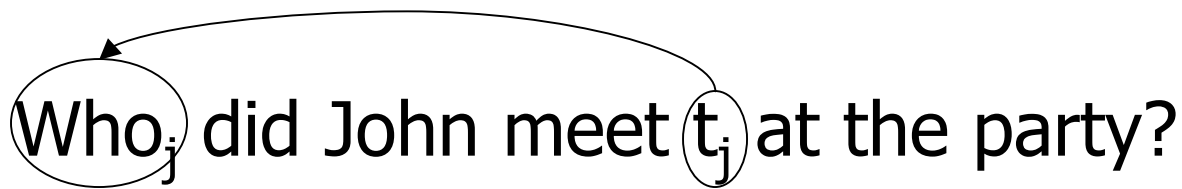
Experiment 2: Summary

- Support for the **structural constraint** hypothesis:
- Response-accuracy data:
 - No differences, with high accuracy rates
- Reading time data:
 - RTs in disambiguating region slowest for extraposed structure. No other differences.
 - *Same as Expt.1*

Syntax: Open Representational Issues

2. Empty categories: What is the evidence for empty categories mediating long-distance dependencies?

Who_j did John meet t_j at the party?



The boy_j was kissed t_j by the girl.

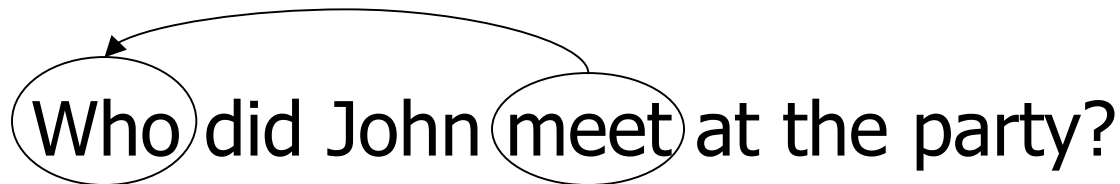


Syntax: Open Representational Issues

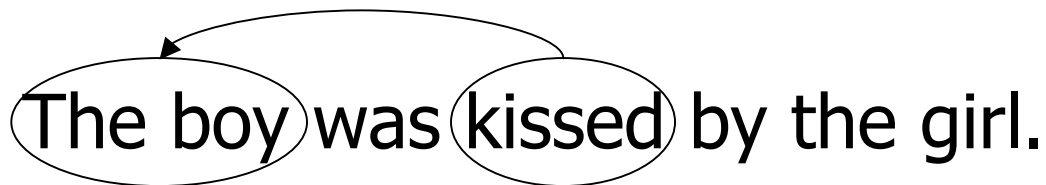
2. Empty categories: What is the evidence for empty categories mediating long-distance dependencies?

Why not direct associations between the positions?

Who did John meet at the party?



The boy was kissed by the girl.



Empty categories

MacDonald (1989): reaction-time evidence for empty categories in English passives.

Useful observation: Pronouns prime their antecedents in on-line language processing (Chang, 1980; Cloitre & Bever, 1984):

(1). John went to the store, and **he** talked to the cashiers.

Probe test: JOHN

(2). John went to the store, and the cashiers were friendly.

Probe test: JOHN

Recognition time for JOHN after (1) is faster than after (2).

Empty categories

MacDonald (1989): Compare probe recognition in passives, which are proposed to contain a null pronominal, to a control case which has no empty pronominal.

Passive:	The girl was kissed.	Gap
Adjectival passive:	The girl was surprised.	No gap
Adjective:	The girl was happy.	No gap

Note: the adjective / verb in each of the three versions predicates the subject "the girl": This is controlled across the conditions.

Prediction of the passive-gap hypothesis: reaction times for "girl" should be faster after the passive condition than after the other two.

Empty categories: MacDonald (1989)

Adjectival passives are morphologically the same as verbal passives, but they pattern like adjectives rather than verbs:

1. a. The happy / surprised girl
b. * The kissed girl
2. a. The girl seemed happy / surprised.
b. * The girl seemed kissed.
3. a. The girl was unhappy / unsurprised.
b. * The girl was unkissed.
4. a. The girl was rather happy / surprised.
b. * The girl was rather kissed.

Empty categories: MacDonald (1989)

Experimental materials: 42 pairs of sentences of the form:

Context sentence:

The Irish terrorists wanted to disrupt the ceremonies.

Target sentence:

The new mayor at the center podium was furious (adjective) / surprised (adjectival passive) / shot (verbal passive).

Task: Probe recognition of the word "mayor" (target noun) / "terrorists" (discourse topic control)

Empty categories: MacDonald (1989)

Results:

People are faster at recognizing “mayor” after the passive condition than after either of the other two conditions:

Passive	Adjective	Adjectival passive
931 msec	1006 msec	990 msec

No differences among the discourse topic control “terrorists”:

Passive	Adjective	Adjectival passive
1015 msec	1040 msec	1016 msec

Empty categories: MacDonald (1989)

Conclusion: There is an empty pronoun mediating the dependency between the object position of the verb and the subject position in a passive sentence.