

Processing pragmatic and referential information II

9.59 / 24.905

March 10, 2005

Ted Gibson

To do today

1. One theory of processing some non-literal language: **The Referential Theory**
 1. The principle of parsimony
 2. The principle of referential support
2. Referential information
3. Modularity re-visited: Can discourse information guide syntactic processing?

Processing non-literal language

- Gricean Maxims: Cooperative conversation.
 - Violating a maxim leads to an implicature.
- One theory of processing some non-literal language
 - **The Referential Theory**
 - Minimize discourse structure, including counting all Gricean implicatures.
 - Relies on violations of Gricean informativity in order to compute implicatures.

Referential theory (Crain & Steedman, 1985; Altmann & Steedman, 1988)

The referential theory was developed to account for the observation that the null context is not necessarily a neutral context: The null context might favor one interpretation over another.

E.g. MV/RR ambiguity:

(1) # The horse raced past the barn fell. (Bever, 1970)

The standard view in the literature was that the garden-path effect in (1) was due to a syntactic preference for the MV over the RR structure.

The referential theory

- **I: The principle of parsimony** (Crain & Steedman, 1985): A reading which carries fewer unsupported implicatures will be favored over one that carries more.
- **II: The principle of referential support** (Altmann & Steedman, 1988): An NP analysis which is referentially supported will be favored over one that is not.

Referential theory explanation of the garden-path effect in (1): There are fewer unsupported *implicatures* (C&S refer to them as presuppositions, but this isn't quite the right term) in the MV structure than in the RR structure. This follows from the principle of parsimony.

Discourse structures in the mental model for the MV structure of "the horse raced":

1. A horse h_i ;

Discourse structures in the mental model for the RR structure of "the horse raced":

1. A horse h_i ;
2. A set of horses H of which h_i is a member;
3. One of this set, h_i , was raced somewhere;
4. None of the other members of the set H have the property in (3), that they were raced in the same way that h_i was raced.

There are three additional implicated structures in the RR structure, so the MV reading is preferred in the null context.

More general case:

When the definite article “the” is used with a head noun and a modifier (either before or after the noun), this implicates the existence of a set of nouns of which only one has the property indicated by the modifier.

This hypothesis relies on an implicature from a violation of a Grice’s conversational maxim of quantity:

Maxim of quantity: Speakers should say as much as needed to be informative, without saying more than is necessary.
(Grice, 1975)

Otherwise the speaker could simply have said “the horse fell” instead of “the horse raced past the barn fell.”

Experimental tests of the principle of parsimony

1. **Crain & Steedman (1985): Bare plurals vs. definite plurals in the MV/RR ambiguity**

Definite determiner ("the") + modifier: implicates the existence of a contrast set.

Indefinites ("a", or bare plural) + modifier: weaker implication of the existence of a contrast set.

E.g.,

"The teacher that was taught by the Berlitz method"

This implicates a set of teachers, one of whom was taught by the Berlitz method, and the others were not.

"A teacher that was taught by the Berlitz method"

This introduces a teacher, but has a weaker implication for a set of teachers.

"Teacher that were taught by the Berlitz method"

This implicates a set of teachers that were taught by the Berlitz method. The contrast set (the teachers that were not taught by the Berlitz method) is more weakly implicated.

Experimental tests of the principle of parsimony

1. **Crain & Steedman (1985): Bare plurals vs. definite plurals in the MV/RR ambiguity**

Speeded grammaticality task:

(2) a. Definite plural, Plausible subject

The teachers taught by the Berlitz method passed the test.

b. Bare plural, Plausible subject

Teachers taught by the Berlitz method pass the test.

c. Definite plural, Implausible subject

The children taught by the Berlitz method passed the test.

d. Bare plural, Implausible subject

Children taught by the Berlitz method pass the test.

Crain & Steedman (1985): Bare plurals vs. definite plurals in the MV/RR ambiguity

Results:

1. Bare plurals were accepted as grammatical more than definite plurals;
2. Implausible subject sentences were accepted as grammatical more than plausible subject sentences.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

“the” + N + modifier: implication of a contrast set of N’s. All modifiers of a head Noun are generally taken to be contrastive following the determiner “the”.

The focus operator **“only”** *always needs* a contrast set, but only one:

(5) In New Haven only Willoughby's coffee is really good.

(5) is true if: (a) the coffee at Willoughby's is good; and (b) the coffee everywhere else in New Haven is not good.

This is an implicit comparison: a contrast set. If no contrast set is explicitly mentioned in the discourse, then one has to be constructed.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

Experiments 1 and 2: MV/RR in self-paced reading and eye-tracking

- (6)
 - a. The, ambiguous (adjective)
The (wealthy) businessmen loaned money at low interest were told to record their expenses.
 - b. Only, ambiguous
Only (wealthy) businessmen loaned money at low interest were told to record their expenses.

- (7) Unambiguous controls:
The/Only (new) vans stolen from the parking lot were found in a back alley.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

Predictions:

Minimal attachment: reanalysis effect at “were told...” in all four versions.

Referential theory: reanalysis effect at “were told...” in (a), (c) and (d) versions, but not in the (b) version.

In (a) and (c), this prediction is because of the use of the definite determiner “the” and a potential modifier of the head noun (the RR reading): more implicated discourse structure.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

(b) Only businessmen loaned money at low interest were told to record their expenses.

In (b), the focus operator “only” needs to find a contrast set for its head noun “businessmen”:

Two options:

1. The MV interpretation: Create a contrast set out of thin air: businessmen as opposed to other types of men / people

2. The RR interpretation: Break the set of businessmen into two subsets. The RR modification of businessmen is one way of instantiating this option: Contrast set already given.

Therefore, the referential theory (the principle of parsimony) predicts that people will follow the RR reading.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

(d) Only wealthy businessmen loaned money at low interest were told to record their expenses.

In (d), the contrast set for “only” is provided by the adjective “wealthy”. There is no need for another contrast set at “loaned”, so the MV structure is predicted to be preferred.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

Summary: condition (b) is predicted to pattern like the unambiguous controls. The others are predicted to show reanalysis effects when compared to the unambiguous controls.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

Self-paced reading results:

Graph removed for copyright reasons.

The predictions of the referential theory were ratified.

Ni, Crain & Shankweiler (1996): “only” vs. “the” in MV/RR ambiguity

Eye-tracking results:

Graph removed for copyright reasons.

The predictions of the referential theory were ratified.

The referential theory

- **I: The principle of parsimony** (Crain & Steedman, 1985): A reading which carries fewer unsupported implicatures will be favored over one that carries more.
- **II: The principle of referential support** (Altmann & Steedman, 1988): An NP analysis which is referentially supported will be favored over one that is not.

Referential theory explanation of the garden-path effect in (1): There are fewer unsupported presuppositions (this is C&S's term: a better term is *implicatures*) in the MV structure than in the RR structure. This follows from the principle of parsimony.

Tests of the principle of referential support

Suppose that there is no difference in the number of unsupported presuppositions for either of two readings.

E.g., Consider (1) in the context of a horse, and a set of horses, only one of which was raced past the barn.

(1) The horse raced past the barn fell.

The principle of parsimony does not apply: no extra implicatures in either interpretation.

Tests of the principle of referential support

II: The principle of referential support (Altmann & Steedman, 1988): An NP analysis which is referentially supported will be favored over one that is not.

An NP is referentially supported if we can pick out the appropriate object of the referring expression from the context.

In the above context, the RR analysis is referentially supported, but the MV is not. The MV structure includes a reference to "the horse", but does not specify which horse, so it is not referentially supported.

Referential (discourse-dependent) expressions

- Linguistic forms that get their meaning from the discourse context.
- Help to create cohesion between sentences
- Examples:
 - Pronouns: A woman lost track of her little boy. **She** was worried.
 - Demonstratives: **That** was the worst exam I had all term.
 - Comparatives: It's the **same** band we heard last week.
 - Substitution: My computer is too slow. I need a faster **one**.
 - Ellipsis: I wish I had more talent. My sister has **more** than I do.
 - Reiteration: I saw a boy win the race. **The boy** was delighted.
 - Synonymy: I saw a boy win the race. **The lad** was delighted.

Anaphora (Anaphoric Reference)

- Anaphor – refers backward
- Cataphor – refers forward
- Antecedent – thing referred to

Bill walked outside. **He** looked up.

The animals snarled at **him**. **Bill** didn't know why.

- VP anaphora (ellipsis)

Mary **drove past the old farm**. Bill **did** too.

Tests of the principle of referential support: Eye-tracking in context

Monitoring visual eye-movements while listening to spoken instructions

“Put the frog on the napkin into the box.”

Two frog context: No looks to the incorrect target (the second napkin)

Photo removed for copyright reasons.

One frog context: Many looks to the incorrect target (the second napkin)

Tests of the principle of referential support in reading

1. Crain & Steedman (1985): V-NP-CP ambiguity

Clausal argument of verb (complement clause / CC) or modifier of NP (relative clause/ RC)

a. Contexts: One or two NP referents

A psychologist was counseling {(two women) | (a man and a woman)}. He was worried about one of them but not the other.

b. Target sentence: RC/CC

The psychologist told the woman that he was having trouble with {(to leave) / (her husband)}.

Tests of the principle of referential support in reading

Predictions:

Minimal Attachment: CC preference independent of context.

Referential theory: CC preference in one referent context; RC preference in two referent context

Task: speeded grammaticality.

Results: The interaction predicted by referential support was observed:

	2 referents	1 referent
CC attachment	46%	78%
RC attachment	88%	50%

Some experiments that failed to find that contexts helped

Ferreira & Clifton (1986): MV/RR ambiguity

Sentences in isolation or in RR supporting contexts:

- a. MV: The editor played the tape and agreed the story was big.
- b. RR: The editor played the tape agreed the story was big.

Contexts: One editor or two editors.

Results: No effect of context: The MV disambiguations were read faster independent of context.

Some experiments that failed to find that contexts helped

Ferreira & Clifton (1986): MV/RR ambiguity

But problem: The contexts weren't biased enough towards the RR structure (Spivey-Knowlton & Tanenhaus, 1994).

In particular, there were additional unsupported implicatures in the RR structures that were not made explicit in the contexts.

The context did not provide the information that one of the editors was played a tape, and the other was not.

Some experiments that failed to find that contexts helped

3. Murray & Liversedge (1994): MV/RR ambiguity, eye-tracking

a. Context: One vs. two referents

Two people were discussing the food that had been prepared at the barbecue. One was a guest that enjoyed meat and the other was a caterer / guest who was a vegetarian.

b. Target

MV: The guest grilled the steak and said it tasted nice.

RR: The guest (who was) grilled the steak said it tasted nice.

Some experiments that failed to find that contexts helped

Results:

The disambiguating region was read slower for the RR compared to either the MV or the unambiguous RR, regardless of context.

But problem:

The contexts aren't biased enough toward the RR structures. The context does not specify that someone had grilled a steak for exactly one of the guests. According to referential theory, this discourse structure needs to be added when the RR structure is processed.

Spivey-Knowlton & Tanenhaus (1994)

Experiment 1:

One referent context:

An actress and the producer's niece were auditioning for a play. The director selected the actress but not the niece.

Two referents context:

Two actresses were auditioning for a play. The director selected one of the actresses but not the other.

Target:

The actress (who was) selected by the director believed that her performance was perfect.

Spivey-Knowlton & Tanenhaus (1994)

Results:

Graph removed for copyright reasons.

Spivey-Knowlton & Tanenhaus (1994)

Results:

Significant interaction between context and target sentences in the disambiguating region “by the director”:

Ambiguous targets were read more slowly than unambiguous controls in the one referent condition, but no differences in the two referent condition.

This is as predicted by referential support.

Modularity re-visited: Can discourse information guide syntactic processing?

Generalizing referential theory to the processing of unambiguous sentences (Grodner, Gibson & Watson, in press)

The referential theory (parsimony, referential support) as stated applies only in the resolution of ambiguity.

Three ways that Referential Theory might apply:

(1) Ambiguity Only Hypothesis

Generalizing referential theory to the processing of unambiguous sentences

(2) Weakly-Interactive Mental Models Hypothesis (Modular: syntax first):

Sentences are parsed using intrasentential criteria, such as syntactic knowledge. The resultant analysis (or analyses in the case of ambiguity) is then evaluated against the context, and changes are incrementally made to the current discourse model. These changes can incur costs that interfere with interpretive processes and lead to comprehension difficulty.

Applies in unambiguous contexts, as well as in resolving ambiguity

Generalizing referential theory to the processing of unambiguous sentences

(3) Strongly-Interactive Mental Models Hypothesis (Non-modular):

The discourse model is constantly updated and accessed in the comprehension of a sentence. Sometimes the sentence causes the construction of discourse structure. Other times the discourse model directs interpretive processes and projects syntactic structures.

Applies in unambiguous contexts, as well as in resolving ambiguity

Materials to test the hypotheses: Restrictive and non-restrictive RCs

- Restrictive RCs: usually function to identify a set. In a null context, this often implicates a contrast set.
 - Non-restrictive RCs: additional information about the head. No implication of a contrast set.
- (4) a. Restrictive RC: The boy that studied for the exam aced the test.
- b. Non-restrictive RC: Mary, who studied for the exam, aced the test.

Restrictive and non-restrictive RCs

Non-restrictive RCs can modify nominal heads that do not permit contrast:

(5)

- a. My father, who ate ham this morning, became extremely ill.
- b. The sun, which rises in the east, can be used to orient oneself.

Restrictive RCs can't:

(6)

- a. *My father that ate ham this morning became extremely ill.
- b. *The sun that rises in the east can be used to orient oneself.

Restrictive and non-restrictive RCs

Observation: Restrictive RCs involve more discourse structure than non-restrictive RCs: a contrast set. Therefore, if referential theory applies in unambiguous structures, a restrictive RC should be harder to process in a null context, other factors being equal.

Restrictive and non-restrictive RCs

(7) Null Context

a. Restrictive RC

A postman that a dog bit on the leg needed seventeen stitches and had a permanent scar from the injury.

b. Non-Restrictive RC

A postman, who a dog bit on the leg, needed seventeen stitches and had a permanent scar from the injury.

Restrictive and non-restrictive RCs

Predictions:

Ambiguity only: no differences.

Both strong and weak mental models hypotheses predict that the restrictive RC should be slower to process than the non-restrictive RC.

Prediction of strong mental models hypothesis

In certain specific situations, the discourse context can cause people to expect certain syntactic structures.

One instance where this may be the case: processing a definite NP (e.g., “the postman”) when there are two potential referents for the head noun in the discourse (e.g., two postmen).

In this situation, we may **expect** modification.

Contextually supported RCs

(8) Supportive Context

a. Restrictive RC

A vicious guard dog bit a postman on the leg and another postman on the arm.

The postman that the dog bit on the leg needed seventeen stitches and had a permanent scar from the injury.

b. Non-Restrictive RC

A vicious guard dog bit a postman and a garbage man.

The postman, who the dog bit on the leg, needed seventeen stitches and had a permanent scar from the injury.

Contextually supported RCs

Prediction of strong mental models hypothesis:
restrictive RCs should be **faster** than non-restrictive
RCs in a supportive context.

The ambiguity-only hypothesis and the weakly
interactive mental model hypothesis do not make this
prediction.

Experiment 1 materials

Null Context, Restrictive RC

A postman **that a dog bit on the leg** needed seventeen stitches...

Null Context, Non-Restrictive RC

A postman, **who a dog bit on the leg**, needed seventeen stitches...

Supportive Context, Restrictive RC

A vicious guard dog bit a postman on the leg and another postman on the arm.

The postman **that the dog bit on the leg** needed seventeen stitches...

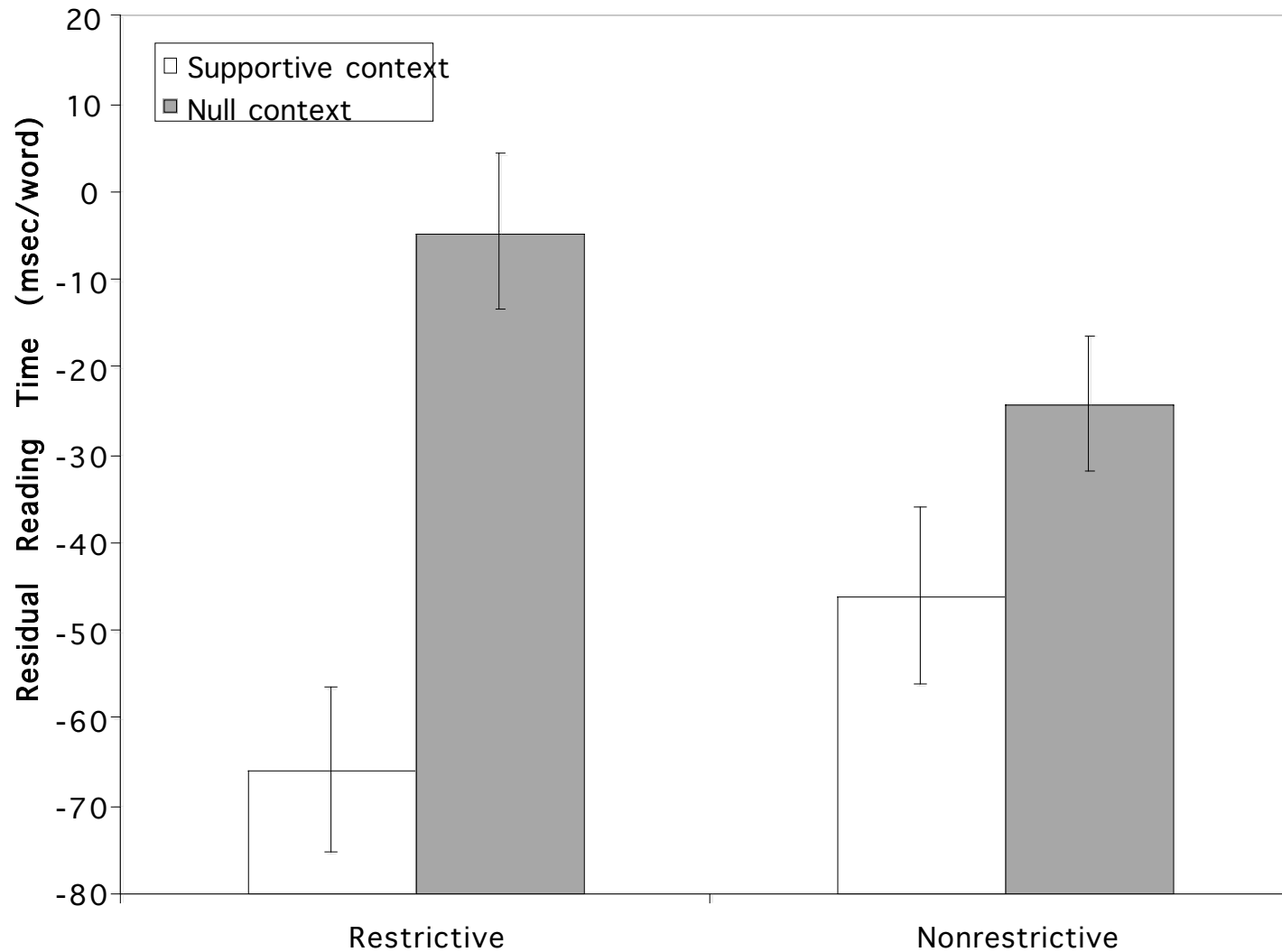
Supportive Context, Non-Restrictive RC

A vicious guard dog bit a postman and a garbage man.

The postman, **who the dog bit on the leg**, needed seventeen stitches...

Results: Discourse complexity experiment

Reaction times during the noun and verb of the RCs ("dog bit")



Results: Discourse complexity experiment

- (1) In the null context, restrictive RCs were read slower than non-restrictive RCs.
- (2) In a supporting context, restrictive RCs were read faster than non-restrictive RCs

These results were as predicted by the strongly-interactive mental models hypothesis, but not by the other hypotheses.

Conclusions of discourse complexity experiment

- (1) A referential theory / mental models theory applies in unambiguous structures, in addition to ambiguous structures.
- (2) The discourse context may sometimes be strong enough to guide syntactic structure building.

What we did today

1. One theory of processing some non-literal language: **The Referential Theory**
 1. The principle of parsimony
 2. The principle of referential support
2. Referential information
3. Modularity re-visited: Can discourse information guide syntactic processing? Yes