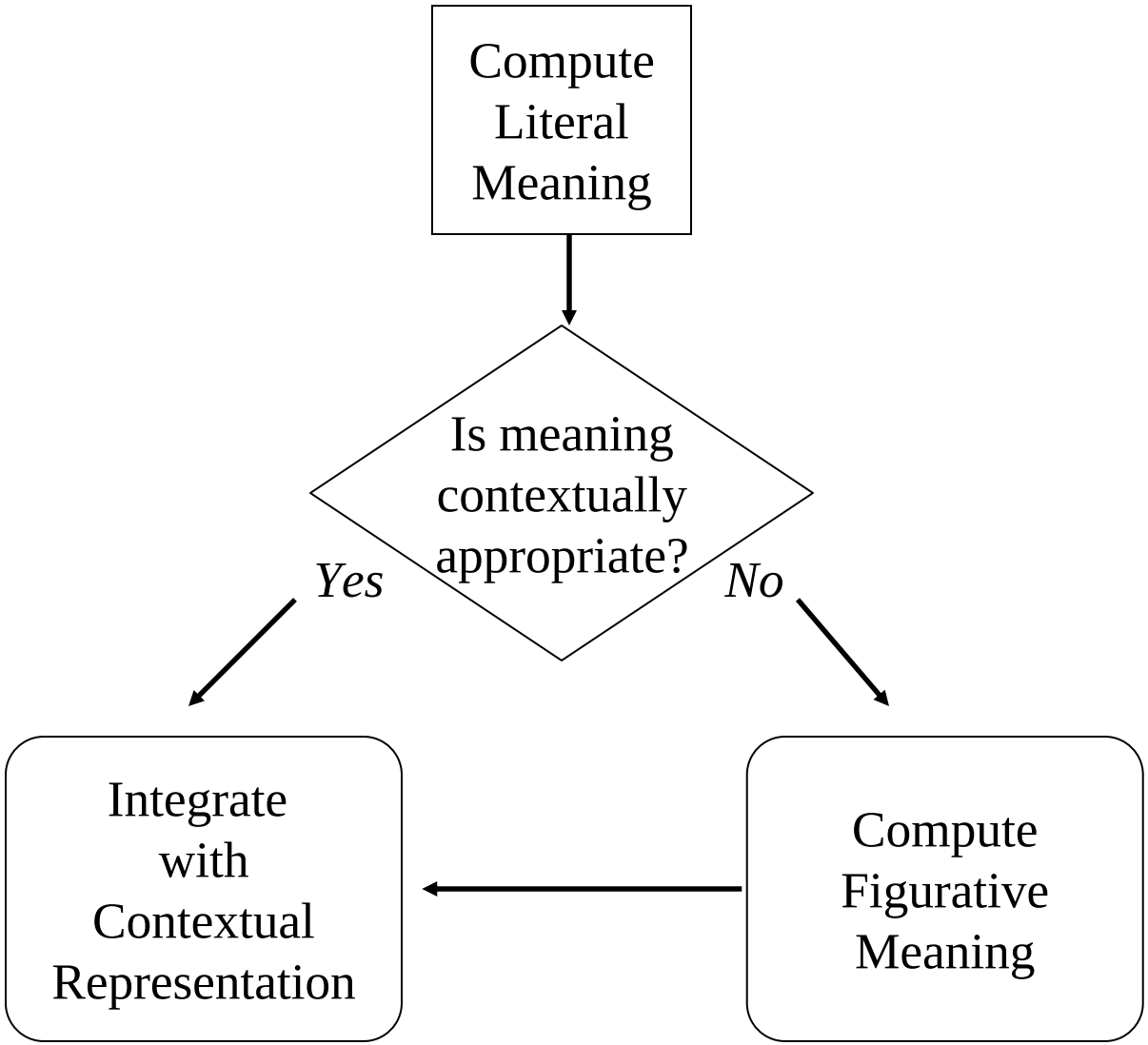
Proposals

- Due Friday March 17 in Coulson's mailbox
  - OK to turn in during our last class (3/16)
- Abstract
  - Is there one?
  - Does abstract provide a quick overview of what comes next?
- Introduction
  - Is it clear that the research question is an interesting and important one?
  - Does the text make clear why EEG/ERP is a good technique to use to answer this question?
  - Has previous work on this topic been described where relevant?
    - Do describe previous studies if you will build on them
    - Don't describe all studies on this topic in great detail
  - Are references cited appropriately?
  - Is text well-organized and coherent?
- Methods
  - Includes discussion of Participants, Materials, Procedure, and EEG Collection
  - Is it clear from the text what you are planning to do in the study?
  - Sometimes a picture is worth a thousand words
  - Give examples of stimuli from each of your experimental categories
- Analysis and Conclusions
  - How will ERPs be measured?
  - If looking at particular ERP component, be clear about how it is measured
  - Describe at least 2 possible outcomes of study, e.g.
    - 1 outcome that would support your hypothesis
    - 1 outcome that would argue against it
  - Explain the theoretical implications of each possible outcome
  - Is text well-organized and coherent?

Metaphor & Discourse

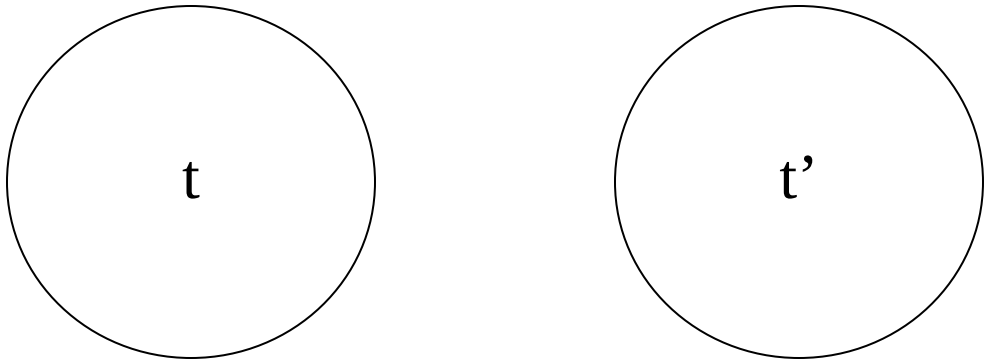
Standard Pragmatic Model



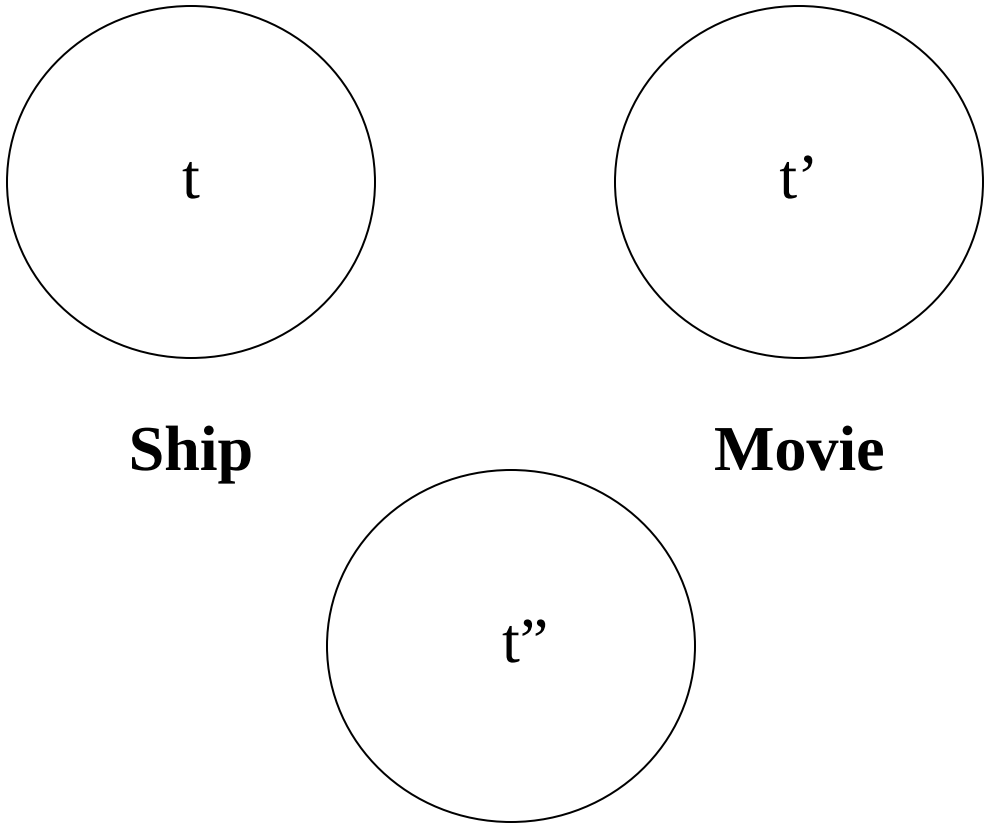
Space Structuring Model

- Mental Spaces – partitions in working memory
- Representations – spaces contain partial cognitive models (hierarchical attribute-value structures)
- Mappings
  - Identity
  - Similarity
  - Analogy
  - Metonymy

Titanic is about the voyage of the Titanic.



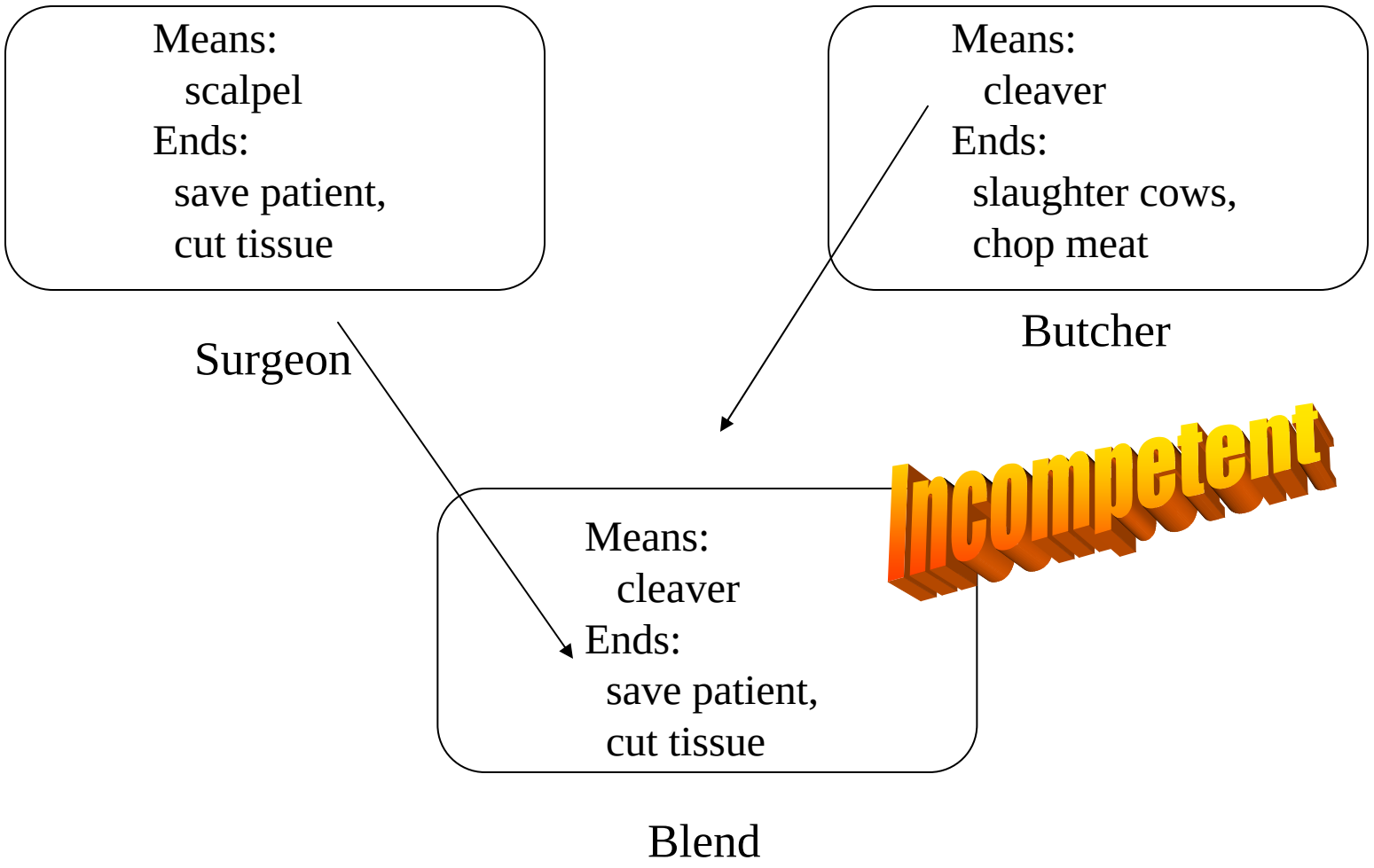
Titanic: Unsinkable after all!



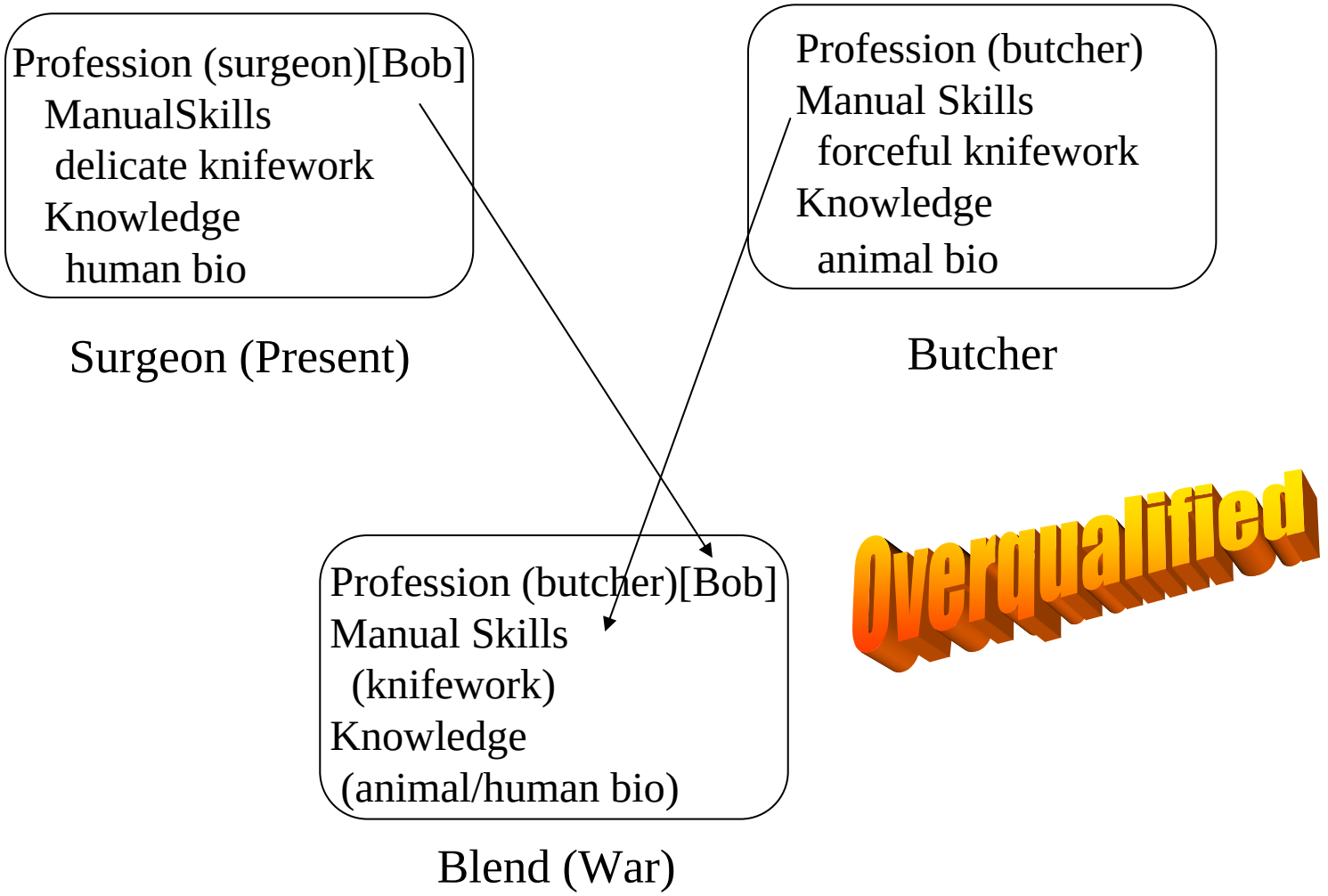
Unsinkable Titanic

Generic	Input	Input	Blended
object	ship	movie	ship
course	voyage	run	voyage
outcome	sinks	wins-oscars	finishes-voyage

Metaphor: The nurses at the hospital say that surgeon is a butcher.



Literal Mapping: During the war, that surgeon worked as a butcher.



Blending Processes

- Composition
  - 4 course dinner
  - Irish 4 course dinner
- Completion
  - Went to Baskin Robbins for ice cream
- Elaboration

Since my last report, this employee has reached rock bottom and has started to dig.

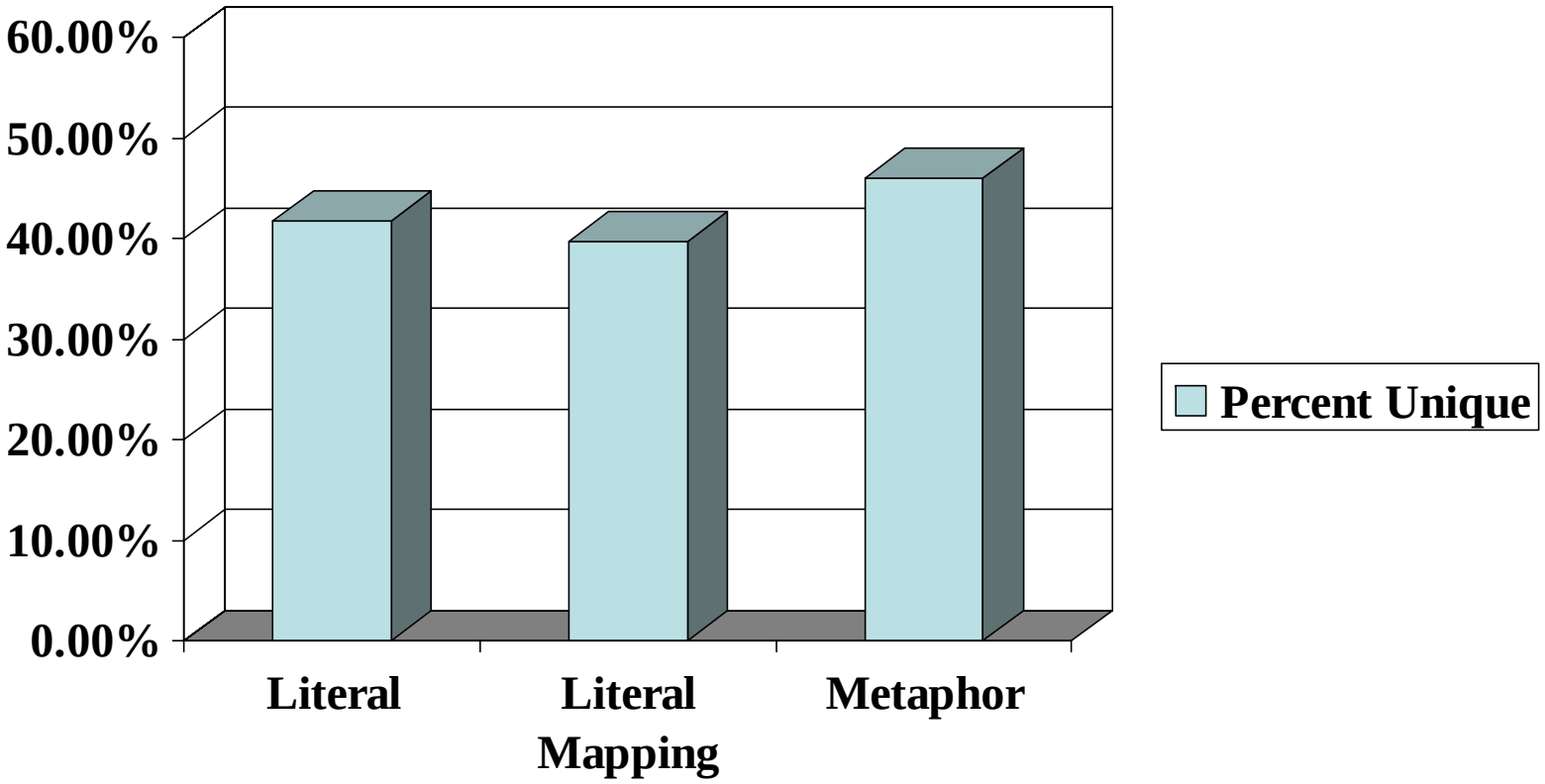
Space Structuring Model

- Explicit grammatical cues used to construct blended space
- Emergent structure activated to produce coherent juxtaposition of input concepts
- Emergent structure can be projected back to inputs
- Metaphor comprehension requires:
  - activation of concepts in generic and input spaces
  - establishment of mappings between spaces
  - activation & integration of concepts in blend

Experiment I: Feature Listing

- Null Context: anchor
- Literal: Last time he went sailing he almost forgot about the anchor.
- Metaphor: Amidst all the trappings of success, his wife was his anchor.
- Literal Mapping: We were able to use a barbell for an anchor.

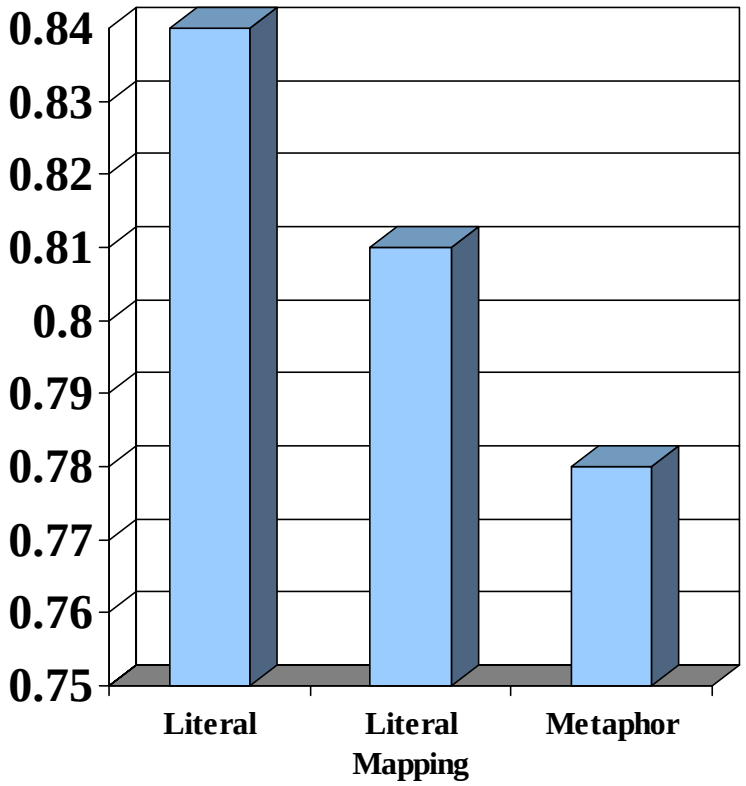
Proportion of Unique Features



Semantic Similarity

- Potentially misleading to focus on unique features
- Semantic similarity assessed using latent semantic analysis (Landauer & Dumais)
- Transform feature set into vector in high dimensional semantic space (300-d)
- Measured cosine of angle between each sentence condition and the null context

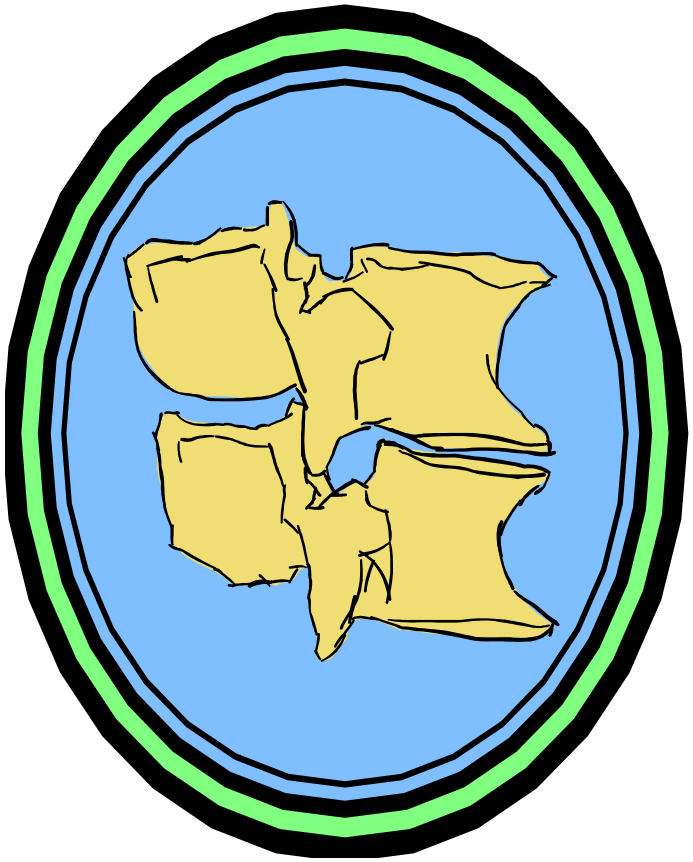
Similarity Scores



- (1 is most similar, 0 is least similar)
- Null Context and Literal Sentences = .84
- Null Context and Literal Mapping = .81
- Null Context and Metaphors = .78

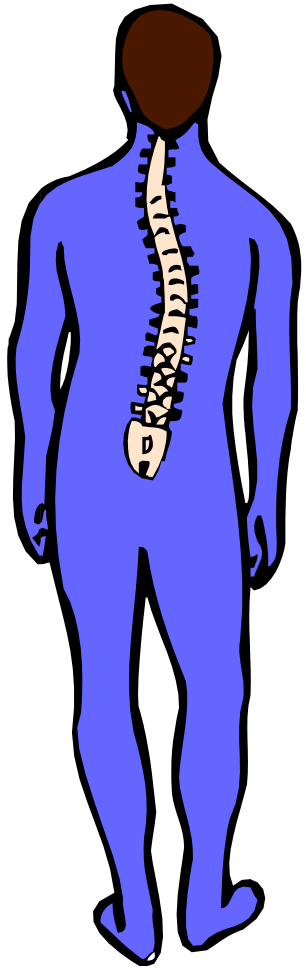
backbone

- The coach said he'd miss his seniors because they were the backbone.
  - RELIABLE, SECURE, RIGID, BEST, FASTEST
- The paleontologist quickly discovered that the foot bones were actually fragments of backbone.
  - BREAK, DELICATE, INJURY



backbone

- At the academy, young FBI officers are taught to target the backbone.
  - VULNERABLE, IRREPARABLE, DAMAGING

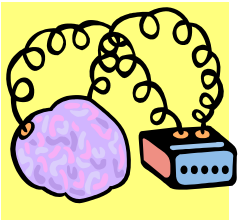


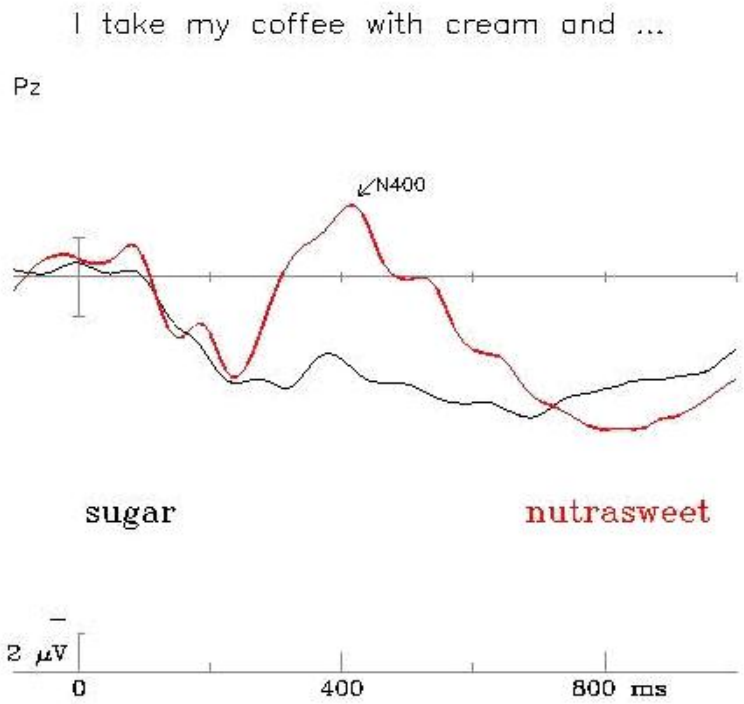
Experiment I

- 60% of features in generated for words in sentence contexts were also generated for words in the null context
- Overall proportion of unique features was high (>40%) in all 3 sentence types
- Metaphors < Literal Mapping and Literal Mapping < Literal in terms of semantic similarity to the null context
- Completion versus Elaboration

- ➢ Constancy in conceptual structure available for meaning construction across different sentence contexts
- ➢ Context-specific activation of conceptual structure
- ➢ Systematic difference in types of features related to differences in blending operations

Event-Related Brain Potentials





Materials

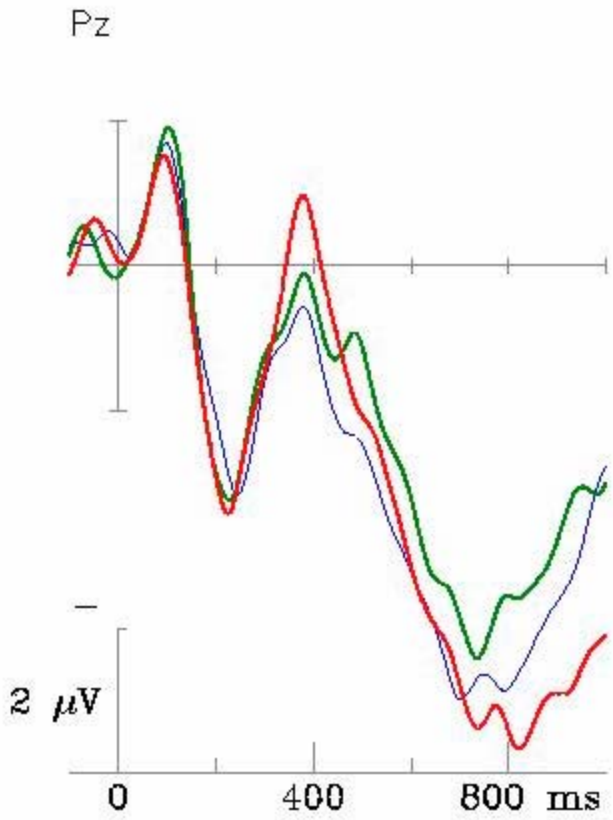
Literal: He knows that whiskey is a strong *intoxicant*.
Litmap: He has used cough syrup as an *intoxicant*.
Metaphor: He knows that power is a strong *intoxicant*.

Literal: The secret ingredient in her stew is *cayenne*.
Litmap: The chef apparently uses salt instead of *cayenne*.
Metaphor: My crazy uncle says jokes are conversation's *cayenne*.

Literal: They had a few chickens in the yard, and in the barn was a *goat*.
Litmap: On our trip to the mountains, Dad thought a bighorn sheep was a *goat*.
Metaphor: Someone had to take the fall, and unfortunately your husband was the sacrificial *goat*.

Predictions

- Literal stimuli will elicit smallest N4, Metaphors largest N4, with Literal Mappings in between.



metaphor
literal mapping
literal

ERPs and Metaphor Processing

- Metaphoric language is harder to understand
- Graded N400 difference argues against literal/figurative dichotomy

Discourse Processing

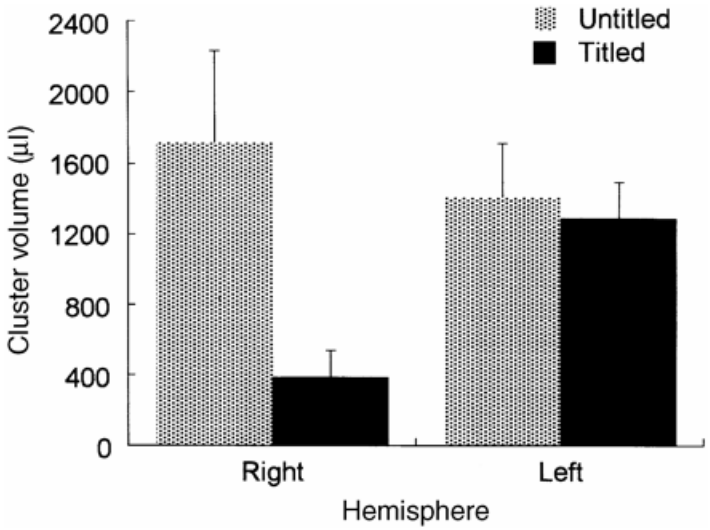
- N400 amplitude indexes congruity with sentence context
- Does it also index congruity with larger discourse context?

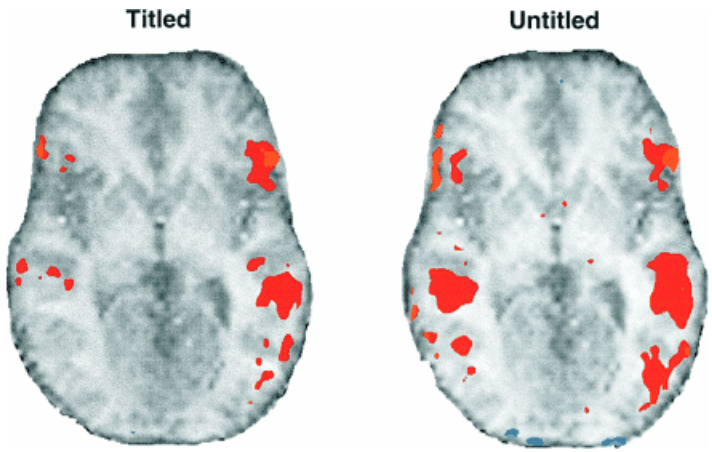
St. George et al. (1994)

The procedure is actually quite simple. First you arrange things into different groups depending on their makeup. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere due to lack of facilities that is the next step, otherwise you are pretty well set. It is important not to overdo any particular endeavor. That is, it is better to do too few things at once than too many. In the shorter run this may not seem important, but complications from doing too many can easily arise. A mistake can be expensive as well. The manipulation of the appropriate mechanism should be self-explanatory, an dwe need not dwell on it here. At first the whole procedure will seem complicated. Soon, however, it will become just another facet of life. It is difficult to foresee any end to the necessity of this task in the immediate future, but then one can never tell.

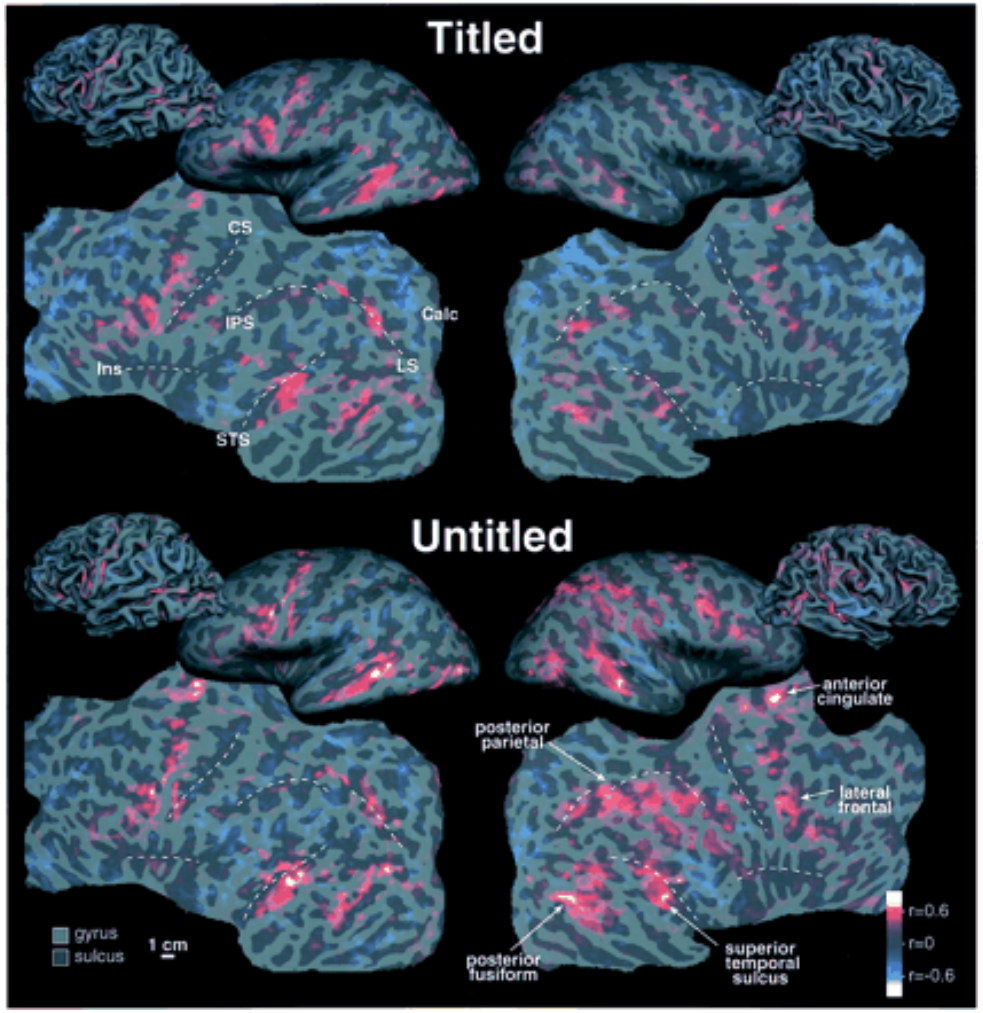
- TITLE: Procedure for washing clothes
- ERPs formed for all content words in titled paragraphs vs. untitled paragraphs
  - N400 larger for words in untitled paragraphs
  - N400 sensitive to discourse-level coherence

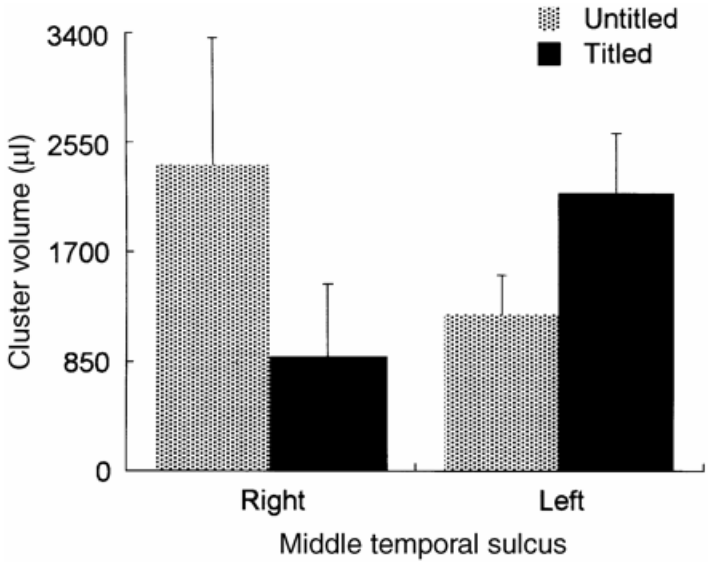
St. George fMRI study





St. George, et al.



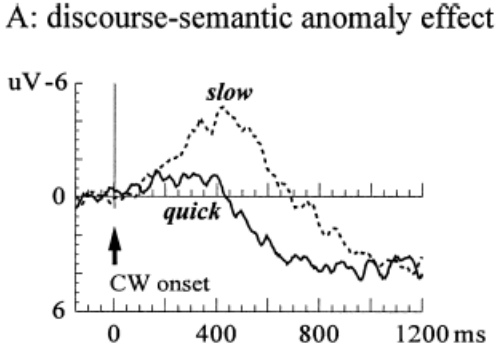


Issues with St. George

- Kind of weird to collapse across all content words in paragraph (less temporal resolution that way)
- Written language might be processed differently than spoken
- Enter: Van Berkum
  - Short stories (3 sentences), timelock to a word at or near the end of the stories
  - Visual & Auditory Presentation

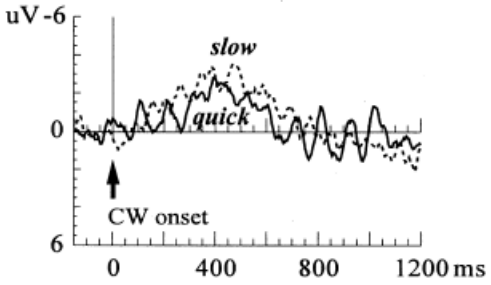
(3) *As agreed upon, Jane was to wake her sister and her brother at five o'clock in the morning. But the sister had already washed herself, and the brother had even got dressed. Jane told the brother that he was exceptionally*

A: discourse-semantic anomaly effect

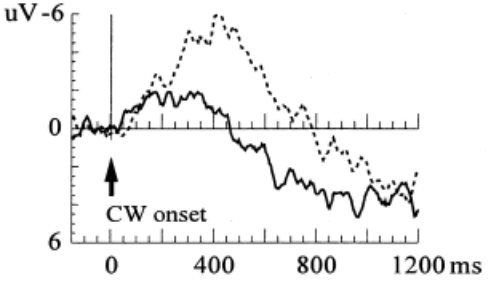


Van Berkum, et al. (1999)

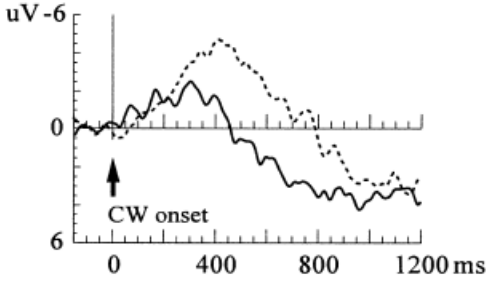
B: control study without the discourse



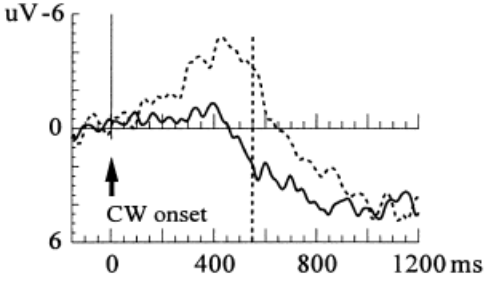
C: effect for low-constraint stories only



D: effect for sentence-medial words only



E: effect for long (>550 ms) words only

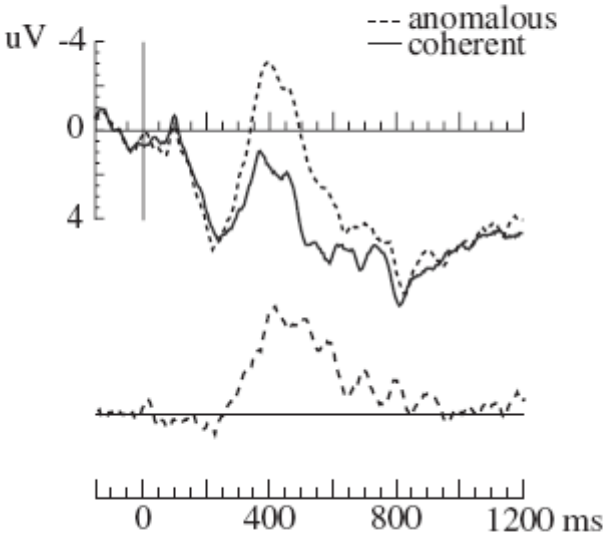


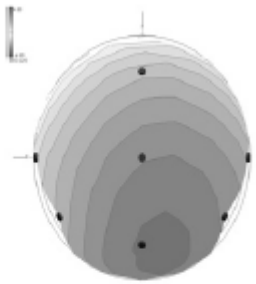
Discourse-level Anomaly Effects

- Locally congruent sentences elicit similar N400 presented in isolation
- Larger N400 for sentence completions not congruent with information set up in the discourse context
- Also true for words in the middle of sentences
  - need not be at end of sentence
- N400 enhancement happened even for low constraint (open-ended) contexts that did not suggest a particular word
- Suggests words are integrated with the discourse context as soon as they are processed for meaning
  - Argues against model of word processing followed by sentence processing followed by discourse processing

Written Materials: Discourse- versus Sentence- Level Anomalies

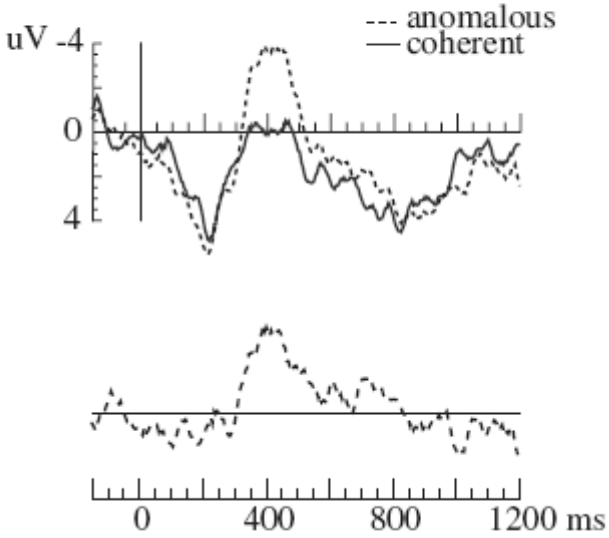
A: Discourse-semantic anomaly effect while reading

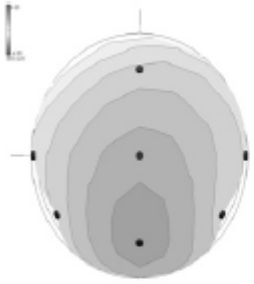




distribution of effect in 300-500 ms

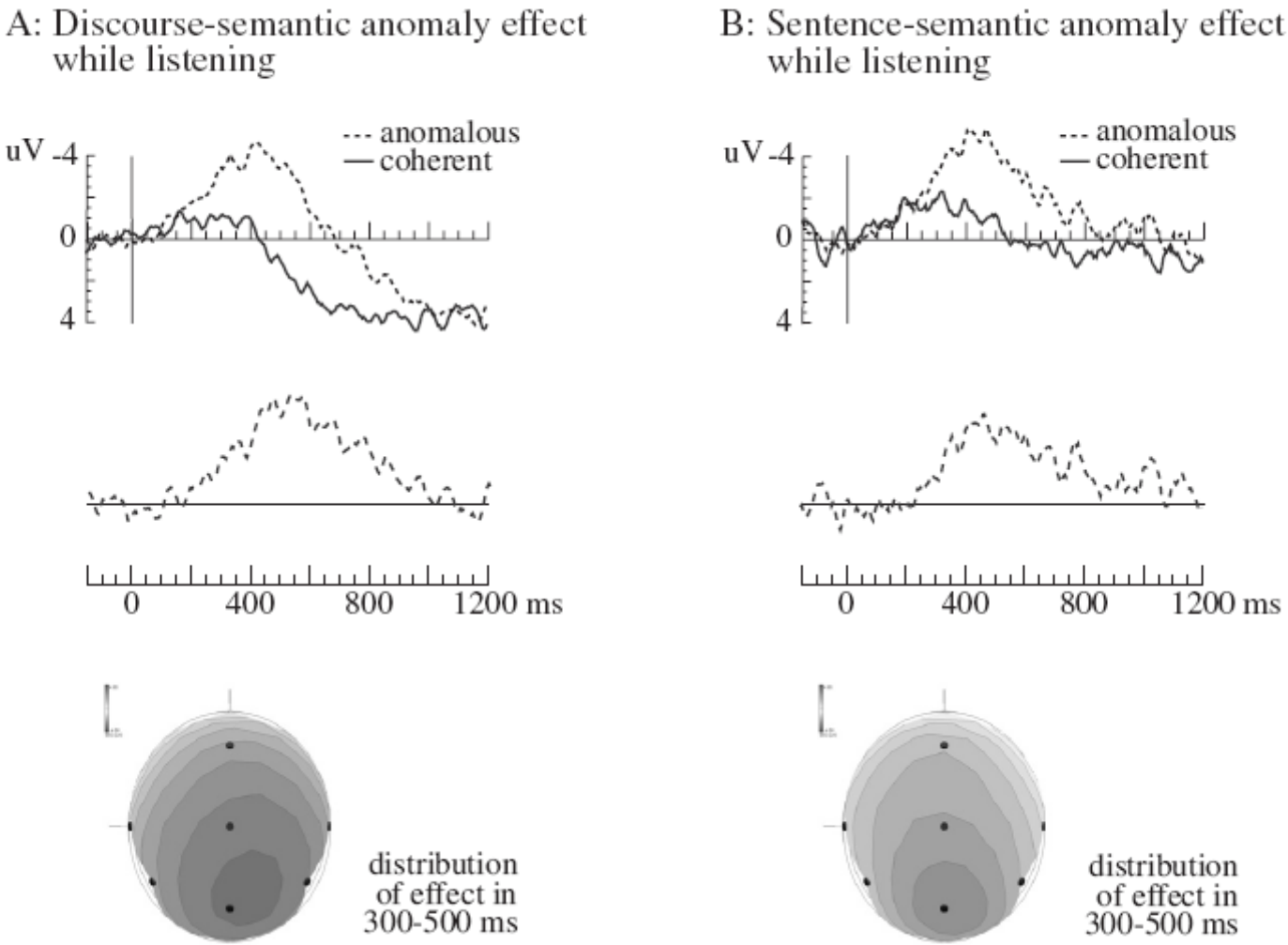
B: Sentence-semantic anomaly effect while reading





distribution of effect in 300-500 ms

Spoken Materials: Discourse- versus Sentence- Level Anomalies



Discourse- versus Sentence-Levels

- Similarity of N400 context effects with sentence- and discourse- level anomalies suggests the brain treats these two levels similarly
- Perhaps there is only context…

Anticipation

(1) *The burglar had no trouble whatsoever locating the secret family safe.*
Of course, it was situated behind a

(2) *een groot schilderij*	*a big*$_{NEU}$ *painting*$_{NEU}$	*neuter gender*	*"zero" suffix*
een grote boekenkast	*a big*$_{COM}$ *bookcase*$_{COM}$	*common gender*	*-e suffix*

ERP effect at adjective suggests people anticipate particular words

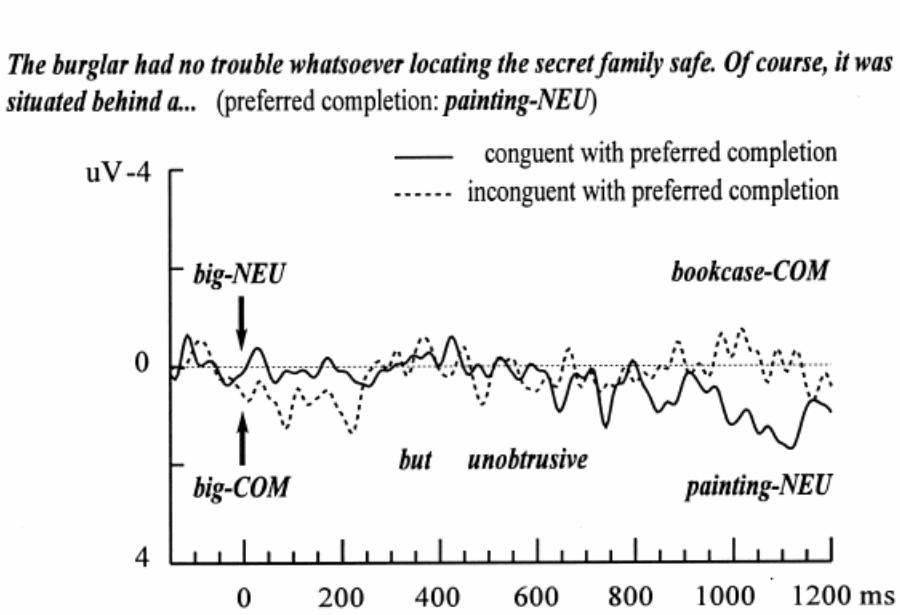
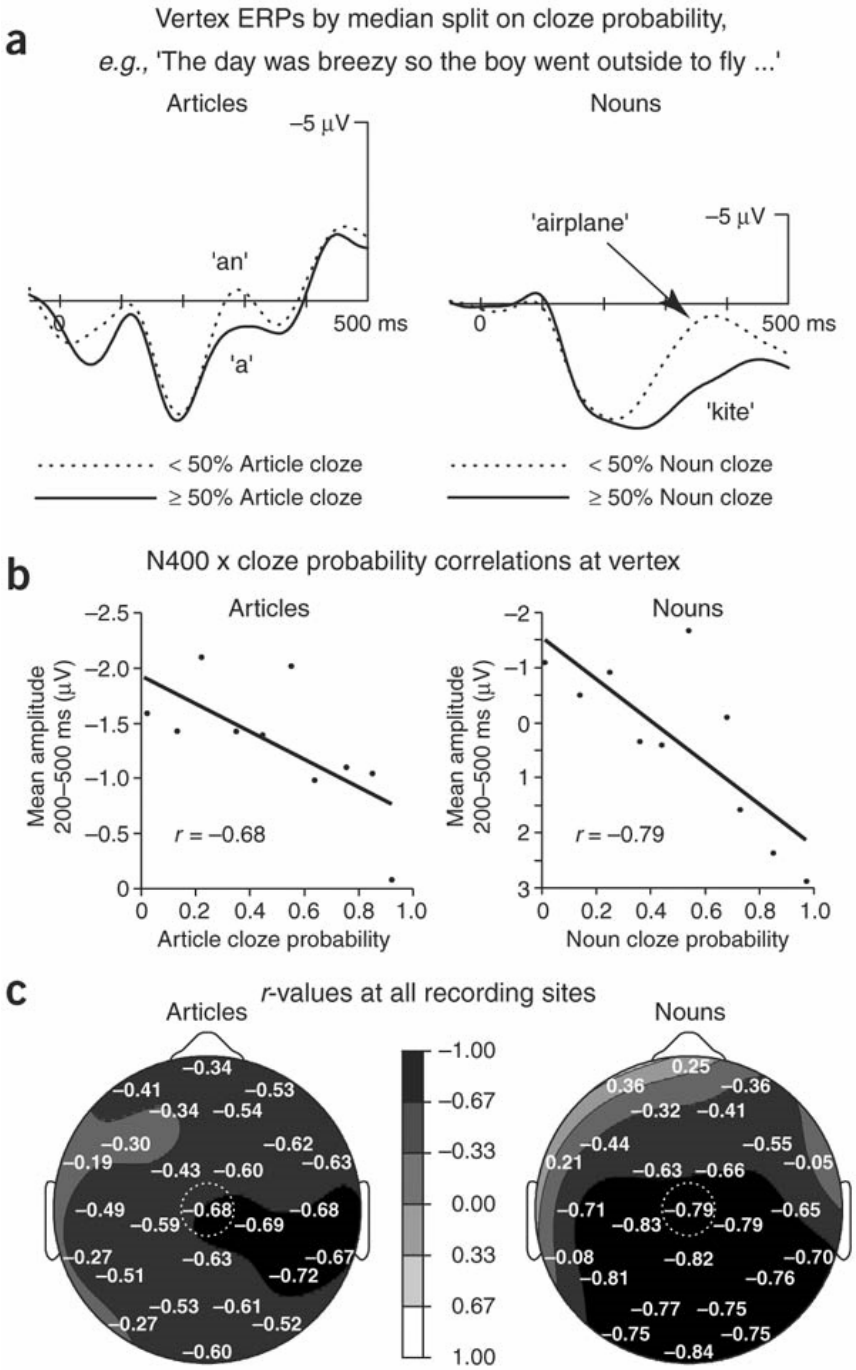


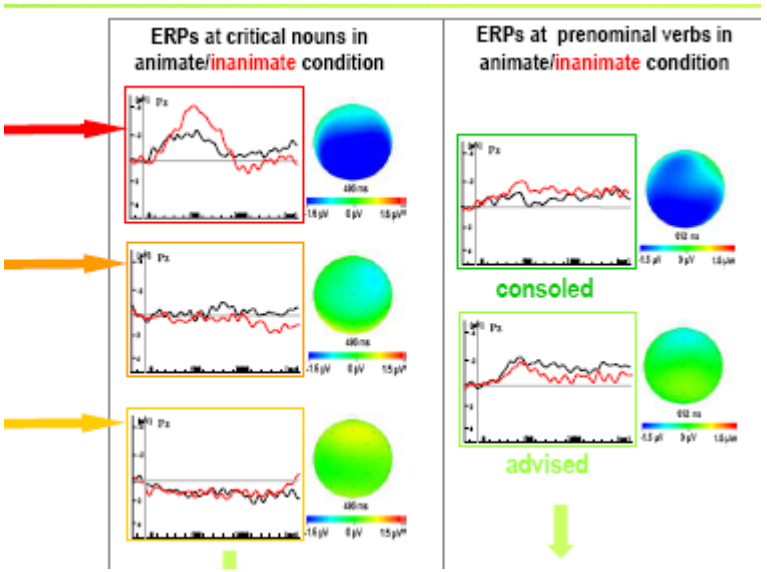
Figure 13.2 ERPs elicited by spoken adjectives whose suffixes are congruent or incongruent with the gender of a predictable noun. Results are shown for a right-temporal site (RT), and for stories with at least 75% cloze probability. Apart from the critical inflection-elicited early positivity, one can also see a discourse-induced N400 effect, elicited if a subsequently presented noun was not the predictable one. Estimated onset of the inflectional suffix is at 0 ms. Negative voltage is up. Data from J. J. A. Van Berkum et al., 2004.


a
Vertex ERPs by median split on cloze probability,
e.g., 'The day was breezy so the boy went outside to fly ...'
Articles
Nouns
–5 μV
'an'
'a'
0
500 ms
'airplane'
'kite'
< 50% Article cloze
≥ 50% Article cloze
< 50% Noun cloze
≥ 50% Noun cloze
b
N400 x cloze probability correlations at vertex
Articles
Nouns
Mean amplitude 200–500 ms (μV)
r = –0.68
r = –0.79
Article cloze probability
Noun cloze probability
c
r-values at all recording sites
Articles
Nouns
–1.00
–0.67
–0.33
0.00
0.33
0.67
1.00

Discourse Context can Overrule Local Anomalies

Example story:

1. Once upon a time a psychotherapist was consulted in her home office by a *yacht/sailor* with emotional problems.
2. The yacht/sailor confided her that everything in life had gone wrong and started crying.
3. The psychotherapist **consoled** the *yacht/sailor* by stating that everybody experiences these kinds of trouble every now and then.
4. But the yacht/sailor doubted whether to continue outlining his problems to her.
5. The psychotherapist **advised** the *yacht/sailor* to be honest not only with her, but especially with himself.
6. At that moment the yacht/sailor cried out that he was absolutely terrified of water.



Nieuwland & Van Berkum, 2005

Happy Peanuts

- “A woman saw a dancing peanut who had a big smile on his face. The peanut was singing about a girl he had just met. And judging from the song, the peanut was totally crazy about her. The woman thought it was really cute to see the peanut singing and dancing like that. The peanut was…” (from Van Berkum & Niewland, in press)
- “salted” elicits larger N400 than “in love”
  - Study done in Dutch where (I believe) in-love is one word

Referential Ambiguity

- Another semantic process in discourse is keeping track of the different referents
- If there are 2 men in a scene, a vague word such as “he” or “the man” could refer to either one, imposing additional cognitive demands over the case where there is only a single referent
- ERP indices of this process was examined by Van Berkum, Brown, & Hagoort (1999)

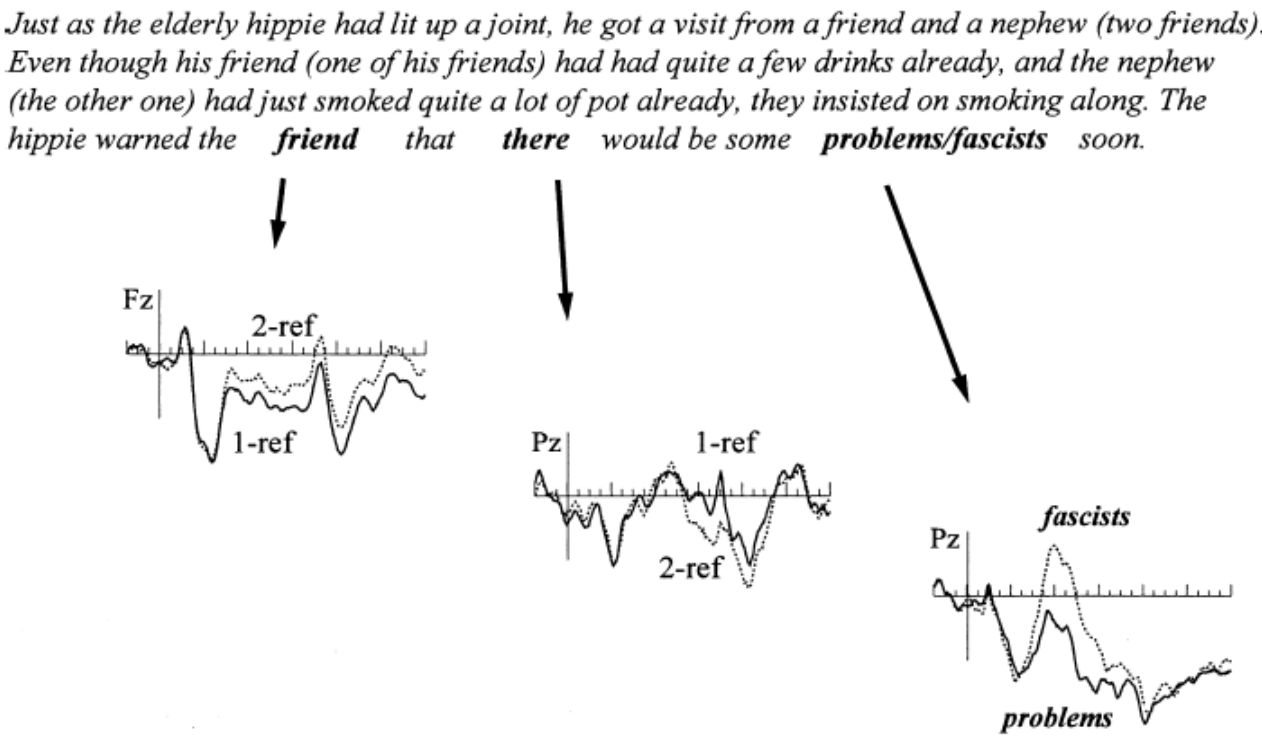
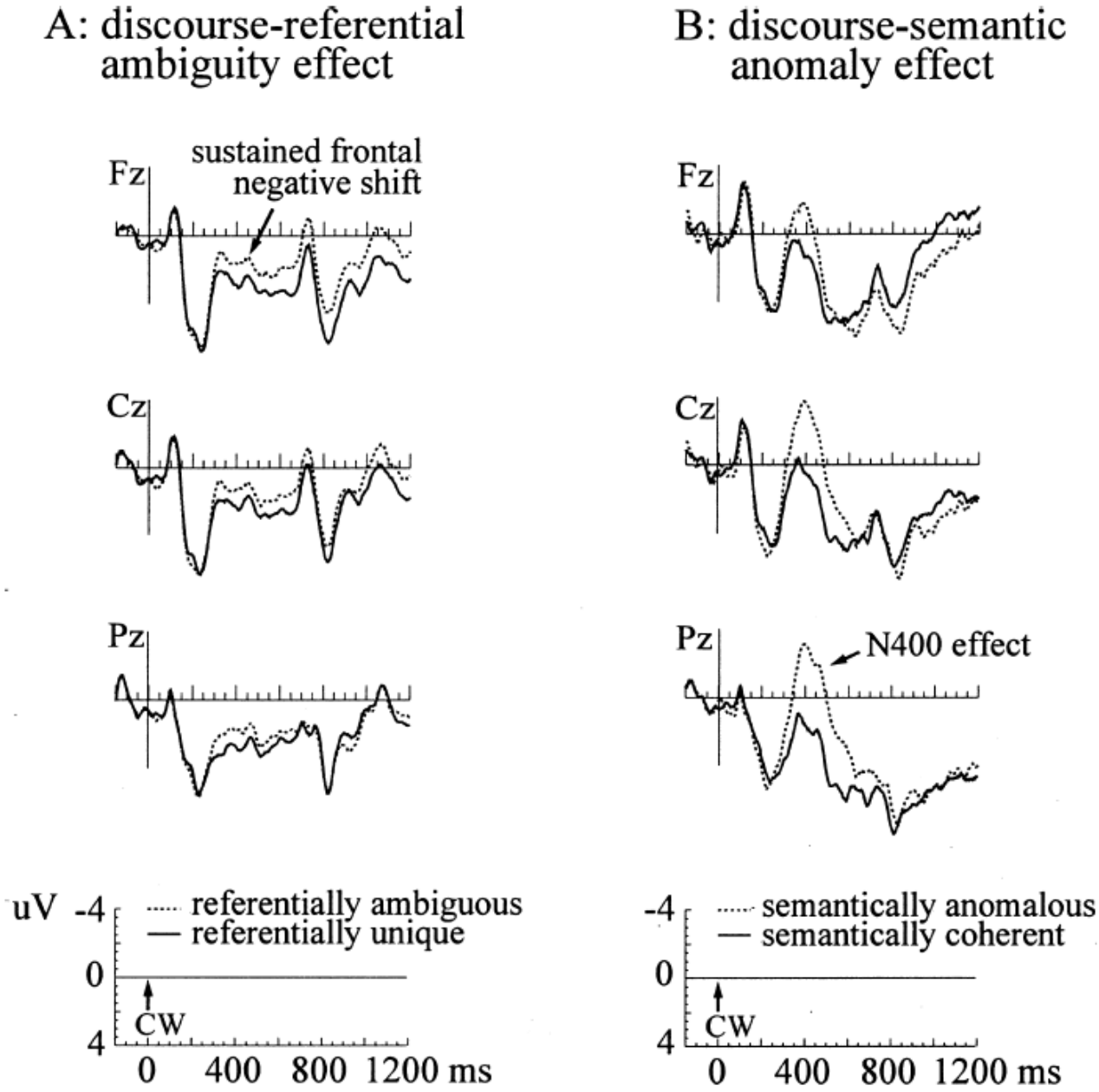


Figure 13.8 From left to right: A sustained frontal negative shift to a discourse-induced referential problem ("friend" is referentially ambiguous in the 2-referent context), a P600/SPS effect to a discourse-induced *syntactic* problem ("there" rules out the provisional relative-clause analysis pursued at "that" in the 2-referent context), and an N400 effect to a discourse-induced *semantic* problem ("fascists" does not fit the wider story context); see text for explanation. The example item is shown here in several variants (1- and 2- referent contexts, coherent/anomalous ending), but any one subject saw only a single variant. Data from "Early referential context effects in sentence processing: Evidence from event-related brain potentials." by J. J. A. Van Berkum, C. M. Brown. & P. Hagoort, 1999a, *Journal of Memory and Language*, 41, 147–182. and from "Semantic integration in sentences and discourse: Evidence from the N400." by J. J. A. Van Berkum, P. Hagoort, & C. M. Brown (1999a). *Journal of Cognitive Neuroscience*, 11(6), 657–671.


A: discourse-referential ambiguity effect
B: discourse-semantic anomaly effect
sustained frontal negative shift
Fz
Cz
Pz
N400 effect
uV -4
0
4
referentially ambiguous
referentially unique
semantically anomalous
semantically coherent
CW
0 400 800 1200 ms

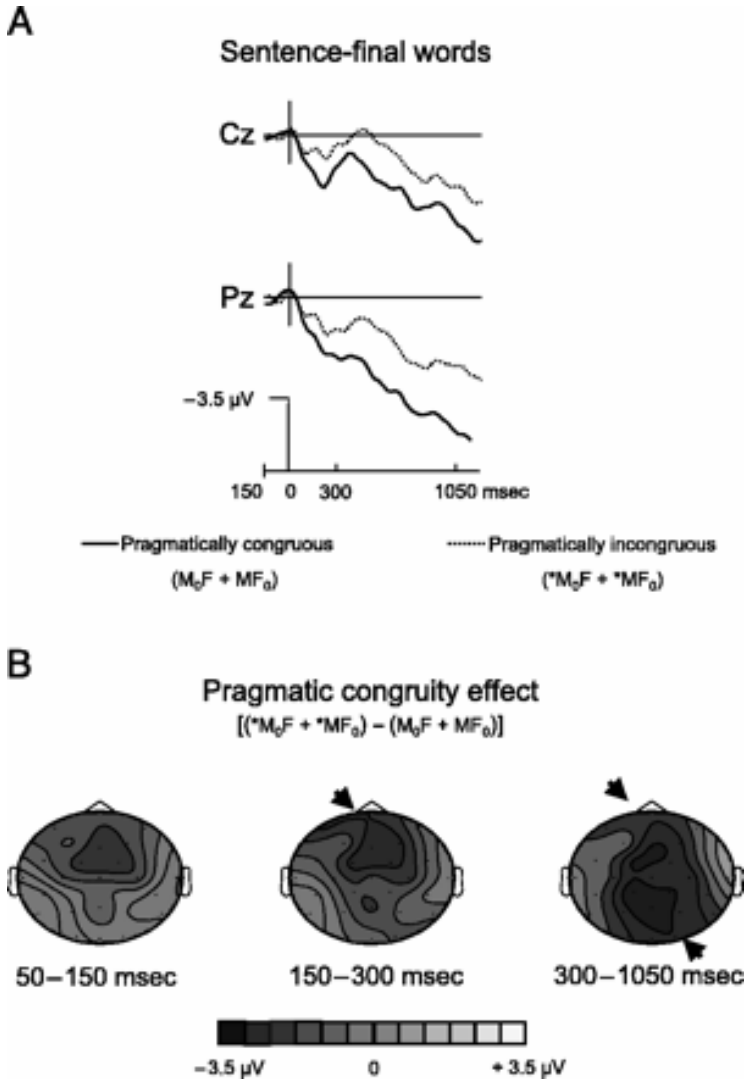
Referential Difficulty versus Integration Difficulty

- Effect of referential ambiguity on ERPs differed from effect of discourse anomaly
  - Different morphology (wave shape)
  - Different topography (scalp distribution)
- Different brain processes involved in each sort of processing
- Relating words to referents occurs very rapidly

Magne, et al. (2005)

MF_0	A-t-il donné une bague ou un bracelet à sa fiancée? (Did he give his fiancée a ring or a bracelet?) Il a donné une *bague* à sa fiancée. (He gave a *ring* to his fiancée.)
*MF_0	A-t-il donné une bague à sa fiancée ou à sa soeur? (Did he give a ring to his fiancée or his sister?) Il a donné une *bague* à sa fiancée. (He gave a *ring* to his fiancée.)
M_0F	A-t-il donné une bague à sa fiancée ou à sa soeur? (Did he give a ring to his fiancée or his sister?) Il a donné une bague à sa *fiancée*. (He gave a ring to his *fiancée*.)
*M_0F	A-t-il donné une bague ou un bracelet à sa fiancée? (Did he give his fiancée a ring or a bracelet?) Il a donné une bague à sa *fiancée*. (He gave a ring to his *fiancée*.)

Words w/inappropriate prosody elicit N400



Prosody & Referential Ambiguity

- Listeners sensitive to use of prosodic cues to disambiguate potentially confusing language
- If prosodic information is present when there is no ambiguity, it causes contextual integration difficulty indexed by N400
- If prosodic information is absent when there is ambiguity, that *also* causes contextual integration difficulty indexed by N400
  - Interestingly, not frontal negativity previously seen by Van Berkum…
- Flaw in study: participants explicitly asked about prosodic appropriateness of sentences

What kind of a system is this?

- Rapid incremental processing at all levels
- Discourse supports predictions about upcoming material
- Discourse can overrule local constraints
- Understanding does not proceed by first computing meaning in a context-free way, and then incorporating contextual information