Linking form and meaning:
evidence from psychgolinguistic research

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Linking form and meaning: mapping principles

Linking form and meaning

The rabbit is eating the carrot.

Linking form and meaning

!The carrot is eating the rabbit.

Mapping principles

- The rabbit is eating the carrot.
- The carrot is eating the rabbit.

- Exactly the same building blocks
- Only differ in order (i.e. form)
- Very different meanings

Mapping principles

- The rabbit is eating the carrot.
- The carrot is eating the rabbit.

Subject   Verb   Object

Agent   Theme
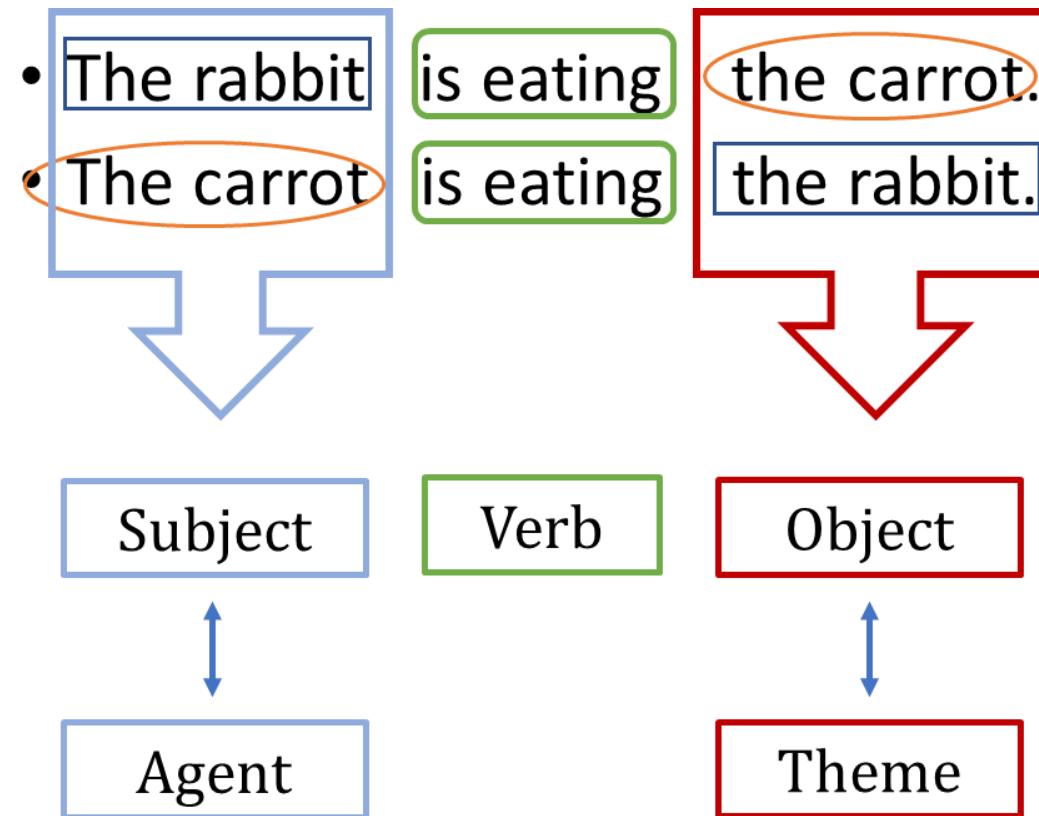
Applications of mapping principles

- Language acquisition

The bunny ate the carrot.

???

Children use the abstract mapping principles (e.g. Gertner, Fisher & Eisengart, 2006)

- Natural Language Understanding

Intransitive sentences

The boy danced.

The boy fell.

Intransitive sentences


The boy danced.
AGENT

The boy fell.
THEME

Challenge to mapping principles

- The rabbit is eating the carrot.

| Subject	Verb	Object
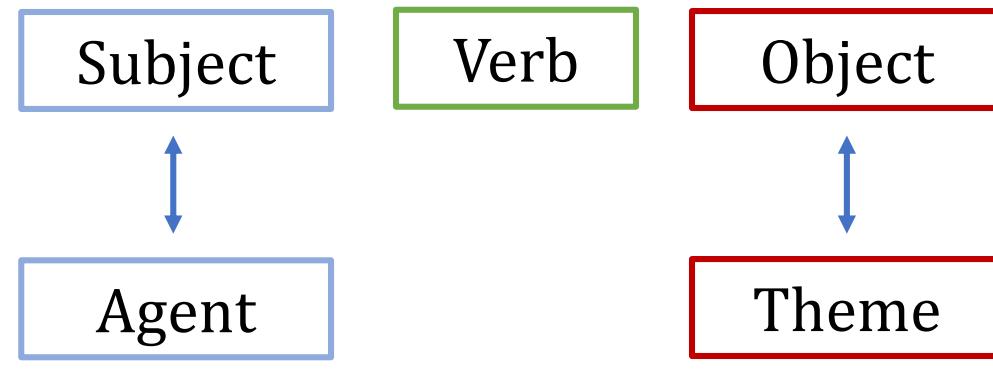
Agent

Theme

The boy danced.

AGENT

The boy fell.

THEME

A theoretical solution
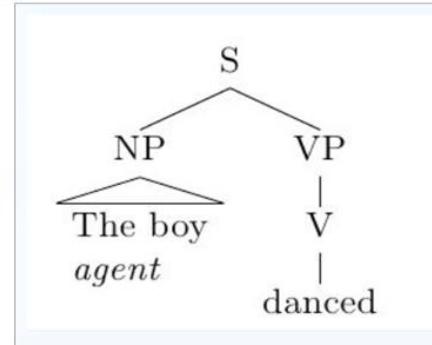
Deep structure   Surface structure
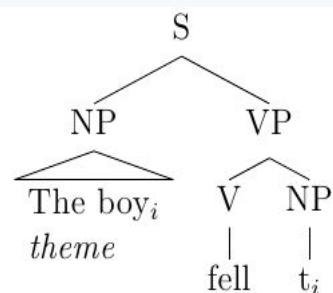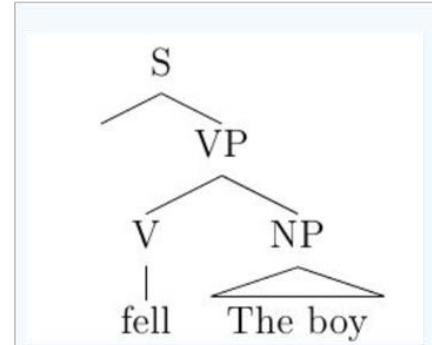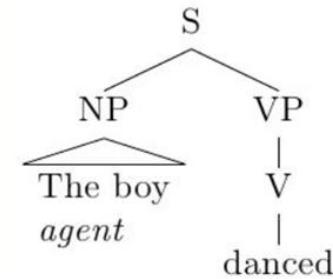
Unaccusative Hypothesis (Perlmutter, 1978; Burzio, 1981)

Language processing evidence

a. The boy danced.
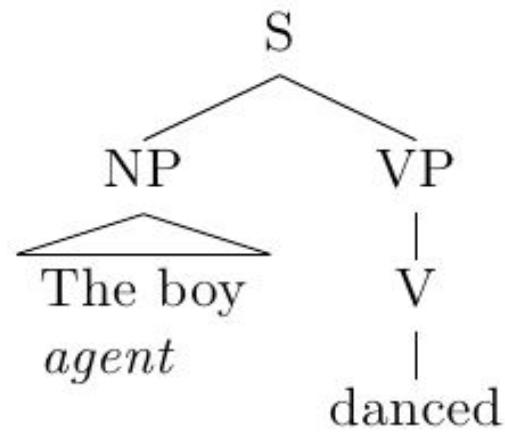
b. The boy$_i$ fell t_i.
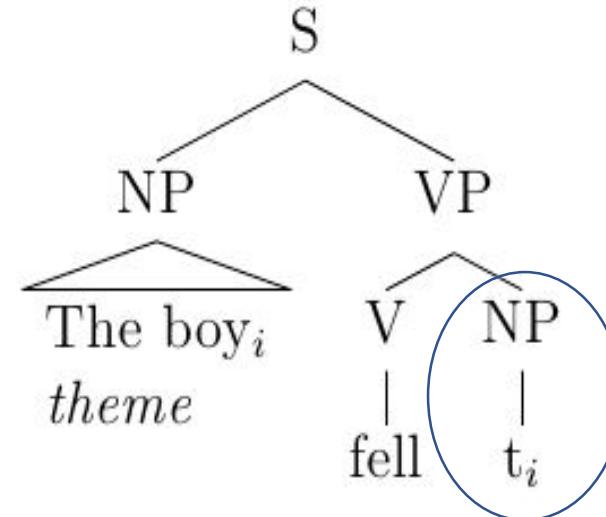
• Subject <u>reactivation</u> at the trace position

Previous studies

- Theme-subject verb (fall): late reactivation around 700 ms after verb offset

- Agent-subject verb (dance): inconsistent

Reactivation Verb	Burkhardt et al. (2003)	Friedmann et al. (2008)	Koring et al. (2012)
Theme-subject	Late reactivation	Late reactivation	Late reactivation
Agent-subject	Early reactivation	No reactivation	Early reactivation

Problems with previous studies

Limitation of the experimental paradigm
- Burkhardt et al. (2003)
- Friedmann et al. (2008)
→Limited temporal resolution leads to incomparable results

Potential confounds
- Animacy
- Imeagability

Data analytical model*
- Koring et al. (2012)

Huang & Snedeker (2020)

Paricipants

- Experiment 1, 2 & 3: 40 native English speakers from the Harvard community

Stimuli

- 40 agent-subject sentences and 40 theme-subject sentences
- 40 filler sentences

Experimental paradigm

- Visual World Paradigm

Visual World Paradigm
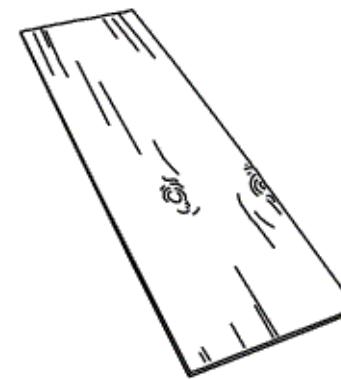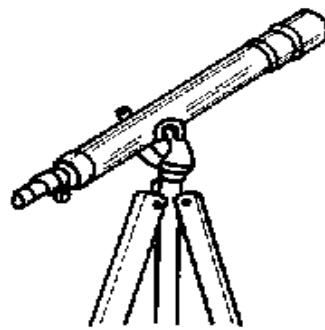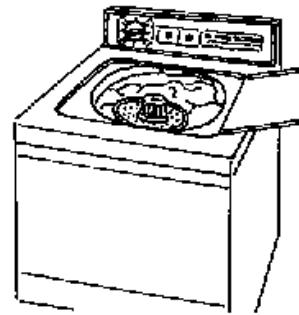
Visual World Paradigm
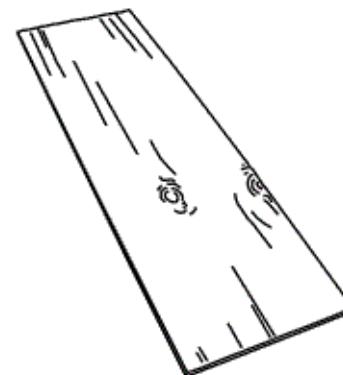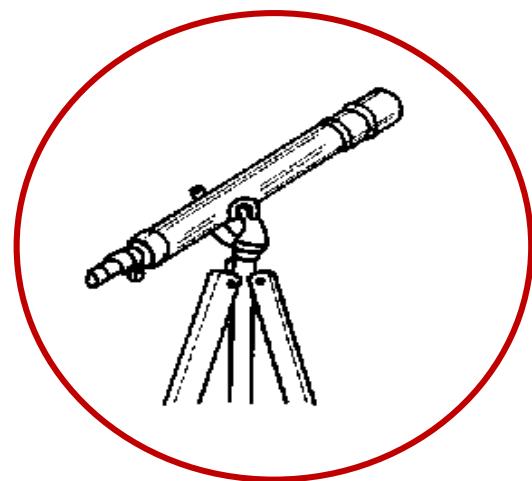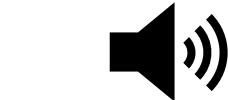
The **astronomer**/**conductor** from a working-class suburb of Los Angeles abruptly *danced*/ *fell* t_i when the party was about to end.
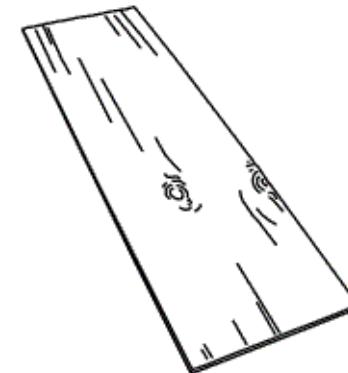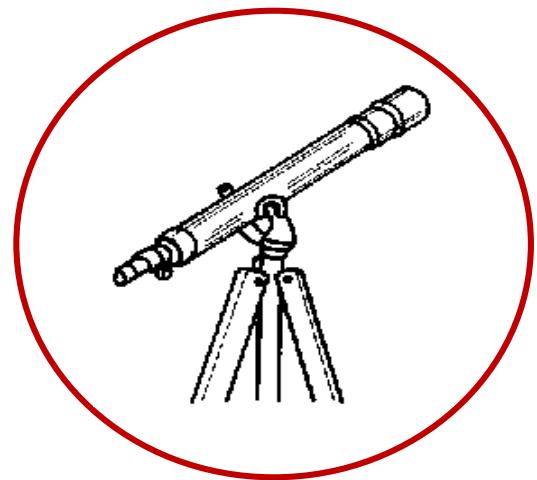
Results: early reactivation window

Huang & Snedeker (2020) *Cognition*
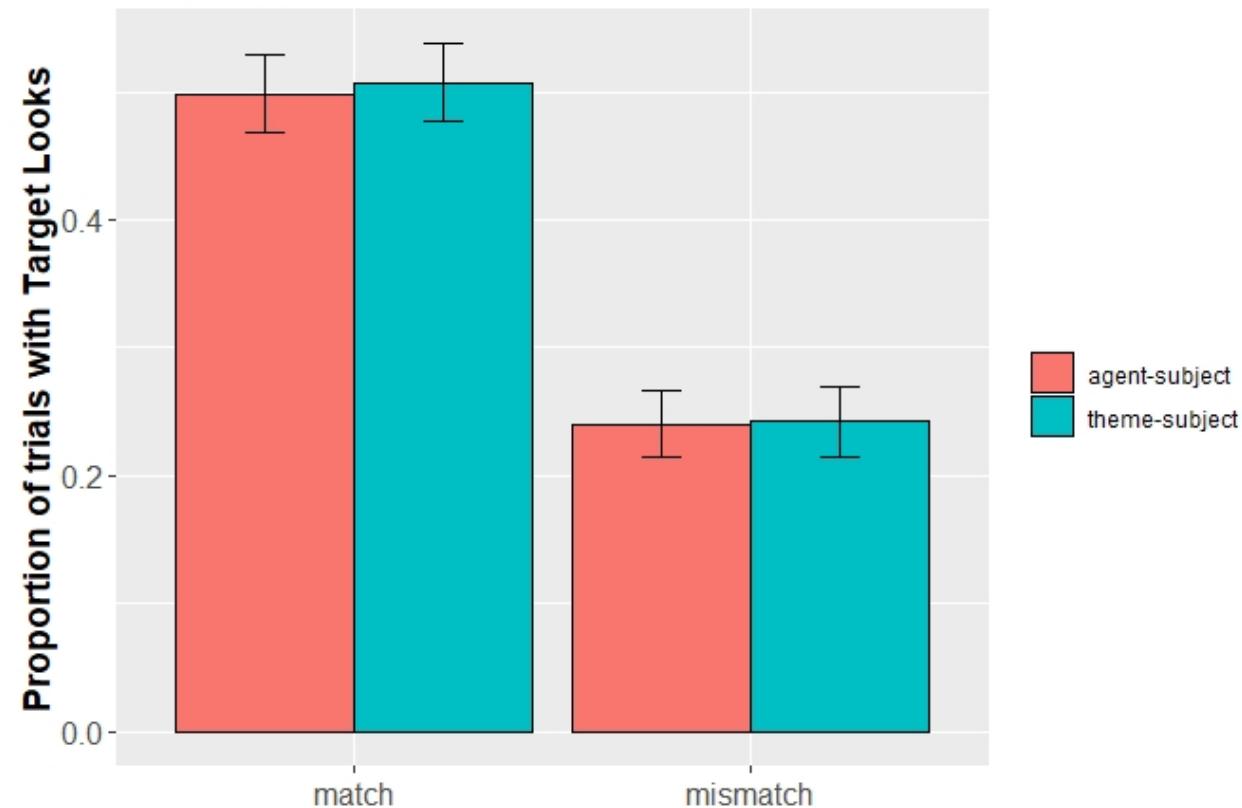
Results: late reactivation window

Huang & Snedeker (2020) *Cognition*
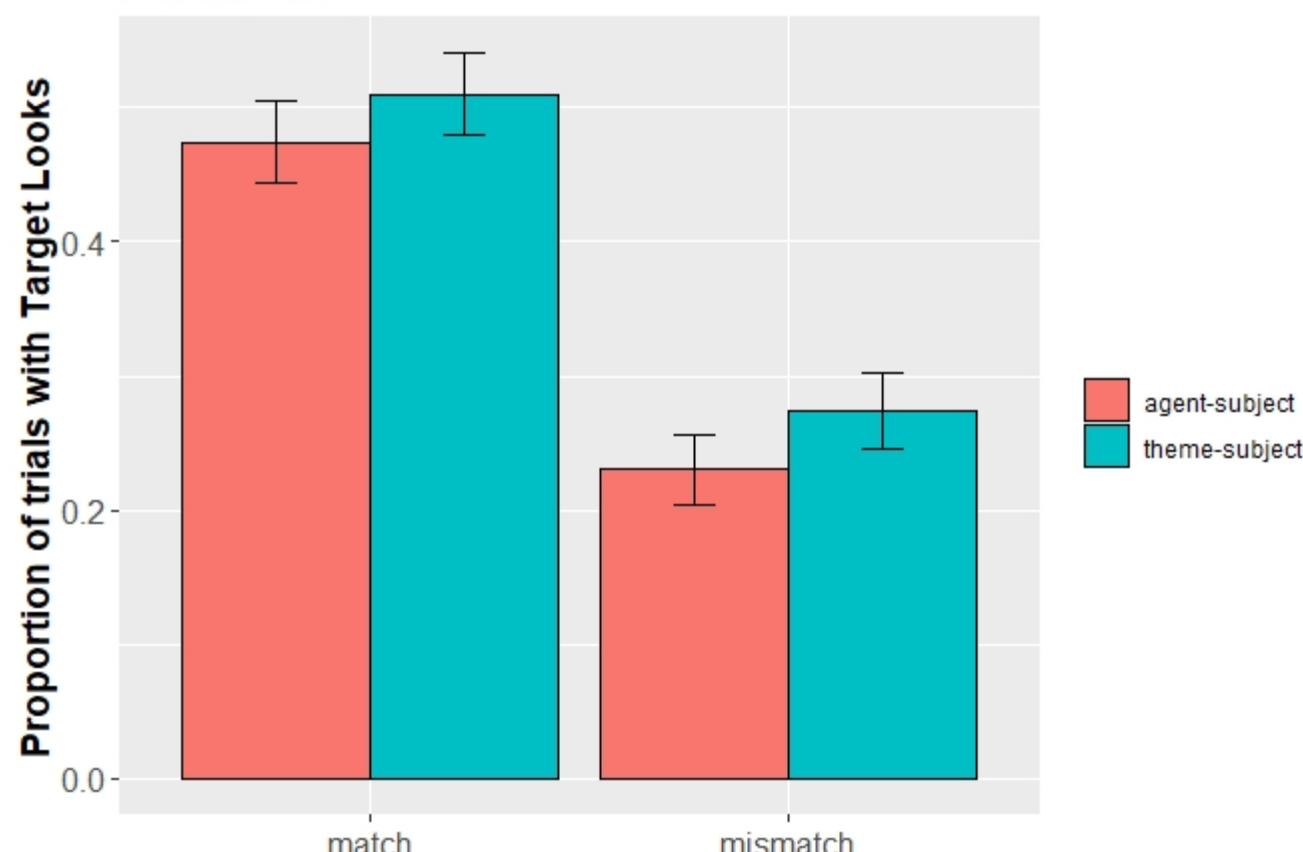
Summary

No difference between agent-subject and theme-subject sentences

These results contradict earlier work

What should we think about the mapping principles between meaning and form?

- Is there a one-to-one correspondence (e.g. subject-agent)? – no
- Can there be a more complex correspondence (e.g. Semantic decomposition)? -maybe

Linking form and meaning: real-time language processing

Garden-path sentence

Garden-path sentences and misinterpretation:

- *Ex: While Mary dressed the baby boy that was cute and cuddly fell off the bed.*

Theories of reanalysis

Garden-path sentences and misinterpretation:

- *Ex: While Mary dressed <u>the baby boy </u>that was cute and cuddly fell off the bed.*

Reanalysis:

Early research focues on structure:

- Comprehenders build a globally licit parse, which implies complete reanalysis (e.g. Frazier & Clifton, 1996)

- Interpretation is linked to structural representation

Huang & Ferreira (2021)

Interpretation

- Comprehension questions that probes into misinterpretation (Christianson et al., 2001)

> *While the man hunted the deer ran into the woods.*

> Did the man hunt the dear? Yes → misinterpretation

Structural representation

- A downstream reflexive as the probe to the syntactic representation (Slattery et al., 2013).

> *After the bank manager telephoned(,) David's **mother** grew worried and gave **himself** approximately five days to reply.*

Q: Is the interpretation linked to the structure?

Huang & Ferreira (2021)

	Match	Mismatch
Garden-Path	While Mary dressed the baby boy that was small and cute fell off the bed and hurt himself very badly.	While Mary dressed the baby girl that was small and cute fell off the bed and hurt himself very badly.
Non-Garden-Path	While Mary dressed, the baby boy that was small and cute fell off the bed and hurt himself very badly.	While Mary dressed, the baby girl that was small and cute fell off the bed and hurt himself very badly.
Comprehension question	Did Mary dress the baby boy?	Did Mary dress the baby girl?

Self-paced reading study

Participants:

- 144 Native English-speaking undergraduate students from University of California, Davis

Apparatus:

- Self-paced reading on Ibex Farm

Design and Procedure:

- Four counterbalanced lists randomly assigned to participants
- Each list consisted of 80 test items and 160 fillers
- All test items followed by a comprehension question probing the possible misinterpretation.
- Comprehension questions also followed half of the fillers and were used as attention checker (75%)

Self-paced reading study

Self-paced reading study

While ____, _____ ____ ____, __ _____ _____ ____ ____.

Self-paced reading study

___ <u>Mary</u> _____ __ __ ___, __ _____ ___ ____ ___.

Self-paced reading study

____ ___, <u>dressed</u> ___ ___, __, __ __ __ __ __ __ __ ____ ___.

Self-paced reading study

_____ ___, _____ the ___, __, __ __ __ __ __ __ __ __ __ ___ ___.

Self-paced reading study

____ ___, _____ ___ <u>baby</u> ___, __ __ __ __ __ __ __ __ __ ____ ____.

Self-paced reading study

___ ___, ___ ___ ___ ___, girl ___ ___ ___ ___ ___ ___ ___ ___ ___.

Self-paced reading study

_____ __ _, ___ ___ __, __. <u>fell</u> __ __ __ __ __ __ __ __ __.

Self-paced reading study

___ ___ ___ ___ ___ ___, ___, ___ off ___ ___ ___ ___ ___ ___ ___

Self-paced reading study

____ ___ ___, ___ ___ __ ___, __ ___ the ___ ___ ___ ___ ____ ___.

Self-paced reading study

_____ ___ ___ _____ __ __ _____ __ __ ___ bed ___ ___ _____ ___.

Self-paced reading study

_____ ___ __, ____ __ __ __ __, __ __ __ __ ___ and ___ _____ ___.

Self-paced reading study

____ ___, ___ ___ __ ___, __, ___ ___ ___ ___ __hurt__ _____ ____.

Self-paced reading study

____ ___, ____ __ ___, __ __ __ __ ___ <u>himself</u> ___.

Self-paced reading study

____ __ _, ____ __ __ __, __ __ __ __ __ __ _____ badly.

Self-paced reading study

Did Mary dress the baby girl?

Yes

No

Predictions

While Mary dressed(,) the baby boy/girl that was small and cute fell off the bed and hurt himself very badly.

- Garden-path effect:

→ Longer reaction time on the verb *fell* with no comma

- Gender mismatch effect:

→ Longer reaction time on the reflexive *himself* with the antecedent *girl*

Results: garden-path effect

Measures	Garden-path	Mismatch	Interaction
Verb (fell)	<.01**	n.s.	n.s.
Spill-over 1	<.01**	n.s.	n.s.
Spill-over 2	<.01**	n.s.	n.s.

While Mary dressed(,) the baby girl that was small and cute fell off the bed and hurt himself very badly.

Huang & Ferreira (2021) *JML*

Results: gender mismatch effect

Measures	Garden-path	Mismatch	Interaction
Reflexive	n.s.	n.s.	n.s.
Spill-over 1	n.s.	<.01**	n.s.
Spill-over 2	n.s.	<.01**	n.s.

While Mary dressed(,) the <u>baby boy/girl</u> that was small and cute fell off the bed and hurt himself very badly.

Response accuracy

Responses to comprehension questions:

- Garden-path (ambiguous): 46%

- Non-garden-path (unambiguous): 64%

Relationship between meaning and form?

Possible outcomes

- Gender mismatch effect only shows up in trials with correct responses → reanalysis leads to correct interpretation

- Gender mismatch effect shows up in trials with both types of responses →reanalysis does not always lead to correct interpretation

Huang & Ferreira (2021) *JML*

Results: split-trial analysis

- ~~Gender mismatch effect only shows up in trials with correct responses →~~
  ~~reanalysis leads to correct interpretation~~

- Gender mismatch effect shows up in trials with both types of responses
  →reanalysis does not always lead to correct interpretation

Measures	Correct	Incorrect
Reflexive	n.s.	n.s.
Spill-over 1	<.001***	<.01**
Spill-over 2	<.01**	<.01**

Huang & Ferreira (2021) *JML*

Summary

- The misinterpretation resulted from the misanalysis can linger even after participants finish reading the entire sentence

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- The gender mismatch effect indicates that participants can find the correct antecedent of the reflexive → reanalysis

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- The gender mismatch effect indicates that participants can find the correct antecedent of the reflexive → reanalysis

- The gender mismatch effect is present regardless of the response accuracy of the comprehension question

Implications

- The misinterpretation is not a result of the incorrect syntactic representation but due to the initial misinterpretation that lingers in memory.

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- An alternative explanation: the local structure is licit, but a global structure is never constructed

  [While Mary dressed [the baby boy] fell off the bed and hurt himself very badly].

Implications

- The misinterpretation is not a result of the incorrect syntactic representation but due to the initial misinterpretation that lingers in memory.

→ ~~Meaning and form are tightly linked in language processing~~

- An alternative explanation: the local structure is licit, but a global structure is never constructed

→ ~~Reanalysis needs to be complete~~

- Studying interpretation and structure together brings new insights into language processing theory

Conclusion

Linking form and meaning

- Mapping principles

- Real-time language processing

Conclusion

Linking form and meaning

- Mapping principles

→ limited

- Real-time language processing

→ incomplete

Future directions

Mapping principles

- More detailed semantics: e.g. agent in transitive sentences vs. agent in intransitive sentences

- Sentence frames and verb meaning: e.g. verbs of existence
  - There existed a king.
  - *There smiled a king.

- Mapping regularities and acquisition of verbs
  - To what degree can phenomena in language acquisition be exaplained by mapping regularities?

Future directions

More detailed semantics: e.g. agent in transitive sentences vs. agent in intransitive sentences

Proto-Agent properties	Proto-theme properties
Volitional involvement in the event or state	Undergoes change of state
Sentience (and/or perception)	Incremental theme
Causing an event or change of state in another participant	Causally affected by another participant
Movement (relative to another participant)	Stationary relative to movement of another participant
Exists independently of the event named by the verb	Does not exist independently of the event, or not at all

Dowty (1991)

Future directions

| Question |
| --- |
| How likely is it that the [subject\|object] chose to be involved in [verbing]? |
| How likely is it that the [subject\|object] was aware of being involved in [verbing]? |
| How likely is it that the [subject\|object] caused a change in the [object]? |
| How likely is it that the [subject\|object] caused the [object] to do something? |
| How likely is it that the [subject\|object] moved during/after [verbing]? |
| How likely is it that the [subject\|object] existed before [verbing] took place? |
| How likely is it that the [subject\|object] was changed in some way as a result of [verbing]? |
| How likely is it that the [subject\|object] was created as a result of [verbing]? |
| How likely is it that the [subject\|object] was stationary? |
| How likely is it that [verbing] could be interrupted and still be referred to as [verbing]? |

Future directions

More detailed semantics: e.g. agent in transitive sentences vs. agent in intransitive sentences
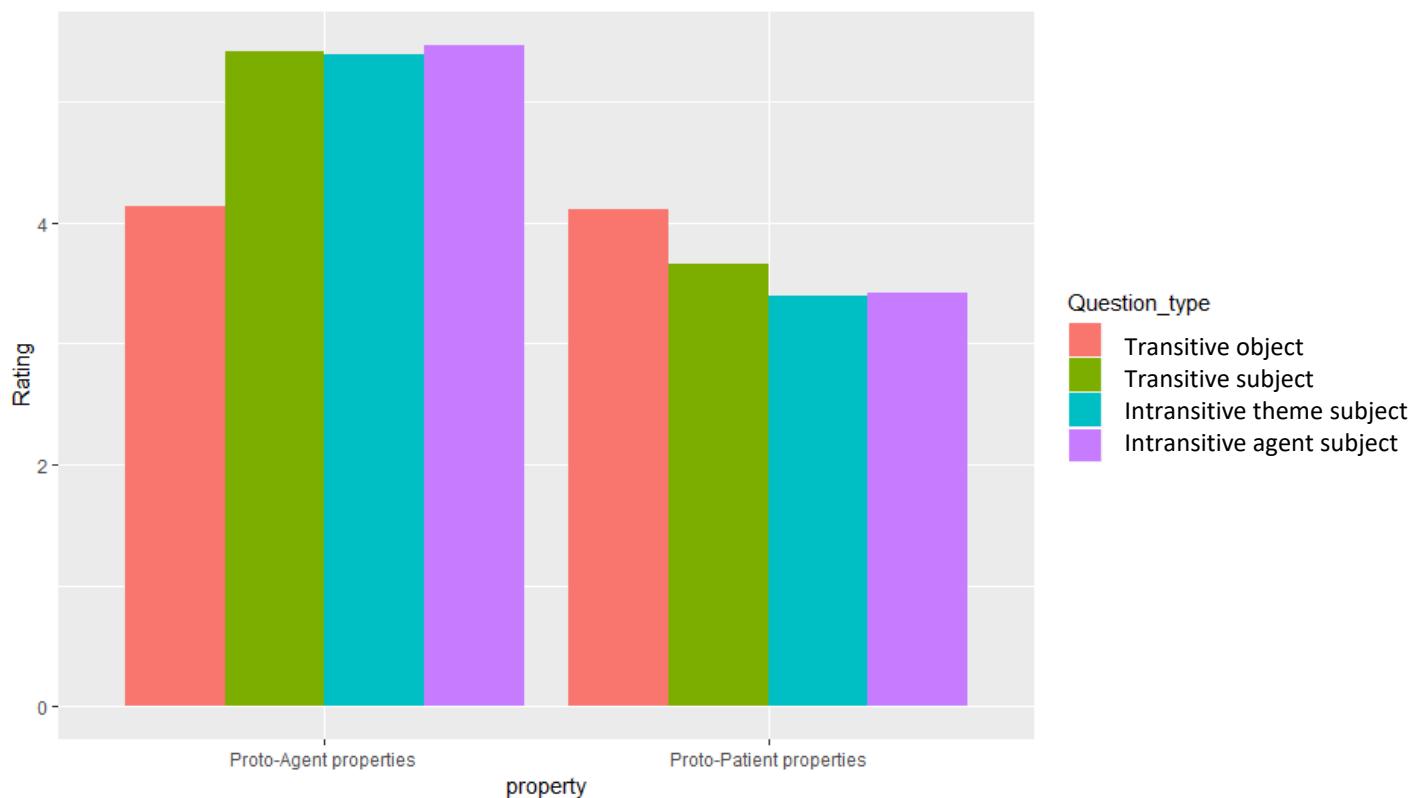
Future directions

Language processing mechanisms

- Can reanalysis be incomplete?

- How does cognitive processes such as memory influence language processing?

- How does different linguistic factors such as plausibility influences language processing?

Future directions

How does different linguistic factors such as plausibility influences the interpretation? → misanalysis, reanalysis, or interpretation?

Plausible

    While Mary dressed the **boy** fell off the stairs and hurt himself very badly.

    While Mary dressed the **girl** fell off the stairs and hurt himself very badly.

Implausible

    While Mary dressed the **maid** fell off the stairs and hurt himself very badly.

    While Mary dressed the **butler** fell off the stairs and hurt himself very badly.

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