

Which verb classes and why?

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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
1. Joe sent/threw Bill a book.
- 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 and
[2]A causes C to change state and
[3]A uses B to do [2]

Spray_{loc}: [1]A causes B to move to C

Benefit_{DO}: [1]A CAUSE B to [2]

[2] B BE-BETTER

Benefit_{from}: [1]A CAUSE B to [2]

[2] B BE-BETTER

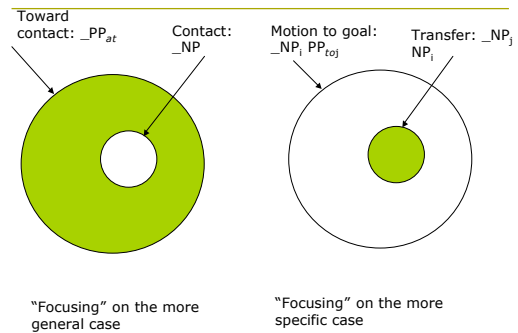
What's left of the SBH

- 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, apocryphally?)

Hovering between two set-theoretically related classes of eventualities



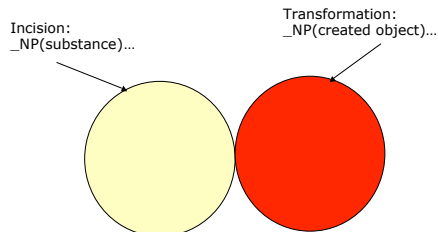
Moving through Levin's alternations I

- Describing the more general case:**
 - 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:**
 - a. Joe sent a card to Bill
b. Joe sent Bill a card (*Joe additionally intends Bill to get the card*)
 - a. Joe loaded the truck with hay. (*Joe additionally causes the truck to become full*)
 - 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**
 - 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 [3] [1] causes [2]
 - 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




Are verbs organized into purely semantic verb classes ?

- The surface syntactic patterns serve as evidence of the existence of participant-role based 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 instruments (*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.
-  The rebels beheaded/killed the traitor king with a sword during the rebellion.

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?

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);

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_{Exp1}: Which needle| did the nurse| stab| the patient with| in the operating room?

IO prime_{Exp2}: Which needle| did the nurse| ready| the patient with| in the operating room?

IO prime_{Exp3}: Which needle| did the nurse| inject| the patient with| in the operating room?

DO prime_{Exp1,2,3}: Which needle| did the nurse| fill| in the operating room?

Y/N prime_{Exp1,2,3}: 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.

RTs at DO region for Expt 1-3

Prime Type	Same verbs	Unrelated verbs	Same instrument subclass verbs
DO prime	1655	1613	1591
IO prime	1477	1730	1815
YN prime	1670	1246	1682

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;

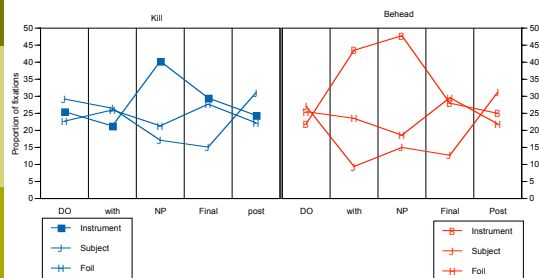
Visual world experiment (preliminary)



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

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