Which verb classes and why?

Jean-Pierre Koenig,
Gail Mauner, Anthony Davis, and Breton Bienvenue
University at Buffalo and Streamsage, Inc.

Research questions:

- Participant roles play a role in the syntactic co-occurrence possibilities of verbs:
  - Which participant-roles based meanings underly verbal subcategorization frames?
  - Is there evidence for participant-role based verb classes in the absence of syntactic correlates?

What verb classes?

Several different ways of classifying verbs syntactically and semantically:
- Subcategorization (e.g., ditransitive verbs)
- Situation types (e.g., verbs denoting events of ingestion);
- Participant role types (e.g., verbs including an obligatory instrument, a cause);
- Semantic frames (e.g., verbs pertaining to commercial events)

Semantic Basis Hypothesis (SBH)

- The first, syntactic, classification (subcategorization) is not independent of the other three, semantic, classifications.
  - Part a: Subcategorization classes entail semantic classes (and linking of syntactic expressions to semantic roles)
  - Part b: You can predict from the (narrow) semantic class of verbs most or all of their possible subcategorization frames (and the linking of semantic roles to syntactic expressions)

The meaning/subcategorization connection

- If a verb is in the ditransitive frame, then it includes as part of its meaning that a transfer of possession occurs; the agent is the subject, the recipient the direct object and the theme the secondary object
- If a verb denotes ballistic motion or future possession, or ... it can occur in the ditransitive frame (with the same linking rules as above)

Why the truth of the SBH matters

- If true, we might infer much of the meaning of a verb by looking at the range of subcategorization frames it occurs in:
  - Useful to language learners;
  - Useful for word sense disambiguation;
  - Useful for developing large computational lexicons;
Is the SBH true?
Yes, but...

First problem: meaning of frames is not always entailed

- *Send, promise, deny, owe...*
  - They don’t include “real” transfer of possession in the ditransitive frame
  1. Joe promised/owed Bill $5.
  2. Joe denied Bill a raise.

First amendment to the SBH

- The meaning of verbs in the ditransitive frame includes as part of their meaning the notion of transfer of possession, but, that meaning can be modified by a modal component.

1. **Joe will transfer the $5 to Bill in all world in which he fulfills his promises**
   - A core situation
   - A modal modification

Second problem: (Narrow) verb meaning does not predict frames

- *Buy, sell, pay...* all denote the same commercial event types, but their linking potential is different
  
  -> Is their meaning different?
  1. *Buy*: cause(x, go (y, [from z to x]))
     [exch [go (money, [from x to z ])]]]
  2. *Sell*: cause(z, go (y, [from z to x]))
     [exch [go (money, [from x to z ])]]]

1. Joan sprayed the paint onto the statue
2. Joan sprayed the statue with paint

- Difference in meaning between *spray loc* and *spray with*, but that’s not enough to get linking right.

3. cause (Joan, go (paint, to (statue))))
4. act-on (Joan, statue, by (cause (Joan, go (paint, to (statue)))))

- Sometimes, there is not even a clear difference in meaning between two subcategorization frames:

1. The tax law will benefit us
2. We will benefit from the tax law
Second amendment to the SBH

 Meaning of lexical entries is a bag of situation-denoting relations. Linking rules for direct arguments proceed from the chosen relation (the KEY relation):

- Spray with:
  1. A causes B to move to C
  2. A causes C to change state
  3. A uses B to do [2]

- Spray loc:
  1. A causes B to move to C

- Benefit:
  1. A CAUSE B to [2]

- Benefit from:
  1. A CAUSE B to [2]

What’s left of the SBH

- Within a language, if:
  - You abstract away from sublexical modal modification;
  - You know which semantic relation is relevant (KEY) for linking of direct arguments,

- Then the SBH holds.

Why semantically-driven subcategories of verbs?

- The SBH does not explain why verbs can occur in different subcategorization frames:
  - Maybe subcategorization variation is like differences in car fenders (P. Postal, apocryphically?)

Hovering between two set-theoretically related classes of eventualities

Moving through Levin’s alternations I

- Describing the more general case:
  1. a. Bob shot the bird.
     b. Bob shot at the bird. (Bob intended, but may not have reached the bird)

- Describing the more specific case:
  2. a. Joe sent a card to Bill
     b. Joe sent Bill a card (Joe additionally intends Bill to get the card)
  3. a. Joe loaded the truck with hay. (Joe additionally causes the truck to become full)
     b. Joe cleared the dishes from the table
  4. a. Joe cleared the dishes from the table
     b. Joe cleared the table of dishes. (Joe additionally causes the table to be encumbered)

Going through Levin’s alternations II

- KEY selection
  5. a. Joe carved a canoe into a log.
     b. Joe carved a log out of a canoe.
     1. Joe incised into a log and
     2. Joe created a canoe and
  6. a. Joe replaced the sugar with salt.
     b. Joe substituted the salt for the sugar.
     1. Joe moved sugar out of place.
     2. Joe moved salt into place.
Stressing one component of a complex event description

Incision: \_NP(substance)\_

Transformation: \_NP(created object)\_

Are verbs organized into purely semantic verb classes?

- The surface syntactic patterns serve as evidence of the existence of participant-role based verb classes in the Syntax/Semantics literature;
- Are verbs organized into such semantic classes even when a language’s surface syntax does not force us to do so?

Purely semantic verb classes matter

- Examine behavioral differences between semantically distinct classes of verbs when syntactic behavior is kept constant:
  - Relative frequency of co-occurrence of phrases across verb classes is as equal as possible;
  - There are no differences in valence alternations across the two classes.

Instrument verb class: ±Obligatory

- Some verbs require of their denotata that it includes an instrument (behead), some do not (kill);
- This semantic factor is part of a larger information-theoretic measure of how strongly verb denotations and semantic properties are associated.

This is indeed a semantic contrast

- No valence alternation differences among the two classes of “instrument” verbs;
- PPs expressing instruments are optional for both the behead and kill verb classes;
- No differences in frequency of co-occurrence between PPs across two verb classes (at least, in our stimuli!).

Smaller participant role classes: subclasses of instruments

- One can classify verbs allowing/requiring instrument roles into various “narrow” semantic subclasses (about two dozen):
  - CUT class: amputate, bone, cut, dissect, guillotine, gore,
  - WHIP class: beat, bat, club, whip, whack,...
  - SKI class: canoe, bicycle, skate, drive, ski, toboggan,...
  - SCOOP class: spoon, pump, milk, sponge, ladle, shovel, siphon, scoop,...
  - DOODLE class: doodle, draw, ink, inscribe, dot, pencil, sketch, print,...
Are there behavioral reflexes of the difference between ±obligatory instrument semantic classes or between the various instrument subclasses?

Example stimuli, task, and predictions for filler-gap studies
- Which sword/Which instrument did the rebels | kill/behead| the traitor king with [gap] | during the rebellion?
- Region-by-region self-paced reading with a secondary judgment task;
- If the distinction between ±obligatory instrument verbs is encoded in the mental lexicon, the instrument role should be more activated after +obligatory instrument verbs;
- RTs to the Direct Object +P[gap] region should be faster for +obligatory instrument verbs

Results
- Reading times were faster in the direct object +P[gap] region for verbs that require instruments than for verbs that do not whether specific WH-fillers are equated for plausibility or whether WH-fillers are abstract names for instruments;
- (Results were replicated for other participant role distinctions that have no syntactic reflexes)

Example stimulus set for syntactic priming studies (Bienvenue et al. 2005)

Target: Which sword| did the knight| stab| the ferocious dragon with| in the fairy tell?

IO prime:
- Which needle| did the nurse| stab| the patient with| in the operating room?
- Which needle| did the nurse| ready| the patient with| in the operating room?
- Which needle| did the nurse| inject| the patient with| in the operating room?

DO prime:
- Which needle| did the nurse| fill| in the operating room?

Y/N prime:
- Did| the nurse| prepare| the needle| in the operating room?

Predictions
- Because IO extraction is relatively infrequent, IO targets should benefit from IO primes;
- If lexical identity is required for facilitation, we expect to find it only in Experiment 1 where the verb is repeated across primes and targets;
- Common membership in a “narrow” instrument class of verbs in the prime and target sentences should lead to inhibition in Experiment 3.

Behavioral measures
- Filler-gap dependencies (how easy it is to integrate a filler depends on whether a class of verbs requires a specific role or not);
- Syntactic priming (syntactic priming may be affected by whether or not primes and targets belong to the same instrument subclass);
- Visual world (looks to instruments may be affected by whether or not a verb belongs to the class of verbs that require vs. allow instruments)
RTs at DO region for Expt 1-3

<table>
<thead>
<tr>
<th>Prime Type</th>
<th>Same verbs</th>
<th>Unrelated verbs</th>
<th>Same instrument subclass verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO prime</td>
<td>1655</td>
<td>1613</td>
<td>1991</td>
</tr>
<tr>
<td>IO prime</td>
<td>1477</td>
<td>1730</td>
<td>1815</td>
</tr>
<tr>
<td>YN prime</td>
<td>1670</td>
<td>1246</td>
<td>1682</td>
</tr>
</tbody>
</table>

Results
- Faster reading for IO targets preceded by primes with repeated verbs relative to DO and Y/N control sentences;
- No priming or inhibition for IO targets preceded by primes with verbs from different semantic classes;
- Slower reading for IO targets preceded by primes with different verbs from the same instrument semantic subclass;

Visual world experiment (preliminary)

Task and predictions
- The eye-movement of participants were monitored while there were listening to audio stimuli;
- Screen contained four images, one of a plausible instrument for the action described in the sentence, one of the sentence’s subject, and two foils;
- We predict more looks to images of instruments for +obligatory instrument verbs than for –obligatory instrument verbs.

Conclusions
- The SBH holds, but only once part of the meaning of verbs is factored out;
- The SBH can be used as a window into the organization of verb meaning:
  - Verb meaning consists of a relational core and a modal component;
  - The relation core consists of a bag of relations.
- There is behavioral evidence for the organization of verbs into strictly semantic participant role classes:
  - Abstract participant role classes: ±obligatory instruments
  - “narrow” instrument classes: CUT class

The king killed/beheaded someone with a sword during the rebellion.

The SBH holds, but only once part of the meaning of verbs is factored out;