Reading Brocher et al.'s About sharing and commitment the retrieval of biased and balanced irregular polysemes

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The issue

 Representation and processing of ambiguous words homonyms have unrelated senses, e.g. BANK 'financial institution' vs. 'river edge'

regular polysemes have predictably related senses, e.g. CHICKEN 'animal' vs. 'meat'

irregular polysemes have related senses, but the relation is accidental, e.g. WIRE 'piece of metal' vs. 'listening device'

- Previous research focuses on homonyms vs. polysemes without clearly distinguishing the two subtypes of polysemes.
- In principle, you could imagine irregular polysemes to pattern either with homonyms (unpredictable) or regular polysemes (partially shared meaning)

Why am I interested?

- Getting a psycholinguistic handle on elusive linguistic distinctions
- Connections with issues in lexeme formation:
 - Sometimes lexeme formation and regular polysemy do the same thing, e.g. reflexivization of verbs.
 - Derived lexemes are often polysemous, apparently instantiating both subtypes of polysemy — and often it is hard to tell which.
 - Regular: CONSTRUCTION action vs. result
 - Irregular: STEAMER cooking appliance vs. steam-propelled boat
 - Hard to decide: Fr. GARAGE action vs. place

Main research question I

- Three possible approaches to the psycholinguistic representation of irregular polysemy:
 - 1. Separate representations: each sense is represented by a disjoint semantic representation. Lexical access consists in one form activating concurrently the two representations, possibly with a frequency bias leading to higher activation for one.



In such an approach irregular polysemy is like homonymy.

Main research question II

2. Underspecified representations: the mental lexicon contains an intermediate, underspecified representation that captures what is common to both senses. Lexical access consists in activating only that representation until decision on a specific sense is required (e.g. because of disambiguating material).



Main research question III

3. Shared features: the mental representations of senses consist in sets of features that overlap. In lexical access, both the shared features and the unshared features are accessed, though the shared features might be more salient.



Previous research I

- Well-documented dominance effect in the processing of biased homonyms (Duffy et al. 1988): when processing an ambiguous word one of whose senses is more frequent than the other (e.g. BANK), the dominant sense ('financial institution') is retrieved more quickly than the subordinate sense ('river edge').
- This is argued to rely on separate representation of the two words: the ambiguous form triggers concurrent activation of two lexical entries; the more frequently used entry is more salient and hence accessed more quickly.
- A series of studies mostly by Frisson and coauthors (see Frisson 2009) compare homonyms and regular polysemes. They replicate the dominance effect for homonyms, but not for regular polysemes. They argue that this provides evidence for an underspecification account of polysemy, where no specific sense is chosen in early stages of lexical processing.

Previous research II

- Importantly though, these studies focus on regular polysemy.
- Foraker & Murphy 2012 do document a dominance effect for polysemes, using a dataset from Klein & Murphy 2001 that is a mixed bag of regular and irregular polysemes. They thus reach the opposite conclusion from Frisson et al.
- However the response pattern is different from that found by Duffy et al., and the strength of the dominance effect is modulated by semantic similarity, which should not arise under a separate representation approach.
- Brocher et al. (2016) is a previous study arguing for a shared feature account through comparison of biased homonyms and biased irregular polysemes. The present study will add balanced ambiguous words (i.e. ambiguous words where the two senses are (about) as likeky) to the comparison.

Predictions of the three models

- If irregular polysemes have separate representations, we expect a robust dominance effect (i.e. processing difficulty when accessing the subordinate sense), for both homonyms and polysemes.
- If irregular polysemes have some form of common representation, dominance effects should be reduced in irregular polysemes when compared to the effect found with homonyms
- Among models positing common representations, an underspecification model predicts that, in the absence of a disambiguating preceding context, biased and balanced polysemes should be processed with equal difficulty.
- On the contrary, a shared feature model is compatible with a more processing difficulty for balanced polysemes, because there is more uncertainty as to the selection of unshared aspects of representation.

Materials I

The authors conducted two norming studies:

- 1. The homonymous vs. polysemic status of an ambiguous word was assessed by exposing speakers to pairs of contexts and asking them to evaluate how similar the word meanings were.
 - (1) Paul wanted to deposit all his cash but the bank was closed
 - (2) The couple went for a nice, long walk alongside the bank
 - 20 participants each judging 50 sentence pairs exemplifying a total of 180 distinct words.
 - Similarity scale from 1 to 7
 - Selected items with scores around 1.35 for homonyms an 3.25 for polysemes.

Materials II

- The biased vs. balanced status of an ambiguous word was assessed by eliciting from speakers free associations for each ambiguous word.
 - Two raters then decided which proposed associations corresponded to which sense.
 - Proportions of association to the highest scoring sense were used as a bias scale, ranging from 0.50 to 1.
 - Selected items with scores around .56 for balanced words and .90 for biased words.

Experiment 1: materials

 Experiment 1 is a priming experiment, which assesses how an ambiguous priming word affects the processing of a disambiguating target.

Ambiguity	Bias	Dominance	PRIME	TARGET
Homonymy	Biased	Dominant	BANK	ROB
	Biased	Subordinate	BANK	CREEK
Polysemy	Biased	Dominant	WIRE	CABLE
	Biased	Subordinate	WIRE	POLICE
Homonymy	Balanced	Dominant	CALF	GOAT
	Balanced	Subordinate	CALF	SHIN
Polysemy	Balanced	Dominant	CONE	WAFFLE
	Balanced	Subordinate	CONE	CRASH

 Targets chosen using the associations proposed by participants in the dominance norming study

Experiment 1: design I

 Continuous priming: participants carry out a lexical decision task on both primes and targets.



Two separate experiments with different Inter Trial Intervals (ITIs), to examine different stages of processing.

Experiment 1: design II

For each condition with a prime, matching condition with a nonword for comparison.

Ambiguity	Bias	Dominance	PRIME	TARGET
 Polysemy	 Biased Biased	 Dominant Dominant	 WIRE GINDER	 CABLE CABLE
•••	•••		•••	•••

 192 experimental items interspersed with 384 (word and nonword) distractors.

Experiment 1: results I

At 50ms ITI, general priming effect, with no contrast between homonyms vs. polysemes or balanced vs. biased items.



 Suggests that at the relevant stage of processing, all senses are accessed.

Experiment 1: results II

At 200ms ITI, contrasts emerge:



Experiment 1: results III

Main results of statistical analysis:

- 1. Dominance effect for biased homonyms: priming only for targets corresponding to the dominant sense.
- 2. No priming effect (and hence no dominance effect) for biased polysemes.
- 3. Uniform priming effect for balanced items (both homonyms and polysemes), with no role of dominance.
- 4. Overall larger priming for balanced than for biased items (Bias×Prime type interaction).

Experiment 1: discussion I

Homonyms: results consistent with previous studies.

- Consistent priming for balanced homonyms at both 50ms and 200ms ITI support separate representation with concurrent lexical access; in the absence of bias both senses prime, as expected.
- For biased homonyms, the contrast between 50ms and 200ms ITIs can be interpreted in terms of the time course of competition: while at early stages of processing of the prime we expect faster access to the dominant sense, by the time the speaker reaches the target, both senses have been activated; hence the uniform priming at 50ms ITI. Activation of the subordinate sense decays faster however (because it is less salient). This explains the dominance effect.

Experiment 1: discussion II

- Irregular polysemes
 - Absence of a dominance effect for biased polysemes speaks against separate representation. If there was the same mode of representation as for homonyms, we should find the same effect.
 - The existence of priming for balanced but not for biased polysemes ar 200ms ITI favors a shared feature account over an underspecification account.
 - Under an underspecification account, we expect balanced and biased polysemes to behave the same (either priming or not priming): by hypothesis, the only thing that is accessed until the disambiguating target is reached is the underspecified representation.
 - Under a shared feature account, we expect that both shared and unshared features of the two senses are activated upon treatment of the ambiguous word.
 - Shared features are by definition more frequent, and hence more easily accessible. This may explain why at the shorter ITI there is uniform priming.

Experiment 1: discussion III

- Nonshared features are less frequent, and hence their activation will decay quickly. This may explain why there is no priming for biased polysemes at the longer ITI: the useful disambiguating information is not salient anymore.
- Balanced, but not biased polysemes lead to competition between senses (= unshared features), just as is well documented for balanced homonyms. With a longer delay this competition increases as readers attempt to resolve the ambiguity. Hence the relevant features are activated, which explains why priming occurs.
- All this is plausible, but highly dependent on hypotheses on the timing of lexical processing that are not directly tested in the paper

Experiment 2: design and materials

 Eyetracking while reading sentences containing an ambiguous word and a later disambiguating sequence.

Frequency	Ambiguity	Sentence
Biased	Homonym	Ken decided on the bank (lake) near the clubhouse, since the other <i>beaches were too</i> crowded for swimming.
Biased	Polyseme	When Mr. Jordon discovered the wire (bomb) in the lamp, the <i>FBI aborted</i> the top secret mission.
Balanced	Homonym	Something seemed to be wrong with the calf (pony) that day , because the <i>animal did not</i> drink nor eat.
Balanced	Polyseme	Marlene looked out for a cone (barrel) on her way home, since a big <i>pothole had been</i> marked there yesterday.

- Importantly, only the less frequent reading is examined.
- Each example sentence has a matched control which is identical except that the ambiguous word is replaced by an anambiguous word.

Experiment 2: predictions

If the shared features account is correct:

- 1. One should find a dominance effect leading to longer reading times in the disambiguating region for biased homonyms. This effect should be less strong (or even absent) for biased polysemes.
- 2. One should find longer reading times for balanced items than for controls, and little difference between balanced homonyms and balanced polysemes. In addition, one should find longer reading times for balanced items relative to controls in the disambiguating region, because speakers may have picked the wrong reading.

Experiment 2: results I

Refresher:

First Fixation is the duration of the first fixation in a region. First pass reading time is the sum of fixations that occur in a region before exiting that region.

Regression path duration is the sum of all fixations in a region, as well as regressive fixations to earlier parts of the sentence before progressing past the region's right boundary.

Total reading time is the sum of all fixations in a region.

Experiment 2: results II

- Main results:
 - Overall, regression path was longer for biased words than for controls. That is not true for balanced words. The effect seems driven by homonyms.
 - Marginal effects on total reading time, suggesting that participants reread homonyms more that polysemes and reread biased homonyms more than balanced homonyms. This suggests that there is regression to biased homonyms at the time of reanalysis.
 - The effect is marginal. In addition, why not examine explicitly whether there is regression after the disambiguating region has been read?
 - Homonyms lead to longer reading times in the disambiguating region, polysemes don't.
 - No significant interaction with dominance, although the numerical tendency goes in the right direction.
 - not significant, hence not significant

Evaluation I

- Within the limits of what one can expect from priming studies, experiment 1 validates the shared features account of irregular polysemes:
 - Polysemes are unlike homonyms in having partially shared representation. Hence, no dominance effect for polysemes in early stages of processing (corresponding to 50ms ITI).
 - Polysemes are like homonyms in having (partially) different representations. Hence, dominance effect in later stages of processing (corresponding to 200ms ITI).
- Experiment 2 fails to strongly validate the predictions of the shared feature account:
 - Total reading times of ambiguous words point in the direction of a differential dominance effect, but not clearly significant.
 - Reading times in the disambiguating region contrast homonyms with polysemes, but no significant interaction with reading times.

Evaluation II

- Does experiment 2 have insufficient sample size? Does it fail to pay attention to relevant variables? (e.g. existence of a regression from the disambiguating region to the ambiguous word)
- Take-home messages for the linguist:
 - Previous literature shows that homonyms reliably lead to dominance effects (Duffy et al.), while regular polysemes don't (Frisson et al.). Clearly, irregular polysemes fall somewhere in between.
 - It is interesting that speakers have gradient judgements on semantic similarity of senses of a polyseme, independent of regularity. It would be worth exploring that in more detail.
 - Connect with literature on computational vs. psycholinguistic measures of semantic similarity?
 - Unclear from the paper: is there a good reason to assume a categorical cutting point between homonymy and polysemy?
 - Also unclear from the paper: how does one distinguish regular from irregular polysemes?