COGNITION AND SEMANTICS
Blooms Taxonomy

**Knowledge**
- Recall of information; Discovery; Observation; Listing; Locating; Naming

**Comprehension**
- Understanding; Translating; Summarising; Demonstrating; Discussing

**Application**
- Using and applying knowledge; Using problem solving methods; Manipulating; Designing; Experimenting

**Analysis**
- Identifying and analyzing patterns; Organisation of ideas; recognizing trends

**Synthesis**
- Using old concepts to create new ideas; Design and Invention; Composing; Imagining; Inferring; Modifying; Predicting; Combining

**Evaluation**
- Assessing theories; Comparison of ideas; Evaluating outcomes; Solving; Judging; Recommending; Rating

**Wisdom**
- Clarity of perception
- Applied Knowledge
- Organised Information
- Meaningful Data
- Facts

**Understanding**
- Knowledge
- Information
- Data
- Facts

**Information**
- Data
- Facts

**Knowledge**
- Understanding principles

**Wisdom**
- Clarity of perception

**Understanding**
- Knowledge
- Information
- Data
Functionalist vs. formalist linguistics

• Basic, perhaps primary, division in linguistics

• Formalist
  • Form is most important
  • Focus is on structure at all levels
  • Description, representation, levels, relations, mappings, rules
  • Formal methods, theories, methods

• Functionalist
  • Function(s) of language are key to understanding linguistic processes/structures
  • Define functions performed by language, relate these to linguistic elements that carry them out
  • Communicative context is central
History

• 1970’s: linguists interested in relation of language to mind
• Associate language structure to things outside language
  • Cognitive principles and mechanisms not specific to language
  • Categorization, pragmatics, interaction, iconicity, economy
• Meaning, not structure, must be primary focus of study
  • Semantic structures at all levels of language
• 1989: first conference
• 2005: first ICLC
Primary threads, researchers

- Prague School
- Igor Mel’čuk (Meaning-Text Theory)
- Wallace Chafe (Amerindian languages)
- Charles Fillmore (Construction Grammar)
- George Lakoff (metaphor, metonymy)
- Ronald Langacker (Cognitive Grammar)
- Leonard Talmy (linguistic imaging)
- Gilles Fauconnier (Mental Spaces)
- Michael Halliday (Systemic Functional Grammar)
- Robert Van Valin (Role & Reference Grammar)
Basic premises

- Focus on cognitive nature of language
- Non-autonomy of language and grammar
- Semantic motivation for language/grammar
- Embodiment and language
- Usage-based nature of language: actual language
- Conceptual metaphors and other figurational devices
- Only 3 kinds of structures in language (extreme austerity)
  - Phonological
  - Semantic
  - Symbolic
- Prototypes, schemas, scenes, etc.
- Felicity of expression
More basic premises

• Linguistic units (words, morphemes) vs. non-linguistic units (e.g. [SCREAM], nonsense words in poetry, onomatopoeia, mimetics)
  • Continuum (scale of entrenchment), impossible to separated
  • Conventionality (also on a scale)

• Only three kinds of relations (again, not just language!)
  • Symbolization
  • Categorization
  • Composition
Semantic space

- Multifaceted field of conceptual potential within which thought and conceptualization unfold
- Cognitive domains: building blocks for semantic space
  - Basic domains: time, space, color, pitch, taste, smell, vision, etc.
  - Non-basic domains: frames, scenes, schemas, scenarios, etc.
- Semantic unit: linguistically relevant unit typically consisting of several cognitive domains
  - Word “sister” domains: kinship, sex, living organisms, 3-D space
  - Representable as a kinship network
  - Words “crazy” vs. “insane”

![Kinship network diagram](image)
Sample comparative kinship systems

- **Hawaiian Kinship**
- **Iroquois Kinship**
- **Sudanese Kinship**
- **Crow Kinship**
- **Eskimo Kinship**
- **Omaha Kinship**
Symbolization

• Connects object in semantic space with object in phonological space
• Profile: specification of linguistic expression
  • Usually pictorial, specifies domain(s)
Categorization

- Humans do this really well
- Semantic pole of [HOUSE]: schema w/ several elaborations/instantiations (bungalow, semi-detached, detached, etc.)
- [HOUSE] is an elaboration of [BUILDING]: barracks, stable, warehouse
- Schema-instance relations: upward: schematic; downward: concrete
- Can structure phonology this way: segments, phonemes, allophones, prosodic contours, etc.
Taxonomy of English lexical relations

Fig. 2.4 Partial taxonomy of lexical units of English
Construal

- Manner of viewing semantic content
- Nouns
  - Semantic pole is schematic conception of physical object
  - Phonological pole is entirely schematic
  - Characterized by interconnection with other entities (e.g. metonymy, connotation, affordances, etc.)
  - Basic subclasses: count, mass
    - Replicability, boundedness, homogeneity
    - But: packaging, grinding
- Predication: interconnected relations
  - Trajector: entity of primary importance
  - Landmark: entities of secondary importance
  - Temporality
  - Sequential scanning
Adjective construal example
Verbs

• Conception of an asymmetrical energetic interaction
  • E.g. agent does some action to patient

• Requires two cognitive abilities
  • Ability to apprehend a relationship
  • Ability to track it through time

• Schema for verbs has:
  • Process (relation with a positive temporal profile)
    • Requires sequential scanning

• Aspect is important
Verb semantic poles

Fig. 2.7  Semantic pole of the verb *fall* (adapted from Langacker 1987, p. 144)
Image schema

- Abstract generalization over images; experiential
- Three main properties:
  - Wholes, Domains, Parts
  - Base, Matrix, Meronymy
- Other properties:
  - prototypicality
  - vagueness
  - dimensionality
  - directionality
  - boundedness
  - plexity
  - scale, proportion, paths, etc.
Image schemata

- Site: open role
  - Salience/prominence
- Superimposition: link
  - Lexicon
  - Processing
- Relation: mediates possible connections
  - Valence
  - Accommodation
Basic concept structures

• Triggered primarily via valence relations
• “Lexical” inventory
• Viewpoint adjustments: turning, scaling, tilting, accommodation
Superimposition

- Compositional
  - To the extent language is
  - Predication
  - Lex/syn/sem expectations
- Instantiation of placeholder parts
  - Trajector
  - Landmark
- Via accommodation
- Similar to unification
Processing traces
What’s grammar then?

• Usage-based (crucially, not rule-based!)
• We process chunks for meaning, creating conventional linguistic units of various sizes, complexity, and generality.
• Coding: finding the right word for a concept
  • Problem solving, search
• Usage event: instance of language use
• Cognitive abilities: focus, attention, memory, construal
Construal

• Ability to understand a given situation in a variety of different ways
  • Need to focus attention on conceptual content
  • Highlighting different aspects of conceptualized scenes
  • Mental imagery

• Parameters of construal
  • Selection: scope of conceptual representations (arm → body)
  • Perspective: figure/ground organization
  • Abstraction: level of specificity at which a situation is portrayed

the glass with water in it
the water in the glass
the glass is half-full
the glass is half-empty
Metaphor resources

- **MetaNet**
- **ATT-Meta**
- **Index of quotations**
- **METAMIA** relational database search
- (lots of others)
TRAINS dialogue

utt1 : s: hello <sil> can I help you
utt2 : u: yeah I want t- I want to determine the maximum number of boxcars of oranges <sil> that I can get to Bath <sil> by seven a.m. <sil> tomorrow morning
utt3 : so <brth> hm <sil>
so I guess all the boxcars will have to go through oran- <sil>
through Corning because that's where the orange juice <brth>
orange factory is
utt4 : so from Corning to Bath how far is that
utt5 : s: two hours
utt6 : u: and it's gonna take us also an hour to load <sil> boxcars right
utt7 : s: right + +
utt8 : u: + okay + so <sil> hm so <sil> every trip will take at least <sil>
three hours <sil> then
utt9 : um
utt10 : s: right we can unload any amount of cargo onto a train in one hour
utt11 : so we can + <sil> do a maximum of three + boxcars in an hour
utt12 : u: + right <sil> okay +
utt13 : okay <sil> so I guess one thing we can do oh <brth> so <brth>
I guess one thing is that we should see how many boxcars we can actually get to Corning in four hours
utt14 : um how far is it from Avon to Bath <sil> to Corning
utt15 : s: <click> <brth> that's six hours it's + shorter + through Dansville
utt16 : u: + okay +
Dialogue turns (German)

Figure 1: An example dialogue

![Image of a screen dump of the graphical user interface of the component while processing the example dialogue. In the upper left corner we see the structures of the dialogue sequence memory, where the middle right row represents turns, and the left and right rows represent utterances as segmented by different analysis components. The upper right part shows the intentional structure.]

The user cannot serve as a dialogue controller like in man-machine dialogues. The only exception is when clarification dialogues are necessary between VERN-MOBIL and a user.

Due to its role as information server in the overall VERN-MOBIL system, we started early in the project to collect requirements from other components in the system. The result can be divided into three subtasks:
Talkbank

- Speech corpora and annotations
- Different types of speech
  - Aphasic
  - Bilingual
  - Dementia
  - Gesture
  - Tutorial
  - Meetings (SCOTUS)
- Same annotations as CHILDES
- Web-browsable
Robotic dialogue

- LS3 Follow Tight
- Alpha Dog
Machine reading

- Aka “deep reading” and “reading the Web”
- YAGO-NAGA
- KnowItAll
- NELL
Ontologies

- SUMO, MILO, etc.
- BabelNet
- Cyc
- GOLD (e.g. ODIN)
- DBPedia
- SNOMED CT
- (WordNet)
SUMO axiom for “relative”

\[
(\Rightarrow)
(familyRelation \ ?\text{ORGANISM1} \ ?\text{ORGANISM2})
(exists \ (?\text{ORGANISM3})
(and
(ancestor \ ?\text{ORGANISM3} \ ?\text{ORGANISM1})
(ancestor \ ?\text{ORGANISM3} \ ?\text{ORGANISM2}))
\]

• If an organism and another organism are related,
• then there exists a third organism such that ancestor the third organism and the organism and ancestor the third organism and the other organism
SUMO axiom for “understand”

(=>
  (and
    (instance ?INTERPRET Interpreting)
    (agent ?INTERPRET ?AGENT)
    (patient ?INTERPRET ?CONTENT)
    (instance ?CONTENT ContentBearingObject))
  (exists (?PROP)
    (holdsDuring
      (EndFn
        (WhenFn ?INTERPRET))
      (believes ?AGENT
        (containsInformation ?CONTENT ?PROP))))

• If a process is an instance of interpreting and an agent is an agent of the process and a content bearing physical is a patient of the process and the content bearing physical is an instance of content bearing object,
• then there exists a proposition such that the agent believes the content bearing physical contains information the proposition holds during the end of the time of existence of the process
Ontology-based Information Extraction with a Cognitive Agent
(Lindes, Lonsdale, & Embley, 2015, AAAI Cognitive Systems)

• OntoSoar project goals
  • Extract genealogy facts from family history books
  • Project extracted information onto a conceptual model to populate a searchable database

• Strategies
  • Use ideas from Embodied Construction Grammar
  • Use the Soar cognitive architecture
  • Integrate several levels of knowledge

• Long term goals
  • Build computational models of human language processing
  • Apply these models to real-world applications
Example 1

243314. Charles Christopher Lathrop, N. Y. City, b. 1817, d. 1865, son of Mary Ely and Gerard Lathrop; m. 1856 Mary Augusta Andruss, 992 Broad St., Newark, N. J., who was b. 1825, dau. of Judge Caleb Halstead Andruss and Emma Sutherland Goble. Mrs. Lathrop died at her home, 992 Broad St., Newark, N. J., Friday morning, Nov. 4, 1898. The funeral services were held at her residence on Monday, Nov. 7, 1898, at half-past two o’clock P. M. Their children:

2. William Gerard, b. 1858, d. 1861.
3. Theodore Andruss, b. 1860.
4. Emma Goble, b. 1862.

Miss Emma Goble Lathrop, official historian of the New York Chapter of the Daughters of the American Revolution, is one of the youngest members to hold office, but one whose intelligence and capability qualify her for such distinction.
A Simple Ontology

Charles Christopher Lathrop was born on 1817 and died on 1865.
Example2

Children of James Harwood. No. 103.

229. Myra, born July 20, 1835 in Eden, Vt. She married Elijah Spencer, Dec. 25, 1851. They had five children: Arvella, born in 1852, is not living; Mariette, born Dec. 25, 1854, married Jonathan Snyder, have a family; Leverett, born Feb. 6, 1857, married Cora Smith, Nov. 2, 1879, had two children, Perry F. and Ida I.. Leverett died May 21, 1910; Rosa E., born Jan. 13, 1860, married Emmett Byers, and have children; and Harrison, born about 1862, is not living. Elijah Spencer died in the Union army in 1863, and his widow married Jonathan Squires, who was born in Ohio, July 25, 1823, by whom she had one son, J. Wilbur, born June 16, 1865, in DeKalb county, Ind., married Cora M. Thomas, Aug. 24, 1887, they reside in St. Joseph, Mich., five children. Mrs. Myra Squires died in Allen county, Ind., Feb. 13, 1874.
A More Complex Ontology

Myra Harwood

Jonathan Squires

J. Wilbur Squires

Feb. 13, 1874
The Solution

Thus, intelligence is the ability to bring to bear all the knowledge that one has in service of one’s goals.

Newell (1990), p. 90
OntoSoar Architecture

- PDF Tools
  - Segmenter (Segment Rules (37))
  - LG Parser (Link Grammar)
  - Meaning Builder (Grammar Constructions (16))
  - Conceptual Semantic Analyzer (Inference Rules)
  - Mapper (User Ontology (OSMX))

- Soar (A total of 260 Soar productions)

- Populated User Ontology (OSMX)

- OntoES Tool Set
  - Text
  - Segments
  - Linkages
  - Meaning Schemas
  - Knowledge Structures
  - Facts
Construction Grammar

Person -> LifeEvent -> Date

Person -> SonOf -> Person

LIFE-EVENT

DATE

REF-EXPR

LE-VERB
Applying Constructions

Charles Christopher Lathrop, N. Y. City, b. 1817, d. 1865, son of Mary Ely and Gerard Lathrop;
More Constructions

Charles Christopher Lathrop, N. Y. City, b. 1817, d. 1865, son of Mary Ely and Gerard Lathrop;
Building Knowledge

Charles Christopher Lathrop, N. Y. City, b. 1817, d. 1865, son of Mary Ely and Gerard Lathrop;
Charles Christopher Lathrop, N. Y. City, b. 1817, d. 1865, son of Mary Ely and Gerard Lathrop;

... his widow married JONATHAN SQUIRES, who was born in Ohio, July 25, 1823, by whom she had one son, J. Wilbur, born June 16, 1865,
## Results on Examples

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<th>P Errors</th>
<th>R Errors</th>
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**Totals/Average**

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**Accuracy Sample 2**

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**Totals/Average**

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<td><strong>Births</strong></td>
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**Accuracy Sample 2**
Data Accuracy for Test Data

- Persons
- Births and Deaths
- Marriages
- Children
Results on *The Ely Ancestry*

a book of 830 pages, including our Example 1

<table>
<thead>
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<th>Item Type</th>
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<td>Children</td>
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<td>Total</td>
<td>35,929</td>
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The Role of Working Memory in Metaphor Production
Chiappe & Chiappe 2007

• Processes well documented – but what about mechanisms?
• Previous research correlates WM and metaphor processing, but
doesn’t distinguish which mechanism of WM is responsible
(storage buffer or inhibitory control).
• Kintsch’s Predication Model successfully produces plausible
interpretation for metaphors
• Based on Predication Model, incorrect explanations must be
inhibited
• Therefore – better inhibitory control should equal better
comprehension.
• Metaphor production under-studied.
Experiment 1 - What effect does inhibitory control have on metaphor comprehension?

- Two working memory tests (listening span and Stroop)
- Metaphor comprehension task (some complex, some simple); RT and interpretation measured.

<table>
<thead>
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<th>RT difficult metaphors</th>
<th>RT easy metaphors</th>
<th>Average RT</th>
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<tbody>
<tr>
<td>HWMS</td>
<td>4560.94 (282.57)</td>
<td>4289.82 (293.91)</td>
<td>4425.38 (281.86)</td>
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<tr>
<td>LWMS</td>
<td>5707.80 (323.94)</td>
<td>5778.94 (319.06)</td>
<td>5742.37 (310.67)</td>
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<tr>
<td>Average RT</td>
<td>5224.44 (229.16)</td>
<td>5152.83 (234.83)</td>
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*Note: Numbers in parentheses are standard errors.*

<table>
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<th>Moderately acceptable</th>
<th>Unacceptable</th>
<th>Uninterpreted</th>
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<tr>
<td>HWMS</td>
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<td>7.22 (0.50)</td>
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<tr>
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<td>7.83 (0.49)</td>
<td>7.86 (0.52)</td>
<td>9.73 (0.93)</td>
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*Note: Numbers in parentheses are standard errors.*
Experiment 2

- Can WM predict quality of metaphors produced?
- Is vocabulary knowledge related to metaphor production?
- WM test (Retrieval Fluency Test), Vocab. Test (Peabody Pic. Vocab. Test - PPVT) and Metaphor Generation Task.

<table>
<thead>
<tr>
<th></th>
<th>Metaphor Generation</th>
<th>Listening Span</th>
<th>Retrieval Fluency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening Span</td>
<td>+.33***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrieval Fluency</td>
<td>+.25*</td>
<td>+.20*</td>
<td></td>
</tr>
<tr>
<td>PPVT</td>
<td>+.44***</td>
<td>+.37***</td>
<td>+.20*</td>
</tr>
</tbody>
</table>
Experiment 3

- Is it really the inhibitory control aspect of WM that matters?
  - Digit span reverse should predict better than digit span forward
- Does print exposure predict quality of metaphors?
- Tests: Listening span, Retrieval fluency, Digit span forward, Digit span reverse, Metaphor generation, Magazine recognition, PPVT

### Table 6
Mean performance on Experiment 3 as a function of working memory capacity

<table>
<thead>
<tr>
<th>Test</th>
<th>HWMS</th>
<th>LWMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening Span</td>
<td>26.13 (0.68)</td>
<td>9.69 (0.37)</td>
</tr>
<tr>
<td>Metaphor Generation</td>
<td>3.46 (0.12)</td>
<td>2.67 (0.12)</td>
</tr>
<tr>
<td>Digit Span Forward</td>
<td>16.29 (0.33)</td>
<td>14.11 (0.38)</td>
</tr>
<tr>
<td>Digit Span Reverse</td>
<td>19.04 (0.62)</td>
<td>16.32 (0.47)</td>
</tr>
<tr>
<td>Retrieval Fluency</td>
<td>100.74 (1.72)</td>
<td>95.37 (1.40)</td>
</tr>
<tr>
<td>PPVT</td>
<td>107.75 (1.29)</td>
<td>97.26 (1.14)</td>
</tr>
<tr>
<td>Magazine Recognition d-prime</td>
<td>1.18 (0.08)</td>
<td>0.79 (0.06)</td>
</tr>
</tbody>
</table>

*Note. Numbers in parentheses are standard errors.*
Table 7
Correlations between working memory functions, vocabulary knowledge, print exposure and metaphor generation

<table>
<thead>
<tr>
<th></th>
<th>Metaphor Generation</th>
<th>Listening Span</th>
<th>Digit Span Forward</th>
<th>Digit Span Reverse</th>
<th>Retrieval Fluency</th>
<th>PPVT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening Span</td>
<td>+.45***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit Span Forward</td>
<td>+.16</td>
<td>+.38***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit Span Reverse</td>
<td>+.20*</td>
<td>+.36***</td>
<td>+.53***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrieval Fluency</td>
<td>+.37***</td>
<td>+.31**</td>
<td>+.01</td>
<td>+.25*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT</td>
<td>+.52***</td>
<td>+.52***</td>
<td>+.18</td>
<td>+.25*</td>
<td>+.29**</td>
<td></td>
</tr>
<tr>
<td>Magazine Recognition</td>
<td>+.42****</td>
<td>+.32***</td>
<td>+.31**</td>
<td>+.18</td>
<td>+.01</td>
<td>+.45****</td>
</tr>
</tbody>
</table>

Note: $N = 101$.

* $p < .05$.
** $p < .01$.
*** $p < .001$.

Conclusions:
- Experiment 1: Inhibitory control implicated because of Stroop correlation
- Experiment 2: HWMS produce better metaphors. WM contributes independently of vocabulary knowledge.
- Experiment 3: WM predicts quality of metaphor production independent of vocab knowledge and print exposure. However, vocab knowledge is much more predictive.
INFLUENCING CATEGORICAL CHOICES THROUGH PHYSICAL OBJECT INTERACTION

- This is a variation of the Stroop effect task
- Taxonomic, non-action vs. taxonomic, action
  - Context lean vs. context rich
- 3 categories
  - Same-Category Objects, Different-Category Objects, Perceptual-Category Objects
- Aim of this paper was to see how participants perform on Shipp et al. (2014) forced-choice triad task after being primed with physical actions that related to the triad items; to see if the actions were more frequent when participants interacted with the objects in a functional capacity
Figure 1. Examples of stimuli employed in the experiment. From left to right: Same Category Object triad, Different Category Object triad, and Perceptual Category Object triad in the context-lean condition (top panels) and in the context rich condition (bottom panels).
Priming

- 48 objects on a table
- Action group, used objects
- Taxonomic group, sort items into categories
- Movement group, move objects from one table onto another table
**Table 1. Mean percentage of action choices in the DCO, SCO and PCO triads across context and priming.**

<table>
<thead>
<tr>
<th>Triad</th>
<th>Priming</th>
<th>Context</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lean</td>
<td>Rich</td>
<td></td>
</tr>
<tr>
<td>DCO</td>
<td>Action</td>
<td>.53</td>
<td>.58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taxonomic</td>
<td>.32*</td>
<td>.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Movement</td>
<td>.46</td>
<td>.40</td>
<td></td>
</tr>
<tr>
<td>SCO</td>
<td>Action</td>
<td>.48</td>
<td>.66*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taxonomic</td>
<td>.60</td>
<td>.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Movement</td>
<td>.48</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>PCO</td>
<td>Action</td>
<td>.48</td>
<td>.78*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taxonomic</td>
<td>.50</td>
<td>.58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Movement</td>
<td>.40</td>
<td>.65</td>
<td></td>
</tr>
</tbody>
</table>

*Note. *Indicates those mean scores that significantly differed from a 50/50 chance ratio.
Figure 3. Mean percentage of action choices across the Action, Taxonomic and Movement Priming conditions. Error bars are standard errors of the mean.

Figure 4. Mean percentage of action choices with Same Category Object (SCO), Different Category Object (DCO), and Perceptual Category Object (PCO) triads in the context-lean condition (light grey bars) and in the context-rich condition (dark grey bars). Error bars are standard errors of the mean.
Results

• They were able to partially replicate the context effect from Shipp et al. (2014).
  • Confirmed that the action choice was least likely to be selected in the DCO as compared to the SCO and PCO conditions.
  • The post-hoc Bonferroni score revealed that action choices were significantly higher for the PCO triads than for the DCO and SCO
• After receiving the action priming condition those participants were more likely to select the action related item among the triads
SEMANTICS
Semantics

- Representation of the meaning of (parts of) utterances
- What does the (word/phrase/clause/sentence) mean?
- To what extent can the meaning be derived?
- To what extent can the meaning be arrived at compositionally?
- What components of linguistic processing contribute to meaning?
- How does cognition fit into all of this?
Meaning categories

- Concepts: basic entities
- Properties: attributes predicated of concepts
  - Intensity
  - Incommensurability
- Events: actions, states, processes
  - Internal structure
- Inventories, relationships
Lexical semantics: word meaning

- Synonym: youth/adolescent, filbert/hazelnut
- Antonym: boy/girl, hot/cold
  - gradable, relational, complementary
- Hyponym/hypernym
- Meronym (part-of relationship)
- Word senses
- Lexical ambiguity
  - Polysemy: 2+ related meanings (bright, deposit)
  - Homonymy: 2+ unrelated meanings (bat, file)
    - homophones
    - homographs
Sense delimitation and lexicalization

- Fuzziness (rich, tall, green, clean)
- Typicality, prototypes
  - Bird: robin vs. penguin
- Lexicalization (snow) (glint, glimmer, glitter, gleam, glisten, glow, glare)
- Culture-specific concepts
  - Western, educated, industrialized, rich, democratic (WEIRD) societies aren’t the only ones
- Lexical gaps: concept not lexicalized in another language
- Granularity mismatch of words crosslinguistically
Truth value response latencies

Figure 6
Average reaction time for different type of sentences adapted from (Collins & Quillian, 1969)
Hierarchical nature of semantic memory

Figure 5
(Collins & Quillian 1969)
Empirical methods and lexical semantics

• Meaning is notoriously difficult to measure
• This paper: polysemy, universal word lists, translation, and overlap
  • 22 concept categories from Swadesh lists for 81 languages (material objects, celestial objects, natural settings, geographic features)
  • Consult translation dictionaries (forward and backward translation)
• Build semantic networks between concepts and lexical items
  • Per-language links
  • Weight connections
  • Build semantic clusters
  • Network analysis statistics
Nonlinguistic variables in language selection

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subset</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geography</td>
<td>Americas</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Eurasia</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Africa</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Oceania</td>
<td>15</td>
</tr>
<tr>
<td>Climate</td>
<td>Humid</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Cold</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Arid</td>
<td>13</td>
</tr>
<tr>
<td>Topography</td>
<td>Inland</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Coastal</td>
<td>36</td>
</tr>
<tr>
<td>Literary tradition</td>
<td>Some or long literary</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>tradition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No literary tradition</td>
<td>53</td>
</tr>
</tbody>
</table>
Rank plots of concepts: heterogeneity

Fig. 4.
Venn diagram of meaning relationships

Green: Spanish
Blue: Lakhota
Red: Coast_Tsimshian
Semantic net inferred via polysemy
Swadesh connectivity
Conclusions

• Surprising degree of polysemous overlap across language families
• Languages differ in overall magnitude of polysemy
• Same concepts tend to be polysemous
• Environment, geography don’t play a role
• Could do this automatically for WEIRD languages
SEMANTICS

Processing of aspect
Vendler’s major lexical aspects
Events

- Relatively temporal relation in conceptual space
- States/conditions of existence, processes, unfoldings
- Actions, executed processes inherently tied to change
- Process: series of states constituting a phenomenon
- Relationality: change is essential to identifying events
- Temporality: time is a crucial element
Acts vs. States

• Stative events
  • Internally uniform
  • Scope: event as a totality
  • More stable temporally, no internal dynamics
  • Less sensitive to temporal distinctions

• Nonstatives (acts)
  • Heterogeneous, internally structured
  • Scope: components
  • Substates involve more temporal change, dynamism
  • Usually nonpresent tenses
Events: resultatives

• Inchoatives
  • Denote interval between two intervals
  • Boundary crossing into a new condition
  • Can’t distribute to moments

• Resultatives
  • Complex event: act + change-of-state
  • Not interruptible
  • Don’t saturate down to the moment

• Ambiguities
  • This shrimp digests easily.
    (inchoative middle, resultative active)
Events properties: tense vs. aspect

- **Tense**
  - Information dealing with temporal (time) properties
  - Past, future, present
    - manger+ai (Frn); sing+s
  - Remoteness is specified in some languages
  - Not just verbs in some languages
    - tu+pus (Lus)

- **Aspect**
  - Nontemporal internal contour of an event
  - How an event is distributed through a time frame
  - Patterns within an event’s temporal frame
  - English usually conflates with tense
Aspectual types

• Perfectivity
  • Perfective: complete, unitized, viewable as single bounded whole, internal structure less salient
  • Imperfective: opposite
  • Present tense: rarely perfective
  • Slavic languages: verb form dichotomy for imperfective/perfective

• Telicity
  • Resultative: dual structure (process+result)
  • Success predicated on built-in goals
  • Necessarily imply previous events
  • Processes that exhaust themselves in their consequences

• Durativity
  • Durative: necessarily distributed over time
  • Punctual: momentary event having no temporal duration
Aspectual types

- Progressivity
  - In progress, on-line, ongoing
  - Continuous and extended from a point into a larger interval
  - Extending an event from the inside
- Interactions
  - w/punctual event: iterative
  - Simultaneity, coextensiveness
  - Stativizing dynamic events
  - Non-permanence, contingency
- Wide linguistic variation
Aspectual types

• Habituality
  • Extends an event from the outside
  • Persistence of an event irrespective of time
  • Indefinite protraction of an event
  • Distribution of an event over several times
  • Not just a case of iteration
  • Interactions: perfectivity, past tense, conditional
Aspectual types

• Iterativity
  • Semelfactive: one act, event
  • Iterative: multiple subevents
  • Event cardinality, cyclicity, dual laterality

• Other aspects
  • Inceptive (incipient, ingressive)
  • Terminative (egressive)
  • Prospective (intentive)
  • Retrospective
  • Intensive
Aspectual interactions
(aka apectual type coercion)

• Ambiguities
  • John had eaten the popcorn by 1:00.
    (event frame punctuality, reference time punctuality)
  • The dog just ran away.
    (proximal preterite, modal)

• Implications for incremental processing?
Paper 1

- Perfective sentences << imperfective for accomplishment verbs (i.e. have an endpoint)
- Cantonese: same, but: imperfective sentences << imperfective with activity verbs
  - Aspectual asymmetry
- So:
  - Lexical (Vendler’s classes) vs. grammatical aspect (boundedness, perfectivity)
Facts: aspectual asymmetry

- RT in English: imperfective << perfective
  - Slower decay, longer activation, better WM retention
- English sentence completion: more locatives w/ imperfective, more perfectives with affected patients
- English ERP higher N400: atypical locations w/ imperfective but not for perfective
- Tighter association w/ locative, imperfective
- Sentence-pair picture matching: more likely to match perfective sentences w/ depictions of completed actions
  - Shorter RT than with imperfectives

- Perfective facilitation
Experiment: what about Cantonese?

- No tense, rich aspect
- Hypothesis
  - Faster perfective processing for accomplishment verbs
  - Faster imperfective processing for activity verbs
- Forced-choice sentence-picture matching

1. ACC: [+dynamic][+durative][+telic]
   se2 fung1 seon3
   write CL letter
   “write a letter”

2. ACT: [+dynamic][+durative][−telic]
   teng1 jam1ngok6
   listen music
   “listen to music”

3. Imperfective gan2
   go3 naam4zai2 jau4-gan2 seoi2
   CL boy swim-IMPF water
   “The boy is swimming.”

4. Perfective zo2
   go3 naam4zai2 jau4-zo2 seoi2
   CL boy swim-PERF water
   “The boy has finished swimming.”
Results

Table 2
Mean Accuracy Rates (in Percentages) for Matched Perfectives and Matched Imperfectives in a Sentence–Picture Matching Task

<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Grammatical Aspect</th>
<th>Lexical Aspect (Verb Type)</th>
<th>ACT</th>
<th>ACC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Subject analysis</td>
<td>Perfective</td>
<td>96.1</td>
<td>8.4</td>
<td>97.8</td>
</tr>
<tr>
<td></td>
<td>Imperfective</td>
<td>98.2</td>
<td>3.9</td>
<td>93.5</td>
</tr>
<tr>
<td>Item analysis</td>
<td>Perfective</td>
<td>96.1</td>
<td>3.5</td>
<td>97.8</td>
</tr>
<tr>
<td></td>
<td>Imperfective</td>
<td>98.2</td>
<td>3.4</td>
<td>93.3</td>
</tr>
</tbody>
</table>

Table 3
Mean Response Times (in Milliseconds) for Matched Perfectives and Matched Imperfectives in a Sentence–Picture Matching Task

<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Grammatical Aspect</th>
<th>Lexical Aspect (Verb Type)</th>
<th>ACT</th>
<th>SD</th>
<th>ACC</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td></td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subject analysis</td>
<td>Perfective</td>
<td>1,086</td>
<td>198</td>
<td>1,037</td>
<td>193</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imperfective</td>
<td>980</td>
<td>172</td>
<td>1,076</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Item analysis</td>
<td>Perfective</td>
<td>1,084</td>
<td>118</td>
<td>1,036</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imperfective</td>
<td>988</td>
<td>145</td>
<td>1,089</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

A. Presentation of either a perfective or imperfective sentence (auditory form):

\[ \text{go3 nam4zai2 taan4g4n2 kam4} \]

CL: boy play-IMP piano

“The boy is playing the piano.”

B. Presentation of a pair of pictures depicting ongoing versus completed events:

C. Decision of which picture matches the utterance by pressing a corresponding key on the computer keyboard.