Verb aspect and argument activation: 
World vs. Word 
Knowledge

Michael Amato, Jon Willits, Maryellen MacDonald
World vs. Word Knowledge

I cooked pasta last night in the kitchen in a pot on the stove for 8 minutes with 4 quarts of water.

• Language reports only a fraction of the detail in the world
• To what extent do language users rely on knowledge of the world vs. language usage?

Verb Aspect

Imperfect Aspect: ongoing events
Perfect Aspect: completed events
Aspect & Arguments in World & Words

Priming from imperfect verbs to locations, but not from perfect verbs (Ferretti, Kutas, & McRae, 2007).

\[
\begin{align*}
\text{was cooking} & \quad \text{had cooked} \\
\text{FAST} & \quad \text{SLOW}
\end{align*}
\]

**H1: World Knowledge**
Comprehenders use aspect to modulate how they use their world knowledge about events

**H2: Word Knowledge**
Comprehenders use knowledge of argument mention distributions in language
H1: World Knowledge
Comprehenders use aspect to modulate how they use their world knowledge about events

was cooking ← kitchen
FAST
knowledge about ongoing cooking events

had cooked ← kitchen
SLOW
knowledge about completed cooking events

Priming via World Knowledge
H2: Word Knowledge
Comprehenders use knowledge of argument mention distributions in language

Priming via Language Statistics
Goal: To contrast 2 explanations for this effect of verb aspect

H1: World knowledge about likely event participants is activated differently by perfect and imperfect aspect verbforms

H2: Co-occurrence statistics between specific verbforms and arguments are tracked and used to aid processing

- Corpus study examining word co-occurrence
- Choose new stimulus pairs of verbs & locations
  - evaluate with corpus, ratings, & sentence completions
- Verbform-location priming study
Corpus Study
Could language co-occurrence between aspectual forms and locations explain the observed differences in priming?

Example:
\[
P(kitchen|\text{was cooking})
\]
\[
P(kitchen|\text{had cooked})
\]

24 verb-location pairs from Ferretti et al. (2007)

Method
Wikipedia Corpus
532,000,000 words
10 word window
Corpus Study

Could language co-occurrence between aspectual forms and locations explain the observed differences in priming?

Example: $P(\text{kitchen}|\text{was cooking})$

$P(\text{kitchen}|\text{had cooked})$

Method

Wikipedia Corpus
352,000,000 words

10 word window
Corpus Study

Could language co-occurrence between aspectual forms and locations explain the observed differences in priming?

Example:

\[ P(kitchen|was\ cooking) \]
\[ P(kitchen|had\ cooked) \]

Conclusion:
Language statistics sufficient to explain priming effect

24 verbform-location pairs from Ferretti et al. (2007)

- related
- unrelated

\[ \text{was cooking} \rightarrow \text{kitchen} \]
\[ \text{FAST} \]
\[ \text{had cooked} \rightarrow \text{kitchen} \]
\[ \text{SLOW} \]
New items to test whether effect of aspect due to World Knowledge vs. Language Statistics

Chose 32 new target locations and 6 verbforms for each:

Average probabilities:

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Previous naming study
New items to test whether effect of aspect due to World Knowledge vs. Language Statistics

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New items to test whether effect of aspect due to World Knowledge vs. Language Statistics

Chose 32 new target locations and 6 verbforms for each:

Example: Ocean

Verbo-Location Relationship

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was drifting

had drifted
New items to test whether effect of aspect due to World Knowledge vs. Language Statistics.

Chose 32 new target locations and 6 verbforms for each:

Average probabilities:

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Example: Ocean

- had drifted
- had sunk
- was drifting
- was sinking
- had drifted
Evaluating the new items

Semantic relatedness ratings for verbform and location

ex: was drifting & ocean  1 2 3 4 5 6 7
had drifted & ocean  1 2 3 4 5 6 7
45 participants

% sentence completions containing a location

ex: Mary was drifting...
Mary had drifted...
95 participants
96 completions each
Primed Naming

- fixation + 250ms
- prime “was cooking” 250ms
- target “kitchen”

Participant reads target aloud as quickly as possible

78 participants
32 trials each
Primed Naming Predictions

H1: General effect of aspect on which types of arguments are activated based on event knowledge

- Locations named fastest after imperfect verb primes
- No difference between high vs low prob

![Graph showing reaction time in z-scores for Imperfect and Perfect Prime tasks with three colors for High, Low, and Unrelated conditions.](image)
**Primed Naming Predictions**

**H2:** Participants rely on fine grained co-occurrence statistics in language; between specific verbforms and mentioned arguments.

- Locations named fastest after high-prob verb primes
- No difference between imperfect vs. perfect imperfect

![bar chart showing reaction times in z-scores for high, low, and unrelated primes for imperfect and perfect verb primes](image)

- Yellow bars represent imperfect primes (was cooking)
- Green bars represent low primes
- Blue bars represent unrelated primes

World Knowledge

verbs → (arguments)
Primed Naming – Results

Reaction Time in z-scores

Verbs

 Imperfect Aspect
 (was cooking)

 Perfect Aspect
 (had cooked)

High Low Unrelated

High Low Unrelated

Imperfect Aspect

Perfect Aspect

Verbs

(Arguments)

Verbs

(Arguments)
Conclusions:
Neither model sufficient for priming data

Evidence for Language Statistics
High probability locations primed by verbforms in either aspect

Evidence for a General Effect of Aspect
Low probability (but related) locations primed by verbforms in imperfect aspect only
How might it be both?

Knowledge about ongoing cooking events

Frequency × Regularity interaction

- “frequency” is item-specific probability
- “regularity” is general pattern of imperfect aspect co-occurring with locations
# Frequency X Regularity in Verb Aspect

## Verb-Location Relationship

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- was drifting
- was singing
- had sunk
- was fishing
- was stealing

- had drifted
- had sung
- had fished
- had sung
**Frequency** × **Regularity** in Verb Aspect

General pattern: *was ___ing* co-occurs with locations

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- *was drifting*  
- *was singing*  
- *was fishing*  
- *was stealing*  
- *had sunk*  

- *had drifted*  
- *had sung*  
- *had fished*  
- *had sung*
General Conclusions

• Aspect affects language processing in 2 ways:
  – Allows specific language statistics for different forms of a verb
  – General effect on argument activation

• How could a language user learn aspect?
  – possibly schemas as in a connectionist network

Co-occurrence in the world $\neq$ Co-occurrence in Language

I cooked pasta last night in the kitchen in a pot on the stove for 8 minutes in 4 quarts of water.
Thank you

Andrea Nett
Rebecca Rozek
Jae Yun Kim
Ariella Carlin
Allison Wolfe
Extra Slides!!!
Semantic Decision – procedure

Naming task is language-like, Pp rely on language statistics

Changing task might shift Pp to rely more on knowledge about the world

**Task:** Is the target a place or is it not a place?

- **fixation** + 200ms
- **prime** “was cooking” 200ms
- **mask** &&&&&&&&&& 50ms
- **target** “kitchen”
Semantic Decision – our items

2(aspect: perf, imperf) X 3(relation: high, low, unrelated)

Effect of relation, no effect of aspect, by subjects and by items.
Low patterns with high.
Completions and naming RTs

![Graph showing completions and naming RTs](image)

- **Perfect Prime**
- **Imperfect Prime**

**naming targets elicited in completion study**
Corpus Study 2: Probability of any location for IA and PA verbs

Difference in locations of 50 frequent arguments
(locations of IA arguments) – (locations of PA arguments)

Conclusions:
1. More locations for IA than PA for most verbs.
2. Consistent with a generalized effect of aspect.