Human processing of polarity items

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Hauptseminar (Frank Richter):
Negative Polarity Items

Why processing evidence?

Linguistic theories are typically based on

- introspective data
- off-line end-of-sentence judgments
- paraphrases

Why processing evidence?

Semantic theories make predictions about

- the possible interpretations of a phrase/sentence
- the relative preferences for the interpretations
- the process of interpretation

Why processing evidence?

Processing data provide

- larger database
- finer distinctions
- evidence about the time course of interpretation

What can we measure?

- anomaly: the occurrence of something other than what the processor “expected”
- processing complexity
- activation

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Paradigms and techniques 1

Anomaly detection

- explicit grammaticality or sensibility judgments
  - questionnaire
  - incremental grammaticality judgment (stops-making-sense)

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Paradigms and techniques 1a: Stops-making-sense

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The _____ _____ _____ _____ _____ _____ _____.

Paradigms and techniques 1a: Stops-making-sense

___ girl ___ ___ ___ _____ ___ _____.

Paradigms and techniques 1a: Stops-making-sense

___ ____ hit ___ ___ ____ ___ ____.

Paradigms and techniques 1a: Stops-making-sense

___ _____ ___ the ___ _____ ___ _____.

Paradigms and techniques 1a: Stops-making-sense

___ ____ ___ ___ boy ____ ___ ____.

Paradigms and techniques 1a: Stops-making-sense

___ _____ ___ ___ ___ with ___ _____.

Paradigms and techniques 1a: Stops-making-sense

___ ____ ___ ___ ___ ____ the ____.

Paradigms and techniques 1a: Stops-making-sense

___ ____ ___ ___ ___ ____ ___ wart.

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The _____ _____ _____ _____ _____ _____ _____.

Paradigms and techniques 1a: Stops-making-sense

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___ _____ hit ___ ___ _____ ___ _____.

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___ ____ ___ ___ ___ ____ the _____.

Paradigms and techniques 1a: Stops-making-sense

___ _____ ___ ___ ___ _____ ___ stick.

Paradigms and techniques 1a: Stops-making-sense

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(1) a. Every boy climbed a tree. The tree was full of apples.

b. A boy climbed every tree. The tree was full of apples.

Paradigms and techniques 1

Anomaly detection

- explicit grammaticality or sensibility judgments
  - questionnaire
  - incremental grammaticality judgment (stops-making-sense)
- implicit “judgments”
  - reading time measures: self-paced reading, eye-tracking

Paradigms and techniques 1b: Self-paced reading

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Since _____ _____ _____ _ _____ _____ _____ _ _____ _____ _____ _____.

Paradigms and techniques 1b: Self-paced reading

_____ Jay _____ ____ _ ____ _____ ____ _ _____ _____
__ ___.

Paradigms and techniques 1b: Self-paced reading

_____ ___ always ____ _ ____ _____ _____ _ _____ _____ __ ___.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ jogs _ ____ _____ ____ _ _____ _____
__ ___.

Paradigms and techniques 1b: Self-paced reading

_____ ____ _____ _____ a _____ _____ _____ _ _____ _____ __ ____.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ _____ _ mile _____ _____ _ _____ _____
__ ___.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ _____ _ _____ seems _____ _ _____ _____ __ ____.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ _____ _ _____ _____ like _ _____ _____ __ ___.

Paradigms and techniques 1b: Self-paced reading

_____ ____ _____ _____ _ _____ _____ _____ a _____ _____ __ ____.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ _____ _ _____ _____ _____ _ short _____ __ ____.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ _____ _ _____ _____ _____ _ _____ distance __ ___.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ _____ _ _____ _____ _____ _ _____ _____

to ___.

Paradigms and techniques 1b: Self-paced reading

_____ ___ _____ _____ _ _____ _____ _____ _ _____ _____

__ him.

Paradigms and techniques 1b: Self-paced reading

(2) a. Since Jay always jogs a mile seems like a short distance to him.

b. Since Jay always jogs a mile it seems like a short distance to him.

Paradigms and techniques 1b: Eye-tracking

- more natural reading: whole sentence visible
- separating initial and later effects

(3) Every time the dog obeyed the pretty little girl showed her approval. (Kroll, Gerfen & Dussias 2007)

Paradigms and techniques 1b: Eye-tracking

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- implicit “judgments”
  - reading time measures: self-paced reading, eye-tracking
  - neurophysiological measures (ERP)

Paradigms and techniques 1b: ERP

Event-related potentials:
small voltage changes measured at the surface of the scalp reflecting cognitive processes

components differ in

- polarity
- latency
- scalp distribution

Paradigms and techniques 1b: ERP

N400: negative-going wave peaking at 400ms post stimulus onset, over centroparietal regions

- indicates semantic “fit”
- triggered by each new lexical item
- reduced if congruent, predictable

Paradigms and techniques 1b: ERP

ELAN and LAN (left anterior negativity)

Early LAN: 100-300ms post onset

- word category violations – initial structure building

LAN: 300-500ms post onset

- word category violations
- agreement violations
- long-distance dependencies

Paradigms and techniques 1b: ERP

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Paradigms and techniques 1b: ERP

P600: late centroparietal positivity

- violations of agreement, case marking
- phrase structure violations
- garden-path sentences
- complex structures, long-distance dependencies
- syntactic reanalysis/repair, integration difficulty, dispreferred structure

Paradigms and techniques 2a

Processing load tasks

- reading time measures: self-paced reading, eye-tracking

(3) a. The cat that the dog bit ran away
b. The mouse that the cat that the dog bit chased ran away.

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Paradigms and techniques 2b

Processing load tasks

- dual-task paradigms
  - primary task: reading or listening to a sentence
  - secondary task at the point where processing difficulty is expected

    word monitoring, tone detection, lexical decision

(4) a. The reporter that the attorney accused admitted the error.
b. The reporter that the attorney that the congressman questioned accused admitted the error.

Paradigms and techniques 2b

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Paradigms and techniques 3a

Activation level: priming

- dual task: reading/listening + lexical decision/word recognition

(5) The policeman saw the boy that the crowd at the party accused # of the crime.

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Paradigms and techniques 3a

Activation level: priming

- dual task: reading/listening + lexical decision/word recognition

(6) a. The boxer told the skier that the doctor for the team would blame himself # for the recent injury.
b. The boxer told the skier that the doctor for the team would blame him # for the recent injury.

Paradigms and techniques 3b

Activation level: priming

- cross-modal integration paradigm:

  reading/listening to sentence fragment, reading next word aloud

(7) a. If you walk too near the runway, landing planes IS/ARE
    b. If you've been trained as a pilot, landing planes IS/ARE

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Summary: How do we measure?

- comparing anomalous/complex construction to control
- assumption: difficulty $\rightarrow$ increased RT
- some techniques not very natural
- typically only one/few paradigm(s) suitable

A study of NPIs

Shao & Neville (1998)
Do different semantic violations all elicit an N400?

- improbability
  - (7) a. Karen knitted her father a sweater for his birthday.
  - (7) b. Karen knitted her father a stove for his birthday.
- hyponymy
  - (8) a. Jane does not eat meat at all, instead, she eats lots of rice and vegetables.
  - (8) b. Jane does not eat meat at all, instead, she eats lots of beef and vegetables.
- NPIs
  - (9) a. Max says that he has never been to a birthday party.
  - (9) b. Max says that he has ever been to a birthday party.

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A study of NPIs

Results:

- improbability: N400
- hyponymy: sustained left anterior negativity beginning around 500 ms post onset
- NPIs: small anterior negativity 300-500ms post onset
- all three: late positivity

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PI licensing: Saddy et al. (2004)

Saddy, Drenhaus, & Frisch (2004)

- processing PIs: syntactic and semantic/pragmatic aspects
- Are the same resources used for NPIs and PPIs?

a. Kein Mann, der einen Bart hatte, war jemals froh.
b. Ein Mann, der einen Bart hatte, war jemals froh.
c. Ein Mann, der einen Bart hatte, war durchaus froh.
d. Kein Mann, der einen Bart hatte, war durchaus froh.

PI licensing: Saddy et al. (2004)

Predictions:

- semantic integration problems: N400
- possibly syntactic processing problems as well: P600

Results:

- grammaticality judgments: more errors and longer RTs in incorrect conditions
- N400 for both violations: mismatch between PI and context
- P600 for PPI violations: syntactic reanalysis

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Intrusion: Drenhaus et al. (2005)

Drenhaus, Frisch, & Saddy (2005)

separating the semantic and syntactic aspects of NPI licensing

a. Kein Mann, der einen Bart hatte, war jemals glücklich.
b. Ein Mann, der einen Bart hatte, war jemals glücklich.
c. Ein Mann, der keinen Bart hatte, war jemals glücklich.

Intrusion: Drenhaus et al. (2005)

acceptability judgment with speeded presentation (RSVP)

- faster and more accurate responses in a, b than in c

ERP

- more accurate answers in a, b than in c
- faster RTs in a, c than b
- N400 in both b and c (somewhat stronger in b)
- P600 in both b and c

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Why intrusion? Xiang et al. (2006)

Xiang, Dillon, & Phillips (2006)

Is the intrusion effect due co-occurrence?

a. No bills that the D. senators have supported will ever become law.
b. Very few bills that the D. senators have supported will ever become law.
c. Only three bills that the D. senators have supported will ever become law.
d. The bills that no D. senators have supported will ever become law.
e. The bills that very few D. senators have supported will ever become law.
f. The bills that only three D. senators have supported will ever become law.
g. The bills that the D. senators have supported will ever become law.

Why intrusion? Xiang et al. (2006)

- offline rating (1=bad, 5=good)
- acceptability judgment with speeded presentation (RSVP)

Results

licensor	offline rating	speeded accuracy
no	4.3	79%
very few	4.0	81%
only three	4.1	93%
intrusive no	2.1	62%
intrusive very few	2.2	60%
intrusive only three	2.2	52%
none	1.7	81%

$\rightarrow$ not a co-occurrence effect

Why intrusion? Vasishth et al. (2005)

Vasishth, Drenhaus, Saddy, & Lewis (2005)

source of the intrusion effect: cue-based retrieval

- matrix subject retrieved to match with main predicate
- when NPI is present, an additional semantic cue will
  - boost activation of accessible licensor
    No man who had a beard was ever happy.
  - fail to boost activation of accessible non-licensor
    A man who had a beard was ever happy.
  - occasionally boost activation of inaccessible licensor
    A man who had no beard was ever happy.

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Intrusion: Vasishth et al. (2006)

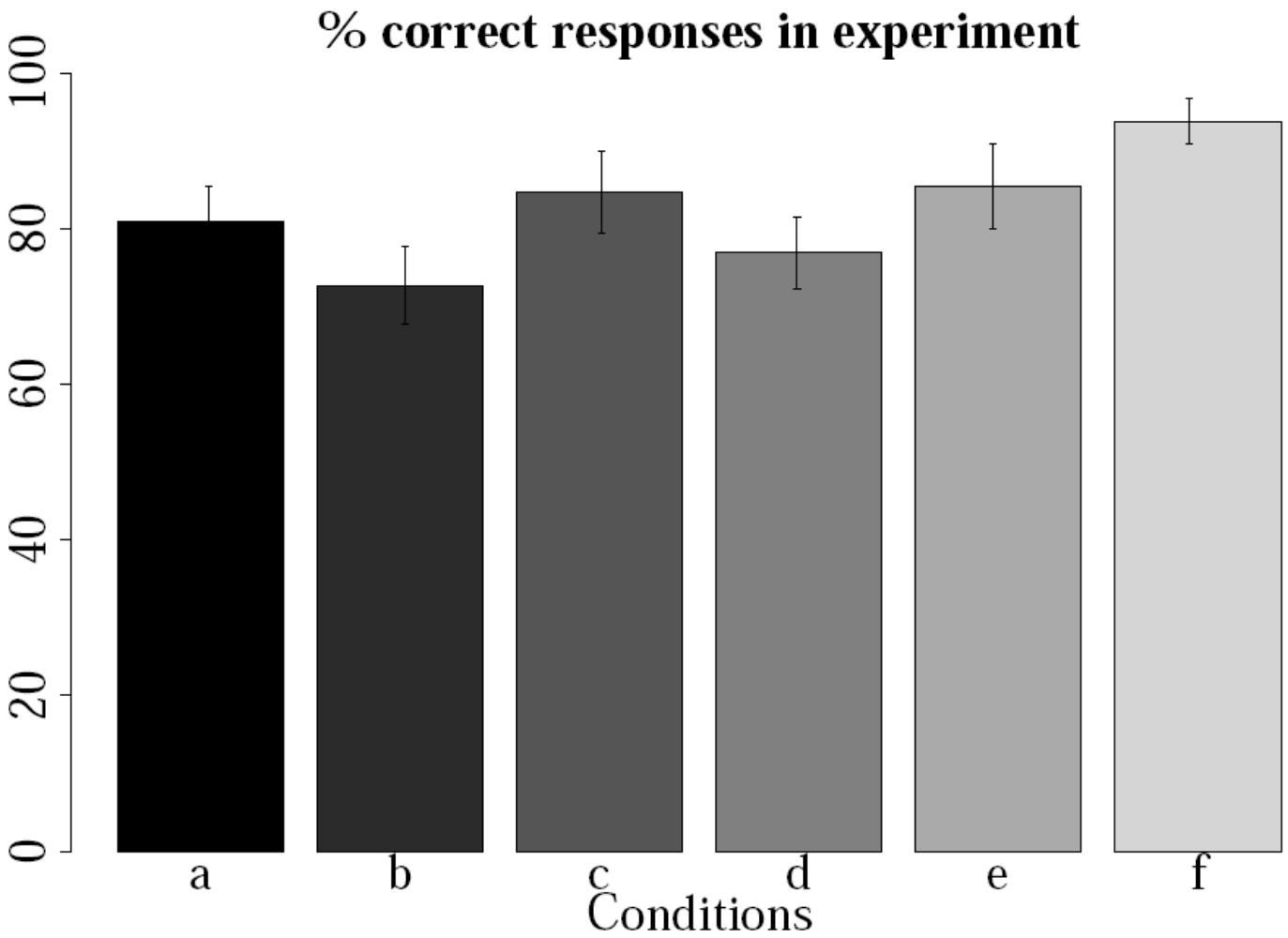
Vasishth, Brüssow, Lewis, Drenhaus, & Saddy (2006)

Are there intrusion effects with PPIs?

eye-tracking study

a. Kein Mann, der einen Bart hatte, war jemals glücklich.
b. Ein Mann, der einen Bart hatte, war jemals glücklich.
c. Ein Mann, der keinen Bart hatte, war jemals glücklich.
d. Kein Mann, der einen Bart hatte, war durchaus glücklich.
e. Ein Mann, der einen Bart hatte, war durchaus glücklich.
f. Ein Mann, der keinen Bart hatte, war durchaus glücklich.

Intrusion: Vasishth et al. (2006)



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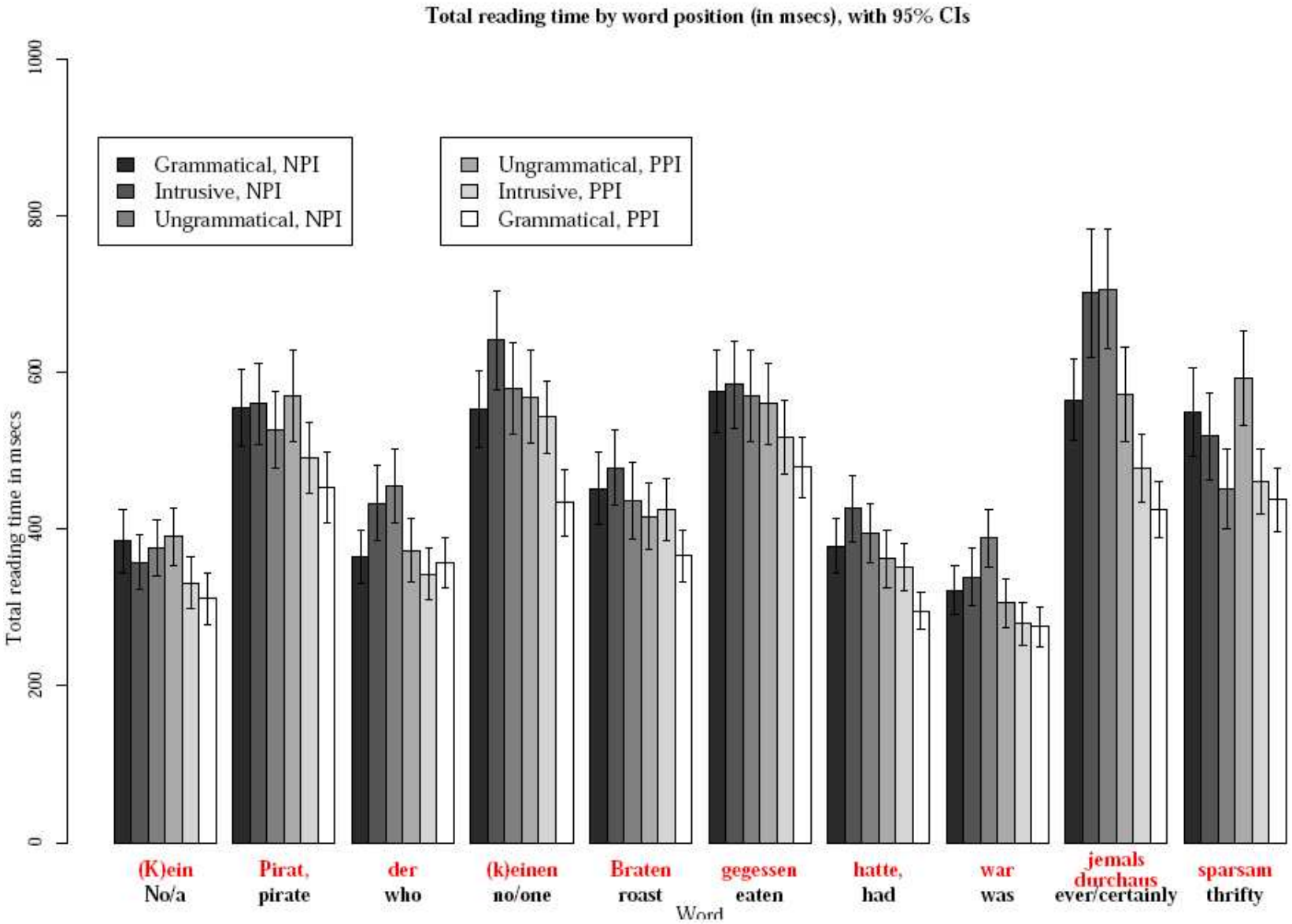

Why intrusion? Xiang et al. (2007)

similarity-based interference:

- NPI licensing
- antecedents for reflexives
- agreement

format of memory representations or partial-cue-match retrieval?

- reflexives: local c-commanding antecedent
- NPIs:
  direct licensing by c-commanding negator, or
  by entire proposition containing licensor (Chierchia 2006)

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Why intrusion? Xiang et al. (2007)

ERP study

a. The tough soldier that Fred treated [. . .] introduced himself [. . .].

b. The tough soldier that Katie treated [. . .] introduced herself [. . .].

c. The tough soldier that Fred treated [. . .] introduced herself [. . .].

a,b. No/Very few restaurants that the local newspapers have recommended [. . .] have ever gone out of business.

c,d. The restaurants that no/very few local newspapers have recommended [. . .] have ever gone out of business.

e. Most restaurants that the local newspapers have recommended [. . .] have ever gone out of business.

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Why intrusion? Xiang et al. (2007)

Results

reflexives:

- gender stereotype violation triggers P600
- no attenuation in intrusion condition (b)
- $\rightarrow$ interference delayed or absent

NPIs:

- P600 in ungrammatical condition (e)
- reduced P600 in c, d
- no difference in latency

$\rightarrow$ intrusion licensing does not reflect partial-cue-match

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Licensors: Warren et al. (2006)

Warren, Vasishth, Hirotani, & Drenhaus (2006)

NPI licensing: a dependency relation (like filler-gap, argument-head)

→ Does locality impact NPI licensing?

unlike in other dependencies, licensors can vary in strength

- strong: licensing NPIs both in restrictor and in scope
- moderate: licensing NPIs only in restrictor

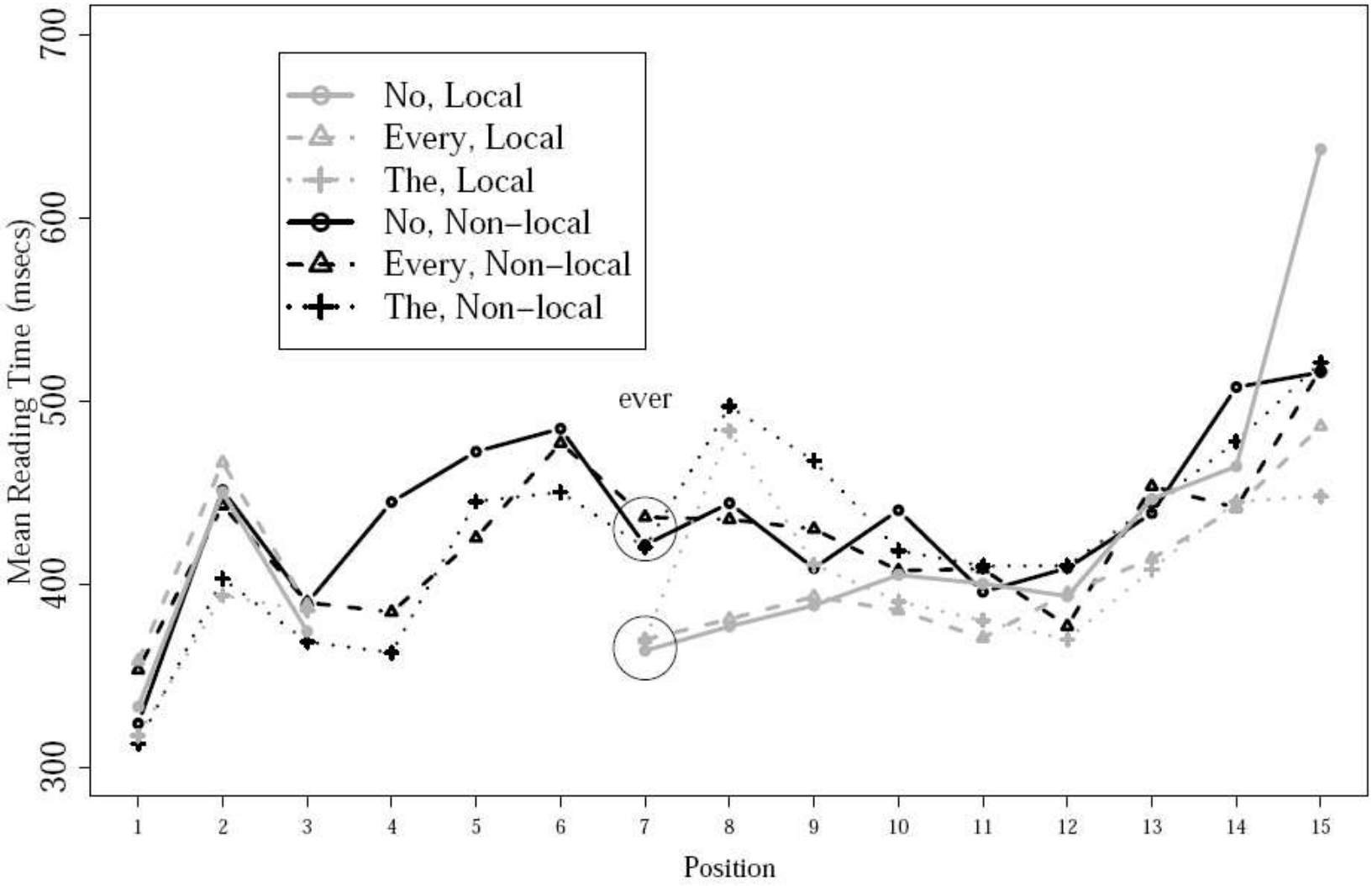
→ Does strength of licensor have an influence?

Licensors: Warren et al. (2006)

English self-paced reading study

a. No man who ever ate apples liked playing football.
b. Every man who ever ate apples liked playing football.
c. The man who ever ate apples liked playing football.
d. No man who the woman said ever ate apples liked playing football.
e. Every man who the woman said ever ate apples liked playing football.
f. The man who the woman said ever ate apples liked playing football.

Licensors: Warren et al. (2006)



Licensors: Warren et al. (2006)

German self-paced reading study

a. Kein Zahnarzt, der jemals nach Asien gereist ist, besass einen Hund.
b. Jeder Zahnarzt, der jemals nach Asien gereist ist, besass einen Hund.
c. Der Zahnarzt, der jemals nach Asien gereist ist, besass einen Hund.
d. Kein Zahnarzt, von dem die Patienten gesagt haben, dass er jemals nach Asien gereist ist, besass einen Hund.
e. Jeder Zahnarzt, von dem die Patienten gesagt haben, dass er jemals nach Asien gereist ist, besass einen Hund.
f. Der Zahnarzt, von dem die Patienten gesagt haben, dass er jemals nach Asien gereist ist, besass einen Hund.

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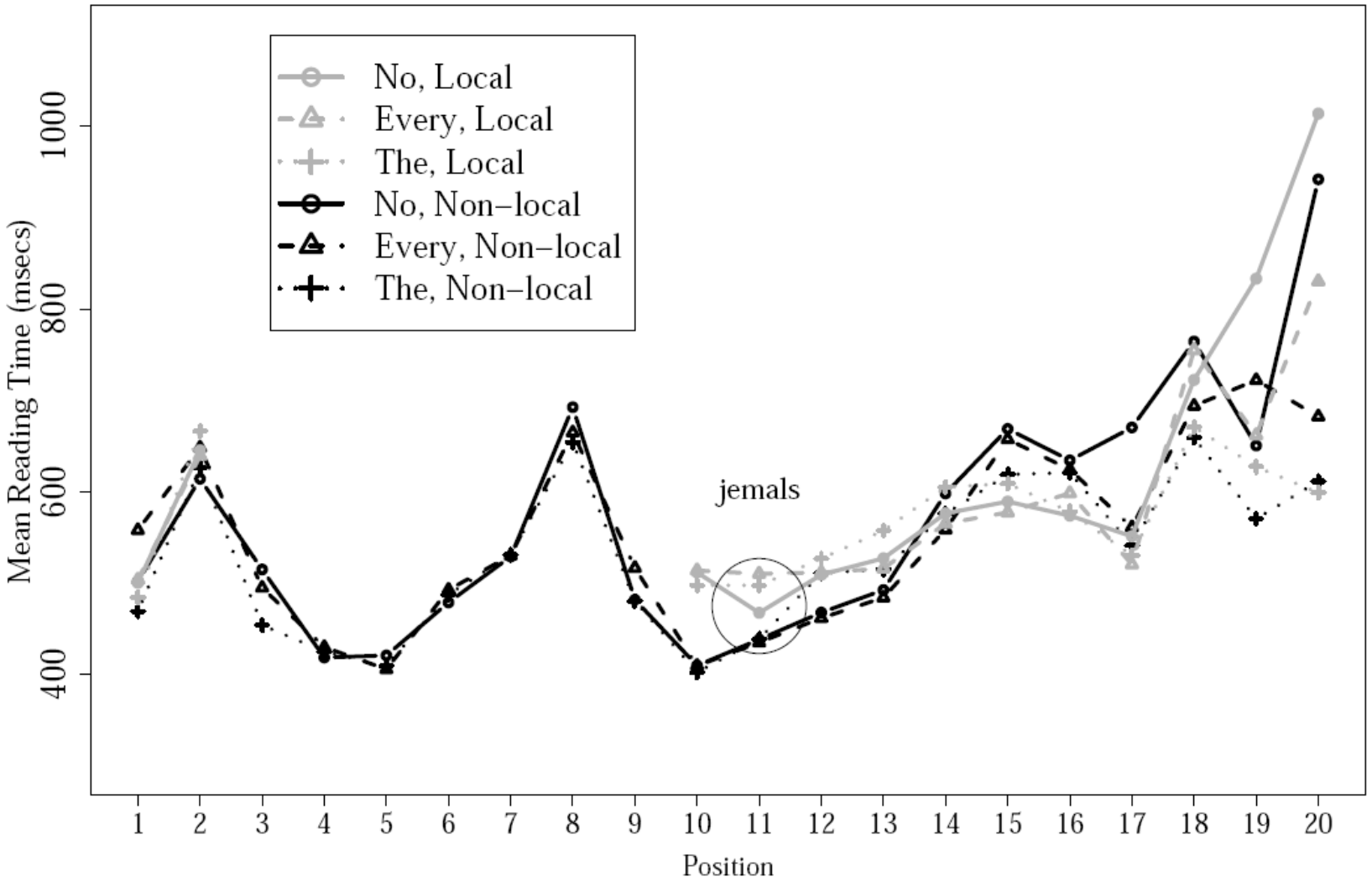

Licensors: Warren et al. (2006)

Summary of results:

English

- non-local dependency processed more slowly than local ones
- not licensed NPI read more slowly than licensed ones
- no effect of licensor strength

German

- anti-locality effect: local NPIs processed *more slowly* than non-local ones
- in local condition: strong licensor condition read faster than moderate one