Meaning & Structure: Influences of Real-World Event Knowledge on Language Comprehension

Ken McRae
U. of Western Ontario
Event Knowledge Includes

- action(s)
- common primary participants
  - agents & patients
- instruments
- locations
- time-course
Event Knowledge

- accrued over each person's lifetime of
  - first-hand experience & participation
  - television & movies
  - listening & reading
Event Knowledge

- develop generalized knowledge of events
- as well as specific memories
Mental Representation & Computation

- difficult unresolved issue
- complex, flexible, dynamic computations

-(roughly) schemas

- eating schema
- probably includes at least
  - someone eating, food, table, chairs, implements, a drink
Language

- multiple types of cues for computation of various aspects of event knowledge

- focus on various aspects
  - eating  dining
  - waitress
  - hamburgers & hot dogs  turkey & stuffing
  - fork
  - breakfast
  - cafeteria
Language

• cues to temporal structure

  • tense: eat vs. ate

  • aspect: was eating vs. had eaten
Our Research

- how event knowledge & linguistic cues influence (on-line) language comprehension

- rich source for expectancy generation
  - event knowledge as a salient cue to upcoming concepts and syntactic structure
**Word Meaning (Lexicon)**

- core meaning
  - kill=[cause[become[not alive]]]
  - abstracted

**World/Event Knowledge**

- events & situations (how the world works)
- participants
- objects
- settings
Word Meaning (Lexicon)

core meaning
kill=[cause[become[not alive]]]
abstracted

read/hear a word

time delay

World/Event Knowledge

events & situations (how the world works)
participants
objects
settings
Goal

- show that knowledge of various aspects of events is computed quickly from words
- used quickly for understanding language

- assume no architecturally-determined time delay
Today's Talk

- single words activate event knowledge
- syntactic cues modulate activation of event knowledge
- event knowledge modulates expectancies for syntactic structure
Prediction 1

- Single words provide rapid access to event knowledge, even out of sentence context.
- Short SOA semantic priming.
Verb ⇒ Noun Priming

Ferretti, McRae, & Hatherell (2001, JML)

- agents
  - arresting - cop
- patients
  - serving - customer
- instruments
  - stirred - spoon
- locations
  - skated - arena
Verb ⇒ Noun Norming

- agents
  - How common is it for each of the following to arrest someone?

- patients
  - How common is it for each each of the following to be served by someone?

- instruments
  - How common is it for someone to use each of the following to perform the action of stirring?

- locations
  - How common is it for someone to skate at each of the following locations?
Verb ⇒ Noun Priming

- 250 ms SOA
- priming effect = unrelated RT - related RT

- verbs primed typical
  - agents
  - patients
  - instruments

- BUT NOT locations
Verb Imperialism
Liz Bates (personal communication)

verbs

- strong cue to events
- strong source for semantic and structural expectations

must be more than just verbs

- verb-final constructions
- pre-verbal NPs as cues to upcoming types of verbs
- nouns cueing other nouns
Noun ⇒ Verb Priming
McRae, Hare, Elman, & Ferretti (2005, Memory & Cognition)

- agents
  - List the things that these people commonly do.
- patients
  - List the things that these people/objects commonly have done to them.
- instruments
  - List the things that people commonly use each of the following to do.
- locations
  - List the things that people commonly do at/in each of the following locations.
Noun ⇒ Verb Priming
McRae, Hare, Elman, & Ferretti (2005, Memory & Cognition)

- agents
  - waiter - serving
- patients
  - guitar - strummed
- instruments
  - chainsaw - cutting
- locations
  - cafeteria - eating
From Event Nouns
Hare, Thomson, Kelly, Friedrich, & McRae (Cognition, under revision)

- event - people
  - sale - shopper
  - robbery - burglar

- event - things
  - breakfast - eggs
  - parade - floats
From Locations
Hare, Thomson, Kelly, Friedrich, & McRae (Cognition, under revision)

- **location - people/animals**
  - hospital - doctor
  - stable - horse

- **location - things**
  - sandbox - shovel
  - barn - hay
From Instruments
Hare, Thomson, Kelly, Friedrich, & McRae (Cognition, under revision)

- **NOT** instrument - people
  - crayon - child
  - hose - gardener

- instrument - things
  - key - door
  - scissors - hair
Conclusion

Single-Word Studies

Aspects of event knowledge cued by:
- Action verbs
- Agents
- Patients
- Instruments
- Locations
- Event nouns
Prediction 2

Activation of event knowledge is modulated by syntactic cues
Aspect & Locations
Ferretti, Kutas, & McRae (2007, JEP:LMC)

- *skated* - arena
  - less salient background knowledge
- highlight event as ongoing vs. completed
  - imperfective vs. past perfect
- *was skating* - arena
- *had skated* - arena
- sentence completions & N400 in sentences
Structure Modulates Event Knowledge Activation

- e.g., activation of agent, patient, instrument only in appropriate position

- in contrast to assumptions/hypotheses of Traxler, Foss, Seely, Kaup, & Morris (2000)

- The lumberjack chopped the *ax* early in the morning.
Active vs. Passive
Ferretti, McRae, & Hatherell (2001, JML)

verbs ⇒ agents & patients

cross-modal naming

"She arrested the" crook cop

"She was arrested by the" cop crook
Conclusions

- syntactic cues/structure modulate expectations for specific types of event knowledge

- structure modulates meaning
Verb Sense & Structure

- meaning partially determines structure

- i.e, structure correlates with verb meaning

- NOT arguing that syntax is reducible entirely to semantics
  - but, exist important relationships
Verb Sense & Structure

sense of verb tied to class of events being referred to

Mike reached over and grasped his wine glass.

No one in the audience grasped Mike's point.
Verb Sense & Structure

- verb sense related to structural

- Ken admitted the students into his class.

- Ken admitted his wife was right all along.
Manipulating Verb Sense

- extra sentential context
- thematic roles
  - agents
    - The K-mart shopper charged
    - The bull charged
    - The crown attorney charged
  - patients
    - She grasped the hand rail
    - She grasped the concept
Causative/Inchoative Alternation
Hare, Tabaczynski, McRae & Elman (in progress)

**causative**
- tends to be transitive (DO)
- The children collected leaves for their project.

**inchoative**
- intransitive (no DO)
- The rainwater collected in the basin.
Transitive/Intransitive

- signal by initial NP

- sentence completions
  - *The children collected ___*
    - 100% transitive
  - *The rainwater collected ___*
    - 92% intransitive
Transitive Items

- causative-inducing initial NP
  - *The children collected dead leaves, insects, and other debris in the yard.*

- inchoative-inducing
  - *The rainwater collected dead leaves, insects, and other debris.*

- one-word at a time moving window
The rainwater collected dead leaves, insects, and other debris.
Intransitive Items

- causative-inducing initial NP
  - *The children collected in the damp playground and the littlest kids jumped in the puddles.*

- inchoative-inducing
  - *The rainwater collected in the damp playground and the littleest kids jumped in the puddles.*
The children collected the rainwater in the damp playground and the...
Conclusions

✿ sense of verb tied to class of events that are being referred to

✿ initial NP

⇒ sense of verb (causative vs. inchoative)

⇒ structural expectations
Verb Sense & DO/SC
Hare, McRae, & Elman (2003, JML; 2004, LCP)

- structure correlates with verb meaning
  - verbs of physical action (*grab*)
    - likely to specify a patient with a DO
  - statement (*say*) or mental event verbs (*think*)
    - likely to specify a proposition with an SC
Verb Sense & DO/SC

- many DO/SC ambiguous verbs have multiple senses
  - grasp
    - grab vs. understand
  - feel
    - experience through senses vs. come to believe
  - admit
    - let in vs. acknowledge
DO/SC Ambiguity

Influence on comprehension using subcategorization bias of verb in the aggregate

Positive effect
- Trueswell, Tanenhaus, & Kello (1993)
- Garnsey, Pearlmutter, Myers, & Lotocky (1997)

Null effect
- Ferreira & Henderson (1989)
- Kennison (2001)
DO/SC Ambiguity

- bias is best captured at level of verb sense?

- WordNet senses
  - thematic fit of initial NP
  - dominant sense
  - thematic fit of postverbal NP

- measured sense-based biases in Brown & WSJ87
Making Sense of Inconsistent Results

<table>
<thead>
<tr>
<th></th>
<th>SC-items</th>
<th>DO-items</th>
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<tbody>
<tr>
<td><strong>null effect</strong></td>
<td></td>
<td></td>
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<tr>
<td>Ferreira &amp; Henderson</td>
<td>61%</td>
<td>85%</td>
</tr>
<tr>
<td>Kennison</td>
<td>79%</td>
<td>54%</td>
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<tr>
<td><strong>positive effect</strong></td>
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<tr>
<td>Garnsey et al.</td>
<td>91%</td>
<td>94%</td>
</tr>
<tr>
<td>Trueswell et al.</td>
<td>100%</td>
<td>100%</td>
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</tbody>
</table>
Experimental Evidence

24 verbs with 2 senses with opposing biases

- admit
  - let in: DO-biased
  - confess, acknowledge: SC-biased

SC & DO biasing contexts

- extensive norming (sentence completions)
- target sentence always contained SC
For over a week now, the trail guide had been denying any problems with the two high school students walking the entire Appalachian trail.

Finally, he admitted (that) the students had little chance of succeeding.

The two freshman on the waiting list refused to leave the professor's office until he let them into his class.

Finally, he admitted (that) the students had little chance of getting into his class.
Results

the students had little chance of
Conclusions

knowledge of meaning-structure relationships for verbs is best captured at the level of verb sense

i.e., the types of events that a particular sense denotes
Take-Home Message

- people possess a great deal of event knowledge
- computed & used rapidly during language comprehension
- knowledge of real-world events is a key source of information driving semantic and syntactic expectancy generation