The Relative Contribution of Syntactic and Semantic Prominence in Pronoun Reference Resolution

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Introduction

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Main Question: Are the observed effects of syntactic prominence actually the result of semantic prominence?

Overview

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- Background
  - Discourse Salience

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  - Syntactic Prominence
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- Implications
- Specific Recommendations for RAP (Lappin and Leass, 1994)

Background: Discourse Salience

A discourse introduces and refers to a number of *referents* (Karttunen, 1976; Heim, 1982, 1983).

Degree to which a referent "stands out" in a discourse is its *salience*.

Most salient referent in current context is default antecedent for subsequent (inter-utterance) pronominal reference.

Factors contributing to salience: syntactic prominence, parallelism, recency, animacy, etc.

Background: RAP

Resolution of Anaphora Procedure (Lappin and Leass, 1994)

Pronoun is resolved to candidate with highest "salience index"

Salience Index determined from a number of sub-indices

- grammatical role
- recency
- grammatical parallelism

Accuracy Rate: 86%

Background: Syntactic Prominence

Referents realized as subjects are preferred for pronominal reference.

Proposed prominence hierarchy:

$$\text{SUBJECT} > \text{OBJECT} > \text{OBLIQUE}$$

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Upper part of hierarchy verified in many experiments

Lower part of hierarchy assumed, but never explicitly verified experimentally

Background: Semantic Prominence

Semantic prominence determined from verb argument structure

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hit: (AGENT, PATIENT)

Background: Semantic Prominence

Semantic prominence determined from verb argument structure

hit: (AGENT, PATIENT)

Semantic prominence hierarchy:

$$\text{AGENT} > \text{PATIENT} > \text{OTHERS}$$

Experiments

Argument-reordering constructions

- active-passive alternation
- dative alternation
- locative alternation

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Argument-reordering constructions

- active-passive alternation
  - John hit Matt.
  - Matt was hit by John.
- dative alternation
- locative alternation

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Argument-reordering constructions

- active-passive alternation
- dative alternation
  - John gave the book to Matt.
  - John gave Matt the book.
- locative alternation

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- active-passive alternation
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  - John sprayed the paint on the wall.
  - John sprayed the wall with the paint.

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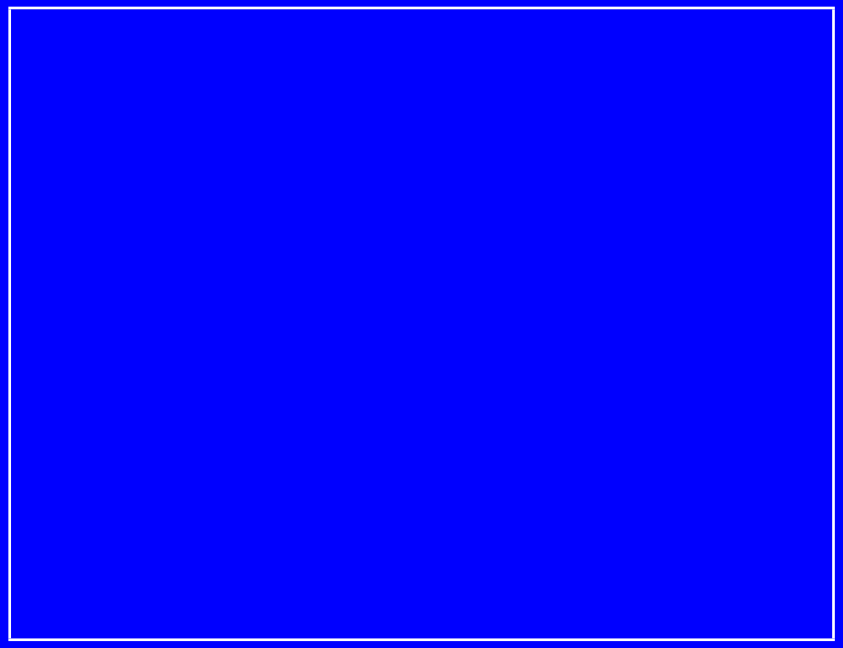
Experiments: Method

Participants performed a self-paced reading task and whole-sentence reading times were measured.



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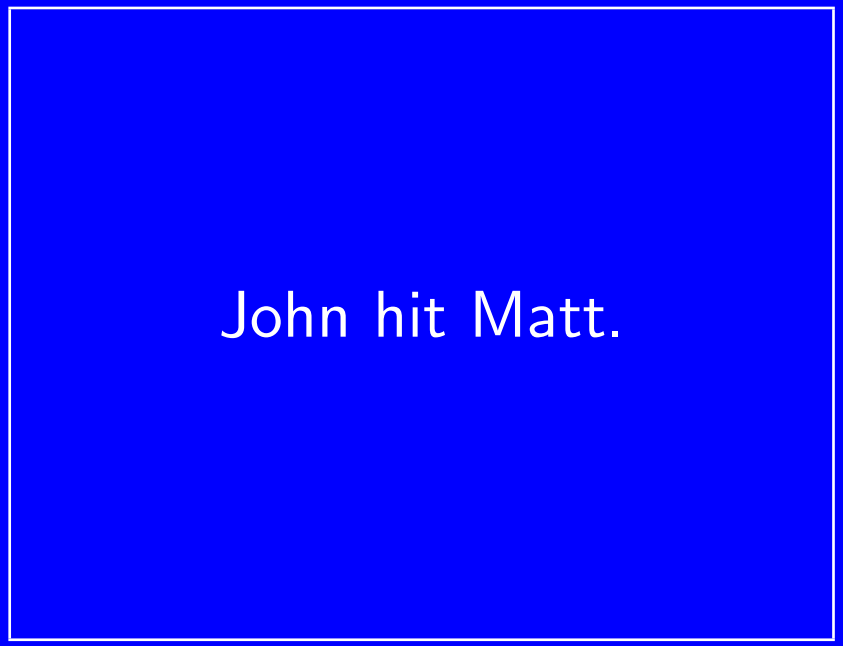

Experiments: Method

Participants performed a self-paced reading task and whole-sentence reading times were measured.

He was angry.

Experiments: Method

Participants performed a self-paced reading task and whole-sentence reading times were measured.

- Useful to examine environments which cause greater/lesser processing load
- Often used in pronoun-resolution experiments

Experiment 1

a.	John sprayed the paint$_i^{\star\star}$ on the wall$_j$.	CONTROL
b.	It ...	

a'.	John sprayed the wall$_j^{\star}$ with the paint$_i^{\star}$.	SPLIT
b.	It ...	

$\star$ - syntactically prominent $\star$ - semantically prominent

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b.	It$_i$ dribbled down and made a mess.	PATIENT
b'.	It$_j$ was big and needed two coats.	LOCATION
a'.	John sprayed the wall$_j^{\star}$ with the paint$_i^{\star}$.	SPLIT
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Predicted RTs of continuations

	SYNPROM only	SEMPROM only
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SPLIT		

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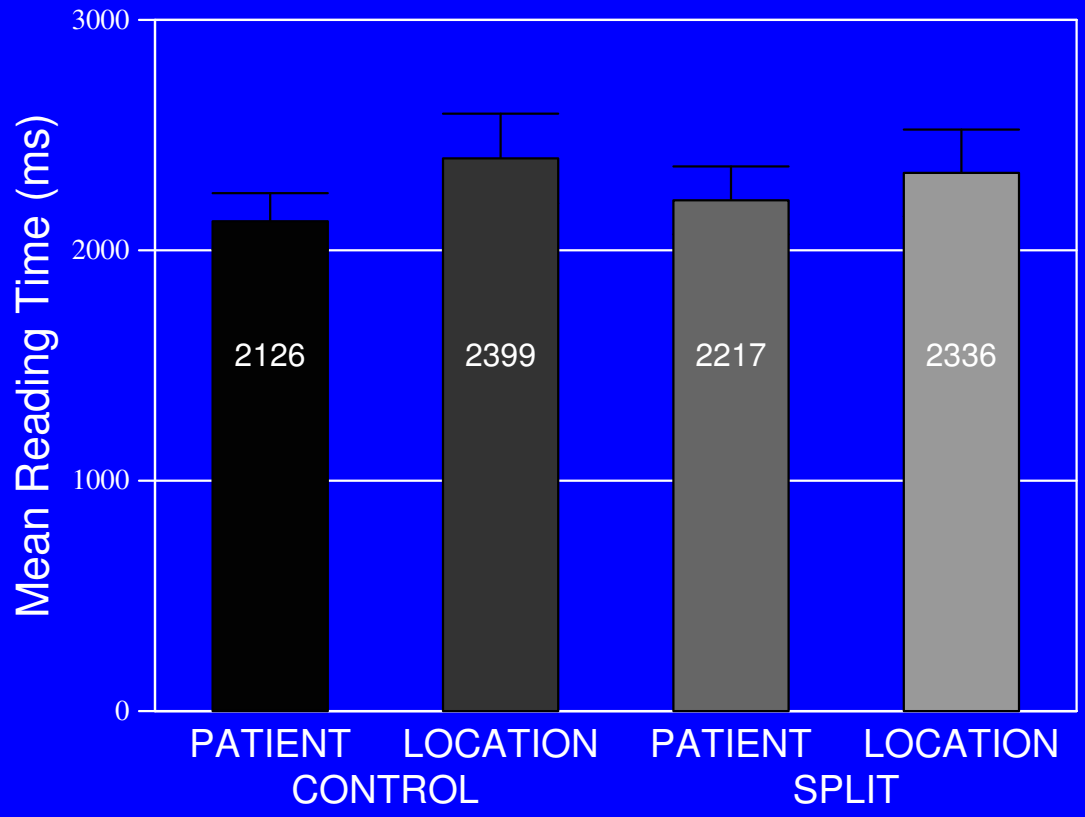
Experiment 1: Results



REFERENT: [by subjects, $F(1, 31) = 11.1\ p < 0.005$; by items, $F(1, 47) = 5.6\ p < 0.05$]

CTRL-PAT vs. CTRL-LOC: [by subjects, $t(31) = 3.6\ p < 0.01$; by items, $t(47) = 3.0\ p < 0.05$]

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- semantic prominence is more important than syntactic prominence, or
- prominence hierarchies are different (i.e., difference between PATs and LOCs is larger than difference between OBJs and OBLs)

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Problem: Relevant reading time comparisons are across different sentences:

It dribbled down and made a mess.	PATIENT
It was big and needed two coats.	LOCATION

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Could observed variation have been caused by differences in structural complexity or lexical frequency?

Experiments 2-3: Repeated-Name Penalty

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John bought two fish.
John grilled the fish and ate them.

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Extend this logic to definite descriptions in the spray/load stimuli.

Experiment 2

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b'.	The paint$_i$ dribbled down and made a mess.	DESCRIPTION

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REFERENT (PAT, LOC) $\times$ FORM (PRO, DSCR)

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SEMPROM only PAT $>$ LOC

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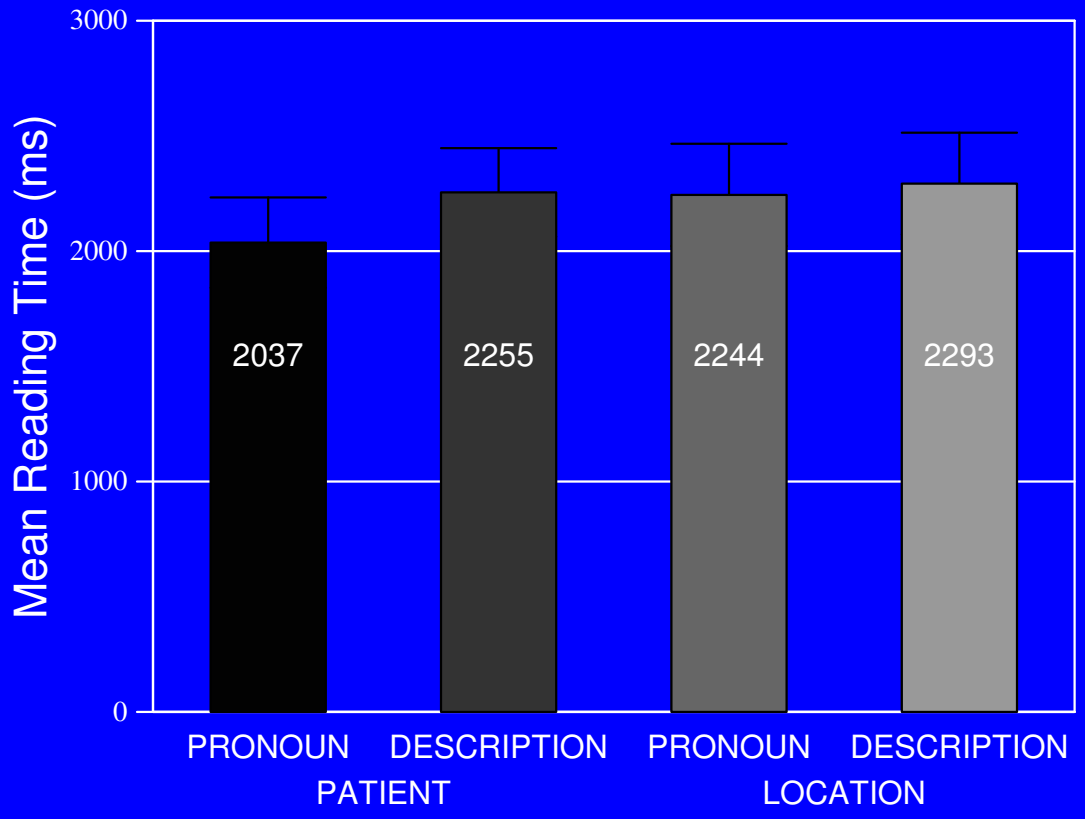

	penalty	by subjects		by items	
PATIENT	218ms	$t(31) = 3.51$	$p < 0.005$	$t(47) = 3.5$	$p < 0.005$
LOCATION	49ms	$t(31) < 1.0$	n.s.	$t(47) < 1.0$	n.s.

PAT vs. LOC penalty pairwise t-test: by subjects, $t(31) = 1.7$ $p = 0.1$; by items, $t(47) = 2.4$ $p < 0.05$

Experiment 3

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SEMPROM only PAT $>$ LOC

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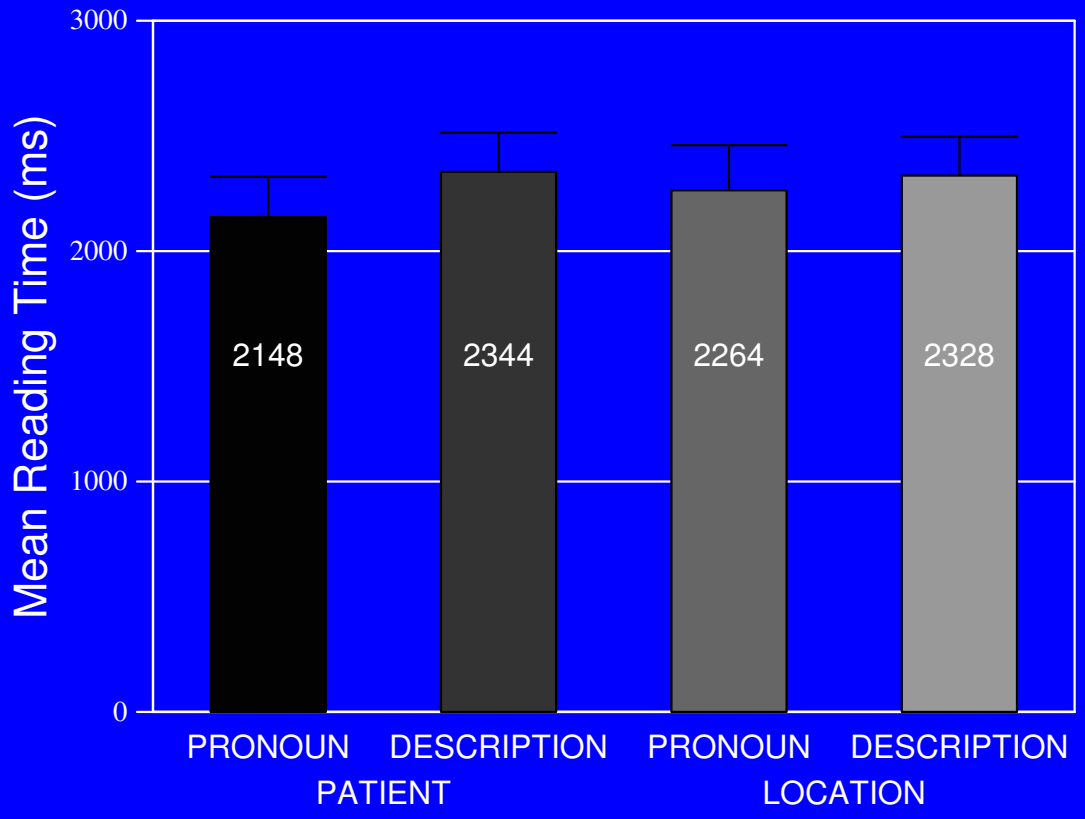

	penalty	by subjects		by items	
PATIENT	188ms	$t(31) = 3.6$	$p < 0.005$	$t(47) = 2.4$	$p < 0.05$
LOCATION	77ms	$t(31) < 1.0$	n.s.	$t(47) < 1.0$	n.s.

PAT vs. LOC penalty pairwise t-test: by subjects, $t(31) = 1.7\ n.s.$; by items, $t(47) < 1.0\ n.s.$

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Experiment 4

Reading time measurements with non-*tough* and *tough*-constructions

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a.	Nancy$_i$** could easily beat Susan$_j$.	CONTROL
a'.	Susan$_j$* was easy for Nancy$_i$* to beat $\emptyset_j$.	SPLIT
b.	She ...	

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Results:

- In CONTROL condition, strong preference for AGENT continuation

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Results:

- In CONTROL condition, strong preference for AGENT continuation
- in SPLIT condition, no greater preference for either continuation

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$$\text{AGENT} > \text{PATIENT} > \text{LOCATION}$$

- Difference between SUBJECTs and OBJECTs larger than difference between OBJECTs and OBLIQUEs

$$\text{SUBJECT} >> \text{OBJECT} > \text{OBLIQUE}$$

Further Work

Continued investigation of relative influence of syntactic and semantic prominence

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- Implementation in reference resolution algorithms

RAP: proposed improvements

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- Add additional salience index: semantic role
- Determine role set
- Determine (relative) weightings of the semantic roles
- Determine semantic role of noun phrases in source text

RAP: semantic role

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- grammatical role
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- semantic role

RAP: role set

Desired: an inventory of semantic roles

- Jackendoff (1972, 1987, 1990)
- Grimshaw (1990)
- Gruber (1965)
- Palmer (1994)
- Fillmore (1968, 1976) (Frame Semantics)

RAP: role weightings

Determine relative weights for every role in the inventory.

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These weightings contribute directly to the semantic role index and combine with other indices to determine overall salience index.

RAP: role recovery module

There must be some method to recover the semantic role information in the source text.

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There must be some method to recover the semantic role information in the source text.

Gildea and Jurafsky (2001) suggest a probabilistic algorithm for determining semantic role based on the FrameNet (Baker et al., 1998) system of roles. Accuracy Rate: 82%

Conclusion

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- Presented data on the psycholinguistic reality of semantic prominence
- Discussed how syntactic and semantic prominence interact with each other as factors contributing to discourse salience
- Considered how the psycholinguistic data may inform computational linguistic models

Thank you!

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Experiment 4: Results