Week 6: Word recognition

Marslen-Wilson, W. D., Bozic, M., & Randall, B. (2008). Early decomposition in visual word recognition: Dissociating morphology, form, and meaning. *Language and cognitive processes*, *23*(3), 394-421.

TABLE 2
Experiment 1a-c: Stimulus properties across test conditions

Condition	*Sem-rel*	*% form overlap*	*Length*		*Lemma frequency*		*N size*		*Word-form frequency*	
			prime	*target*	*prime*	*target*	*prime*	*target*	*prime*	*target*
1. −M −S +O scandal-scan	1.5	.57	6.4	3.7	13.1	16.5	1.1	9.9	9.6	11.0
2. +M −S +O archer–arch	2.2	.66	6.3	4.1	8.0	16.7	2.4	9.7	5.8	10.5
3. +M midS +O barely-bare	4.6	.69	6.3	4.3	7.4	22.0	2.1	7.5	6.8	11.9
4. -M midS +O attach-glue	5.1	n/a	5.9	4.4	12.4	24.5	3.0	6.3	5.5	10.5
5. +M +S +O bravely-brave	7.7	.69	6.8	4.6	7.4	21.8	0.9	6.7	6.6	15.0
6. −M +S −O accuse-blame	7.8	n/a	5.5	4.3	14.2	23.9	3.1	8.6	7.9	14.2

+/−M: Morphologically decomposable/not decomposable; +/−O: Orthographic overlap high/low; +/Mid/−S: Semantically highly related/moderately related/unrelated; Sem-rel = semantic relatedness.

Wu, Y., Duan, R., Zhao, S., & Tsang, Y. K. (2020). Processing ambiguous morphemes in Chinese compound word recognition: Behavioral and ERP evidence. *Neuroscience*, *446*, 249-260.

Table 1. Sample stimuli and their linguistic properties

	Prime Type			Target Type	
	Dominant	**Subordinate**	**Unrelated**	**Dominant**	**Subordinate**
Example	月牙	月末	粉尘	月亮	月份
Translation	Crescent moon	Month-end	Dust	Moon	Month
Mean stroke number	7.97 (2.31)	8.35 (2.08)	8.31 (1.48)	8.23 (2.12)	8.54 (2.15)
Mean character frequency (log)	5.01 (0.47)	5.01 (0.53)	4.92 (0.49)	5.00 (0.47)	5.00 (0.47)
Whole-word frequency (log)	3.13 (0.84)	3.01 (1.00)	3.13 (0.48)	3.27 (0.67)	3.41 (0.85)
Semantic transparency	4.79 (0.71)	4.87 (0.57)	4.63 (0.60)	4.60 (0.54)	4.42 (0.54)
Whole word semantic relatedness with dominant targets	3.67 (0.36)	2.06 (0.44)	1.67 (0.52)	–	–
Whole word semantic relatedness with subordinate targets	1.97 (0.48)	3.56 (0.46)	1.69 (0.57)	–	–

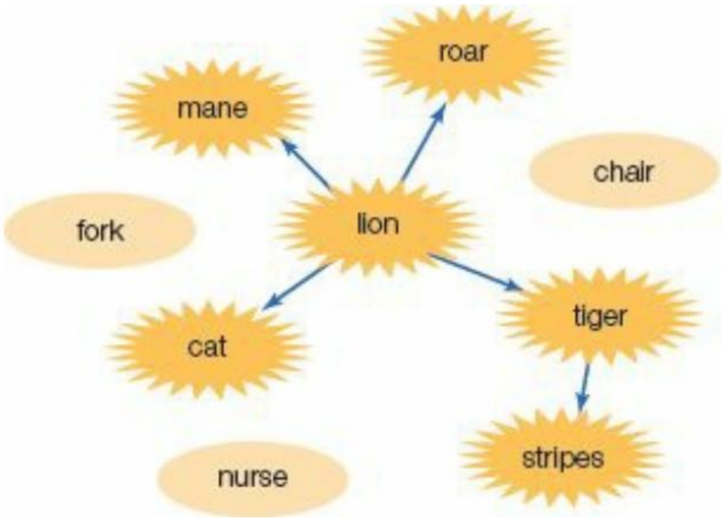
Note. Standard deviations are in parentheses.

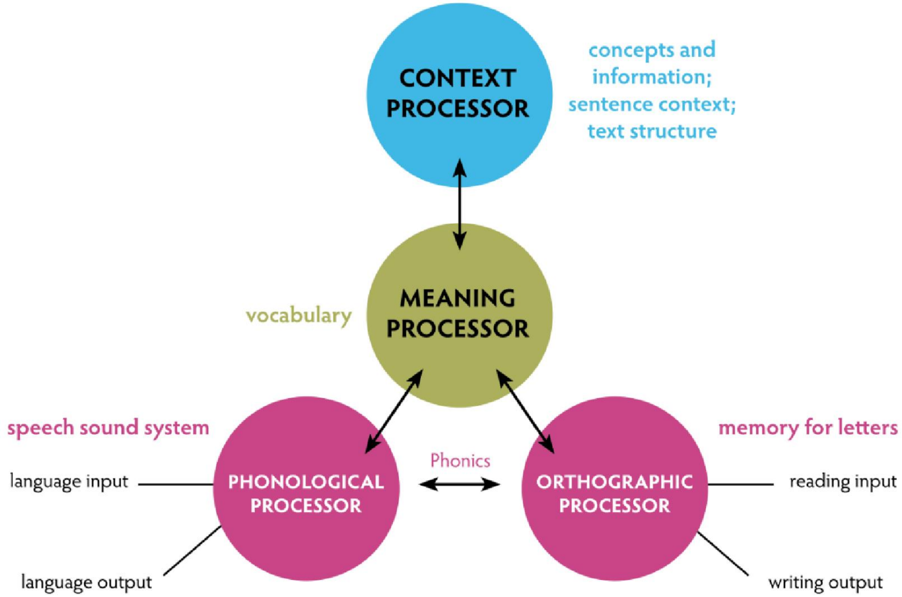
- semantic priming
- morpheme
- word
- L2

How to get measures of these variables?

- KF database (Kucera & Francis, 1967)
- Celex database (Baayen, Piepenbrock, & van Rijn, 1993)
- SUBTLEXus (based on 51 million words in total)
  - https://www.ugent.be/pp/experimentele-psychologie/en/research/documents/subtlexus
- English lexicon project
  - https://elexicon.wustl.edu/
- Subtlex_ch
  - https://www.ugent.be/pp/experimentele-psychologie/en/research/documents/subtlexch

- What will happen if we take phonemic (or orthographic) units into consideration and find out how they are connected to word representations.

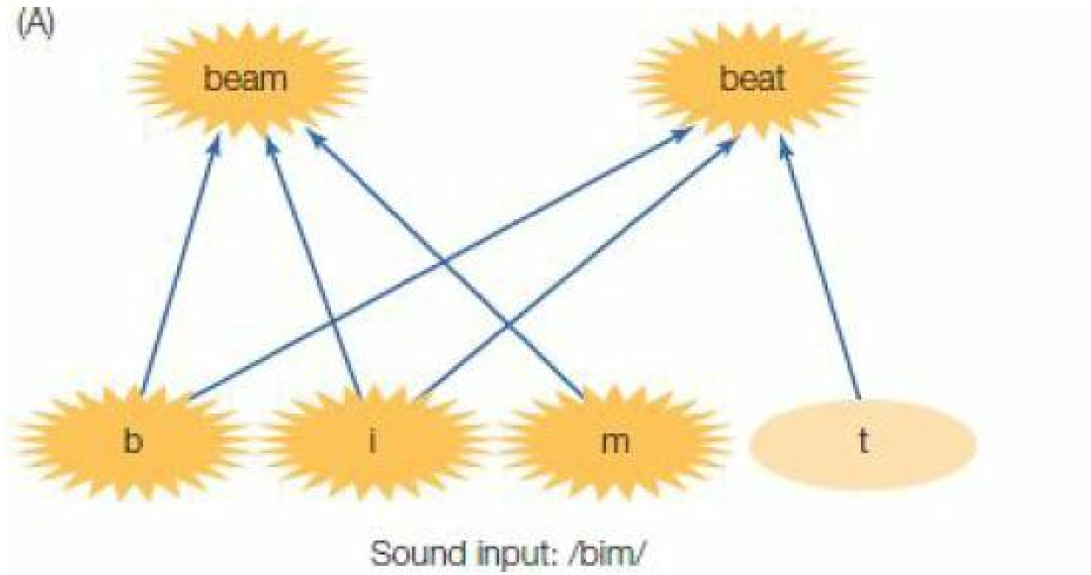




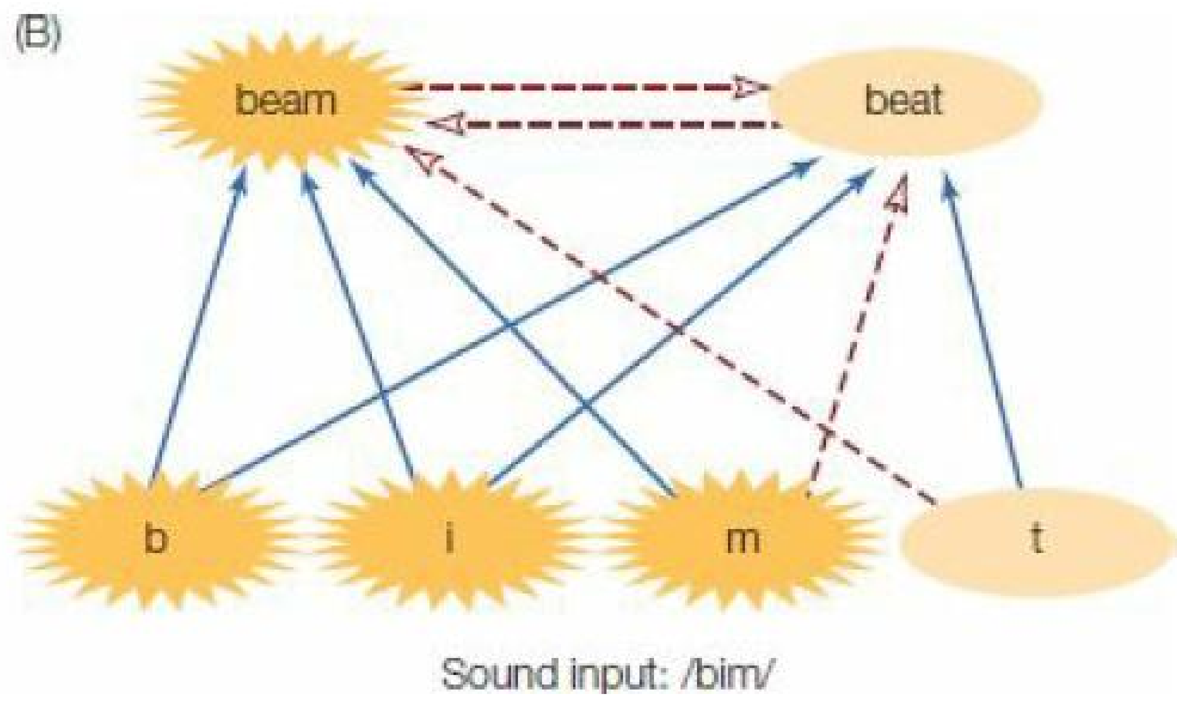
1.3 How to build this into models of word recognition?

- Excitatory connections: connections along which activation is passed from one unit to another, so that the more active a unit becomes, the more it increases the activation of a unit it is linked to.

(A) A simple model showing only excitatory connections (solid lines and arrows).



Question: Why hearing the word *beam* should make it harder to subsequently recognize *beat*?



(B) A model with inhibitory connections (red dashed lines) in addition to excitatory links. As the activation of a phoneme or word rises, activation is decreased for units that are connected to it via inhibitory links. For example, the rise in activation for *beam* results in the suppression of activation of *beat*. (2019:293)

2. Ambiguity

- What about when the sound overlap between words is not partial, but complete?
  - homophones: Two or more words that have separate, non-overlapping meanings but sound exactly the same (even though they may be spelled differently)

bred, bread	made, maid	side, sighed	flea, flee
none, nun	blew, blue	missed, mist	main, mane
bridal, bridle	waste, waist	know, no	in, inn
sun, son	stare, stair	seen, scene	fair, fare
team, teem	pea, pee	hour, our	retch, wretch

- homographs: Words that are spelled exactly the same but have separate, non-overlapping meanings (and may or may not sound the same).

  The performer took a deep **bow**.
  It’s difficult to hunt with a **bow** and arrow.
  Jerry is headed **down** the wrong road.
  I’ve really been glad to have my **down** parka this winter.
  Silvia is **content** with her lot in life.
  The **content** of this course is difficult.

- polysemous: Words that can convey related, but different meanings, such as the various related meanings of paper, which can, among other meanings, refer to a specific material or a news outlet.

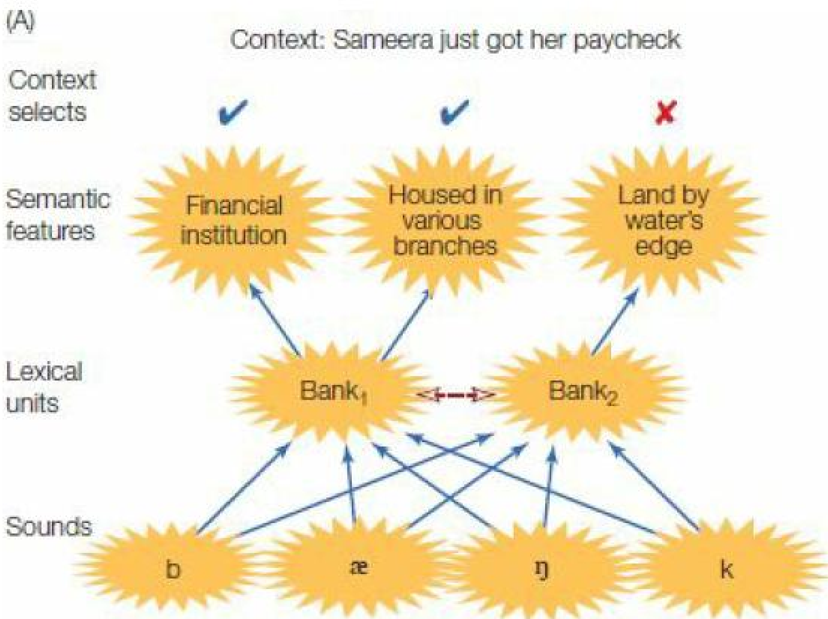
  She’s got a **run** in her stocking.
  There was a **run** on the banks this week.
  Sam went out for an early morning **run**.
  I’d like to **run** my fingers through your hair.
  Let’s **run** through the various options.
  He’s had a **run** of bad luck.
  Can you **run** this over to the post office?

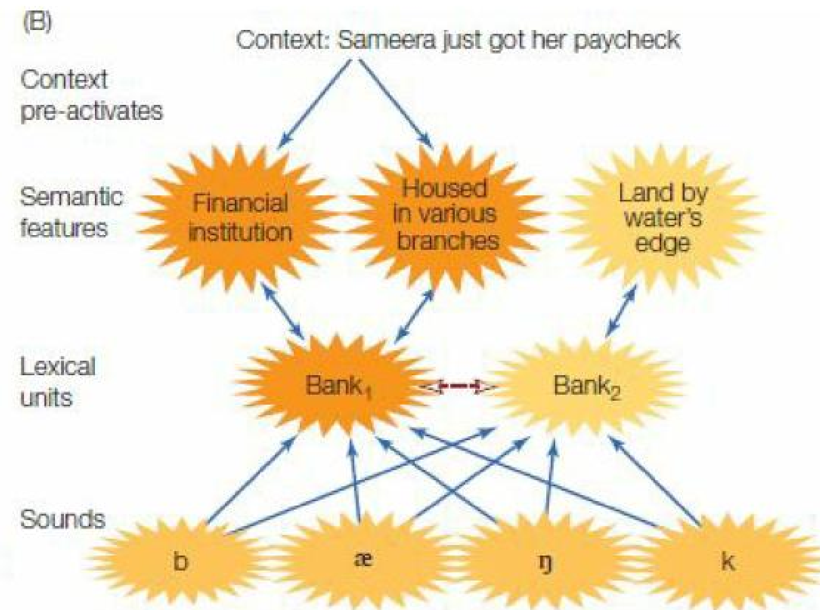
How is it that words manage to make themselves useful after all? In other words, how is it that we ultimately arrive at a single interpretation, despite the numerous possible meanings?

Context

- Bottom-up approach: models that allow links going from the bottom up, e.g., from the sound level to the word level
- Top-down approach: models that allow a bidirectional flow of information between levels

2 ways in which context can help word recognition





1. Flow in one direction only;
2. bottom-up;
3. Contextual information (used by a separate decision mechanism) helps to select the most appropriate meaning.

1. Activation can move from the top semantic level down to lower levels;
2. Context "pre-activate" some semantic features so that one meaning is more active even before the word *bank* was uttered.

- Simultaneous activation of word meanings
  - *Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other bugs in the corner of his room*
  - **crossmodal priming task:** An experimental task involving both spoken and written modalities. Participants typically hear prime words (which are often embedded within full sentences) and then must respond to test words displayed orthographically on a computer screen.

(A)

BIASING CONTEXT

Condition 1: Ambiguous prime
"Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other **bugs** in the corner of his room."

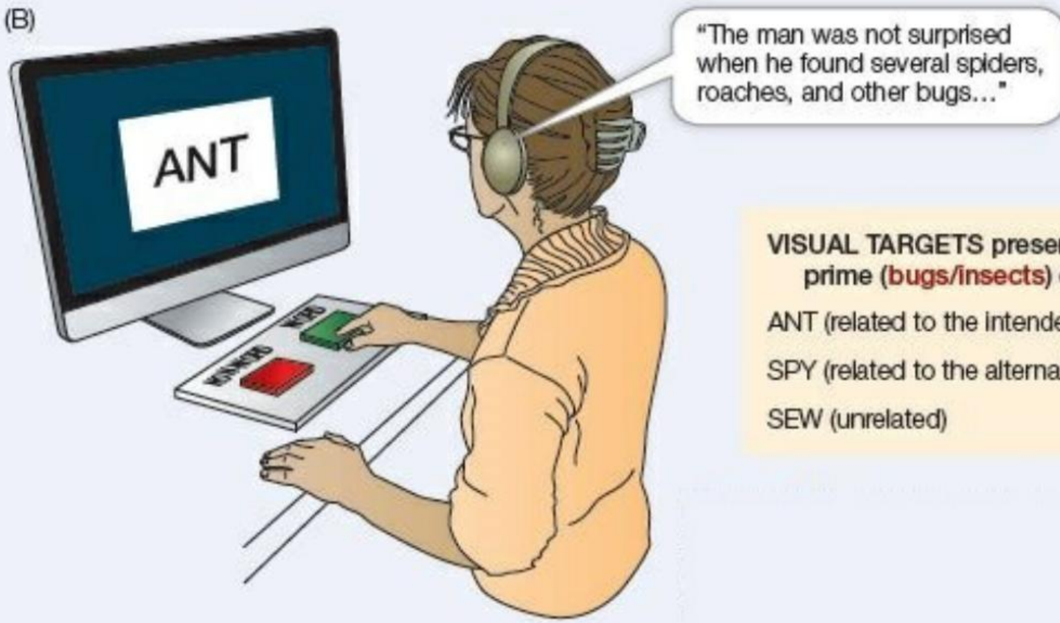
Condition 2: Unambiguous prime
"Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other **insects** in the corner of his room."

NEUTRAL CONTEXT

Condition 3: Ambiguous prime
"Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several **bugs** in the corner of his room."

Condition 4: Unambiguous prime
"Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several **insects** in the corner of his room."

(B)



VISUAL TARGETS presented either immediately after the prime (bugs/insects) or several syllables downstream

ANT (related to the intended meaning of the ambiguous prime)

SPY (related to the alternative, unintended meaning)

SEW (unrelated)

TABLE 8.2 Lexical decision times in milliseconds across all conditions

(A) Visual target presented immediately after prime

Ambiguity condition	**Context condition**	**Target condition**		
		Relevant (*ant*)	**Irrelevant (*spy*)**	**Unrelated (*sew*)**
Ambiguous (*bugs*)	Biasing	708	715	746
	Neutral	703	708	743
Unambiguous (*insects*)	Biasing	710	747	744
	Neutral	702	732	742

(B) Visual target presented several syllables after prime

Ambiguity condition	**Context condition**	**Target condition**		
		Relevant (*ant*)	**Irrelevant (*spy*)**	**Unrelated (*sew*)**
Ambiguous (*bugs*)	Biasing	795	849	848
	Neutral	800	846	845
Unambiguous (*insects*)	Biasing	808	843	849
	Neutral	811	847	846

- Conclusions:
  - Upon hearing ambiguous words, listeners immediately access both meanings of the word, even when the context favors only one;
  - however, the contextually irrelevant meaning is quickly suppressed, so that within a few syllables of the ambiguous word, there is no longer any evidence of increased activation of the irrelevant meaning of the ambiguous word.

3. WORD RECOGNITION MODELS

- Modality-specific issue:
  - word recognition could apply equally well to the spoken or written language modality
  - spoken language unfolds one sound at a time, rather than being uttered all at once, and once it's been uttered, it's gone
  - At what point do people begin matching a string of speech sounds to a stored word representation?
    - For example, when you hear the sequence of sounds /k/, /ae/, and /t/, the word cat will be activated, and also, to a lesser extent, the words cot and can, among others.
    - But when does the activation of possible word representations begin, given that there's a time lag between the first and last sounds of a word?
    - Does the activation of word candidates start even before the end of the word is encountered in the speech stream, or is it delayed until all the sounds of the word have been uttered?
    - And if people do wait until the entire word has been uttered before activating lexical candidates, how do they identify where the end of the word is anyway, given that usually no silences occur between words in running speech?

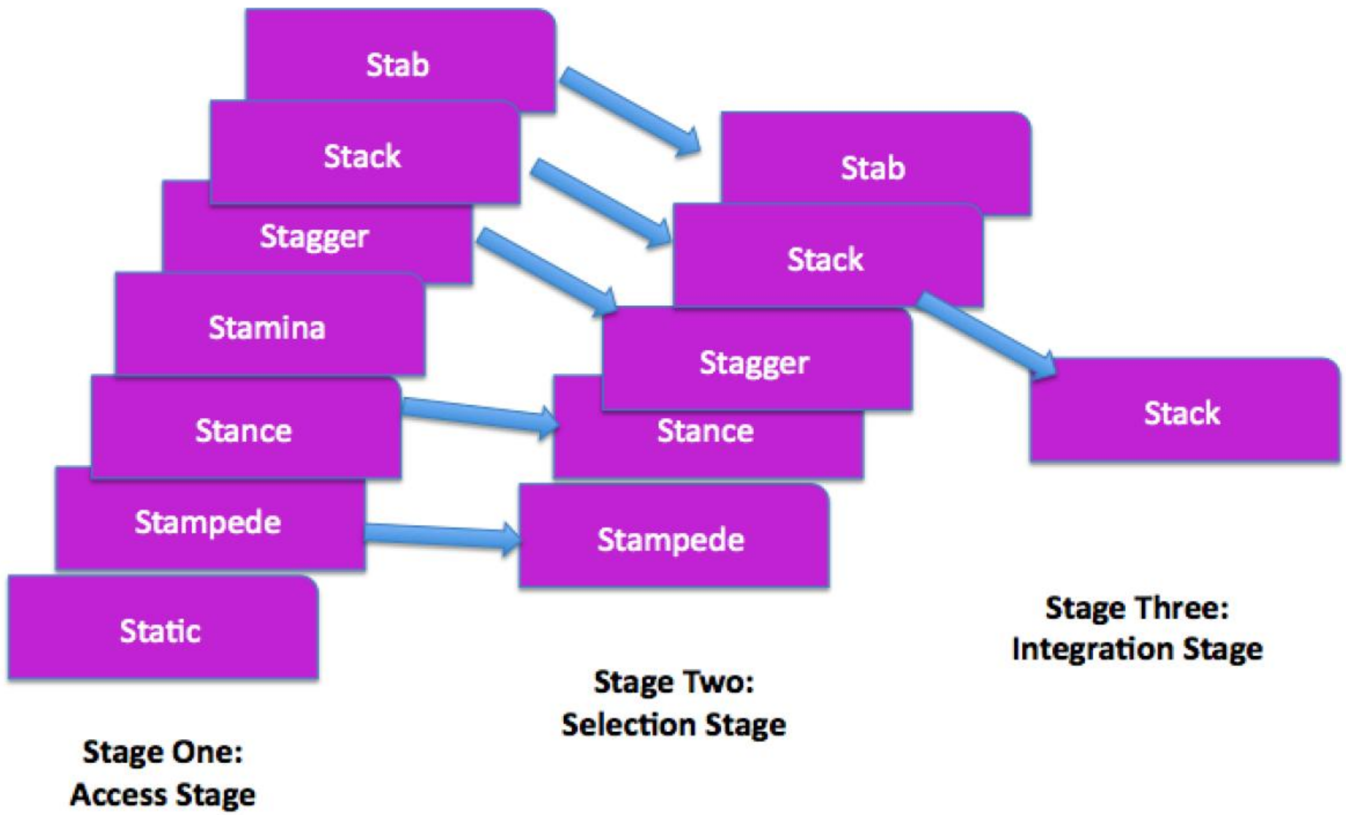
- Evidence of priming (that is, speeded responses) for words like spy and ant meant that both meaning representations for bugs were activated.
- We can use a similar logic now, but instead of giving subjects entire words, we can present partial words and see whether there's any evidence of priming for words that are related to potential matches to partial words.
  - For example, imagine recording a word like con/form, and cutting off the sound file right in the middle of the sound /f/.
  - So, if lexical activation is delayed until the ends of words are identified, we wouldn't expect to see priming for any words that are related to conform
  - if lexical activation is initiated, we'd expect to see priming not only for words related to conform, but also for words conflate, confuse, confine, confide, conflicted, and so on.
  - Such words, with their overlapping onsets, are known as *cohort competitors*

- cohort model（群模型, Marslen-Wilson et al. in the late 1970s)
  - cohort: a group of words that are in a common candidate set during lexical selection
  - lexical activation begins right after the beginning of a word, with multiple cohort competitors sharing the first few phonemes becoming active.

TABLE 8.3 Winnowing down cohort candidates as a word unfolds in time

Initial sounds heard	Cohort candidates
/kæ /	cat, cap, cast, can, cash, cad, camp, cab, cattle, capture, candidate, catholic, candelabra, captain, canteen, castrate, Canada, cancel, castle, canister, captive, candle, cantaloupe, castoff, candy, cannibal, cashew, cantankerous, California, castaway, (many others)
/kæn/	can, candidate, candelabra, canteen, Canada, cancel, canister, candle, cantaloupe, candy, cannibal, cantankerous, (others)
/kæn?/	canister, cannibal
/kæn?s/	canister

Cohort Model



– Word recognition is incremental : humans recognize the word before hearing the whole word

- gating task: As more and more sound input comes in over time as the word unfolds, the set of possible matching candidates dwindles until the *uniqueness point*, at which there remains only one possible match with the sound input.
- lexical decision task: reaction time for non-words is approximately constant from first non-word phoneme (e.g. sthoidik, thouziding)

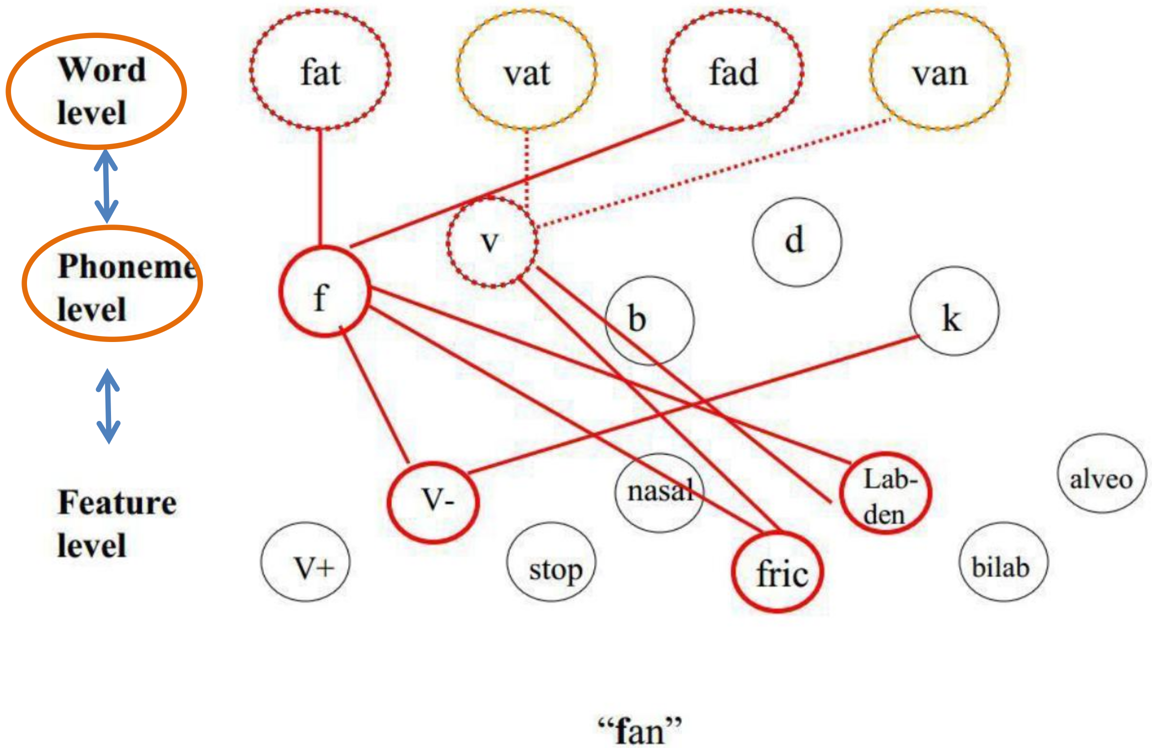
- Word recognition is influenced by context: words can be recognized sooner in context than isolation
  - earlier recognition for words in sentence contexts:
    - I eat fish but don’t enjoy chi-.
    - Did you give the toys to the chi-.
- This is referred as early selection with the interation of bottom-ip and top-down information.
  - activation and compertition: word-initial corhort
  - filtering: context and later input
  - both activation and filtering are parallel processing that do not depend on the size of cohort

- According to cohort model, word recognition occurs in three stages:
  - access: competitors compete for activation and with more auditory input, some competitors are removed
  - selection:only one word remains active out of all the activated competitors
  - integration: the semantic and syntactic properties of the activated word are incoporated into high-level utterance representation

- Problems of cohort model:
  - the emphasize on word onset is potentially problematic (difficult to specify in the speech stream). Mispronounciations/misperceptions won’t activate the correct word
  - frequency effect: after controlling for recognition point, more frequent words are recognized faster than less frequent words
  - Contextually anomalous words
    - “The room is painted a hideous shade of oracle

- Trace model(McClelland et al., 1986)
  - degree of activation or inhibition from units at each of three levels (phonemic feture, phoneme, word) is determined by the resting activation level of word units.
  - features activate phoneme units, and then word units
  - there is not mechanism that determines when a word has been recognized, but if activation reaches threshold, the it is interpreted as activation

TRACE Model



- connections betwee levels are bi-directional and excitatory
- connections within levels are inhibitory producing competition between alternatives

- Evidence for Trace model
  - The TRACE model makes a clear prediction that words whose sounds overlap with the target word in the middles or ends (and not just the onsets) should become activated as well.

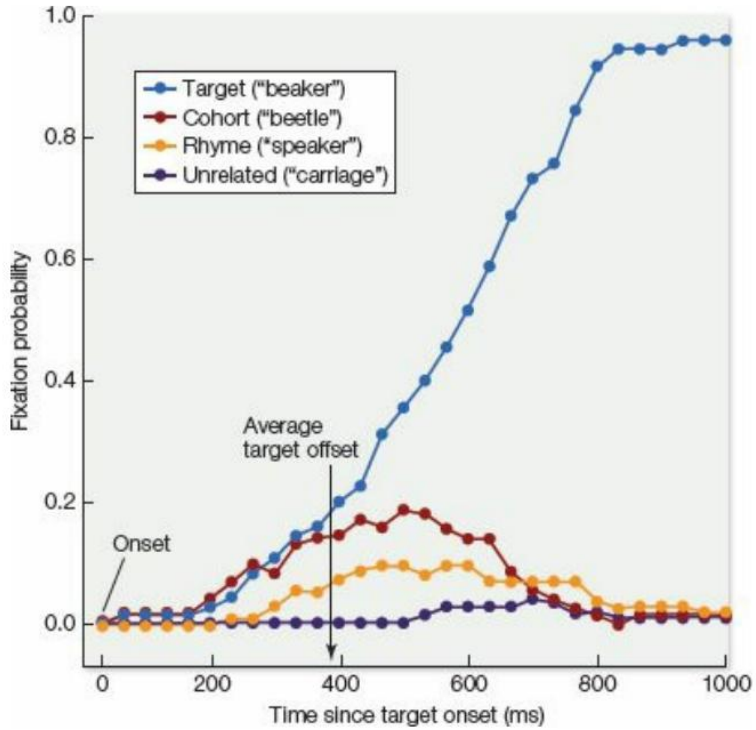


Figure 8.10 Eye movements reveal a "rhyme effect." The graph reflects the subjects' likelihood of looking at the target referent (beaker), its cohort competitor (beetle), its rhyme competitor (speaker), and an unrelated object (carriage). Note that the rhyme effect occurs later than the cohort effect (see Figure 8.7) and is more subtle. (Adapted from Allopenna et al. 1998, *J. Mem. Lang.* 38, 419.)

- Share some similarities with cohort model (word selection over time): preserve the large-scale competition effects that are part of word recognition, without any need for identification of the left edges of words
- can explain some empirical findings, such as Ganong effect
- treats all features as equal
- Lack of invariance
- Duplicated activation

- Written words:
  - both spoken and written language show similar effects of semantic priming and competition.
  - Moreover, there are implications for both spoken and written language of allowing a top-down flow of information within the system, with activation spreading from words to sounds or letters.
  - But just as there are specific challenges that arise for the understanding of spoken words, the same is true for words in their written form.

- Writing system
  - An alphabet is a standardized set of basic written symbols or graphemes (called letters) that represent the phonemes of certain spoken languages.
  - Logogram is a written character that represents a word or morpheme.
  - Syllabary is a set of written symbols that represent the syllables or (more frequently) moras which make up words.
  - Abjad is a writing system in which only consonants are represented, leaving vowel sounds to be inferred by the reader.
  - Abugida is known as alpha-syllabary, pseudo-alphabet, is a segmental writing system in which consonant-vowel sequences are written as units, each unit is based on a consonant letter, and vowel notation is secondary.

- In spoken languages, sounds that have no intrinsic meaning are combined to form larger, meaningful units like morphemes and words. But in logographic writing systems, the smallest units of combination do have intrinsic meaning.